THERE'S A

FUTURE

VISIONS FOR A BETTER WORLD

BBVA

IV. GLOBAL SOCIETY

V. PEOPLE

VI. BBVA: ANTICIPATING THE FUTURE

Possible Futures and the Future We Want

Francisco González

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> "Life is a series of collisions with the future;
> it is not the sum of what we have been, but what we yearn to be."
> José Ortega y Gasset

There's a Future: Visions for a Better World is the fifth book in this annual series that BBVA devotes to disseminating the best knowledge on the greatest topics of our time.

We launched our project in 2008 with *Frontiers of Knowledge,* which explored the recent advances and key challenges faced by scientific research in the eight areas recognized by the Frontiers of Knowledge Awards, presented by the BBVA Foundation.

This book was followed by editions dedicated to *globalization,* a phenomenon that is vital to understanding our times; *innovation,* understood as the greatest factor able to help humanity tackle the huge problems we face and to improve our general quality of life; and *ethics and values,* because the changes our global society is undergoing require a review and reaffirmation of our ethical values in order to guarantee balanced and sustainable development.

Encouraged by how well our books were being received, we created OpenMind (www.bbvaopenmind.com), an online community dedicated to sharing and spreading knowledge. The contents of OpenMind are based on the books we have published so far and on those we will publish in the future. This means our books are now at the fingertips of a much broader and more varied public. These contents are supplemented by material from other authors and readers, both specialist and non-specialist. But

above all, OpenMind is a space to discover, discuss and generate new ideas in an open and multidisciplinary setting. OpenMind is also available as an iPad App — completely free of charge, of course — and in the near future, it will exist in a format suitable for all types of tablets and for mobiles.

Little by little, this project is growing and reaching a larger audience. This fifth book, on the future, enriches it still further.
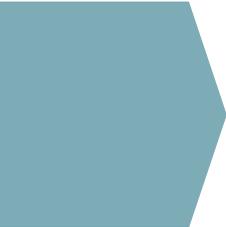
> This book presents a wide range of articles that encompass many different visions of the future [...] It is a multidisciplinary cross-section designed to map out the basic lines along which our reality is changing and in which direction they are taking us [...] We believe that a better future for people is possible, and contributing to that future is the cornerstone of our work

WHY THE FUTURE?

The main reason behind this theme is its coherence with our corporate cultural values, summed up in our vision: *"BBVA, working towards a better future for people."* Clearly, this entails anticipating the future. And to do this, we need to know the past and the present, detecting the trends that are shaping the future every step along the way.

That is why at BBVA we give centre stage to knowledge as a tool for improving the future of people. And ultimately, that is the justification for this project, which seeks to generate and disseminate the best knowledge.

This forward-facing approach, looking further ahead, is present in each of our earlier books. The frontiers of knowledge are mobile: the efforts we make today will broaden our horizon of tomorrow and our ability to manage it. We are interested in globalization because it has a profound effect on our future. The books in this series on innovation and ethics explicitly referred to the twenty-first century perspective in their titles, because both innovation and ethics are key ingredients for a better future.

In some ways, this book represents a necessary synthesis and extension of the previous ones. Through it, we seek to integrate the various elements we are coming to understand: How do they interact with each other? Where are they leading us? And, more importantly, what can we do to ensure that this path, with all its acknowledged risks, leads us to improve people's quality of life in a sustainable way?

This is a very tough task, "it is difficult to make predictions, especially about the future." This famous quote, uttered by renowned physicist Niels Bohr almost a century ago, is — if possible — even truer today. We have known since Heraclitus that "there is nothing permanent

except change," but in our era, the rhythm of change is accelerating. We are living in a period of transformation of unprecedented magnitude and speed. The future seems to be hurtling towards us at full tilt.

For this very reason, if predicting the future is particularly difficult today, preparing for it is also vital and urgent. As Albert Einstein said, "we will have the future we deserve."

This book does not uphold the naïve and dangerous pretension of foretelling "the" future. Instead, we seek to be thought-provoking and to trigger debate over a future that will be the result of various interacting forces and of our own decisions: a future that is shaping itself day by day in its many facets.

That is why this book presents a wide range of articles that encompass many different visions of the future, both in focus and theme. It is a multidisciplinary cross-section designed to map out the basic lines along which our reality is changing and in which direction they are taking us.

Our authors — specialists of the highest order in their various fields — propose "possible futures" that do not necessarily agree with each other. But all these visions have shared characteristics: firstly, analytical rigor and scientific objectivity, presented in a language and framework accessible to the non-specialist reader; secondly, a profoundly optimistic spirit. And when I say optimistic, I do not mean that they paint a Utopian view of the future, free from difficulty; instead, they all partake of the notion that the future is not predetermined — that people — humanity — can influence the future and change it through their actions and decisions. As Peter Drucker said, "the best way to predict the future is to create it." Finally, all our authors share a strong ethical component: they want their work to contribute to creating the best possible future for people, for this generation and for generations to come.

Therefore, all the authors in this book, whatever their theses, share BBVA's fundamental values: we too believe that a better future for people is possible, and contributing to that future is the cornerstone of our work.

Every year, one of the most rewarding aspects of preparing the new book is the contact with the authors: we are privileged to work with people and teams of the highest level, who are keen to understand and know more, who are open to debate and new ideas. Through them, we broaden our knowledge, open our minds and enrich ourselves as human beings. We are extremely proud of the growing band of first-rate authors who have contributed to our project and who have become part of OpenMind, where thanks to the Internet, everyone has access to their ideas and can discuss and share important knowledge.

I would like to take this opportunity to show my appreciation to all of them, particularly to the authors who have contributed to this book, *There's a Future*: a fine group of experts in diverse fields. A number of them — such as professors Sánchez Ron, Tiwari, Mato and Broecker — have collaborated in previous books. Their presence here can only be a sign
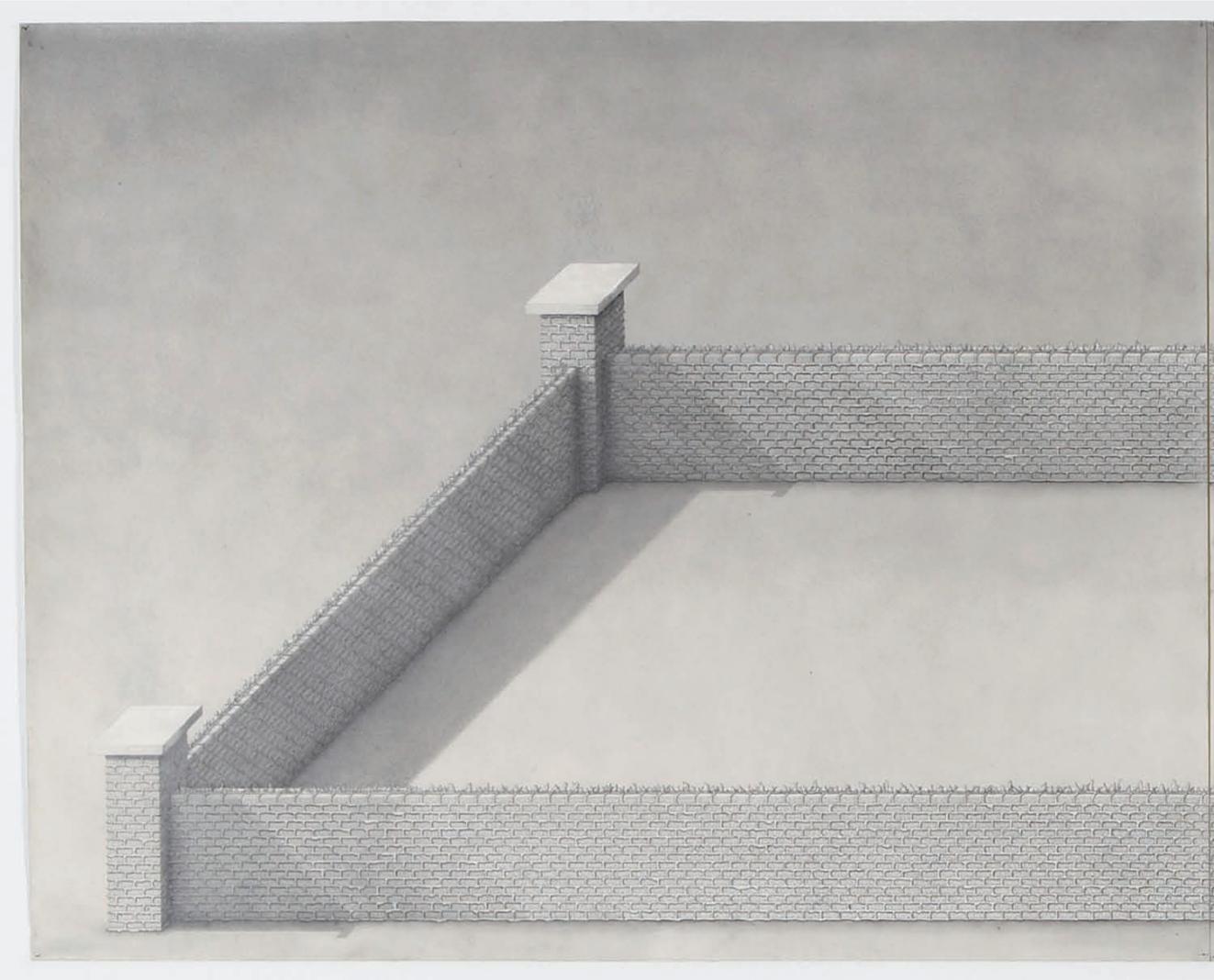
Paul Noble, *Heaven,* 2009

of their valuable support for our project. Others have joined this edition to enrich even further the panorama of ideas and the OpenMind authors. All of them make a valuable contribution to bringing us closer to their vision of the future. Through all these contributions, we hope to present a broader, deeper, more open and suggestive panorama of the challenges that await us in the coming decades and to consider how to frame the answers that will allow us to move towards that better future that together we can and must build.

   In order to cover such a large area, we have divided the book into six parts: the fundamentals of futures studies (the discipline formerly known as Futurology); science and
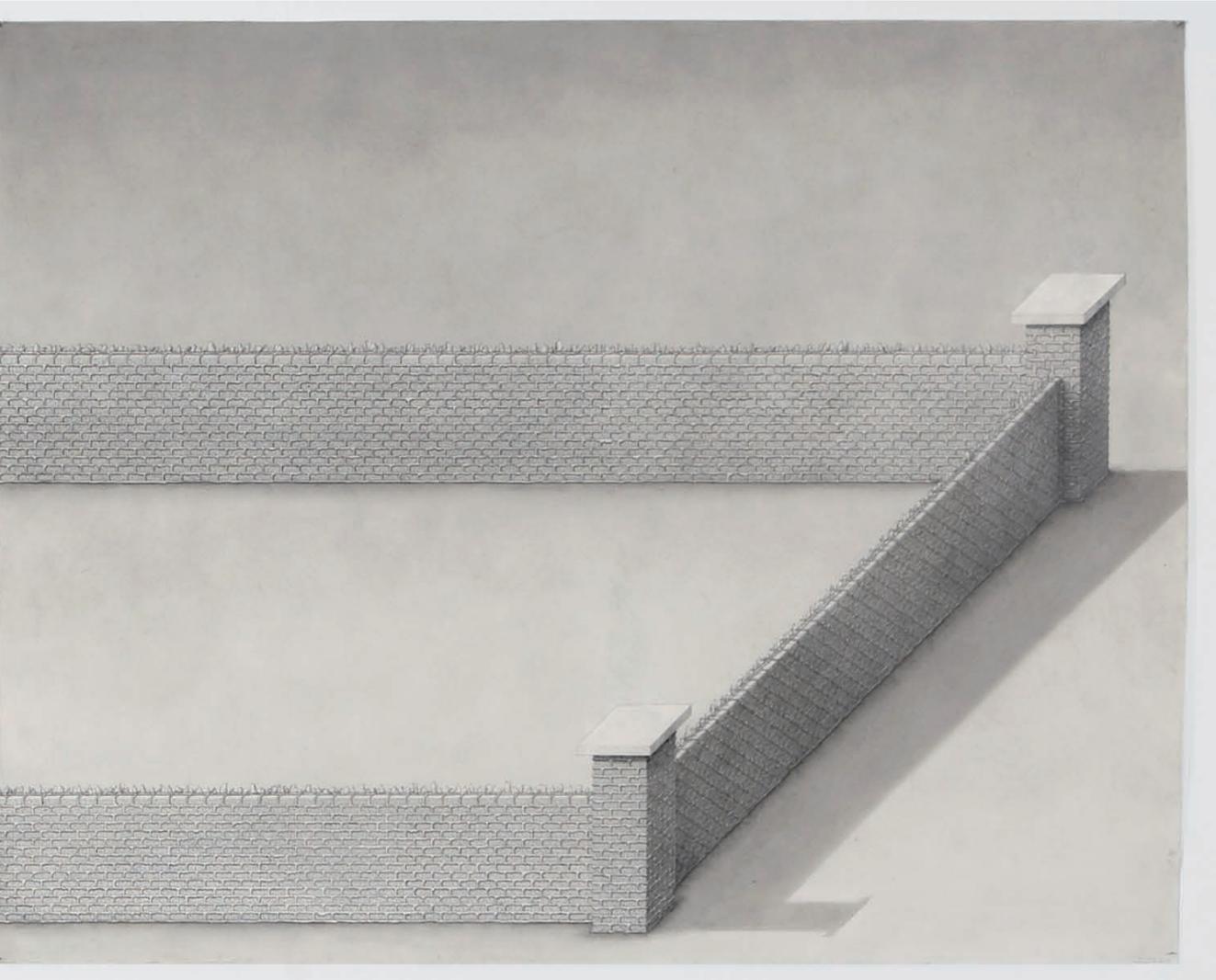
technology; the planet; society; people; and finally, Vision 2020+, a summary of how BBVA sees the coming years and how we are preparing for them.

In the first article, Sohail Inayatullah sets out the rules and basic methods behind futures studies. He examines how the discipline has moved from focusing on "predicting the future" to its current state, in which it strives to design and define alternative futures. The central and most suggestive conclusion he draws is that futures studies have evolved to such an extent that they now not only have the capacity to predict and interpret the future, but they can also play an important part in creating it.

As an example of current methodology, Jerome Glenn gives us the State of the Future Index, drawn up as part of the Millennium Project. Glenn offers us an overview of our future using historical data on key indicators collected globally over the past 30 years. Of course, such a large spectrum of variables throws up mixed results; yet Glenn concludes in a largely optimistic way: overall, in the future the world will be for the most part better than it is today.

The second section of the book is devoted to science and technology, areas with traditionally strong ties to the future in the public imagination. And this is no coincidence: from the very first plough to today's nanotechnology, science has pointed out the door to the future, and technology has been the key to open it.

Touching on this idea, José Manuel Sánchez Ron begins this section by mapping out a panorama of future predictions throughout history in various scientific fields. He reveals how our capacity to make scientific predictions has always been rather unreliable. Conversely, our powers of prediction improve when we enter the realm of technology. By examining the close and extremely complex relationship between science and technology, he concludes that technological prediction plays an important part in determining the future direction of science.

Kevin Warwick then guides us through the future of artificial intelligence and robotics. He pays particular attention to the "fusion" between technology and the human brain. Warwick believes that computerized cerebral interfaces, such as those created by "invasive" brain implants or even external electrodes, could improve human capacities. This issue raises a host of difficult social and ethical problems. We are on the threshold of a great technological leap and many of the ethical questions he raises can only be fully understood once the scientific and technical issues have been solved.

Sandip Tiwari's article provides a fascinating summary of the incredible possibilities of science in the twenty-first century, as well as its hidden pitfalls. Nanotechnology enables us to work at a molecular or even atomic level. The line between human and machine is disappearing at such a speed that Tiwari predicts a time when both will become one. Another key consequence of technological progress is the unimaginable accumulation of data it produces. Tiwari argues that this will lead us to develop a new branch of information sciences and a completely new theory of networks. This in turn will give rise to a collection of intelligent applications he calls "emergent machines." These machines will be almost indistinguishable from humans and "autoreplicants." He also foresees tools that he calls "evolutionary machines" capable of constructing molecules and enabling the production of new types of proteins, parallel to those that form life.

This section concludes with José M. Mato's article on medicine and its predictive capacity. He argues that the hegemony of the genocentric theory over recent years has led molecular biology to develop a deterministic approach that fails to address key questions such as how and why a single genotype gives rise to very diverse phenotypes. He proposes that the enormous amount of data used in genomics masks quality-control problems in some areas of

research. Even though inadequate data management could be addressed with high performance techniques or "omics," scientific rigor is still vital for quality control and the credibility of any research in the eyes of peers or project leaders.

The third section focuses on the environment. Paul Raskin opens the subject with his article on sustainability. He believes that concern for this issue springs from our current "Planetary Phase of Civilization," which marks the beginning of a global society. Ever-increasing levels of human activity and the ecological footprint of humanity have a huge impact on the biosphere. He concludes that we are already entering a high-risk zone. Yet at the same time he tells us that moments of transformation such as this are opportunities to change priorities and to mobilize the enormous potential of this Planetary Phase of Civilization in order to solve global sustainability problems.
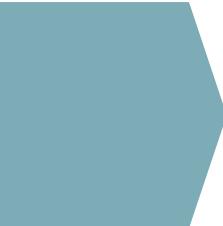
BBVA is preparing to make a big contribution to this global effort involving governments, institutions, companies and civil society all over the world, in line with our vision of working towards a better future for people

Wallace Broecker takes part in our project once again, this time to raise a key question for our future: the impact of global warming on the distribution of rainfall. Using a simulation model based on data from 30 000 years of history, he concludes that great changes are on their way, especially in the arid areas of the earth: the Middle East and the western United States will become even drier, whilst the Nile and China will receive more rain. The Amazon rainforests will gradually move north, leaving vast dry zones in Brazil and Bolivia. These and other changes will have enormous economic, social and political repercussions.

The final article in our section on the planet examines the question of where and how we will live. Mitchell Joachim and Melanie Fessel explore urban design, architecture and environmental planning. They explain how urban design is currently at an impasse; they propose Urbaneering as a viable way forward. Urbaneering is the practice of rethinking all human implications on their surroundings. The design of an urbaneered city incorporates elements such as crowd-sourcing, localized energy, e-government, biotech applications (e.g. for waste management) and high-throughput computation. These technologies will contribute to restructuring all human needs and the very infrastructure of the city.

The fourth section examines the possible evolution of a global society.

Joaquín Vial, Clara Barrabés and Carola Moreno address the effects of the great demographic transformation we are witnessing now. First, they highlight the challenges arising from the heterogeneous nature of this transition: each country or region faces specific impacts.

Key characteristics of this new map are population ageing (and the tensions this generates in developed regions at the end of their demographic transition); the inexorable rise of China in the global context; the growing demands of populations in less developed countries; and regional differences in population growth. These decisive events will take place in a complex environment characterized by climate change and fierce competition for natural resources, which means an increased risk of regional conflict.

Daniel Altman's contribution focuses on growth forecasts for various regions, using conditional convergence theory, which he applies to China. Altman asks himself whether China will be able to sustain its rapid growth rate over the coming decades. He concludes that cultural factors are key to long-term growth and that the influence of Confucianism — although it brings certain benefits in preserving social stability — will become an obstacle. This does not mean that China is condemned to slow growth, but rather that maintaining the current development process will require very deep changes.

Nayef Al-Rodhan addresses the future of international relations. He believes we need to move away from the concept of international relations as a collection of zero-sum games and instead promote a more sustainable new world order, based on what he calls "symbiotic realism." Symbiotic realism focuses on the promotion of human dignity and symbiotic relations between states, based on absolute wins for all parties. It is a broader and more integrated vision of the dimensions and dynamics of our world, extending the concept of global actors to include not only countries but also large collective identities and international organizations (multilateral institutions, NGOs and transnational corporations). Furthermore, it takes into account the specific needs to protect the environment, natural resources and the rights of women.

Any positive focus on changing international relations must be based on a solid and efficient model of international cooperation. This is the issue tackled by Claus Leggewie in his article, in which he recommends redefining our current culture of cooperation. The ability that most distinguishes humans from animals is that of collaboration. Collective objectives, knowledge and shared beliefs lie at the heart of the success of the human race and they should balance the social-Darwinist demands for the survival of the fittest. Leggewie advocates redesigning and strengthening global institutions with this in mind, and he applies his method to analyse the current difficulties experienced by Mediterranean countries.

The fifth section of the book revolves around how people will live in the global society of the future. This question takes us beyond material issues. The great upheavals that are rapidly transforming our lives — whether technological, economic, environmental, ethical, cultural, etc. — are causing many people to reassess their basic priorities. It is this issue of priorities and values that is the real key to the future. In the words of Friedrich Nietzsche, "all sciences must, from now on, prepare the way for the future work of the philosopher: this work being understood to mean that the philosopher has to solve the problem of values and that he has to decide on the hierarchy of values."
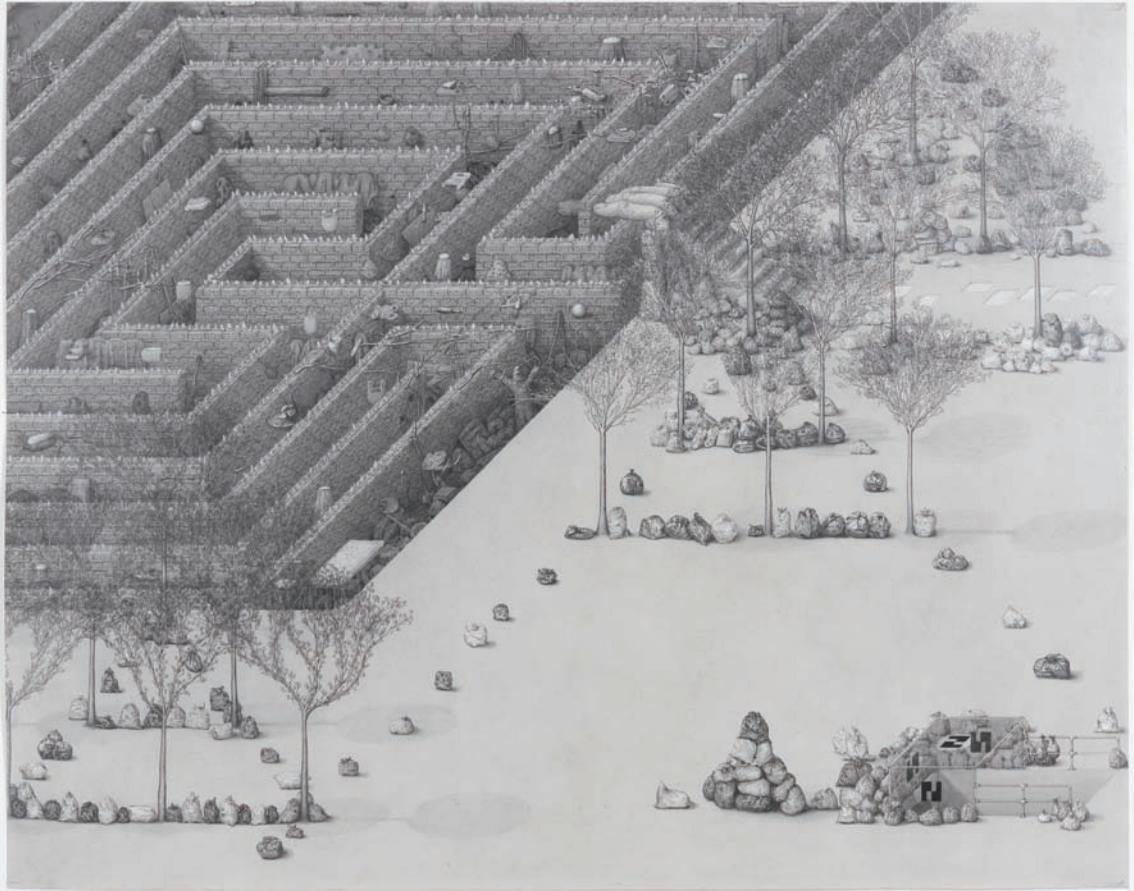
Paul Noble, *Welcome to Nobson,* 2010

Amitai Etzioni opens this section with an article that reviews what has traditionally been described as "the good life" in various civilizations. In general, the acquisition of wealth has taken a secondary role to the search for happiness through spirituality and knowledge. He concludes that none of the "spiritualist" movements — some more ascetic than others — have succeeded in inspiring a sufficiently broad and lasting/sustainable society in our time. Therefore, he believes that instead of seeking to eliminate consumerism, we should focus on finding constructive ways of controlling and channelling it.

In her article, Jennifer Gidley explores the future of education. She believes that current education is antiquated and that if we are to face a context of increasing global and social complexity, education must give people the tools and skills needed to cope with continual adaptation. This means attaching less importance to a predefined body of knowledge and concrete skills, and giving more space to creativity, the imagination and dialogue in a more

holistic and pluralist approach. We should move towards an evolutionist educational focus that prepares us to manage our changing, complex and unpredictable surroundings.

The final article of this section is by Anne Lise Kjaer, who explores how consumer trends will evolve. Her arguments resonate with ideas proposed by Etzioni, as she describes how for many people economic growth has not brought more happiness. At the same time, this constant growth in consumption levels is unsustainable, which is becoming an ethical issue for more and more people. This concern will lead us towards a more sustainable model. New platforms and social networks will enable people to avoid conventional commercial channels. Organizations and companies will find it increasingly difficult to communicate with the public and to gain their trust. Only those who are perceived as transparent and concerned about people and the environment will enjoy success.

In the final section of our book, we present how BBVA sees the future and how we are preparing to participate in it. "Vision 2020+" was written by Beatriz Lara together with the team at our Innovation Centre. The article analyses the most important change factors and trends shaping the future.
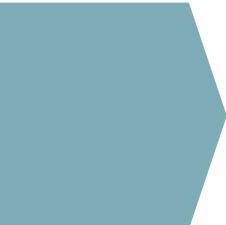
The next few decades will provide a huge opportunity. The world is well equipped to tackle its key challenges. Scientific progress today drives the technological progress of tomorrow, and the proliferation of technological development is the main source of innovation as different ideas are recombined to create new products and services

Three alternative scenarios, or "possible futures," arise from this analysis. The most important conclusion is that the challenges we face are very complex and the risks are serious, yet the best of these three scenarios — named "World in Balance" in the article — is within our reach. But to achieve it, we need to act in a rapid, decisive and coordinated way, involving governments, institutions, companies and civil society all over the world. The article sets out the basic lines of this action and ends with a summary of how BBVA is preparing to make a big contribution to this global effort, in line with our vision of working towards a better future for people.

PAST, PRESENT AND POSSIBLE FUTURES: KEYS TO THE TWENTY-FIRST CENTURY GLOBAL ECONOMY

When we analyse humanity's great challenges for the coming decades, on which the survival of our species and the planet depend, we come to the conclusion that most, though not all, are challenges related to the economy. Essentially, we are striving to bring more prosperity and well-being in a

sustainable way to a greater number of people all over the world (almost 7 billion people today and around 9.3 billion people towards the middle of this century, according to UN forecasts [2011]).

This requires us to solve different yet interrelated problems. We need to reduce the huge inequalities in income and well-being between different parts of the world and between different social classes within countries. We have to tackle the consequences of the demographic revolution: ageing populations in the most developed parts of the world and in certain emerging economies, together with a lack of basic services (health, nutrition, education) for a rapidly growing number of children and young people in the poorest countries. Lastly, and most importantly, we need to find a way to make progress in these areas whilst still preserving natural resources and limiting, or even reversing, the environmental destruction caused by human activity.

These challenges are becoming ever more urgent, but the current economic and financial crisis seems to be placing them further and further out of reach. However, if we look to the past, we find reasons to be optimistic. The work of Angus Maddison (1995), which continues today as the Maddison Project, allows us to observe that global average per capita income has quadrupled in the last century, in spite of huge setbacks in the form of the two world wars and the Great Depression, and despite the five-fold increase in world population. At the same time, worldwide average life expectancy has doubled to reach around 60 years (Acemoglu and Johnson 2007).

It is true that this undeniable progress has come hand in hand with rising inequality throughout this period. Yet the percentage — and the absolute number — of people living in extreme poverty is falling: between 1981 and 2010 it fell by 550 million people, a decrease from 50 percent of world population to around 20 percent, (Glenn, Gordon and Florescu 2011).

Jerome Glenn's article draws up a balance sheet of humanity's progress and regression through the indicators that make up the State of the Future Index. This demonstrates that over the past 30 to 40 years, we have made progress on indicators related to increasing income and reducing poverty; improving health, education and gender equality; and reducing war. But we are moving backwards on issues as important as income inequality, environmental destruction and the risk of terrorism.

To sum up in a very simplified way, we could say that the world is becoming a more efficient and productive place, able to generate more wealth and well-being for people. It also offers people better health and education, longer life expectancy and more opportunities. In some ways, it is more peaceful and stable, with fewer wars.

These are no small achievements; they are sustained improvements of considerable scope. Without doubt, the world is now a better place to live in that it was 100 or even 30 years ago.

However, we cannot rest on our laurels, precisely because the indicators in which we are making no progress or in which we are actually going backwards are key to the sustainability of these achievements. We are making economic progress at the expense of growing environmental destruction, with an unending increase in greenhouse gas emissions and high

consumption of finite energy and other resources. All of this compromises our ability to keep growing and generating wealth. Rising income inequality and increased terrorism point to potential political and social instability. We must also factor in the growing unemployment and global debt arising from the economic crisis.

This is what has happened in the recent past. But to turn our gaze to the future, we need to understand which factors are driving these trends and how they interact.

I think we can group these factors into three, closely interrelated themes: technological revolution, globalization, and the spread of democracy and individual rights.

We are witnessing what must be the biggest and fastest technological revolution humanity has ever seen. It revolves around two basic areas: information and telecommunications, and health and medicine. The latter is largely responsible for the increase in life expectancy and the conditions that foster this. But above all, it is a source of great prospects for improvement over the coming decades.

The information technologies revolution is possibly the biggest factor shaping our times, and not just because of its intrinsic ability to generate wealth in the sectors and industries directly related to it. It also facilitates and magnifies all human activity. The information revolution lies behind our exponential increase in capacity, and it has exponentially reduced the cost of storing, distributing and processing information in order to generate knowledge. It is hard to overestimate the importance of this, as it represents a tremendously powerful motor for development and the dissemination of scientific research in all fields, technological applications, company management and education. This has transformed the daily life of people all over the world: not just how we work but also how we interact and how we relax. The transformation is set to continue at high speed.

In short, the information technologies revolution is multiplying the human capacity to generate knowledge, to make new things, to tackle new problems and therefore, it is expanding innovation and productivity in all human activity.

The technological revolution has also facilitated the development and impact of other important factors that shape our times: the globalization and spread of democracy and human rights.

This current wave of globalization may have begun in the 1950s before the information revolution, but it has been greatly strengthened by it. Globalization is a very complex phenomenon that impacts many aspects of human activity (not just economic, but also social, political and cultural). We have already dedicated a book to these issues (the second of our series). But perhaps the single most influential event to mark global evolution over the last decades has been the creation of a much more integrated global market, accompanied by exponential growth in international commercial and financial flows. For example, according to IMF statistics, international trade has grown from representing less than 10 percent of global

GDP in the 1950s to around 50 percent now. Direct investment has grown even more rapidly, particularly international financial operations that today amount to several times global GDP. This has been a strong factor behind the increase in global economic efficiency and global growth potential — a consequence, at least in principle, of better resource allocation.

At the same time, globalization has paved the way for new economic powers to enter the global scene, mostly in Asia, but also in Latin America. These powers have boosted growth and made a decisive contribution to reducing world poverty. In this book, Vial, Barrabés and Moreno cite data showing that in the period 1960 to 2000, emerging countries represented 25 percent of global growth (compared to the 70 percent of developed countries). In the period 2000 to 2030, these same countries will make up two thirds of global growth (compared to one third in developed countries). BBVA Research has identified the most important emerging countries in terms of size and growth potential. These countries are known as EAGLEs: Emerging and Growth-Leading Economies. Ten countries belong to this group: Brazil, China, Korea, India, Indonesia, Mexico, Russia, Taiwan and Turkey. They will represent half of global growth in the next 10 years, completely transforming the global economic and geopolitical map.

The last determining factor I would like to highlight behind the revolution of global society and the global economy of recent decades is the expansion of democracy and human rights. Never before has such a large proportion of the world population been able to choose its leaders and decide on the policies these leaders put into place. According to the most rigorous historical indexes on global democratization (Polity IV and Freedom House, both uncannily similar in their results), global democracy has leapt forward since the Second World War, and particularly since the 1980s. These indexes run from 0 to 1, with 0 representing a complete absence of democracy. After the Second World War, the indexes stood at 0.2, rising to 0.3–0.4 in the 1970s. At the start of the twenty-first century, they registered 0.6–0.7 (data from Acemoglu 2013). This means democracy has moved from being a minority regime at global level, to being the predominant form of government. At the same time, most countries with authoritarian or semi-authoritarian regimes now grant their people greater margins of freedom than in the past. Moreover, this progress has not been restricted to entire populations within each country or society. There has also been a big improvement in minority rights (ethnic, religious, sexual, etc.) and most notably, an improvement in women's rights, generating a huge positive impact on society and the economy.

Of course, this progress has not been smooth and linear; still today it is partial and incomplete. Even if we leave aside the fact that the quality and depth of democracy in many theoretically democratic countries is far from perfect, it is clear that large areas of the globe — including countries like China, the most densely populated and economically dynamic country today — live under non-democratic governments.

Nonetheless, the expansion of democracy and political, social and civil rights over the past decades has been unprecedented in human history. Furthermore, it has helped direct the impact of globalization and the technological revolution towards increasing well-being for all world citizens.

Why is this the case? In principle, the most common and conventional causal link in social sciences runs from technology to institutions. In general, history supports the notion that technological progress and economic prosperity foster democracy and the growth of individual rights. However, the opposite point of view also has a strong and venerable tradition, stretching back to Adam Smith himself. This argument states that institutions (whether political, legislative or social) and at a deeper level, the cultural traits of a society, define the nature, rhythm and spread of technological change and therefore, of economic growth.
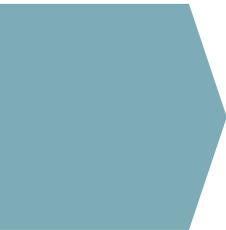
> **There must be organizational and cultural transformation that enables banks to build a reputation of transparency with their customers, responding to their needs with efficiency, agility and flexibility, and striving to make a positive contribution to solving social problems**

The latter argument enjoyed a comeback in twentieth-century economic theory with the institutionalist school founded by Thorstein Veblen (1898), in opposition to dominant neoclassical thought. More recently, "neoinstitutionalist" perspectives have received a definitive boost through the Nobel Prizes awarded to Ronald Coase in 1991, Douglass North in 1993 and Oliver Williamson (disciple of Coase) in 2009. Coase's 1960 article, "The Problem of Social Cost," is said to be the most cited article in the history of economic literature, while North's work *Institutions, Institutional Change and Economic Performance* captures the essential thinking behind this movement. Recently, followers of this school of thought, albeit with different focuses, have been making waves. Among them is Niall Ferguson, who attributes differential development and the political domination of western economies in the Modern Age to six "killer apps" that the rest of the world is missing: free competition, science, the rule of law, medicine, consumerism and the work ethic (Ferguson 2011). Through their widely published works, Acemoglu and Robinson (2012), together with one of the authors of this book, Daniel Altman (2011), have all made significant contributions to stimulating interest in the role of institutional and cultural factors in medium- and long-term growth.

The theoretical or academic "renaissance" of the role of institutions has been endorsed by the practice of multilateral institutions such as the IMF, the OECD and the World Bank. These

bodies systematically link the success of development programmes to policies of institutional reform.

The main argument behind recovering the value of institutions is summed up magnificently by Douglass North: "If we know the sources of plenty, why don't poor countries simply adopt policies that make for plenty? […] We must create incentives for people to invest in more efficient technology, increase their skills and organize efficient markets. Such incentives are embodied in institutions" (North 1995).

In short, the spread and rhythm of technological progress, and the relevance of its innovations, depend on whether the judicial-institutional-cultural system provides the opportunities and right incentives for the largest number of people and organizations within each society.

Growth and development therefore require a cultural-institutional framework that guarantees reasonable rights for creators and innovators, and that rewards the initiative shown by entrepreneurs. At the same time, it must extend opportunities to as many citizens as possible, creating a level playing field for competition, one that is free from barriers to entry for all activities, businesses and jobs. It should also provide basic services and infrastructure to allow all citizens to achieve their potential and participate in productive activities.

These societal characteristics have usually been associated with a pluralistic and participative political system, in which no single person or group can exercise unlimited power in their own interest. Of equal importance is a legal system that guarantees fairness and the legitimate rights of all.

This type of institution, which Acemoglu and Robinson have called "inclusive" as opposed to "extractive" institutions, has shown itself to be better equipped to foster growth and well-being for everyone.

To counter this theory of the positive effect of democracy on economic development, we could take the case of China, a non-democratic country that has enjoyed tremendous economic growth over the past three decades.

However, other historical examples could be given to argue against the case for China, the most recent and directly applicable being the Soviet Union. The USSR's extraordinary growth between the 1930s and the 1970s can be explained as a technological catch-up that came from more advanced countries, driven by the large-scale forced transfer of resources from agriculture to industry. This development model collapsed when the forced industrialization reached its limits, limits that could not be pushed back through technological progress and innovation because the right culture, incentives and controls were not in place.

Altman's article in this book suggests that China could go down a similar route, even though the country could enjoy more prolonged growth and a less abrupt ending thanks to the very nature of this particular technological revolution. On the other hand, the information revolution

is an increasing threat to the existence of "non inclusive" institutions, in a context of better-informed citizens who find it easier to form associations and coordinate their actions through the Internet. Herein may lie the greatest hope technology can bring for the future of China and of the world.

Given our recent trajectory, the next few decades will provide a huge opportunity. The world is well equipped to tackle its key challenges. Scientific progress today drives the technological progress of tomorrow, and the proliferation of technological development is the main source of innovation as different ideas are recombined to create new products and services. With an "inclusive," open and free environment, the next few decades could see unprecedented wealth creation. This wave of prosperity could be generated so as to include regions such as Africa and sectors of society that have thus far been excluded. We can eliminate poverty and improve income distribution. And we can do it in a way that is fair for future generations, i.e. respecting the environment and biodiversity, preserving finite natural resources, and fighting global warming.

Yet this is no easy task. Success is far from guaranteed. First, we are working against the clock. Population growth and economic development are leading to increasing environmental threats and pressure on natural resources that at a certain point could become irreversible. We are lagging behind the schedules set for controlling greenhouse gas emissions, and there is no hope this situation will improve in the near future.

Finally, the most fundamental of all our problems is that our institutional-cultural system has not kept pace with technology. Our societies have not adapted their values, governance structures and regulations sufficiently. Indeed, most citizens have not adjusted their values and attitudes to reflect the demands of the new global context that technology has created.

The depth, speed and scale of technological change and the new horizons opened up by these changes in all areas (economic, social or cultural) strike at the heart of deeply rooted institutions, activities, habits and certainties. The ensuing process of adaptation generates uncertainties and conflicts at both political and social levels, pitting countries and social sectors against each other as they adopt different visions and attitudes to the change, right down to the level of the individual.

Therefore, the divisions between groups begin to widen. These gaps form for a variety of reasons: the adoption of new technologies, differing levels of income, secular groups and individuals against their religious counterparts, etc.

This diversity makes it hard to set global objectives and strategies to tackle global problems. As Zizek (2004) explains, the first world's exclusive focus on ecological crisis, racism and intolerance seems cynical in the face of the extreme poverty, hunger and violence in the third world. Conversely, any attempt to cast first-world concerns as trivial, compared to the catastrophic "real" problems of the third world, is but a form of escapism in the face of certain threats to our shared destiny.
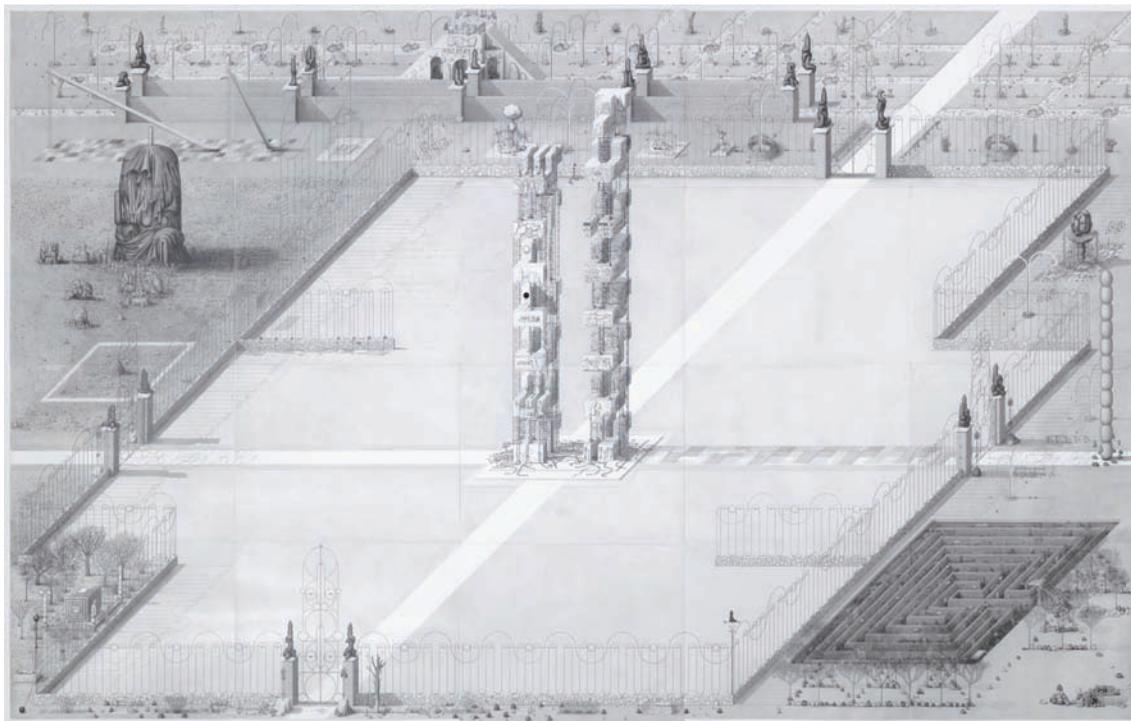
Paul Noble, *Welcome to Nobson* (detail), 2010

In any case, such marked divisions foster defensive reactions that seek to "protect" (isolate) groups as a function of their nationality, race, creed or other criteria, in many cases under authoritarian regimes. This can give rise to environments that are unfavourable or even explicitly opposed to international cooperation, the diffusion of knowledge, and innovation.

This situation becomes even more complex and takes on new features in the context of the information revolution. The open, anonymous character of the Internet and the constant extreme difficulty associated with protecting data and communication properly gives terrorists many more opportunities, whether they are organized groups or fanatic individuals. Terrorism is becoming a greater risk than traditional armed conflicts.

Ultimately, if we are to achieve that better future — the one technology makes possible — we must demand global conditions of freedom and human rights, free initiative, education and the sharing of knowledge.

At the same time, we need to reinforce the mechanisms of global governance to make sure that all legitimate interests all over the world are represented and that they can agree on and implement sufficiently ambitious programmes to tackle our shared problems. This runs from the

basic coordination of economic policy, to projects that foster medium- and long-term development in the most disadvantaged areas, and efforts to tackle big environmental issues.

But governments alone cannot achieve all this. It requires cooperation from everyone, in many different fields: companies, NGOs and citizens, both individually and through their many formations in civil society. In such an interconnected world with information flowing freely and instantly, these complex collaborative connections can form faster and more concretely than ever before.

Similarly, an even greater role is given to all kinds of people and organizations who set examples and stimulate others: people who promote and implement initiatives to improve aspects of other people's lives. They become leaders of change; some may join their initiatives, while many others will learn from their efforts. They also have a very important medium-term impact: influencing the conscience of large segments of the population.

Change needs more leaders, supported by a growing number of people who are increasingly interconnected, better informed and more aware of the importance of human rights and collaboration to reach common goals. We need a cultural and ethical shift to adapt our values and institutions so that we can make the best of all the opportunities that scientific and technological progress offer.

THE FINANCIAL SYSTEM: NECESSARY INSTITUTIONAL REFORM

The financial industry lies at the heart of the economic system and is key to moving towards a better future. In particular, banks are necessary tools that enable millions and millions of companies and families all over the world to have more opportunities and increase their quality of life, by financing their investments, helping them buy homes and offering the right products for their savings. That is why banks are extremely powerful levers of economic development and social stability. There is a large body of evidence to support the positive causal relationship between increased bank credit and growth. The recent economic crisis has revealed this relationship once again, but in a negative way. Serious problems in banks in many countries are in large part responsible for decreased growth.

But beyond our current situation, the crisis has revealed very serious problems in the functioning of the international financial system. Undoubtedly, there have been errors on the part of regulators and supervisors, but also very grave mistakes in many large and small financial institutions in various countries. These mistakes can be put down to carelessness, or in many cases, to the flagrant breach of basic banking practice: prudence, transparency, and integrity. The public image of banks has been greatly tarnished by the perception that they are "to blame" for the crisis, together with the latter's enormous costs in terms of public resources,

growth and employment. Banks have lost most of the trust placed in them by their customers and society. This is clearly negative for banking institutions, but it is also negative for global well-being. A solvent financial system that works efficiently is fundamental to sustainable growth.

We need to transform the financial industry, and the crisis itself represents a trigger to accelerate this process. Change is already underway: unstoppable change with far-reaching consequences because the factors behind this change are unstoppable and far-reaching: technological progress and the economic and social transformation it is driving will change people's habits and behaviour. All companies will have to cope with changes in their clientele, but these changes will be more strongly felt in the service industries where the informative and virtual — as opposed to physical — element is really important (Miles 2000).

This is particularly the case for the financial industry and for banks, as their basic goods are information and money. And money is dematerialising into accounting records, i.e. into information that can be stored, processed and transmitted in real time at costs so low as to approach zero.

However, banking has not yet undergone a transformation comparable to that seen in other information-based sectors such as music or entertainment.

This is partly because banking is a highly regulated sector with heavy intervention from public bodies. It is also because the exceptionally good economic and monetary environment in the years leading up to the crisis drove the business and profits, in spite of relatively high levels of inefficiency throughout the industry.

But the technological revolution is underway and its impact is increasingly broad and deep. Plus, the current crisis is pushing change along several different lines. It has unleashed a process of change in banking regulation and supervision. On the one hand, it is putting in place the mechanisms needed to adapt these areas to a more global arena; this will inevitably result in fewer differences between each national or regional market. On the other hand, reform is underway of the prudential mechanisms: there are more demanding capital and liquidity requirements, caps on debt, better consumer protection, heavy investment in risk control systems, compliance, etc. This all means lower profitability — not just during the crisis but also in the future — but it also facilitates access to a broader, more homogeneous market.

In summary, banks must respond to new demands from customers and from a society that is better informed and more exigent. They must also achieve this in a climate that is adverse in terms of reputation and profitability.

That is why transformation must deliver not only a qualitative increase in efficiency but also a profound review of the way in which banks interact with their customers.

Efficiency gains could in part be found in a drastic consolidation, something that is already underway. But true change will spring from a sustained process of innovation through the

intensive — and intelligent — use of technology. Hand in hand with the technological transformation, there must be organizational and cultural transformation that enables banks to build a reputation of transparency with their customers, responding to their needs with efficiency, agility and flexibility, and striving to make a positive contribution to solving social problems.

The industry will be much more competitive than in the past, and it will offer huge opportunities if between us all we manage to harness the enormous possibilities of technology to build a more efficient, stronger and more sustainable global financial system; one that is able to generate more opportunities and greater well-being for all its citizens.

BBVA, A LEADER OF THE FINANCIAL INDUSTRY OF THE FUTURE

Any process of change requires leaders to set an example. BBVA aspires to become a leader in the transformation of the financial industry in the twenty-first century.

At BBVA, we believe we are in a good position to lead this change. We are a strong, diversified and global financial group. And long before the crisis, for more than a decade, we have been working on building a new business model that anticipates the future.

Our aspirations and the nature of our project are summed up in our vision: "BBVA, working towards a better future for people."

Fundamentally, this means one thing: at BBVA we are optimists; we view the future with ambition. We believe that human beings can and must solve the challenges of our time to build a better future. A better future for people is a better future for BBVA. And BBVA can and must make a big contribution to achieving it.

Our project is based on three pillars: principles, people and innovation.

Of these three pillars, principles are the key. At BBVA we like to remind ourselves that we work in accordance with the premise that ethics are not only desirable but also profitable. Advocating a culture of prudence, transparency and integrity at all costs often means sacrificing easy short-term gains. But this is the only way to ensure the sustainability of our project in the medium and long term. Thanks to these principles, BBVA has avoided many of the errors made by our peers, and during the crisis we have strengthened our position with respect to the global industry. Yet principles do not merely help avoid mistakes; they are vital to our relationship with people, our second pillar.

Our business model is founded on establishing stable, long-term relationships of trust with our customers, who are at the centre of all our activity. And naturally, we strive to form similar relationships with our partners, our shareholders, our regulators and supervisors, and with the citizens of the countries in which we operate. In short, with people. This trust can

only be won and maintained through constantly ethical behaviour, which includes always seeking to provide the best solutions for their needs in a flexible and convenient way, and at the best price.

The key to achieving this lies in our third pillar: innovation. A sustained innovation effort is needed to create a new model for producing and distributing services that really does set us apart: completely focused on the customer, more efficient, flexible, simple and convenient. This means innovation not only in terms of technology, but also in organization and culture.

In my foreword to the third book of this series, I had the opportunity to comment on our innovation model (González 2011). In this edition, Beatriz Lara briefly describes our innovation method, some of the areas we are working in, and a few of our projects and accomplishments. I will therefore dedicate a few brief lines to setting out the more conceptual aspects of innovation at BBVA.

Our innovation focus takes knowledge as its starting point. If we want to offer the best solutions to the present and future needs of our customers, we first need to understand them very well. BBVA, like all banks, has a huge amount of information on its customers. The big challenge lies in turning this information into useful knowledge to design products that better satisfy their needs, to set the right price for their circumstances and to identify the best distribution channels. That is why at BBVA we are pioneers of data mining and the construction of intelligent algorithms that anticipate customer demand.

At the same time, here at BBVA we are addressing how to implement a profound transformation of our distribution network. BBVA is one of the most efficient banks in the world, but we want to go much further than that. We are moving towards a distribution model that supersedes the multi-channel approach. We are building a platform that is both physical and virtual, one continuous and unbroken space that customers can access as they wish. In other words, whichever channel they choose, they will be able to move seamlessly between it and other channels, enjoying the best functionalities and products that BBVA can offer.

This platform will form the basis of a concept far-removed from that of a bank: a company that of course offers a wide range of financial products and services, but that also provides other services based on information and knowledge, incorporating contributions from users themselves and maximizing the potential of social networks. Moreover, all this will be achieved thanks to the growing functionalities of mobile phones, and in the future, of many other devices, as well as the possibilities of very cheap universal access to information that the cloud offers our customers.

At BBVA we want to leverage the potential of our model in markets that offer great growth opportunities. Which is why we are not only leaders in Mexico and the whole of Latin America, we are also building a solid franchise in the US — the biggest market in the world with the greatest growth potential of all developed countries. And we are also firmly present in China and Turkey. All of these markets are going to see the greatest share of global growth over the

coming decades, plus they still have a very high percentage of the population who do not have access to financial services, which multiplies our potential for growth.

The technologically advanced and highly efficient BBVA project represents an important competitive advantage for customers in developed countries (who are sophisticated and intensive users of technology). But it is also particularly well equipped to develop flexible, simple models at low cost, facilitating access to financial services for large segments of the population (as we have already done in Latin America). It is suited to tackling key markets where BBVA has no current physical presence.

Without a doubt, the biggest contribution BBVA can make to a better future for people is through its daily activity. But at the same time, BBVA carries out a large amount of corporate social responsibility work, which we see as another way to contribute towards developing and improving the societies in which we operate. BBVA devotes over 70 million euros a year to this effort (74 million euros in 2011, which represented almost 2.5 percent of our attributable profit).

This work focuses on areas we think are the most powerful levers for opening up opportunities for people and helping them improve their future: financial inclusion, the generation and dissemination of knowledge, and education. And in 2011, we added advocating social entrepreneurship to the list.

Supporting financial inclusion is BBVA's response to the fact that fewer than 1 billion people are currently customers of a bank. Consequently, there are around 2.5 billion adults who are excluded from basic financial products and services, who are therefore excluded from the chance to better their circumstances, or are subject to usury.

The conventional banking model cannot provide even the most basic financial products and services at an accessible price for global citizens with low incomes, many of whom live in remote areas.

As I have mentioned, through its banking activity, BBVA is developing and applying lighter and cheaper schemes based on mobiles, cards or agents for lower income segments of the population. Through these schemes, BBVA has acquired 2 million customers in Mexico and 1 million in the rest of Latin America.

Furthermore, in order to help more disadvantaged people, BBVA created the BBVA Microfinance Foundation in 2007. This non-profit institution was endowed with 200 million euros in order to support the development of microfinance.

The Foundation currently operates in Latin America, although it may be rolled out to other regions in the future, and it has two fields of activity. The first is creating a network of microfinance institutions in the region. The second is developing initiatives that contribute to transforming the microfinance sector. All of this is done in a philanthropic way, open to the whole sector.

The Foundation's strategy consists in acquiring controlling stakes in microfinance institutions that are leaders in their field, enjoy a good reputation and have a good track record. The Foundation brings capital and resources to define their solvency and facilitate their expansion, as well as know-how to improve their corporate governance, management, risk control, the creation and implementation of new products and services, and the development of human capital. This process is fuelled by the synergies of the network set up in order to share best practices.
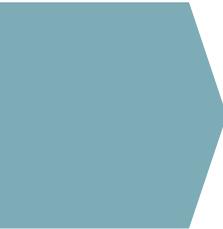
> **At BBVA we are optimists; we view the future with ambition. We believe that human beings can and must solve the challenges of our time to build a better future. A better future for people is a better future for BBVA. And BBVA can and must make a big contribution to achieving it**

At the close of 2011, the Foundation was operating in six countries (Chile, Peru, Colombia, Puerto Rico, Argentina and Panama) via eight institutions. It attended 1 million customers — which represents almost 4 million beneficiaries — through a network of 359 offices. Since it was launched, it has granted 2.5 billion euros in credit, with an average of just over 1 000 euros per credit. Most credits have been awarded to small entrepreneurs, of whom 60 percent are women.

The Foundation also carries out important disinterested initiatives to improve the microfinance sector in tandem with universities, multilateral organizations such as the Inter-American Development Bank and the World Bank, as well as with national public-development bodies.

Of all these initiatives, I would like to highlight the specialist training programmes; the creation of a Universal Corporate Government Code for Microfinance Institutions, accompanied by a guide on how to apply it; the training given to members of the executive boards of these institutions; and public-private partnerships such as the one signed in Panama for developing and improving the management of microfinance in the country.

The BBVA Microfinance Foundation is now the biggest microfinance network in Latin America, and it is still growing: at the time of writing this foreword, the Foundation announced its entry into the Dominican Republic — its seventh country — through the acquisition of 31 percent of ADOPEM. As well as providing opportunities to improve well-being and the quality of life for millions of people, it also offers disinterested support for the development of microfinance throughout the region. This carries a consequent multiplier effect on its impact on all disadvantaged consumers and on social and economic development.

The newest string to BBVA's bow of corporate social responsibility is social entrepreneurship, an incipient form of organization that combines the culture of companies with conventional assistance networks. It seeks to generate economic profits that can be reinvested, thereby guaranteeing the sustainability and scalability of the initiative, with the resulting social benefits. In short, it means putting the best practices of entrepreneurial excellence at the service of the common good.

There are a growing number of social entrepreneurs, pioneers of profound change who advocate market solutions to the problems of all. These are generally small-scale initiatives in developing countries: a small effort in the face of giant global problems. But they are also a very powerful force for change and they can play an important role in redirecting our world towards a better future.

The work of the BBVA Microfinance Foundation has much in common with social entrepreneurship. And since 2011, BBVA has offered specific support programmes for social entrepreneurs.

In 2011, BBVA created an investment vehicle for this type of initiative, endowed with 3 million euros. At the same time, we launched the "Momentum Project" to evaluate and support projects of this kind. The first edition of the "Momentum Project" focused on Spain and ended up supporting ten projects (and financing seven). In 2012, the initiative was expanded to Mexico and Peru, and a programme of courses and workshops for young entrepreneurs was run throughout Latin America, with ambitious plans to expand over the next few years.

Without a doubt, education is the most powerful tool for increasing people's opportunities and helping them access higher levels of well-being and quality of life. Education programmes account for over half the resources BBVA devotes to corporate responsibility. In this field, we focus on financial education, for two reasons: first, because this is the field we know best and it is where we can make the biggest contribution; secondly, because financial education is a key way for people to broaden their horizon of possibilities and to improve their quality of life in the medium and long term.

In this context, BBVA has developed the Global Financial Education Plan. The plan includes the "Future Values" programme, aimed at schoolchildren in Spain and Portugal. In the 2011–2012 biennium, the programme reached over 650 000 beneficiaries in 3 500 schools in Spain, and 105 000 students in 800 centres in Portugal. In Latin America, the programme is called "Going forward with your Future" and it focuses mainly on adults, assisting them to manage their personal finances. It has helped 405 000 people, mostly in Mexico where the programme was launched. It is now being rolled out to other countries in the region.

Recently, BBVA has been supporting financial education initiatives in the US for adults ("Money Smart") and for children ("Teach Children to Save" or "Get Smart about Credit").
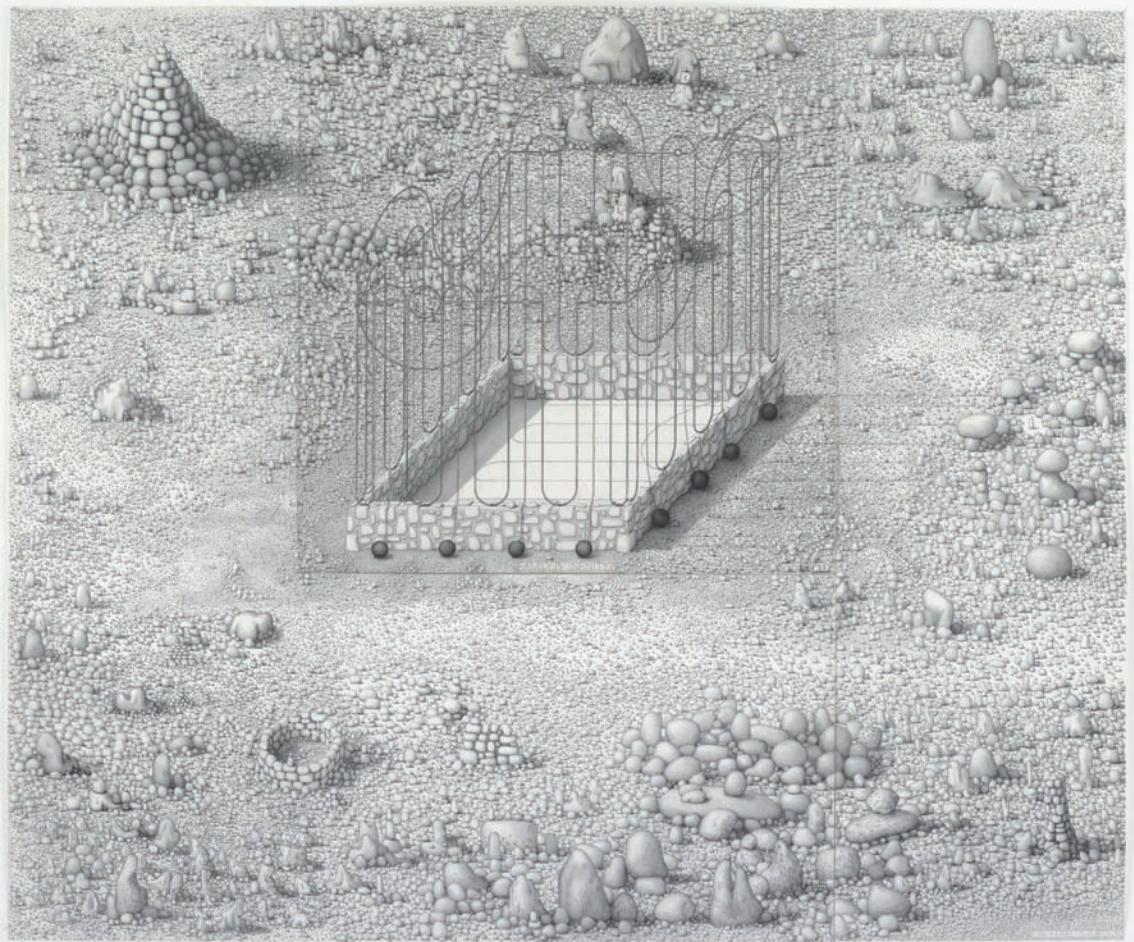
Paul Noble, *Family is Infinity (or Hard Labour),* 2010

Moreover, through the "Children Getting Ahead" programme, BBVA grants yearly scholarships and study support to 65 000 Mexican children so they can continue to study. These children come from environments affected by emigration to the US; many homes are left without a head of the family and in a precarious economic situation.

Finally, I would like to highlight our "Advancing Knowledge" policy. BBVA's commitment to knowledge springs from our profound conviction that knowledge is essential to improving our personal and collective future.

This policy is largely under the leadership of the BBVA Foundation, which dedicates around 20 million euros a year to different programmes supporting scientific research and its dissemination. It places particular emphasis on the social sciences, biomedicine, environmental

sciences and basic sciences, as well as artistic creation (especially, though not exclusively, contemporary music).

Aside from supporting research teams and projects that have an important impact on scientific progress and on opening new horizons, the Foundation's strategy also plays a key role in communicating this knowledge to society. It likewise strives to bring society closer to scientific and creative activity by making an example of the people and teams who allow us to expand our realm of knowledge and enrich our cultural spectrum.

Important tools in this task are the awards the Foundation grants or supports. Of these awards, I would like to highlight those dedicated to musical creation, the preservation of biodiversity, secondary education and above all, the Frontiers of Knowledge Awards. This year, these awards celebrate their fifth anniversary. In their short existence, they have become a world-class benchmark in their fields, which not only include traditional disciplines that are vital for our future (the basic sciences, musical creation, economics and company management), but also five multidisciplinary fields that revolve around key questions for the twenty-first century global society: biomedicine; ecology and conservation biology; information and communication technologies; climate change; and development cooperation.

It is under this same impetus that BBVA publishes this collection of books, and supports its parallel form, the OpenMind knowledge community. I strongly hope that all who read this book will enjoy it and learn from it, just as we have in editing it. I encourage you to join and support our efforts by participating in OpenMind, so that we can make it a rich, open and live space for debating, sharing and spreading the best knowledge on issues that are fundamental to achieving a better future for everyone.

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I. Fundamentals
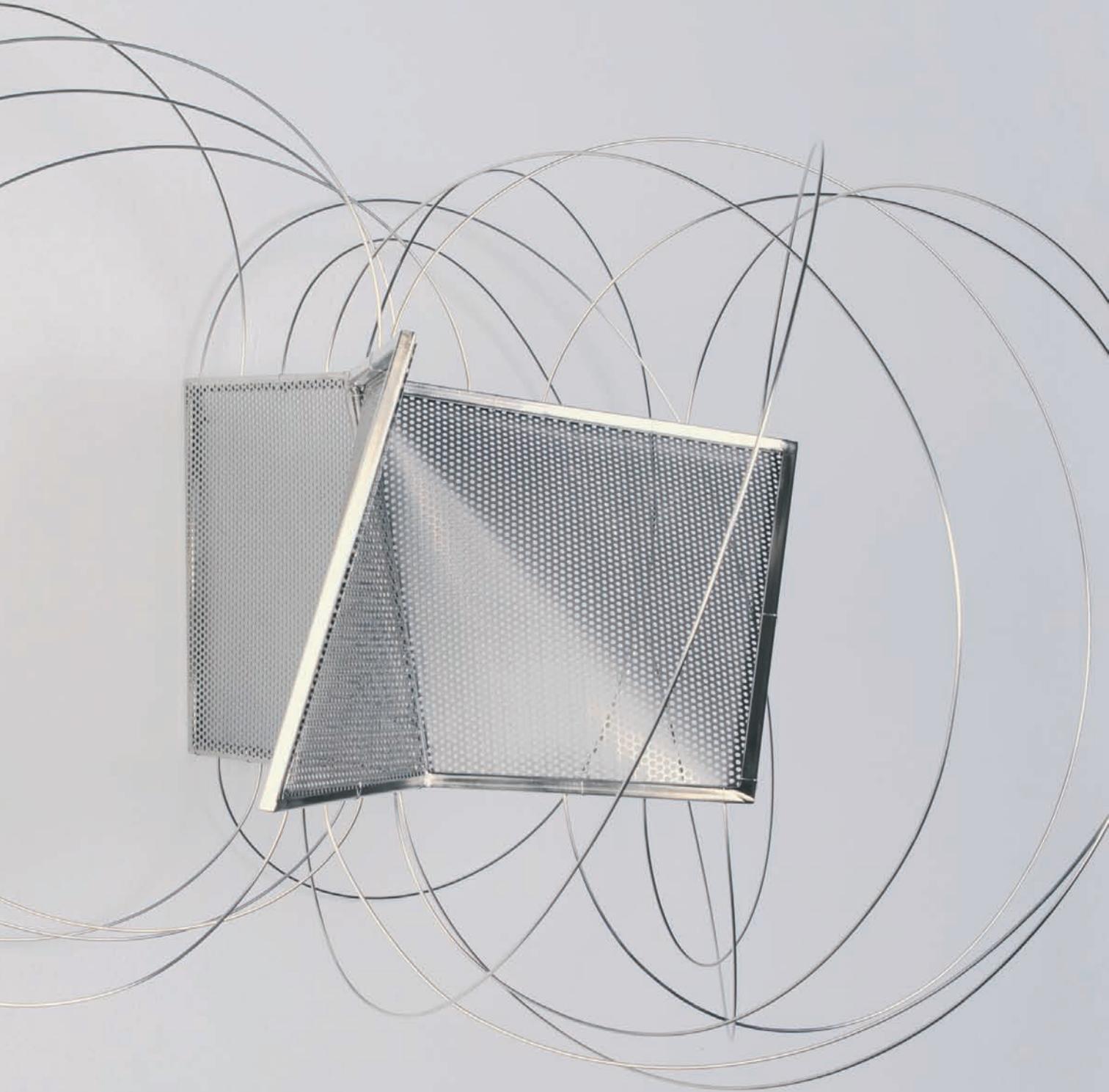
Futures Studies: Theories and Methods

Sohail Inayatullah

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INTRODUCTION

Futures studies is the systematic study of possible, probable and preferable futures including the worldviews and myths that underlie each future. In the last fifty or so years, the study of the future has moved from predicting the future to mapping alternative futures to shaping desired futures, both at external collective levels and inner individual levels (Masini 1993; Bell 1996; Amara 1981; Sardar 1999; Inayatullah 2000; Saul 2001).

During this period, futures studies has moved from focusing on the external objective world to a layered approach wherein how one sees the world actually shapes the future one sees (Inayatullah 2002). In this critical futures approach — the poststructural turn — the external world is informed by the inner and, crucially, a person's inner world is informed by the reality of the external. While many embrace futures studies so as to reduce risk, to avoid negative futures, particularly the worst case, others actively move to creating desired futures, positive visions of the future (Masini 1983). The identification of alternative futures is thus a fluid dance of structure (the weights of history) and agency (the capacity to influence the world and create desired futures).

As the world has become increasingly risky — at least in perception, if not in fact — futures studies has been eagerly adopted by executive leadership teams and planning departments in organizations, institutions and nations throughout the world. While futures studies sits comfortably as an executive function by providing the big picture, there

Blanca Muñoz, *Campo magnético triple* (detail)

remain tangible tensions between the planning and futures frameworks. Planning seeks to control and close the future, while futures studies seeks to open up the future, moving from "the" future to alternative futures.

To understand the future(s), one needs a cogent theoretical framework. Four approaches are crucial to foresight (Inayatullah 1990). The first is predictive, based on empirical social sciences. The second is interpretive, based not on forecasting the future but on understanding competing images of the future. The third is critical, derived from poststructural thought and focused on asking who benefits by the realization of certain futures and which methodologies privilege certain types of futures studies. While truth claims are eschewed, the price of epistemology is not: every knowledge decision privileges reality in particular ways (Shapiro 1992; Foucault 1973). The fourth approach is participatory action learning/research. This approach is far more democratic and focuses on stakeholders developing their own future, based on their assumptions of the future (for example, if the future is linear or cyclical) and what is critical to them (Inayatullah 2007).

While a theory of the future is useful, a conceptual framework for understanding the future is still necessary. Among others is the Six Pillars approach (Inayatullah 2008). The first pillar is "Mapping the future," with its primary method being the futures triangle (Inayatullah 2002; 2007). The second pillar is "Anticipating the future" with emerging issues analysis (Molitor 2003) as the focal methodology. The third pillar is "Timing the future," with micro-, meso- and macrohistory (Galtung and Inayatullah 1997) being the most useful "methods." The fourth pillar is "Deepening the future" with causal layered analysis (Inayatullah 2004) being the foundation (even though causal layered analysis is a theory of futures studies as well). The fifth pillar is "Creating alternatives" with scenario planning being the most important method. The last pillar, "Transforming the future," has visioning and backcasting (Boulding 1995) as its most important methods.

From the premodern to the modern

Premodern attempts to understand the future focused on astrology. By and large, the purpose of astrology was to help individuals avoid dangerous circumstances by providing an early warning system. However, unquestioned belief in the astrological system was essential since warnings and forecasts as well as psychological analyses were of a general nature. The future was not contested. In modern futures studies, questioning and divergent views are not only incorporated, they are essential to robustness and resilience. In contrast to astrology, alternatives are embraced.

While recent futures studies includes contesting the views of the future as well as ways of knowing — the deep cultural myths and metaphors — of researchers and participants, a generation back futures studies placed a far greater emphasis on forecasting. It was the

Donald Petit, *Star trails*

technique par excellence of planners, economists and social scientists. The assumption behind forecasting is that the future can be generally if not precisely known. With more information, particularly more timely information, decision-makers can make more effective choices. Having more information is especially important since the rate of technological change has dramatically increased. However, the need for information, as in times before, is necessitated by a fear of the future, a feeling of impotence in the face of forces we cannot understand, that seem larger than us. The unconscious assumption is that through better forecasting, the world, the future, can be more effectively controlled thus increasing profits or hegemony.

As business-as-usual has disappeared — largely due to a perception that the world is far riskier (the break-up of the Soviet Union, the Asian Financial Crisis, 9/11, SARS, Bird Flu, the Global Financial Crisis, climate change, the potential breakdown of the Eurozone) — futures studies has become more commonplace. Change truly has become the norm. Dramatic developments in digital, genomic, nano and neuro technologies point to more disruptions. The

rise of Chindia and the relative decline of the USA suggest that the uni-polar world is finished. In response, governmental, corporate, think-tank and non-government organizations have embraced the formal study of the future. Some use futurists as consultants who provide market advice; others use futurists to develop internal capacity through foresight workshops; and still others have senior executives attend more formal courses in futures studies. This has led to discussion as to where, within organizations, it is best to house the study of the future. More often than not, futures studies is housed in the planning department. However, while this may appear logical, as both deal with forward time, there are significant differences between the two.
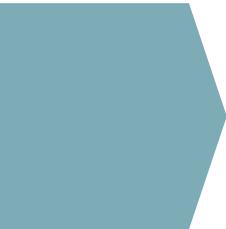
Futures studies creates alternative futures by making basic assumptions problematic. Through questioning the future, emerging issues analysis, and scenarios, the intention is to move out of the present and create the possibility for new futures

PLANNING, POLICY AND FUTURES STUDIES

When compared to planning, the futures approach:
1. is longer-term, from five to fifty years (even 1 000 years) instead of one to five years;
2. links horizon three (20–30 years) with horizon two (5–20) and horizon one (the present to five years);
3. is committed to authentic alternative futures where each scenario is fundamentally different from the other. When planners and economic forecasters use scenarios, they are often mere deviations from each other;
4. is committed to multiple interpretations of reality (legitimating the role of the unconscious, of mythology, of the spiritual, for example, instead of only views of reality for which empirical data exists);
5. is more participatory, in that it attempts to include all types of stakeholders instead of only powerbrokers;
6. consciously uses different ways of knowing, from drama or postcards from the future to various games (for example, the Sarkar game [Hayward and Voros 2006], or the CLA game);
7. is more concerned with the futures process, which is as important as the elegance of the strategic plan itself, if not more so;
8. although a technique, is also very much action-oriented, more concerned with creating the future than simply predicting it; and
9. is as much an academic field as it is a participatory social movement.

From the view of the planning discourse, the foresight function is merely one approach among many necessary to create a good plan. For planners, futures studies is useful as long as it aids in planning for the future and does not make planning or policymaking problematic. Futures studies can be disruptive, challenging the current framework instead of seeking to make strategy more effective. For futurists, disruption through methods such as emerging issues analysis (popularized in Nassim Taleb's work, *The Black Swan*, 2010) and scenario planning in fact enhances strategy effectiveness by ensuring that the plan is more robust and resilient.

The growth of futures studies is also a result of the desire of government to find information that can aid in making better policy. Futures studies, along with systems analysis, is used to better understand the second and third order effects of specific policy decisions. For many, futures research is merely long-term policy analysis or research and should not be seen as a separate field or discourse. However, there are real and important distinctions between futures research and policy research/analysis. The most significant is that futures studies creates alternative futures by making basic assumptions problematic. Through questioning the future, emerging issues analysis, and scenarios, the intention is to move out of the present and create the possibility for new futures. Policy analysis is concerned with analysing the viability of particular policies, not calling the entire discussion or the framework of decision-making into question.

In general, in planning and policy analysis, the future is often used to enhance the probability of achieving a certain policy. This is often phrased as "preparing for the future," or "responding to the challenge of the future." The future thus described is singular and more often than not it is a given. The future becomes an arena of economic conquest and time becomes the most recent dimension to colonise, institutionalise and domesticate. Futures research, however, intends to liberate time for strict technique, from instrumental rationality. It asks: what are the different ways one can "time" the world? How, for example, do different cultures, groups and organisations imagine time? It is not "preparing for the future," but by challenging the orthodox future, it opens up the possibility of alternative futures. Once alternative futures are created, then futures studies as practice seeks to develop individual and organizational capacity to invent the desired future.

Of course, policy analysis itself is a dynamic field. For example, new models of policy development have attempted to move beyond muddling through (as needs or problems come up), rational-economic decision-making (material goals) and *satisficing* (doing what you can given political and budgetary limitations), arguing primarily that these strategies are not useful during times of rapid change and dramatic crisis. Muddling through, in particular, is not useful during times of turbulence since incremental policy change does not help the organisation or nation transform to meet dramatic new conditions. The rational-economic model is useful at setting

and achieving objectives but it does not take into account extra-rational efforts. It is overly dependent on quantitative factors; it reinscribes self-interest and national self-interest (balance of powers). Satisficing, while excelling at implementation, does not ask whether the job was worth doing. Interest in finding ways to include the possibility of discontinuous change, of forecasting trends before they emerge, has been a natural progression in the evolution of the policy sciences. Futures studies fits well into the effort of finding better ways for government and business to incorporate the unknown into decision-making.

While policy researchers would prefer an investigation into the future that was more short-term, immediately beneficial to the organization, and framed within the language of the organization, by and large, futures research is often less concerned with predicting the future than with attempting to envision novel ways of organising how decisions are reached and who is eligible to participate in these decisions. It does this by asking participants to envision their ideal organisational world and then it aids in creating strategies to realise that world.

Moreover, from a critical view, to suggest that policy futures statements must be clear to the policymaker is at some level just banal. Institutions create obscure language because that language serves particular interests. It is the analysis of those interests (and the mechanisms they employ to seek and maintain power) that becomes the vehicle for investigating what images of the future are possible and which are likely to become reality. In this sense, how to make better policy or more future-oriented policy without investigating the political interests of certain policies is equally banal. Organizations stay focused in the present as bureaucrats and others are served by the current structure. Attempts to create new futures can undermine present power structures. Administrators agree to consider the future only to gain new political alliances or to achieve modernity (gain funding or prestige) but rarely to make structural or consciousness changes.

Engaging in futures studies thus requires at least a gloss of theoretical accounts as to the nature of the real and the true. In this sense, it is useful to envision policymaking, planning and futures process as having four dimensions or types: predictive, interpretive, critical and action learning.

EPISTEMOLOGY AND TYPES OF FUTURES STUDIES

In the *predictive*, language is assumed to be neutral, that is, it does not participate in constituting the real. Language merely describes reality serving as an invisible link between theory and data. Prediction assumes that the universe is deterministic, that is, the future can be known. By and large this view privileges experts (planners and policy analysts as well as futurists who forecast), economists and astrologers. The future becomes a site of expertise

Donald Petit, *Star trails*

and a place to colonise. In general, the strategic discourse is most prevalent in this framework with information valued because it provides lead time and a range of responses to deal with the enemy (a competing nation or corporation). Linear forecasting is the technique used most. Scenarios are used more as minor deviations from the norm than as alternative worldviews.

In the *interpretive,* the goal is not prediction but insight. Truth is considered relative with language and culture both intimately involved in creating the real. Through comparison, through examining different national or gender or ethnic images of the future, we gain insight into the human condition. This type of futures studies is less technical, with mythology as important as mathematics. Learning from each model — in the context of the search for universal narratives that can ensure basic human values — is the central mission for this epistemological approach. While visions often occupy centre stage in this interpretive view, the role of structures

is also important, whether class, gender, or other categories of social relations. Planning and policy analysis rarely practise an interpretive cultural form of goal setting or impact analysis.

In the *critical,* futures studies aims not at prediction or at comparison but seeks to make the units of analysis problematic, to *undefine* the future. For example, at issue are not population forecasts but how the category of population has become valorised in discourse: for example, why population instead of community or people, we might ask? The role of the State and other forms of power in creating authoritative discourses is central to understanding how a particular future has become hegemonic. Critical futures studies asserts that the present is fragile, merely the victory of one particular discourse, way of knowing, over another. The goal of critical research is to disturb present power relations through making our categories problematic and evoking other places, other scenarios of the future.

Critical futures studies draws its inspiration from poststructuralism. The task in critical futures studies is to make the universal particular, to show that it has come about for fragile political reasons, merely the victory of one discourse over another, not a Platonic universal. To do so, one needs discursive genealogies that attempt to show the discontinuities in the history of an idea, social formation or value. Through genealogy and deconstruction, the future that once seemed immutable is now shown to be one among many. As such it is replaceable by other discourses. Deconstruction then becomes a method of unpacking a text (broadly defined) and showing the discourses that inhabit it. Deconstruction moves beyond relativism by asking what the price of a particular discourse is. What future is put forth? What future is silenced? Genealogy historically traces how a particular discourse has become dominant at the expense of other discourses. The shape and type of future (instrumental versus emancipatory, for example) is often different in each type of discourse.

As important as genealogy and deconstruction is "distancing." Distancing differentiates between the disinterest of empiricism and the mutuality of interpretative research. Distancing provides the theoretical link between poststructural thought and futures studies. Scenarios become not forecasts but images of the possible that critique the present. Scenarios make the present remarkable, thus allowing other futures to emerge. Distancing can be accomplished through utopias as well, as they function as "perfect," "no," or far-away places — other spaces.

Ideally, one should try to use all three types of futures studies. If one makes a population forecast, for example, one should then ask how different civilisations approach the issue of population. Finally one should deconstruct the idea of population itself, defining it, for example, not only as an ecological problem in the third world but relating it to first-world consumption patterns as well. Empirical research then must be contextualised within the civilisation's science from which it emerges and then historically deconstructed to show what a particular approach is missing and silencing.

In the fourth type, *participatory action learning,* the key is to develop probable, possible and preferred estimations of the future based on the categories of stakeholders. The future is constructed through deep participation. The categories employed are not given *a priori* but rather developed as cooperative practice. The future thus becomes owned by those having interests in the future. Moreover, there is no perfect forecast or vision. The future is continuously revisited, questioned.

In the first type of futures studies (most comfortable to planners and policy analysts), by and large, techniques such as linear regression, multiple regression, factor analysis and econometrics are used. All these assume that the future is based on the linearity of the past. They also assume that the empirical world can be known and that the universe is fundamentally stable, with reality primarily sensate. But given that specific events can throw off a forecast, empirical futurists have re-invented Delphi, or expert event forecasting. Delphi polling is done in many rounds so as to gain consensus and done anonymously so as to reduce the influence of a particular opinion maker. More recently through crowdsourcing, Delphi has taken an even more dramatic twist becoming not an oracle of the expert priest (futurist, economist, scientist) but a representation of the most up-to-date perspective of the user. While in Delphi and other similar systems, hierarchal expertise is primary (one expert or multiple experts in anonymous dialogue) in new peer-to-peer systems, information of the future is derived through the wisdom of the many, argue Michael Bauwens, Elina Hiltunen (2011) and Jose Ramos (2012). Moreover, the wisdom of the many is not only derived through rational means, but as Stuart Candy (2010) suggests, through direct immanence, wherein a possible scenario of the future (an ecotopia) is enacted in a public space.

A CONCEPTUAL FRAMEWORK FOR FUTURES STUDIES: THE SIX PILLARS

Futures studies has often been criticized, and quite rightly so, for lacking a conceptual framework, a foresight process. However, in the last decade a number of frameworks that are inclusive of strong theory and practice have been developed. These include Voros' generic foresight process framework (2003) and the Six Pillars approach, which is derivative of Dator's Manoa school (Dator 1979).

The Six Pillars provide a theory of futures thinking that is linked to methods and tools, and developed through praxis. The pillars are: mapping, anticipation, timing, deepening, creating alternatives and transforming. They can be used as theory or in a futures workshop setting. In a workshop setting, they can be used in a linear sequential sense, that is, from mapping (using the futures triangle) to transforming (via visioning and backcasting) or by the workshop director selecting a particular pillar to focus on.

Mapping

In the first pillar, past, present and future are mapped. By mapping time, we become clearer on where we have come from and where we are going. Three tools are crucial.

The "Shared History" method consists of having participants in a futures workshop write down the main trends and events that have led up to the present. A historical timeline is then constructed up to the present. "Shared History" asks: What are the continuities in our history, what is discontinuous? This opening tool creates a framework from which to move to the future. In a research setting, the history of the issue is articulated either via empirical (historical data points) or interpretive frames of reference (the meanings individuals give to the data points).
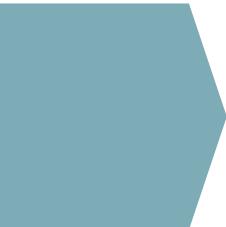
> **The Six Pillars provide a theory of futures thinking that is linked to methods and tools, and developed through praxis. The pillars are: mapping, anticipation, timing, deepening, creating alternatives and transforming**

The futures triangle maps today's views of the future through three dimensions. The image of the future pulls an organization forward. Each organization or institution has contending images of the future. At the global macro level, while there are many images of the future, five or so are archetypal. These are: 1) evolution and progress — more technology, man as the centre of the world, and a belief in rationality; 2) collapse — a belief that man has reached his limits, indeed he has overshot them: world inequity, fundamentalism, tribalism, nuclear holocaust, climate disasters: all point to a worsening of the future; 3) Gaia — the world is a garden, cultures are its flowers, we need social technologies to repair the damage we have caused to ourselves, to others and to nature, becoming more and more inclusive is what is important. Partnership between women and men, humans and nature, and humans and technology are the next evolutionary jumps; 4) globalism — barriers between nations and cultures can be eliminated once we move to a free market system. Technology and the free flow of capital can bring riches to all. Traditional isms and dogmas are the barriers stopping us from achieving a new world; and, 5) back to the future — we need to return to simpler times, when hierarchy was clearer, when technology was less disruptive, when the rules of hierarchy were clear. Change is overwhelming; we have lost our way and must return.

Along with images are the pushes of the present. These are quantitative drivers and trends that are changing the future: the obvious ones are an ageing population, mobile Internet penetration, climate change, and the number of women in higher education. There are also weights. These are the barriers to the change we wish to see. Each image has differing

weights. Those who imagine a globalized world are weighed down by nationalists and protectionists. The Gaian (Lovelock 2006) image is weighed down by the dominance of hierarchy — male, empire or expertise. By analysing the interaction of these three forces, the futures triangle helps develop a plausible future. Strategies can then be articulated as to what is required — greater emphasis on the pull of the future, the weight of the past, or the push of the present.

Anticipation

The second pillar of futures thinking is Anticipation, with emerging issues analysis (Molitor 2003) as the main method (see Figure 1). Emerging issues analysis seeks to identify bell-weather regions, where new social innovations start. It also seeks to identify issues before they become unwieldy and expensive, and, of course, to search for new possibilities and opportunities. Emerging issues include disrupters such as: Will robots soon have legal rights? Will meditation be part of every school curriculum? Will we develop pharmacies in our bodies? Will the smart toilet help us with early diagnostics? Will the slow cities movement redefine the 24/7 world? Will smart bots (eco, health) create more fuel- and health-efficient persons, houses, communities and businesses? Will eating meat be illegal in the long run and in the short run seen as a kind of child abuse?

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Figure 1. Emerging Issues Analysis

Problems/issues

Trends

SEEDS

Emergency issues/weak signals

Unknown ⟵————————————————⟶ Known
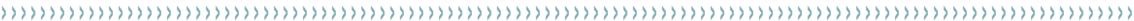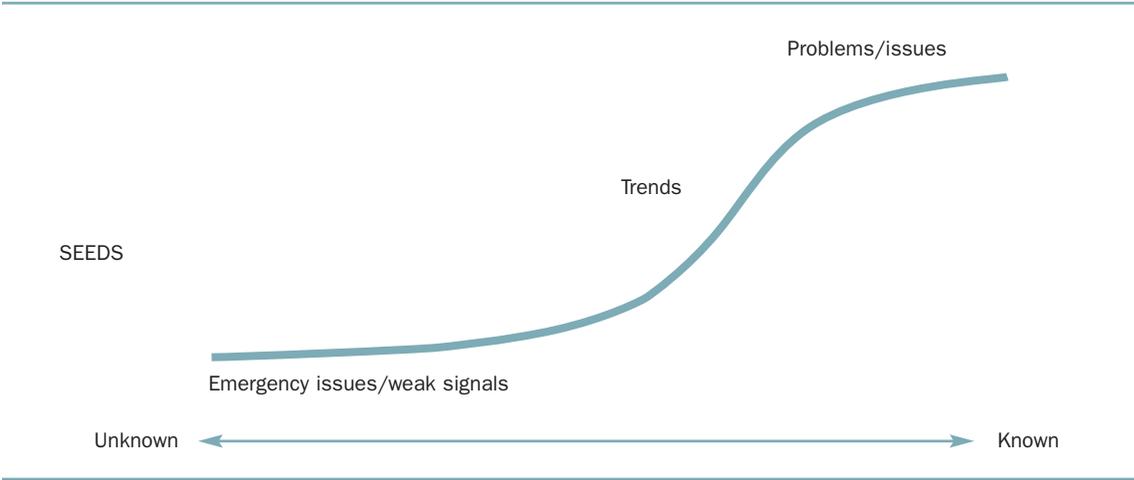
While solving emerging issues leads to little political pay-off — i. e. voters will not reward the leader for solving tomorrow's problems — they can help minimize harm and indeed help individuals and organizations respond far more swiftly to emerging challenges.

Timing the Future

The third pillar is Timing the Future. This is the search for the patterns in change, the stages and mechanisms of long-term change. Macrohistorians (Galtung and Inayatullah 1997) posit that a number of patterns are critical if we wish to understand the shape of time:

1. The future is linear, stage-like, with progress ahead. By hard work, we will realize the good future. Foundational writers include Auguste Comte (1875) and Herbert Spencer (1973).

2. The future is cyclical; there are ups and downs. Those at the top will one day find themselves at the bottom. Because they are on the top, they are unable to adapt and adjust as the world changes. Their success was based on mastery of yesterday's conditions. Few are able to reinvent their core stories. Foundational writers are Ssu-Ma Chien (Watson 1958), Ibn Khaldun (1967) and Oswald Spengler (1972). Related to the cycle is the pendulum, developed by Pitirim Sorokin (1957). In this approach, nations and organizations tend to oscillate between extremes of two poles (centralization or decentralization, modernity and religion, or civilian and military rule). Knowing where one is in the pendulum can lead to more effective strategy, helping to decide how and when to act.

3. The future is a spiral: parts are linear and progress-based, and parts are cyclical. With leadership that is courageous and has foresight, a positive spiral can be created. The dogmas of the past are challenged but the past is not disowned, rather it is integrated in a march toward a better future. The foundational thinker for this approach is P. R. Sarkar (1987).

4. New futures are more often than not driven by a creative minority. They challenge the notion of a used future. Instead of imitating what everyone else is doing, they innovate. This can be social, political, cultural, spiritual or technological innovation. These change agents imagine a different future and inspire others to work toward it. When there is no creative minority, instead of sustainable systems what result are bigger and bigger empires and world-states. Power and bureaucracy continue unchallenged, charisma becomes routinized and the hunger for something different, something that can better meet human needs, drifts away. Size or growth takes over; inner and outer development disappears. The work of Arnold Toynbee (1972) and, to some extent Vilfredo Pareto (1968), is foundational to this approach.

5. There are hinge periods in human history, when the action of a few can make a dramatic difference. It is in these periods, especially, that old ways of behaviour are no longer helpful: what succeeded before no longer works. We are likely in this phase now. This approach is generally favoured by most transformational futurists — Alvin Toffler, Oliver Markley, Duane Elgin, P. R. Sarkar, Riane Eisler, Ervin László, Hazel Henderson, James Dator, James Robertson and many others share this framework.

At a meso-institutional level, there are three contrasting positions as to the nature of institutional change. First, real change comes from those who live in institutions. It is not from changing the external world but either by changing how we see the world — appreciation, gratitude, looking for the positives in every situation, in the now (Tolle 2003) — or by deep inner meditation that leads to consciousness change (Sarkar 1987). Once we become different the nature of reality changes.

Second, real change is not consciousness but institutional change, changing the laws that govern society, the rules and regulations. Taxation, legislation and incentives to lead societal change, as Singapore can attest to.

Third, real change comes from new technologies. They change how we do what we do. As Marshall McLuhan argued, we create technology and then it creates us (1962). For example, we create the Internet and now we define how we work (flexible but 24/7), how we play (gaming), and even how we meet partners. Technology creates new economies and the tensions result when society lags behind, when power relations do not change.

At the meso-organizational level, Jenny Brice, formerly of Fuji Xerox, and Patricia Kelly provide useful theories of change. Using the virus as an analogy for social change, they argue that the goal is not to transform the entire organization but merely to find the champions, these generally account for 10 percent of the organization's staff. In this quest, it is crucial not to lose focus by fighting with the resisters, also around 10 percent. Rather, they are transparently quarantined. Early adopters account for nearly 40 percent and they are to be supported — with incentives and increased importance — while the remaining 40 percent tend to be bystanders, not overly concerned with organizational dynamics as long as their basic needs are met.

Finally, there is microtiming, or the biography of change. There are two aspects here. First, futures thinking differs depending on what stage of life one is in. For example, the future of a teenager is likely to be shorter-term oriented (because of brain development) than that of an adult. Vulnerability is likely to be more of a factor for the elderly than for a young adult.

Second is the microhistory that frames life stages. Here, the guiding question is how one sees the stages of life: the traditional birth–student–work (one job)–retirement–death structure or an alternative rendering, for example, student–work (multiple and portfolio careers), mentoring, spiritual life, death and then conscious or unconscious rebirth. Many other patterns are possible, including the transhumanists who see the stages as birth–student–work–retirement and then endless life through technological life extension. This biography of life thus is the unconscious structure to how we imagine our lifecycle. At issue is this: as the world dramatically changes — living longer and the move to a grey future — will the classical biography still hold? Or will new patterns of life be invented?

Timing the future thus focuses on the wise use of macro-, meso- and micro-patterns of change to better influence social reality.

Donald Petit, *Star trails*

Deepening the Future

Pillar four is deepening the future. One method is foundational: causal layered analysis (Inayatullah 1998, 2004). Causal layered analysis (CLA) seeks to unpack, to deepen the future. It has four dimensions. The first is the litany, or the day-to-day future: the data, the commonly accepted headlines of the way things are or should be. Solutions to problems are at this level are usually short-term oriented. The second dimension is deeper, focused on the social, economic, political causes of the issue: the systemic. The third dimension is the culture or worldview. This is the big picture, the paradigm that informs what we think is real or not real, the cognitive lenses we use to understand and shape the world. The fourth dimension is the myth or the metaphor: the narrative. Metaphors are often the vehicles of myths.

Levels 1 and 2 are most visible; levels 3 and 4 are broader and deeper and more difficult to identify. Outsiders to the institution or organization are far more effective in discerning these levels of reality.

If we look at health care, we know that there is a high rate of medical mistakes leading to serious injury or death. At level one, the solution is more training for health practitioners, particular doctors, as policymakers focus on people generally. At level two, we search for causes for these mistakes. Is it lack of communication between health professionals? The state of the hospital? Hospital design? Lack of understanding of new technologies? Incorrect diagnosis? Wrongly prescribed medicines? Systemic solutions seek to intervene by making the system more efficient, smarter, ensuring that all parts of the system are seamlessly connected. Hospitals are redesigned for safety especially for an ageing society (to minimize the risk of falls, for example).

But if we move to a deeper, worldview level, we see the problem may in fact be the paradigm of Western medicine itself: its reductionism, its focus on technique and the disowning of its softer and more holistic potentials. The doctor remains far above, the nurse below and the patient even lower. It is the hierarchy of knowledge that is the root problem at this level. Merely instituting more training or more efficient systems ignores power. The solution is to empower patients (listen to them from their interpretive perspective, their views of healing and the future), or a move to different health systems — complimentary health systems, for example. Certainly, alternative health is the disowned self of modern medicine. Many researchers are integrating opposites — using modern and ancient medicine to develop better outcomes.

At the myth level, the deeper problem is the notion that "doctor knows best." Patients give up their power when they see medical experts: patients enter the hospital system and immediately regress to their child selves. Doctors resort to expert selves — and with dehumanized bureaucracies ensuring a focus on efficiency, mistakes continue to occur.

CLA seeks to integrate these four levels of understanding (see Table 1). Each level is true (at its level), internally consistent, and solutions need to be found at each level. Litany

interventions lead to short-term solutions, easy to grasp, packed with data. Systemic answers require interventions by efficiency experts. Governmental policies linked to partnership with the private sector often result. Worldview change is much harder and longer term. It requires seeking solutions from outside the framework in which the solution has been defined. And myth solutions require the deepest interventions, as a new story needs to be told, rewiring the brain and building new memories for the personal and collective body.

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Table 1. Causal layered analysis — levels, problems and solutions

CLA Level	Problems and Solutions
Litany	High rate of medical mistakes Solution: More GP Training
Systemic causes	Audit on causes of mistakes: communication, new technologies, administration Solution: More efficient, smarter systems
Worldview	Reductionist modern medical paradigm creates hierarchy Solution: Enhance power of patients Solution: Move to different health systems
Myth/metaphor	"Doctor knows best" Solution: "Take charge of your health"

CLA asks us to go beyond conventional framings of issues. However, it does not privilege a particular level. For example, with respect to the global financial crisis (Inayatullah 2010), one can read this narrowly as a mortgage or banking crisis, or more broadly as a decline of the West and the rise of Chindia, or even more broadly as the end of the industrial era and the need for a global green economy. Each reading has its own metaphors and myths. If the narrative is the mortgage crisis then the solution is a move from "I shop therefore I am" to "I live within my means." If a geopolitical shift, then it is from "limits of the West" to "peaceful rise of Asia" (Bajpai 2012: 12–37; Inayatullah 2012). And if it is truly a foundational shift, the narrative moves from "growth and progress forever," to "Gaia": moving up and down layers, and horizontally across discourses and worldviews, increasing the richness of the analysis.

CLA thus leads to depth. For example, in policing, it means moving from the litany of more police to solve crime and safety issues to systemic change wherein cities and communities are redesigned for safety (via lighting, via community policing, via surveillance cameras) and then to worldview changes (Inayatullah 2012; IEET). At the worldview level, the hierarchical military structure of policing is transformed to one where security is co-produced with multiple stakeholders (citizens, communities, private security firms) from exclusionary hierarchy to flatter inclusionary cultures. Finally for any changes to be successful, the core narrative of the "thin

blue line" must be challenged, where police are special and know everything. Community policing or broader safety strategies will not succeed unless a new narrative defines who the police are. Without narrative and worldview changes, a focus only on litany and system will create a reality where "culture eats strategy for breakfast."

CLA can also be applied to the self. One could, as participants from around the world have, investigate the litany of the self (how do I represent my self to others); the system of the self (is there one self; a tri-self of id, ego and super-ego; or a multiplicity of selves searching for a gestalt); the dominant worldview in terms of how my mind is organized — a democracy, a dictatorship, chaos; and finally, what the core metaphors of the mind are. Is my mind like a to-do list? A highway, with the ego as a driver? Is it a river ecosystem with many tributaries? The CLA process begins with the self as is, moves to multiple selves and then challenges the core story (stories) of the self and seeks to transform it (them) (Stone 1993).

After the future is deepened, we can then broaden it, using the fifth pillar.

Creating Alternatives

The fifth pillar is focused on methods to create alternative futures. The most important method in this pillar is scenario planning. Just as every futures project needs to have engaged in a futures triangle (an environmental scan), emerging issues analysis (what is likely to disrupt the map) and CLA (what the competing narratives are), it must also include alternative futures. Scenarios are the tool par excellence of futures studies. They open up the present, contour the range of uncertainty, reduce risk, offer alternatives, create more flexible organizational mindsets, and even better, they predict.

There are many scenario methods. The first is the multi-variable. This is derived from the futures triangle and emerging issues analysis. Based on the images or the drivers or the emerging issues, a range of scenarios or stories/pictures of the future are created. From a workshop on e-health futures in Bangladesh (Inayatullah and Shah 2011) based on the drivers of the proliferation of mobile technology, demographic shifts (more young people), the traditional role of women and microcredit, increasing costs of ageing and the high costs of hospitals, four futures resulted. These were "the Leapfrog," the "e-health car," "Cloud 2025" and "Co-payment 2025."

First, "the Leapfrog." In 2025, the smart use of technology through low-cost diagnostic devices such as medical apps and bio-sensors create a dramatic transformation in health care. The traditional (modern Western) health system is leapfrogged. Individuals throughout Bangladesh gain access to inexpensive interactive technologies. The e-health infrastructure is developed from the bottom up. The Ministry of Health provides the standards and other rules to ensure integration and interoperability" (Ibid., 15).

In the second scenario, the "e-health car," continuing the traffic metaphor, the Ministry of Health Information Systems successfully drives Bangladesh to this future. While all

stakeholders are important, in this metaphor the owner is the government and the navigator is the entire healthcare system, but the driver is the Ministry. Individual, tailored solutions are developed for patients in rural and urban areas.

In the third future, "Cloud 2025," cloud computing provides health information and diagnostic applications ubiquitously to all. The "cloud" is a public space; however, for administrative purposes health is organized through *upazilas* or sub-districts (currently there are 500 in Bangladesh). The Cloud health network begins through tracking of the birth of every child in Bangladesh. Once the births are registered then their health life cycles can be tracked, monitored and their life stages health-enhanced.

In the fourth future, "Copayment 2025," the primary question is the payment mode of future systems and their financial viability. This future is centralized with individuals provided with financial incentives to stay healthy via public disbursements. Thus, prevention as a worldview becomes primary. Donors and insurance agencies, along with the government and health professionals play a decisive part in this future. Information is not just one way, i. e., giving citizens health education, but it becomes a two-way street through financial incentives and new mobile technologies. Citizens use new digital devices or work with local health caseworkers to enhance their own understanding of their personal tailored health futures. As citizens become more empowered, health costs are likely to decline.

While there is considerable similarity in the scenarios, the level of authority of the Ministry of Health is crucial. The second differentiation is the level of technology; is it the cloud or less integrated tablets providing information to doctors in the main city?

The second scenario technique — the double variable method — identifies the two major uncertainties and develops alternatives based on them. This method, among others, has been developed by Johan Galtung (1998; see also www. transcend. org). In the Bangladesh e-health case study, it was used to identify the key uncertainties. The two drivers chosen for this method were "system structure" and "politics." The extremes for "system structure" were labelled "centralized" (run by the central government) and "decentralized" (run by multiple stakeholders), whereas those for politics were labelled "hostile politics," meaning resisting participatory mobilization and empowerment and "viable or amenable to change," meaning fostering participation and engagement. Four scenarios were created. These were 1) ministry-run, hijacked by politicians; 2) ministry-run, but projects succeed as there is no political interference; 3) market- and multi-stakeholder e-health sabotaged by favoritism (read: corruption); and 4) market- and multi-stakeholder that succeeds because of technological and social innovation by participants. Government mainly plays the role of setting the standards.

In this project, the scenarios developed in the multi-variable method were tested by the double variable method.

Figure 2. e-health futures: the double variable method

The double variable method is excellent for strategy development; however, it is crucial to debate the key variables. Its weakness is that no outlier scenario is developed.

The third scenario method is developed by James Dator. It articulates scenario archetypes (Dator 1979). These are:

• Continued Growth — where current conditions are enhanced: more products, more roads, more technology, and a greater population. More growth is considered the solution to every problem.

• Collapse — this future emerges as "Continued Growth" fails. The contradictions are too great: between the economy and nature; between men and women; between the speculative and the real economy; between religious, secular and postmodern approaches; and between technology and culture.

• Steady State — this future seeks to arrest growth and find a balance in the economy and with nature. It is a balanced, softer and fairer society. Community is decisive in this future. Steady State is both back to nature and back to the past. Human values are first here. Endless growth — cities, an expanding population, technology — is often seen as the problem.

• Transformation — this future seeks to change the basic assumptions of the other three. Transformation comes about either through dramatic technological change (artificial intelligence eliminates the bureaucracy and many forms of governance; genetics changes the nature of nature, for example) or through spiritual change (humans change their consciousness through experience of deep transcendence).

This approach is easy to use as the assumptions of the future are provided; one only needs to fill in the details of the scenario for the nation, institution or organization in question.

Developed by Peter Schwartz (1995; 1996) of the Global Business Network, the fourth model of scenario writing is focused on the organizational. The scenario structure is composed of four variables: best case (what the organization aspires to); worst case (where everything goes bad); outlier (a surprise future based on a disruptive emerging issue) and business as usual (no change). This model is best used when working in a particular organization, where there is a shared culture.

In a recent workshop for a Malaysian university, the business-as-usual scenario involved funding by the government with a curriculum developed by the professors. In the worst case, because of globalization, the university becomes irrelevant and closes down. In the best case, the university becomes the preferred technical university, the MIT of the nation with community, industry, academics, staff and alumni all engaged stakeholders. In the outlier scenario, the university ceases to be government- and academic-run but rather becomes more à la carte, student-run.

The fifth scenario technique has four dimensions: the preferred, the world we want; the disowned, the world that we reject or are unable to negotiate; the integrated, where owned and disowned are united in a complex fashion; and last is the outlier, the future outside of these categories. Continuing the Malaysian university example, the preferred was an Integration of University and Industry, seen by many as "The Way." The disowned was the individual and competition, or "Separate ways." The Integrated was "Our way," wherein one plus one equals three. Industry and university create interdependence, needing each other they create a new way. In the outlier scenario, there is economic collapse, as everyone moves to survival mode. It is "no way" (see Table 2).

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Table 2. Schwartz's scenario model

Scenarios	Preferred	Disowned	Integrated	Outlier
Description	Economic growth	Economic decline	Economic transformation	Economic collapse
System	Seamless system	Antagonistic systems	Synergy between stakeholders	System disintegrated
Worldview	Interdependence	Independence	Integration	Survival
Metaphor	The way	Separate ways	Our way	No way

Transforming the Future

The final pillar is Transformation. Three methods are crucial: 1) visioning; 2) backcasting; and 3) transcend — resolving conflicts between visions. In transformation, the future is narrowed

toward the preferred. Which future do individuals desire? Which futures do organizations, cities and nations desire?

Visions and visioning are foundational to the field. Visions work by pulling people along. They give individuals and groups a sense of the possible. They also inspire the noble within each person by calling individuals to sacrifice the short term for the longer term, for the greater good. Finally, they help align individual goals with institutional goals. An organisation or nation or civilisation without a compelling vision of the future and a conviction that agency is possible will decline, argues Fred Polak in his *The Image of the Future* (1972).

To develop a vision, there are three methods: analytically through scenarios, via questioning, and through creative visualization.

In the scenario process, the preferred future is the best case. In the questioning process, individuals are interrogated as to the nature of a preferred day in their life in the future. They might be asked: What happens once you wake up? What does your home look like? What type of technologies do you use? Who do you live with? What is the design of your home? What types of building materials were used? Do you go to work? What does work look like? What do you eat? These questions force individuals to think in more detail about the world they would like to live in.

The preferred future can also be discerned through a process of creative visualization. In this process, individuals are asked to close their eyes and enter a restful state. From there, in their mind's eye, they take steps to a hedge or wall (the number of steps is based on how many years into the future they wish to go). Over the hedge is the preferred future. They walk into that future. The facilitator asks them for details such as: Who is there? What does the future look like? What can you see, smell, hear, touch, taste? This exercise articulates the future from the right brain — it is more visual — accessing the unconscious.

The three visioning methods — the analytic scenario, the questioning, and the creative visualization — are then triangulated to develop a more complete view of the future.

Backcasting

The vision can then be backcasted. Developed by Elise Boulding (Boulding and Boulding 1995), backcasting works by moving individuals into the preferred future — or any particular scenario, for example, the worst case. We then ask, in the instance of the preferred, what happened in the last twenty years to bring us to today? What were the trends and events that created today? Backcasting fills in the space between today (the future) and the past. Doing so makes the future far more achievable. The necessary steps to achieve the preferred future can then be enacted. This can be done via a plan or via action learning steps, where a process of experimentation begins to create the desired future. This can be a budgeted-for transition strategy or a full-scale reengineering.

Donald Petit, *Star trails*

Backcasting as well can be used to avoid the worst-case scenario. Once the steps that led to the worst-case scenario are developed, then strategies to avoid that scenario can be enacted.

Conflict between visions

What happens, though, when there is conflict between visions of the future? Johan Galtung's transcend method (1998) (Figure 3) is an excellent way forward (see www. transcend. org). It focuses not on compromise, or far worse, withdrawal, but on finding win–win solutions. To do so, all the issues that are contested in the two visions need to be spelled out. And then through a process of brainstorming, creating alternatives, new ways to integrate the visions can occur. In one city case study, one stakeholder group desired a green sustainable city; another

group, a far more exciting modern, international and glamorous city. Through the transcend method, the greens understood that their city would become boring. They thus realized that the glamorous vision was a way to recover that aspect of their disowned personalities, but also that the modern dimension of the city could help them innovate. The modernists understood that without sustainability as a guiding principal there would be no way forward for anyone: each aspect of the vision needed the other. A more integrative vision was articulated, using this method, from which strategies could be developed.

Figure 3. The Transcend method

QUESTIONING THE FUTURE

The Six Pillars process can also be reduced to the following simple questions. The questions in themselves are a method: a way to question the future. They can be used to help individuals and organizations to embark on transformation.

1. What is the history of the issue? Which events and trends have created the present?
2. What are your projections of the future? If current trends continue, what will the future look like?
3. What are the hidden assumptions of your predicted future? Are there some things taken for granted (about gender, or nature or technology or culture)?
4. What are some alternatives to your predicted or feared future? If you change some of your assumptions, what alternatives emerge?
5. What is your preferred future?
6. How did you get here? What steps did you take to realize the present?

The final question is based on CLA:

7. Is there a supportive narrative, a story? If not, create a metaphor or story that can provide cognitive and emotive support for realizing the desired future.

To conclude, futures studies — research — is concerned not only with forecasting the future, interpreting the future and critiquing the future, but also with creating not just the possibility but the reality of alternative worlds, alternative futures. Through structured methods, the emergence of new visions and strategies result. The Six Pillars approach provides a conceptual and methodological framework for this journey.

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FROM A FOCUS ON PREDICTING THE FUTURE, THE MODERN DISCIPLINE OF FUTURES STUDIES HAS BROADENED TO AN EXPLORATION OF ALTERNATIVE FUTURES AND DEEPENED TO INVESTIGATE THE WORLDVIEWS AND MYTHOLOGIES THAT UNDERLIE POSSIBLE, PROBABLE AND PREFERRED FUTURES. THIS CHAPTER PROVIDES A CONCEPTUAL FRAMEWORK FOR THE STUDY OF THE FUTURE. CASE STUDIES DERIVED FROM ORGANIZATIONAL, INSTITUTIONAL AND NATIONAL FORESIGHT STUDIES ARE USED TO ILLUSTRATE THEORIES AND METHODS.

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Professor Sohail Inayatullah is a political scientist/futurist at the Graduate Institute of Futures Studies, Tamkang University, Taiwan; and the Centre of Policing, Intelligence and Counter Terrorism, Macquarie University, Sydney. He is also an associate with Mt Eliza Executive Education, Melbourne Business School, where he co-teaches a bi-annual course entitled, "Futures thinking and strategy development."

He is one of the 2010 Laurel award winners for all-time best futurists as voted by the Shaping Tomorrow foresight network, an association of 2900 foresight professionals. He received his doctorate from the University of Hawaii in 1990. In March 2011, he received an honorary doctorate from the Universiti Sains Malaysia, Penang.

He has worked with hundreds of organizations and institutions throughout the world including the Government of Malaysia, Ministry of Higher Education; the Australian Government, Department of Agricultural, Fisheries and Forestry; Samsung Press Foundation; BRAC Bangladesh; the Australian Federal Police; and Health Canada.

Professor Inayatullah has authored/edited thirty books (with titles such as *Questioning the Future*; *The University in Transformation*; *Youth Futures*; *Macrohistory and Macrohistorians*; and *Alternative Educational Futures*). He has written journal special issues, CD-ROMs and over 350 journal articles and book chapters, as well as contributed to the *Oxford Encyclopedia of Peace*, the *Routledge Encyclopedia of Philosophy*, the Macmillan *Encyclopedia of the Future* and the Unesco *Encyclopedia of Life Support Systems*.

15 Global Challenges for the Next Decades[1]

Jerome C. Glenn[2]

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Although many of the trends and possible future developments explained in this chapter can be quite depressing, based on sixteen years of research on the 15 Global Challenges identified by The Millennium Project, I have come to the conclusion that we have the resources and ideas to address them, and that there is more agreement about how to build a better future than is evident in the media, yet decision-making and institutional capacity — so far — is insufficient to make the decisions fast enough and on the scale large enough to build a better future.

Nevertheless, pessimism is unfounded, and it gives the excuse not to try to make better decisions that improve the future. Humanity is winning more than losing, although where we are losing is very serious. There is no guarantee that all will work out well, but the odds are in our favor — especially if more people and institutions understand that it is possible that we can all succeed, because we are already succeeding in many areas. If, however, more people and institutions do not get more strategic about addressing these challenges, then the negative scenarios are more likely.

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1. Much of this material is based on research and analysis from previous *State of the Future* reports and is used with the permission of the authors and The Millennium Project. See www.millennium-project.org
2. Jerome C. Glenn is the lead author of the annual *State of the Future* report from 1997 to 2013 and CEO of The Millennium Project.

When you consider the many wrong decisions and good decisions not taken — day after day and year after year around the world — it is amazing that we are still making as much progress as we are.

Fifty years ago, people argued that poverty elimination was an idealistic fantasy and a waste of money to try and eliminate; however, extreme poverty has fallen from 52 percent of the world in 1981 to about 20 percent in 2010. Extraordinary! The majority of the world was in extreme poverty just thirty-one years ago and now less than 20 percent?! Pessimists are just not doing their homework. And today people argue about the best ways to achieve that goal, not whether or not it is worthwhile to try.

Twenty-five years ago, people thought that civilization would end in a thermo-nuclear world war III between the USSR and the USA; today people think everyone should have access to the world's knowledge via the Internet, regardless of income, nationality, or ideology. Extraordinary change! Within one lifetime. And now, an even more amazing thing: Google is making the phrase "I don't know" obsolete.

It is possible within twenty-five years that anyone who wants it could have computational power many times beyond their individual brain's capacity — and have that capacity available twenty-four hours a day, and seven days a week while walking down a street with just voice recognition from imbedded intelligent computer chips in buildings. You won't need your own computer to access all that.

But we all know the future is not necessarily rosy. If current trends in population growth, resource depletion, climate change, terrorism, organized crime, and disease continue and converge over the next 50–100 years, it is easy to imagine a continually unstable world with a series of catastrophic results. At the same time, if current trends in self-organization via future Internets, transnational cooperation, materials science, 3-D printing, alternative energy, cognitive science, inter-religious dialogues, synthetic biology, and nanotechnology continue and converge over the next 50–100 years, it is easy to imagine a world that works for all.

Computational biophysics can simulate the physical forces among atoms, making medical diagnostics and treatment more individually accurate. Computational biology can create computer matching programs to quickly reduce the number of possible cures for specific diseases, with millions of people donating their unused computer capacity to run the matching programs (grid computing). Computational media allows extraordinary pixel and voxel detail when zooming in and out of 3-D images — making it seem more real than reality. Computational engineering brings together the world's available information and computer models to rapidly accelerate efficiencies in design. All these are changing the nature of science, medicine, and engineering, and their acceleration is attached to Moore's law; hence, computational everything will continue to accelerate the knowledge explosion. Tele-medicine,

View of Dubai, 2010

tele-education, and tele-everything will connect humanity, the built environment, and computational everything to address our global challenges.

The world is getting richer, healthier, better educated, more peaceful, and better connected and people are living longer, yet half the world is potentially unstable. Protesters around the world show a growing unwillingness to tolerate unethical decision-making by power elites. An increasingly educated and Internet-connected generation is rising up against the abuse of

power. Food prices are rising, water tables are falling, corruption and organized crime are increasing, environmental viability for our life support is diminishing, debt and economic insecurity are increasing, climate change continues, and the gap between the rich and poor continues to widen dangerously.

Information and communications systems from simple mobile phones to supercomputers are augmenting human decision-making. It is reasonable to assume that the accelerating rates of these changes will eventually connect humanity and technology into new kinds of decision-making with global real-time feedback.
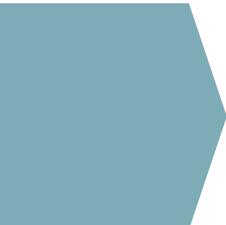
> **We have the resources and ideas to address them, and [...] there is more agreement about how to build a better future than is evident in the media, yet decision-making and institutional capacity — so far — is insufficient to make the decisions fast enough and on the scale large enough to build a better future**

But history has taught us that good ideas and technologies can have unintended and negative consequences. These capabilities will eventually make it possible for a single individual acting alone to make and deploy a bioweapon of mass destruction and for organized crime to become far more powerful than today — when its combined income is already twice that of the total of the world's military budgets. These and other dangerous future possibilities are not inevitable; there are many excellent solutions being pursued and making great progress, unbeknownst to the general public. Every year, The Millennium Project updates data about the global situation and prospects for the future, with most of the data updates going slowly but surely in a positive direction. Nevertheless, the world is in a race between implementing ever-increasing ways to improve the human condition and the seemingly ever-increasing complexity and scale of global problems.

So, how is the world doing in this race? What's the score so far? A review of the trends of the twenty-eight variables used in The Millennium Project's global State of the Future Index (SOFI) provides a score card on humanity's performance in addressing the most important challenges.

An international Delphi panel selected over a hundred indicators of progress or regress for the 15 Global Challenges described later in this chapter. Variables were then chosen that had at least twenty years of reliable historical data. The resulting twenty-eight variables were submitted to an international panel selected by The Millennium Project Nodes to forecast the best and worst value for each variable in ten years. The results were integrated into the 2012 SOFI (Glenn, Gordon and Florescu 2012).

Where are we winning?
- Increasing access to water
- Increasing literacy rates
- Extending life expectancy at birth
- Reducing poverty (living on $1.25 a day)
- Reducing infant mortality
- Reducing war
- Reducing HIV prevalence
- Increasing the number of Internet users
- Increasing GDP per capita
- Increasing the number of women in parliaments
- Increasing secondary school enrollment
- Improving energy efficiency
- Reducing population growth
- Reducing the prevalence of undernourishment
- Reducing nuclear proliferation

Where are we losing?
- Increasing total debt
- Increasing unemployment
- Increasing income inequality
- Increasing the human ecological footprint/reducing biocapacity ratio
- Increasing greenhouse gas emissions
- Increasing terrorist attacks
- Reducing voter turnout

Where is there either no significant change or change is not clear?
- Corruption
- Freedom rights
- Electricity from renewables compared to non-renewables
- Forest lands
- R&D expenditures
- Physicians per capita

The 2012 SOFI in Figure 1 (Ibid.) shows that the ten-year future for the world is getting better — but at a slower rate of improvement than over the past twenty years. However, in many of the areas where we are winning, we are not winning fast enough, such as reductions in HIV,

malnutrition, poverty; increasing access to water; and nuclear proliferation. And areas of uncertainty represent serious problems: corruption, political freedom, fossil-fuel consumption, and forest cover. Some of the areas where we are losing could have quite serious impacts, such as unemployment, greenhouse gas emissions, debt, income gaps, and terrorism. Nevertheless, this selection of data indicates that ten years from now, on balance, will be better than today. We are winning more than we are losing.

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Figure 1. The 2012 State of the Future Index
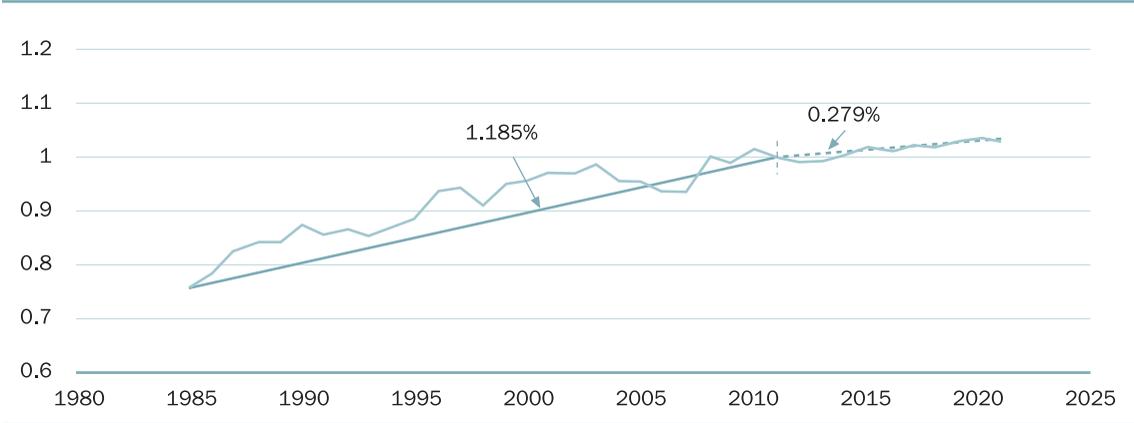
EVOLUTION OF THE 15 GLOBAL CHALLENGES

In 1996, The Millennium Project[3] asked several hundred futurists around the world what was going on now that could become very significant to the future in twenty-five years' time and that is either not know or misunderstood. A total of 182 developments were collected by the Delphi survey. Another set of Delphi surveys and interviews collected and rated 131 actions to address these developments. These were all distilled into fifteen global issues with overviews and strategies.

These global issues identified by the Delphi surveys and interviews in 1996–1997 were:

1. World population is growing; food, water, education, housing, and medical care must grow apace

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3. The Millennium Project is a global participatory think tank created in 1996 under the American Council for the United Nations University that is now an independent organization with forty-six nodes around the world. It identifies thought leaders and scholars to participate in research, connecting global and local perspectives.

2. Fresh water is becoming scarce in localized areas of the world

3. The gap in living standards between the rich and poor promises to become more extreme and divisive

4. The threat of new and re-emerging diseases and immune micro-organisms is growing

5. Capacity to decide is diminishing (as issues become more global and complex under conditions of increasing uncertainty and risk)

6. Terrorism is increasingly destructive, proliferating, and difficult to prevent

7. Population growth and economic growth are interacting adversely with environmental quality and natural resources

8. The status of women is changing

9. Religious, ethnic, and racial conflicts are increasingly severe

10. Information technology offers both promise and peril

11. Organized crime groups are becoming sophisticated global enterprises

12. Economic growth is bringing both promising and threatening consequences

13. Nuclear power plants around the world are aging

14. The HIV epidemic will continue to spread

15. Work, unemployment, leisure, and underemployment are changing

With sixteen years of hindsight, these issues are still indeed critical to the future. However, The Millennium Project's Planning Committee at that time felt these issues stressed the problems more than the opportunities, giving an unbalanced view of the future. To correct this, the same process of collecting judgments and research conclusions of futurists via Delphi surveys and interviews was conducted in 1997–1998. This time, the international panel of futurists was asked what positive developments could evolve over the foreseeable future to significantly improve the human condition. A total of 180 developments were identified with 213 actions to increase the likelihood that they will improve the human condition; the results were then distilled to 15 Global Opportunities with overviews and strategies.

The global opportunities identified in 1997–1998 were:

1. Achieving sustainable development

2. Increasing the acceptance of global long-term perspectives in policymaking

3. Expanding the potential for scientific and technological breakthroughs

4. Transforming authoritarian regimes to democracies

5. Encouraging diversity and shared ethical values

6. Reducing the rate of population growth

7. Evolving strategies for world peace and security

8. Developing alternative sources of energy

9. Globalizing the convergence of information and communications technologies (ICT)

10. Increasing advances in biotechnology
11. Encouraging economic development through ethical market economies
12. Increasing the economic autonomy of women and other groups
13. Promoting inquiry into new and sometimes counter-intuitive ideas
14. Pursuing promising space projects
15. Improving institutions

The following year we combined the two lists into 15 Global Challenges through a series of Delphi surveys and interviews, and we identified 213 actions. At this point the representatives for Finland on The Millennium Project Planning Committee said, "Stop! Don't keep changing. This is a good list. Keep it; we want to use it to evaluate progress in our country. If you keep changing, it will be difficult for us to compare progress from one year to the next." So the Global Challenges have remained the same.

THE 15 GLOBAL CHALLENGES IN 2012

The 15 Global Challenges from 1999 to 2012 are:
1. How can sustainable development be achieved for all while addressing global climate change?
2. How can everyone have sufficient clean water without conflict?
3. How can population growth and resources be brought into balance?
4. How can genuine democracy emerge from authoritarian regimes?
5. How can policymaking be made more sensitive to global long-term perspectives?
6. How can the global convergence of ICT work for everyone?
7. How can ethical market economies be encouraged to help reduce the gap between rich and poor?
8. How can the threat of new and re-emerging diseases and immune micro-organisms be reduced?
9. How can the capacity to decide be improved as the nature of work and institutions changes?
10. How can shared values and new security strategies reduce ethnic conflicts, terrorism, and the use of weapons of mass destruction?
11. How can the changing status of women help improve the human condition?
12. How can transnational organized crime networks be stopped from becoming more powerful and sophisticated global enterprises?
13. How can growing energy demands be met safely and efficiently?

Nocturnal view of Great Britain and the north-west coast of Europe

14. How can scientific and technological breakthroughs be accelerated to improve the human condition?

15. How can ethical considerations become more routinely incorporated into global decisions?

The order of each of the issues, opportunities, and challenges are not prioritized by any definition of importance. Challenge 1 is not more or less important than Challenge 15. The volume of responses from the international panel was used to order the items in each list. The challenges are interdependent: an improvement in one makes it easier to address others; deterioration in one makes it harder to address others. Arguing whether one is more important than another is like arguing that the human nervous system is more important than the respiratory system. These challenges are transnational in nature and transinstitutional in solution. They cannot be addressed by any government or institution acting alone. They require collaborative action among governments, international organizations, corporations, universities, NGOs, and creative individuals.

Let's briefly go over each one:[4]

How can sustainable development be achieved for all while addressing global climate change?

Total human-induced greenhouse gas (GHG) emissions are about 49.5 gigatons of CO_2 equivalent per year.[5] Nature absorbs about half of this annually, but its ability to do that is diminishing. Global ecosystem services are being depleted faster than nature can resupply. The world is warming faster than the latest IPCC projections.[6] According to NOAA, the first six months of 2012 were the hottest in the US since record-keeping began in 1895. Glaciers are melting, polar ice caps are thinning, and coral reefs are dying. Rapid population and economic growth over the past hundred years has reduced environmental viability for life support; the impact over the next hundred years could be far greater. It is time for a US–China Apollo-like ten-year goal and global R&D program to address climate change. These two countries are the greatest emitters of GHGs and have the largest economies. Such a joint program — with other countries joining in — could focus on accelerating the development of new technologies like electric cars, saltwater agriculture, carbon capture and reuse, solar power satellites, pure meat without growing animals, maglev trains, urban systems ecology, and a global climate change collective intelligence to support better decisions and keep track of it all. These technologies would have to supplement other key policy measures, including carbon taxes, cap and trade schemes, reduced deforestation, industrial efficiencies, cogeneration, conservation, recycling, and a switch of government subsidies from fossil fuels to renewable energy.

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4. The complete text of the *15 Global Challenges* totals 1 900 pages. It is available at http://www.millennium-project.org/millennium/2012SOF.html
5. US Department of Energy, Energy Information Agency, http://www.eia.gov/oiaf/1605/ggrpt/pdf/industry_mecs.pdf
6. Distillation of multiple sources: http://www.global-warming-forecasts.com/underestimates.php

How can everyone have sufficient clean water without conflict?

Over two billion people have gained access to improved drinking water since 1990, but 783 million people still do not have such access. Water tables are falling around the world, 40 percent of humanity gets its water from sources controlled by two or more countries, and global water demand could be 40 percent more than the current supply by 2030 (2030 Water Resources Group 2009). The slow but steady Himalayan meltdown is one of the greatest environmental security threats in Asia. Its mountains contain 40 percent of the world's freshwater, which feeds 40 percent of humanity via seven great Asian rivers. Breakthroughs in desalination — such as the pressurization of seawater to produce vapor jets, filtration via carbon nanotubes, and reverse osmosis — are needed along with less costly pollution treatment and better water catchments. Future demand for freshwater could be reduced by saltwater agriculture on coastlines, hydroponics, aquaponics, vertical urban agriculture installations in buildings, the production of pure meat without growing animals, increased vegetarianism, fixes for leaking pipes, and the reuse of treated water.

How can population growth and resources be brought into balance?

The UN mid-range forecast estimates that world population is expected to grow by another two billion in just thirty-eight years, creating an unprecedented demand for resources. Most of that growth will be in low-income urban Asia. Today Asia has 4.2 billion people and is expected to grow to 5.9 billion by 2050. By 2030, the global middle class is expected to grow by 66 percent — about 3 billion more consumers with increased purchasing power and expectations (McKinsey Global Institute 2011). Population dynamics are changing from high mortality and high fertility to low mortality and low fertility. The world's fertility rate has fallen from 6 children in 1900 to 2.5 today.[7] If fertility rates continue to fall, world population could actually shrink to 6.2 billion by 2100, creating an elderly world difficult to support. Today life expectancy at birth is 68 years, which is projected to grow to 81 by 2100.[8] By 2050 there could be as many people over 65 as there are under 15,[9] requiring new concepts of retirement. Scientific and medical breakthroughs are likely over the next 20–30 years that could give many people longer and more productive lives than most would believe possible today. People will work longer and create many forms of self-employed tele-work, part-time work, and job rotation to reduce the economic burden on younger generations and to maintain living standards. If new concepts of employment are not invented, increased political instability seems inevitable.

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7. See *United Nations World Population Trends* at http://www.un.org/popin/wdtrends.htm
8. See World Health Organization figures at
   http://www.who.int/gho/mortality_burden_disease/life_tables/situation_trends/en/index.html
9. See UN Population Division report, *World Population Ageing: 1950-2050* at
   http://www.un.org/esa/population/publications/worldageing19502050/

How can genuine democracy emerge from authoritarian regimes?

Current demographic shifts and improved education, compounded by economic volatility, are increasing demands for more transparent democratic systems. Although democracy has been growing for over twenty years, Freedom House reports that political and civil liberties declined in 2011 for the sixth consecutive year. New democracies must address previous abuses of power to earn citizens' loyalties without increasing social discord, slowing the reconciliation process, and reducing human rights. An educated and correctly informed public is critical to democracy; hence, it is important to learn how to counter and prevent various ideological disinformation campaigns, information warfare, politically motivated government censorship, reporters' self-censorship, and interest-group control over the Internet and other media, while reinforcing the pursuit of truth.

Old ideological, political, ethnic, and nationalistic legacies also have to be addressed to maintain the long-range trend toward democracy. Since democracies tend not to fight each other and since humanitarian crises are far more likely under authoritarian than democratic regimes, expanding democracy is *sine qua non* for building a peaceful and just future for all. Meanwhile, international procedures are needed to assist failed states or regions within states, and intervention strategies need to be designed for when a state constitutes a significant threat to its citizens or others.

How can policymaking be made more sensitive to global long-term perspectives?

Humanity needs a global, multifaceted, general long-term view of the future with long-range goals to help it make better decisions today to build a brighter future. Attaining such long-range goals as landing on the moon or eradicating smallpox that were considered impossible inspired many people to go beyond selfish, short-term economic interests to great achievements. Short-term, selfish economic decision-making has led to many problems, ranging from the Euro crisis to the political stalemate in Washington and insufficient actions from Rio+20. The options to create and update national, global, and corporate strategic foresight are so complex and are changing so rapidly that it is almost impossible for decision-makers to gather and understand the information required to make and implement coherent policy. At the same time, the consequences of incoherent policies are so serious that new systems for collective intelligence are needed to improve resilience.

National legislatures could establish standing "Committees for the Future," as Finland has done. National foresight studies should be continually updated, improved, and conducted interactively with issue networks of policymakers and futurists and with other national long-range efforts. Decision-makers and their advisors should be trained in futures research (Glenn and Gordon 2009) for optimal use of these systems. Governments could add foresight as a performance evaluation criterion, add foresight to their training institutions, and require a

"future considerations" section be added to policy reporting requirements. Government budgets should consider five-to-ten-year allocations attached to rolling five-to-ten-year SOFIs, scenarios, and strategies. Governments with short-term election cycles should consider longer, more stable terms and funds for the staff of parliamentarians. A successful Global Future Collective Intelligence System should help policymaking become more sensitive to global long-term perspectives. Participatory policymaking processes augmented by e-government services can be created, informed by futures research. Universities should fund the convergence of disciplines, teach futures research and synthesis as well as analysis, and produce generalists in addition to specialists.

> **These challenges are transnational in nature and transinstitutional in solution. They cannot be addressed by any government or institution acting alone. They require collaborative action among governments, international organizations, corporations, universities, NGOs, and creative individuals**

How can the global convergence of ICT work for everyone?

Over two billion Internet users, over six billion mobile phone subscriptions,[10] and uncountable billions of hardware devices are intercommunicating in a vast real-time multi-network, supporting every facet of human activity. It is reasonable to assume that most of the world will experience ubiquitous computing and eventually spend most of its time in some form of technologically augmented reality. The race is on to complete the global nervous system of civilization. Ericsson forecasts that 85 percent of the world's population will be covered by high-speed mobile Internet in 2017. Humanity, the built environment, and ubiquitous computing are becoming a continuum of consciousness and technology reflecting the full range of human behavior, from individual philanthropy to organized crime. New forms of civilization will emerge from this convergence of minds, information, and technology worldwide.

One of the next "big things" could be the emergence of collective intelligences for issues, businesses, and countries, forming new kinds of organizations able to address problems and opportunities without conventional management. Collective intelligence can be thought of as a continually emerging property that we create (hands on) from synergies among people, software, and information that continually learns from feedback to produce just-in-time knowledge for better decisions than any one of these elements acting alone. Real-time streamed

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10. World Bank report, *Maximizing Mobile: 2012 Information and Communications for Development,* at
    http://siteresources.worldbank.org/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/IC4D-2012-Report.pdf

communications shorten the time it takes from situational awareness to decisions. The Web is evolving from the present user-generated and participatory system (Web 2.0) into Web 3.0, a more intelligent partner that has knowledge about the meaning of the information it stores and has the ability to reason with that knowledge, using conceptual descendants of today's Jeopardy-beating Watson from IBM and Apple's affectionate Siri.

Low-cost computers are replacing high-cost weapons as an instrument of power in asymmetrical warfare. Cyberspace is also a new medium for disinformation among competing commercial interests, ideological adversaries, governments, and extremists, and it is a battleground between cybercriminals and law enforcement. Fundamental rethinking will be required to ensure that people will be able to have reasonable faith in information. We have to learn how to counter future forms of information warfare that could otherwise lead to the distrust of all forms of information in cyberspace. Nevertheless, the value of ICT for reducing the divisions among people outweighs its divisiveness. It is hard to imagine how the world can work for all without reliable tele-education, tele-medicine, and tele-everything. Universal broadband access should become a national priority for developing countries to make it easier to use the Internet to connect developing-country professionals overseas with the development processes back home, improve educational and business usage, and make e-government and other forms of development more available.

How can ethical market economies be encouraged to help reduce the gap between rich and poor?

Assuming no new European crisis and that Europe's recession will only shrink their economy by –0.3 percent, the IMF estimates that the world economy will grow at 3.5 percent in 2012. With world population growth at 1 percent, humanity will get about 2.5 percent wealthier by traditional standards. According to the World Bank, extreme poverty ($1.25/day) has fallen from 1.94 billion people (52 percent of the world) in 1981 to 1.29 billion (about 20 percent) in 2010, while world population increased from 4.5 billion to nearly 7 billion during the same time. At this rate, however, about one billion people might still be living in extreme poverty in 2015.[11] World unemployment grew to 9 percent in 2011 from 8.3 percent in 2010.[12] The landscape of geo-economic power is changing rapidly as the influence of BRIC and other emerging economies as well as of multinational enterprises is rising. Lower- and middle-income countries with surplus labor will be needed in higher-income countries with labor shortages. This could

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11. United Nations. 2010. *Rethinking Poverty*. New York: Department of Economic & Social Affairs, ST/ESA/324. Available at http://www.un.org/esa/socdev/rwss/docs/2010/fullreport.pdf
12. International Labor Organization, *Global Unemployment Trends 2012*. Available at http://www.ilo.org/global/research/global-reports/global-employment-trends/WCMS_171571/lang—nl/index.htm
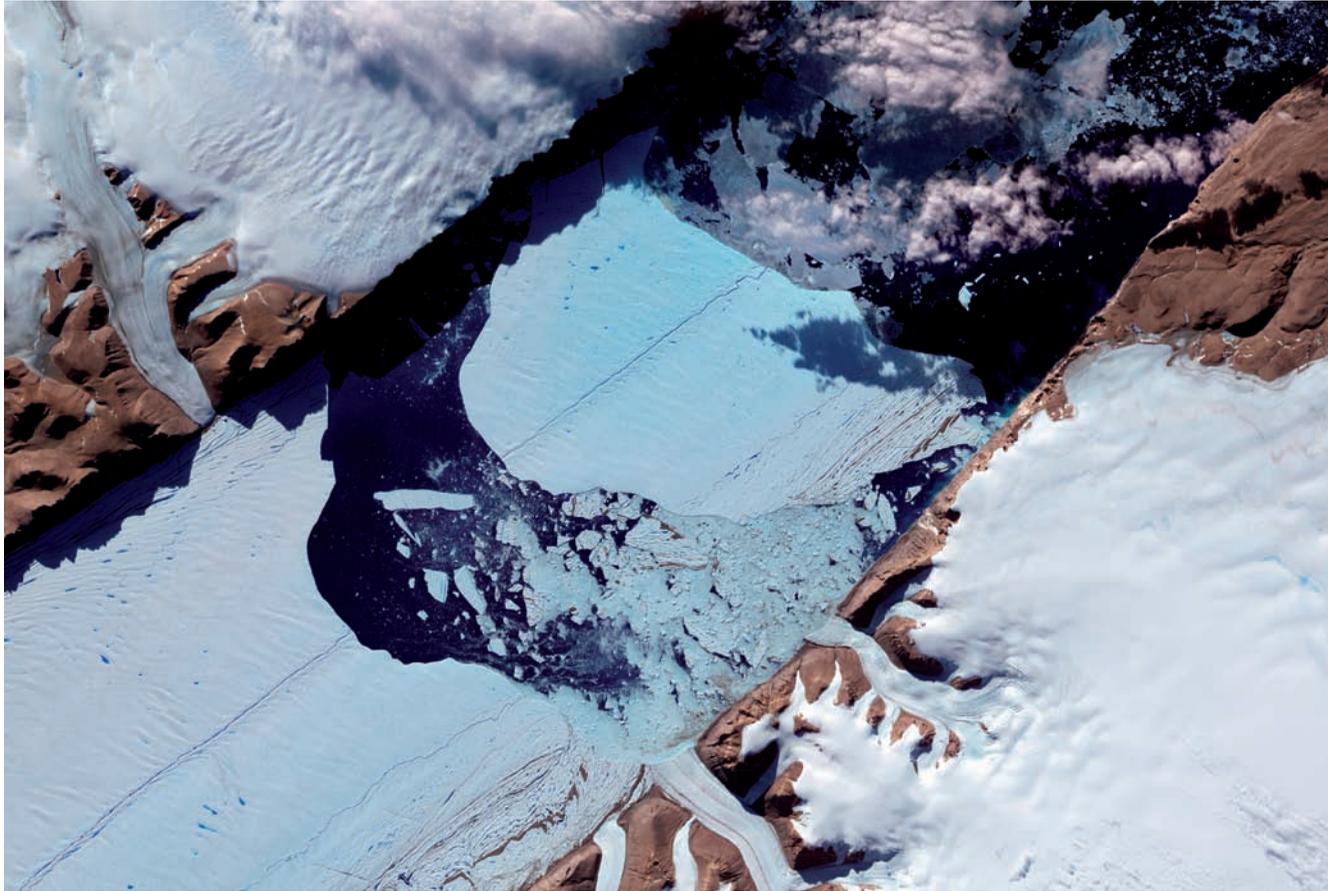
View of the Petermann Glacier, to the north-east of Greenland

continue the brain drain problem, yet online computer matching systems can connect those overseas to the development process back home.

The *2012 State of the Microcredit* reports that the number of very poor families receiving a microloan rose from 7.6 million in 1997 to 137.5 million in 2010, affecting more than 687 million people. The rapid increase of entrepreneurship, self-employment and SMEs, plus global communications and an international division of labor that develop new forms of business governance and relationships, all have the potential to raise living standards and reduce income disparities among nations.

Ethical market economies require improved fair trade, increased economic freedom, a "level playing field" guaranteed by an honest judicial system with adherence to the rule of law, and by governments that provide political stability, a chance to participate in local development decisions, reduced corruption, insured property rights, business incentives to comply with social

and environmental goals, a healthy investment climate, and access to land, capital, and information. Approximately one billion people in ninety-six countries now belong to a co-operative, according to the International Co-operative Alliance. Since half of the world's major economies are multinationals, these businesses play a crucial role in poverty alleviation and in building a sustainable economic system. Direction from central government with relatively free markets is competing with the decentralized, individualized private enterprise for lifting people out of poverty. The world needs a long-term strategic plan for a global partnership between rich and poor. Such a plan should use the strength of free markets and rules based on global ethics.

> **Humanity, the built environment, and ubiquitous computing are becoming a continuum of consciousness and technology reflecting the full range of human behavior, from individual philanthropy to organized crime. New forms of civilization will emerge from this convergence of minds, information, and technology worldwide**

How can the threat of new and re-emerging diseases and immune micro-organisms be reduced?

The health of humanity continues to improve. The incidence of infectious diseases is falling, as is mortality from such diseases as malaria, measles, and even HIV/AIDS.[13] New HIV infections have declined 21 percent over the past 12 years, and AIDS-related deaths dropped by 19 percent between 2004 and 2010.[14] The US Food and Drug Administration have approved Truvada, the first drug approved to reduce the risk of HIV infection in uninfected individuals.[15] However, a new infectious disease has been discovered each year over the past forty years, twenty diseases are now drug-resistant, and old diseases have reappeared, such as cholera, yellow fever, plague, diphtheria, and several others. In the last six years, more than 1 100 epidemics have been verified. International collaboration to reduce HIV, SARS, and H1N1 (swine flu) has built better global health systems. The dramatic improvements in health and medical services over the past twenty years could be reduced by the ongoing economic

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13. World Health Organization, "MDG 6: Combat HIV/AIDS, Malaria and Other Diseases." Available at http://www.who.int/topics/millennium_development_goals/diseases/en/index.html

14. UNAIDS. *World AIDS Day Report 2011*. Available at http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2011/JC2216_WorldAIDSday_report_2011_en.pdf

15. US Food and Drug Administration. "FDA Approves First Drug for Reducing the Risk of Sexually Acquired HIV Infection." Press Release: July 16, 2012. Available at http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm312210.htm

problems that are cutting health budgets around the world. The global public debt is about $40 trillion, while the world's GDP in 2012 is about $80 trillion (PPP). Bill Gates and others supporting health programs are pleading with G20 governments to keep their pledges of $80 billion annually from 2015 onward to create a healthier world.[16] Because the world is aging and is increasingly sedentary, cardiovascular disease is now the leading cause of death in the developing as well as the industrial world. However, infectious diseases are the second largest killer and cause about 67 percent of all preventable deaths of children under five (pneumonia, diarrhea, malaria, and measles). Nevertheless, the last twenty years have seen a 30-percent drop in deaths of children under five. Mortality from infectious disease fell from 25 percent in 1998 to less than 16 percent in 2010.[17]

High-density population growth and slow progress in sanitation in poorer areas keep many preventable diseases active. Some of the largest health impacts remain schistosomiasis (200 million cases), dengue fever (50 million new cases a year), measles (30 million cases a year), onchocerciasis (18 million cases in Africa), typhoid and leishmaniasis (approximately a million each globally), rotavirus (600 000 child deaths per year), and shigella childhood diarrhea (600 000 deaths per year).[18] The best ways to address epidemic disease remain early detection, accurate reporting, prompt isolation, and transparent information and communications infrastructure, with increased investment in clean drinking water, sanitation, and handwashing. WHO's eHealth systems, smartphone technology, international health regulations, immunization programs, and the Global Outbreak Alert and Response Network are other essentials of the needed infrastructure.

How can the capacity to decide be improved as the nature of work and institutions changes?

The acceleration of change and interdependence, plus the proliferation of choices and the growing number of people and cultures involved in decisions, increases uncertainty, unpredictability, ambiguity, and surprise. This increasing complexity is forcing humans to rely more and more on expert advice and computers. Just as the autonomic nervous system runs most biological decision-making, so too are computer systems increasingly making the day-to-day decisions of civilization. The acceleration of change reduces the time from the recognition of the need to make a decision to completion of all the steps to make the right decision. As a result, many of the world's institutions and decision-making processes are inefficient, slow, and ill informed. Institutional structures are not anticipating and responding quickly enough to the

16. *Innovative vision from Bill Gates at the G20 Summit*. Realizing a 'Green Economy'
   http://southgreeneconomy.blogspot.com/2011/11/innovative-vision-from-bill-gates-at.html
17. World Health Organization. *Millennium Development Goals: progress towards the health-related Millennium Development Goals* (May 2011). Available at http://www.who.int/mediacentre/factsheets/fs290/en/index.html
18. World Health Organization. *Global Health Observatory Data Repository.* Available at http://apps.who.int/ghodata/

acceleration of change; hence, social unrest is likely to continue until new structures provide better management. This may also trigger a return to the city and subregional cooperation as the locus of policy leadership and management. Today's challenges cannot be addressed by governments, corporations, NGOs, universities, and intergovernmental bodies acting alone; hence, transinstitutional decision-making has to be developed, and common platforms have to be created for transinstitutional strategic decision-making and implementation.

How can shared values and new security strategies reduce ethnic conflicts, terrorism, and the use of weapons of mass destruction?

Although the vast majority of the world is living in peace, half the world continues to be vulnerable to social instability and violence due to growing global and local inequalities, falling water tables, increasing energy demands, outdated institutional structures, inadequate legal systems, and increasing costs of food, water, and energy. In local areas of worsening political, environmental, and economic conditions, increasing migrations can be expected, which in turn can create new conflict.[19] Add in the future effects of climate change, and there could be up to 400 million migrants by 2050,[20] further increasing conditions for conflict. Yet the probability of a more peaceful world is increasing due to the growth of democracy, international trade, global news media, the Internet, NGOs, satellite surveillance, better access to resources, and the evolution of the UN and other international and regional organizations.
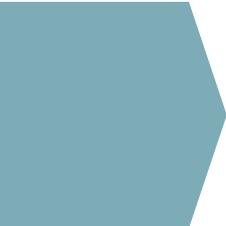
Ethical market economies require improved fair trade, increased economic freedom, a "level playing field" guaranteed by an honest judicial system with adherence to the rule of law, and by governments that provide political stability and business incentives

The number of nuclear weapons has fallen from 65 000 in 1985 to 11 540 in 2011.[21] Wars — as defined by 1 000 or more battle-related deaths — have been steadily decreasing over the past two decades, although the past two years have seen an increase, mainly due to the Arab Spring/Awakening.[22] Terrorism is changing from transnationally organized attacks to attacks by

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19. International Organization of Migration. *Migration, Climate Change, and the Environment.* Available at http://www.iom.int/jahia/Jahia/activities/by-theme/migration-climate-change-and-environment
20. International Organization of Migration. *Report of the Ninety-Ninth Session of the Council*. Available at http://www.iom.int/jahia/webdav/shared/shared/mainsite/about_iom/en/council/99/MC_2310_Rev1.pdf
21. Correspondence with International Atomic Energy Agency Staff.
22. Department of Peace and Conflict, Uppsala University, http://www.pcr.uu.se/research/ucdp/datasets/

small groups and single individuals.[23] Mail-order DNA and future desktop molecular and pharmaceutical manufacturing could one day give single individuals the ability to make and use weapons of mass destruction from biological weapons. Ubiquitous sensor systems in public spaces plus better mental health and education systems will be needed to reduce such future threats. Governments and industrial complexes find themselves under multiple daily cyberattacks (espionage or sabotage) from other governments, competitors, hackers, and organized crime. It seems intellectual software arms races will be inevitable. Backcasted peace scenarios should be created through participatory processes to show plausible alternatives to the full range of conflict possibilities.

How can the changing status of women help improve the human condition?

The empowerment of women has been one of the strongest drivers of social evolution over the past century and is acknowledged as essential for addressing the global challenges facing humanity. Women are increasingly engaged in decision-making, promoting their own views and demanding accountability. Women account for 19.8 percent of the membership of national legislative bodies worldwide, and in thirty-two countries the figure is over 30 percent. Women represent 14.3 percent of the total 273 presiding officers in parliaments.[24] There are twenty women heads of state or government. Patriarchal structures are increasingly challenged around the world. Women hold 41 percent of the world's paid employment, but hold 20 percent of senior manager positions.[25] The process toward gender political-economic equality seems irreversible. Meanwhile, violence against women is the largest war today, as measured by deaths and casualties per year. In some areas, violence against women at one point in their lives can be as high as 70 percent.[26] About 70 percent of people living in poverty are women, who also account for 64 percent of the 775 million adult illiterates.[27]

How can transnational organized crime networks be stopped from becoming more powerful and sophisticated global enterprises?

The world is slowly waking up to the enormity of the threat of transnational organized crime (TOC), but it has not adopted a global strategy to counter it. In the absence of such a strategy, TOC income has grown to more than $3 trillion a year. Its potential ability to buy and sell government decisions could make democracy an illusion. Havocscope.com estimates the total

23. RAND Corporation, http://smapp.rand.org/rwtid/search.php
24. Women in National Parliaments, http://www.ipu.org/wmn-e/world.htm
25. Women in Senior Positions in the European Union, www.ec.europa.eu/social/BlobServlet?docId=4746&langId=en
26. UN Secretary-General's Campaign, *Violence Against Women,*
    https://www.un.org/en/events/endviolenceday/pdf/UNiTE_TheSituation_EN.pdf
27. United Nations statistics and indicators on women and men, http://unstats.un.org/unsd/demographic/products/indwm/

black market in only 91 of 196 countries in the world to be valued at $1.93 trillion. There is a degree of double accounting in some of these numbers, but to share the scope of Havocscope's estimates: corruption and bribery represent $1.6 trillion; money laundering, $1.4 trillion; counterfeiting and intellectual property piracy, $654 billion; global drug trade, $411 billion; financial crimes, $194 billion; environmental crimes, $138 billion; and human trafficking and prostitution, $240 billion. These figures do not include extortion and data from 105 countries; hence, the total organized crime income could be over $3 trillion — about twice as big as all the military budgets in the world.

The UN Office on Drugs and Crime has called on all states to develop national strategies to counter TOC as a whole. This could provide input to the development and implementation of global strategy and coordination. It is time for an international campaign by all sectors of society to develop a global consensus for action against TOC. OECD's Financial Action Task Force has made forty good recommendations to counter money laundering, but these crimes continue unabated. Two conventions help bring some coherence to addressing TOC: the UN Convention against Transnational Organized Crime, which came into force in 2003; and the Council of Europe's Convention on Laundering, which came into force in May 2008. Possibly through an addition to one of these conventions or the International Criminal Court, a financial prosecution system could be established as a new body to complement the related organizations addressing various parts of TOC. In cooperation with these organizations, the new system would identify and establish priorities on top criminals (defined by the amount of money laundered) to be prosecuted one at a time. It would prepare legal cases, identify suspects' assets that can be frozen, establish the current location of the suspect, assess the local authorities' ability to make an arrest, and send the case to one of a number of preselected courts. Such courts, like UN peacekeeping forces, could be identified and trained before being called into action, so as to be ready for instant duty. Once all these conditions were met, then all the orders would be executed at the same time to apprehend the criminal, freeze access to the assets, open the court case, and then proceed to the next TOC leader on the priority list. Prosecution would be outside the accused's country. Although extradition is accepted by the UN Convention against Transnational Organized Crime, a new protocol would be necessary for courts to be deputized like military forces for UN peacekeeping, via a lottery system among volunteer countries. After initial government funding, the system would receive its financial support from the frozen assets of convicted criminals rather than depending on government contributions.

How can growing energy demands be met safely and efficiently?

In just thirty-eight years, the world should create enough electrical production capacity for an additional 3.3 billion people. There are 1.3 billion people (20 percent of the world) without

electricity today,[28] and an additional 2 billion people will be added to the world's population between now and 2050. Compounding this is the requirement to decommission aging nuclear power plants and to replace or retrofit fossil fuel plants. About 3 billion people still rely on traditional biomass for cooking and heating.[29] If the long-term trends toward a wealthier and more sophisticated world continue, our energy demands by 2050 could be more than expected. However, the convergences of technologies are accelerating to make energy efficiencies far greater by 2050 than most would believe possible today. So the world is in a race between making a fundamental transition to safer energy fast enough, and the growing needs of an expanding and wealthier population.

About half of the new energy generation capacity comes from renewable sources today.[30] IPCC's best-case scenario[31] estimates that renewable sources could meet 77 percent of global energy demand by 2050, while the World Wildlife Fund claims 100 percent is possible.[32] The costs of geothermal, wind, solar, and biomass are falling. Setting a price for carbon emissions could increase investments. If the full financial and environmental costs for fossil fuels were considered — mining, transportation, protecting supply lines, water for cooling, cleanups, waste storage, and so on — then renewables will be seen as far more cost-effective than they are today. Without major breakthroughs in technologies and behavioral changes, however, the majority of the world's energy in 2050 will still come from fossil fuels. In 2010, the world spent $409 billion on fossil fuel subsidies,[33] about $110 billion more than in 2009, encouraging inefficient and unsustainable use.

How can scientific and technological breakthroughs be accelerated to improve the human condition?

The continued acceleration of science and technology (S&T) is fundamentally changing what is possible, and access to the S&T knowledge that is changing prospects for the future is becoming universal. Computational chemistry, computational biology, and computational physics are changing the nature of science, the acceleration of which is attached to Moore's law. R&D on 3-D printers is merging the industrial, information, and biological revolutions. Synthetic

28. International Energy Agency. *World Energy Outlook 2011.* Available at http://www.iea.org/Papers/2011/weo2011_energy_for_all.pdf
29. UN Secretary-General's Advisory Group on Energy and Climate. *Energy for a Sustainable Future.* Available at http://www.un.org/millenniumgoals/pdf/AGECCsummaryreport[1].pdf
30. UN Environment Programme, "Global Renewable Energy Investment Powers to Record $257 Billion." Available at http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=2688&ArticleID=9163&l=en
31. *Renewable Energy Sources and Climate Change Mitigation Special report of the Intergovernmental Panel on Climate Change.* Available at http://srren.ipcc-wg3.de/report/IPCC_SRREN_Full_Report.pdf
32. *The Energy Report: 100% Renewable Energy by 2050.* Available at http://wwf.panda.org/what_we_do/footprint/climate_carbon_energy/energy_solutions/renewable_energy/sustainable_energy_report/
33. International Energy Agency. *World Energy Outlook 2011.* Available at http://www.worldenergyoutlook.org/media/weowebsite/energysubsidies/ff_subsidies_slides.pdf

biology is assembling DNA from different species in new combinations to create lower-cost biofuels, more precise medicine, healthier food, new ways to clean up pollution, and future capabilities beyond current belief. Swarms of nanorobots are being developed that should be able to manage nano-scale building blocks for novel material synthesis and structures, component assembly, and self-replication and repair. Although synthetic biology and nanotech promise to make the extraordinary gains in efficiencies needed for sustainable development, their environmental health impacts are in question. CERN, the European Organization for Nuclear Research, announced that it has discovered a Higgs-like boson particle that might explain the fundamental ability of particles to acquire mass, giving rise to future applications of energy and matter unimaginable today. We need a global collective intelligence system to track S&T advances, forecast consequences, and document a range of views so that all can understand the potential consequences of new S&T.

How can ethical considerations become more routinely incorporated into global decisions?

The acceleration of S&T change seems to grow beyond conventional means of ethical evaluation. Is it ethical to clone ourselves or bring dinosaurs back to life or to invent thousands of new life forms from synthetic biology? Public morality based on religious metaphysics is challenged daily by growing secularism, leaving many unsure about the moral basis for decision-making. Many turn back to old traditions for guidance, giving rise to the fundamentalist movements in many religions today. Unfortunately, religions and ideologies that claim moral superiority give rise to "we–they" splits that are being played out in conflicts around the world. The moral will to act in collaboration across national, institutional, religious, and ideological boundaries that is necessary to address today's global challenges requires global ethics.

Collective responsibility for global ethics in decision-making is embryonic but growing. Corporate social responsibility programs, ethical marketing, and social investing are increasing. New technologies make it easier for more people to do more good at a faster pace than ever before. Single individuals initiate groups on the Internet, organizing actions worldwide around specific ethical issues. News media, blogs, mobile phone cameras, ethics commissions, and NGOs are increasingly exposing unethical decisions and corrupt practices. Advance software experts in the self-organizing international group called Anonymous have become a new force increasing world attention to help the Arab Spring, Wikileaks, the Occupy movement, and opposition to police brutality.

Global ethics are emerging around the world through the evolution of ISO standards and international treaties that are defining the norms of civilization. They may also be evolving from protests around the world that show a growing unwillingness to tolerate unethical decision-making by power elites. The proliferation and scope of unethical decisions that led to the 2008 financial crisis seem not to have been addressed sufficiently to prevent future crises. We need

to create better incentives for ethics in global decisions, promote parental guidance to establish a sense of values, encourage respect for legitimate authority, support the identification and success of the influence of role models, implement cost-effective strategies for global education for a more enlightened world, and make behavior match the values people say they believe in. Entertainment media could promote memes like "make decisions that are good for me, you, and the world."
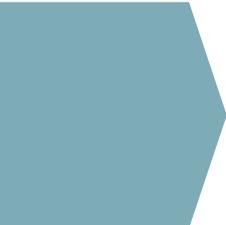
Collective responsibility for global ethics in decision-making is embryonic but growing. Corporate social responsibility programs, ethical marketing, and social investing are increasing. New technologies make it easier for more people to do more good at a faster pace than ever before

SOME CONCLUSIONS DISTILLED FROM SIXTEEN YEARS OF RESEARCH ON THE GLOBAL CHALLENGES

Without a serious focus on green growth, falling water tables, rising food/water/energy prices, population growth, resource depletion, climate change, terrorism, and changing disease patterns, catastrophic results around the world are likely and will force migrations over the next few decades to make much of the world increasingly unstable. To prevent this, fortunes will be made in areas such as green nanotech manufacturing, synthetic biology for medicine and energy, methods to increase human intelligence, retrofitting energy plants to produce construction material and buildings to produce energy, transferring agriculture from freshwater to saltwater on coastal regions of the word, electric vehicles, growing pure meat without growing animals, and using the principles of urban systems ecology to make cities become conscious technologies.

The global challenges facing humanity are transnational in nature and transinstitutional in solution. No government, international organization, or other form of institution acting alone can solve the problems described in this report: climate change, cybersecurity threats, organized crime, rich–poor gaps, environmental pollution, international finance, gender discrimination, changing disease situations, and the need for sustainable development. The world may have to move from governance by a mosaic of sometimes conflicting national government policies to a world increasingly governed by coordinated and mutually supporting global policies implemented at national and local levels.

Although many people criticize globalization's potential cultural impacts, it is increasingly clear that cultural change is necessary to address global challenges. The development of

genuine democracy requires cultural change, preventing the transmission of AIDS requires cultural change, sustainable development requires cultural change, ending discrimination against women requires cultural change, and ending ethnic violence requires cultural change.
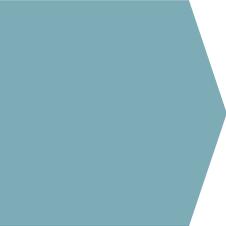
Economic growth and technological innovation have led to better health and living conditions than ever before for more than half the people in the world, but unless our financial, economic, environmental, and social behaviors are improved along with our industrial technologies, the long-term future is in jeopardy

Many see the world as a fixed-pie, zero-sum game, with someone's gain becoming another's loss. Others see an expanding pie, grown by new efficiencies and innovations, "a rising tide lifting all boats." And a few others see the world as an exponential growth of pies — with the Internet redistributing the means of production in the knowledge economy, cutting through old hierarchical controls in politics, economics, and finance. They expect a world of unlimited possibilities and think that synergetic analysis will create a better world than decisions based solely on competitive analysis. Countering the "me-first, short-term profits" mindset may be essential to engaging the world in more serious consideration of long-term strategies.

Economic growth and technological innovation have led to better health and living conditions than ever before for more than half the people in the world, but unless our financial, economic, environmental, and social behaviors are improved along with our industrial technologies, the long-term future is in jeopardy. The world needs a long-term strategic plan for improving the human condition for all.

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Humanity is facing major global challenges that are transnational in nature and transinstitutional in solution. This essay confronts fifteen of the biggest issues, including how to achieve sustainable development, guarantee access to clean drinking water, foster ethical market economies and fight new as well as re-emerging diseases. While the panorama may appear pessimistic, humanity is winning more than losing — even if where we are losing is very serious. But these challenges cannot be addressed by any single government or institution acting alone. They require collaborative action among governments, international organizations, corporations, universities, NGOs, and creative individuals. We need a serious focus on green growth, falling water tables, rising food/water/energy prices, population growth, resource depletion, climate change, terrorism, and changing disease patterns, otherwise the results may well be catastrophic.

BIOGRAPHY

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The Millennium Project

Jerome C. Glenn is the co-founder and director of The Millennium Project, a global futures research think tank. He has been co-author of its annual *State of the Future* report for the last sixteen years. He was the Washington, DC representative for the United Nations University as executive director of the American Council for the UNU 1988–2007.

He has published over 100 future-oriented articles in publications such as the International Tribune, New York Times, Royal Society of Arts Journal, and The Futurist. He is author of *Future Mind: Merging the Mystical and the Technological in the 21st Century* (1989), *Linking the Future:* *Findhorn, Auroville, Arcosanti* (1979), and co-author of *Space Trek: The Endless Migration* (1978 and 1979).

Glenn has a BA in Philosophy from American University, an MA in Teaching Social Science – Futuristics from Antioch Graduate School of Education, and he was a doctoral candidate in General Futures Research at the University of Massachusetts. He has received the Donella Meadows Medal, the 2012 Computerworld Laureate, the Kondratieff Medal, an Emerald Citation of Excellence, as well as an honorary professorship and doctorates from Universidad Ricardo Palma in Peru and Universidad Franz Tamayo in Bolivia.

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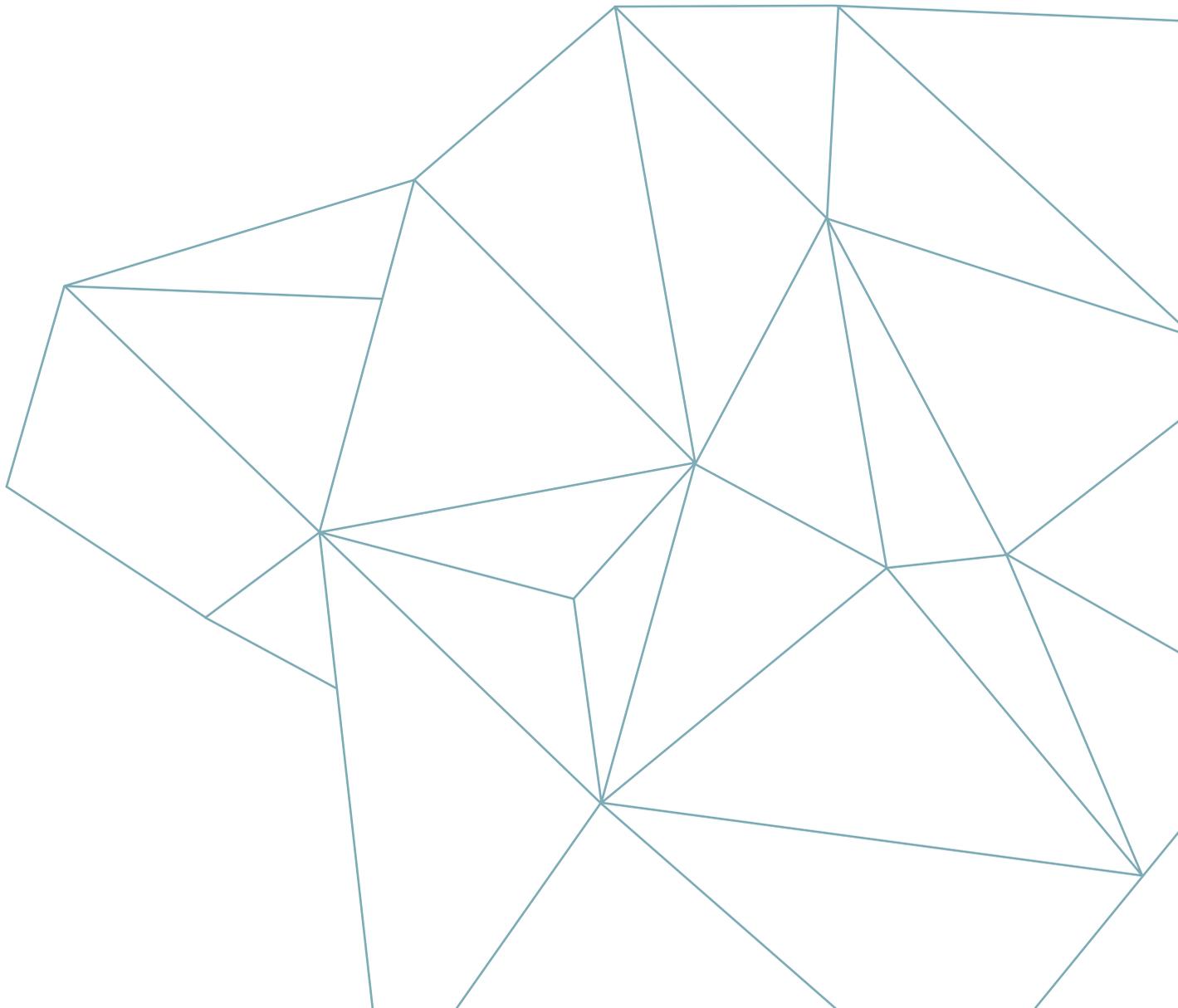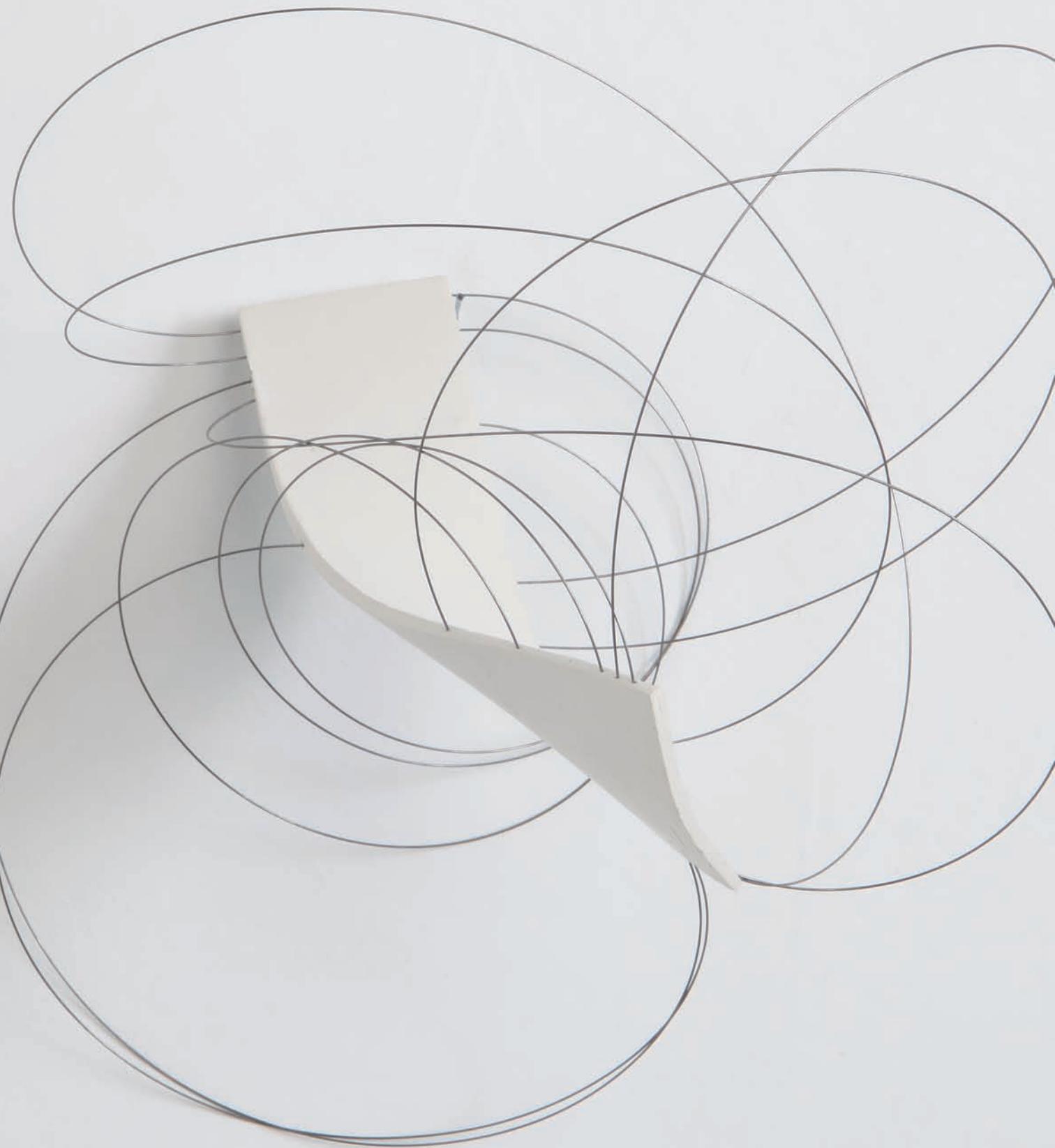
The Past Is Prologue: The Future and the History of Science

José Manuel Sánchez Ron

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"Whereof what's past is prologue, what to come
In yours and my discharge"
William Shakespeare, *The Tempest,* Act II, Scene 1

We live on the borderline between the past and the future, with the present constantly eluding us like a shadow that fades away. The past gives us memories and knowledge – confirmed or awaiting confirmation: a priceless treasure that shows us the way forward. However, we really do not know where that road will lead us in the future, what new features will appear in it, or whether or not it will be easily passable. Of course, these comments can be obviously and immediately applied to life, to individual and collective biographies: think, for example, of how some civilisations replaced others over the course of history, to the surprise — in most cases — of those who found themselves cornered by the passage of time. Yet they also apply to science, the human activity with the greatest capacity for making the future very different from the past.

Precisely because of the importance of the future to our lives and societies, an issue that has repeatedly emerged is whether it is possible to predict the future, doing so based on a solid knowledge of what the past and the present offer us. If it is important to understand where historical and individual events are headed, it is even more important to do so for the scientific future. Some may wonder, "Why is it more

Blanca Muñoz, *Espacio combado magnético* (model), 1998

important? Are the life, lives and stories — present and future — of individuals and societies not truly essential? Should we not be interested in these beyond all other considerations?" Admittedly so, yet it still must be stressed that scientific knowledge is a central — irrevocably central — element in the future of these individuals and societies, and, in fact, in the future of humanity.

THE (DETERMINISTIC) NEWTONIAN DREAM

From this perspective, it is clearly important to be able to predict the future of science. Actually, prediction is the ultimate purpose of science, which seeks to determine the future evolution of phenomena that occur in nature. In my opinion, science is but the development of logical systems with predictive capabilities. The primitive and erroneous science of astrology sought to explain what happens on Earth – including the future lives of individuals – based on the location and movements of the planets. Later, with the publication of the powerful physics of motion developed by Isaac Newton (1642–1727) in his great 1687 work *Philosophiae Naturalis Principia Mathematica*, it was thought that the determinism underlying the basic equations of Newtonian dynamics would make it possible to determine the evolution of any movement if the baseline data were known. The most categorical and famous statement on this point is the one made by Pierre-Simon Laplace (1749–1827) in one of his books, *Essai philosophique sur les probabilités* (1814):

> "An intelligence that could at a given moment comprehend all the forces by which nature is animated and the respective situation of the beings who compose it, if it were sufficiently vast enough so as to submit this data to analysis, would encompass in one single formula the movements of the greatest bodies of the universe and those of the lightest atom; for this intelligence, nothing would be uncertain and both the future, as well the past, would be present before its eyes."

Of course, Laplace knew very well that it would not be possible to have all the necessary information, or the capacity of calculation, that would permit fulfilling the deterministic Newtonian programme ("All these efforts to seek the truth tend to always lead it back to the intelligence that we have just imagined, but from which it will always remain infinitely distant"), and it was precisely because of this that he took up the theory of probability.

This Newtonian dream was crushed by quantum mechanics (developed by Werner Heisenberg in 1925 and Erwin Schrödinger in 1926) with the intrinsic probabilism of its basic variable; wave function (discovered by Max Born in 1926) and the uncertainty principle (revealed by Heisenberg in 1927); as well as by chaos (Edward Lorenz 1993) with the dependence of the solutions of chaotic systems on small changes in initial conditions.

Interesting and fundamental as these considerations are, they are not the subject of the topics addressed in this book, nor are they what I wish to analyse here. The future of science I plan to address is the future in the forecasts that scientists have made about the future contents and directions of science.

IMAGINING THE FUTURE

Let us start by observing that it is not hard to find people who, in the past, made predictions about the scientific future. The English clergyman Francis Godwin (1562–1633) wrote prophetically in a book published posthumously (Godwin 1638), "You shal then see men to flie from place to place in the ayre; you shall be able, (without moving or travailing of any creature,) to send messages in an instant many Miles off, and receive answer againe immediately; you shal bee able to declare your minde presently unto your friend, being in some private and remote place of a populous Citie." Then Christopher Wren (1632–1723), though famous as an architect, was firstly an eminent astronomer. In his 1657 keynote address as the new Professor of Astronomy at Gresham College in Oxford, he predicted that the "Time would come, when Men […] should be able to discover *Two thousand* Times as many Stars as we can; and find the Galaxy to be Myriads of them; and every nebulous Star appearing as if it were the Firmament of some other World, at an incomprehensible Distance, bury'd in the vast Abyss of inter-mundious Vacuum: That they should see the Planets like our Earth, unequally spotted with Hills and Vales: that they should see Saturn […] changing more admirably than our Moon" (Wren 1750, 200–206).

Both Godwin and Wren were correct, (although Godwin was not correct about thought transmission, or at least, not so far), though it would be some time before their predictions came true. However, these kinds of predictions are not what interest me here, since they are easy to imagine, having been made many times in the past. Predictions about space — often better described as precursory musings or the stuff of science fiction — have been common throughout history, especially in terms of flying to the Moon. Lucian of Samosata (c. AD 125–195) imagined a trip to the Moon and the Sun on a flying boat propelled by nothing but "whirlwinds" (García Gual 2005). Even one of the protagonists of the Scientific Revolution, Johannes Kepler (1571–1630), who devised three laws of planetary motion that bear his name, dreamt up a trip to the moon. He was transported with the help of lunar demons, although his true purpose was to describe what an observer on our planet would see from it. In this respect, Kepler's dream (*Somnium,* published posthumously in 1634) was more in line with the best scientific standards than the possibilities imagined by Francis Godwin or Lucian of Samosata, or even those made by the Perpetual Secretary of the Académie des Sciences in Paris, Bernard le Bovier de Fontenelle (1657–1757) in his book *Entretiens sur la pluralité des*

mondes, published in 1686, in which he considered the possibility of extra-terrestrial life on other planetary worlds.

More interesting than these kinds of predictions are others made in the nineteenth century, while the theory — already complete, as we shall see — was still held that all physical phenomena would one day be explained through the pillars of Newtonian physics. Newtonian physics had yet to be applied to the other great natural forces known at the time: magnetism and electricity. Initial success was seen in laws such that proposed in 1785 by French physicist Charles-Augustin de Coulomb (1736–1806), which extrapolated the law of universal gravitation to the domain of electricity (or better, electrostatics). His law asserted that the force between two charges is proportional to the product of their values divided by the square of the distance between them. However, electromagnetic phenomena could only be explained by going beyond the Newtonian model and using a different theoretical framework: electrodynamics, developed in the 1860s by the Scottish physicist James Clerk Maxwell (1831–1879), as centred around the fields as opposed to the Newtonian action at a distance.
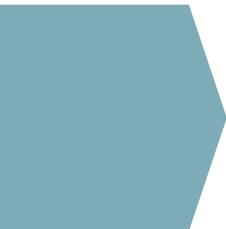
> **Prediction is the ultimate purpose of science, which seeks to determine the future evolution of phenomena that occur in nature. In my opinion, science is but the development of logical systems with predictive capabilities**

UNEXPECTED FUTURES

With the Maxwellian synthesis completed in the late nineteenth century, physicists increasingly believed that with Newtonian dynamics and Maxwell's electrodynamics, the theoretical basis for describing nature was indeed complete. Thus, the outstanding American physicist Albert Abraham Michelson (1852–1931; he became the first American to receive the Nobel Prize for Physics in 1907) apparently made the following remarks during a speech on 2 July 1894 at the inauguration of the Ryerson Physical Laboratory at the University of Chicago:[1] "It seems

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1. The remarks are cited in this way in the corresponding article bearing his signature (Michelson 1894). Also see Lagemann (1959). Robert Millikan, who is also an American physicist and a Nobel Prize Laureate, offered a different vision of Michelson's role. He wrote: "He gave the address on the place of very refined measurement in the progress of physics — an address in which he quoted someone else, I think it was Kelvin, as saying that it was probable that the great discoveries in physics had all been made, and that future progress was likely to be found in the sixth place of decimals." (Millikan 1951, 39–40). In any event, for my purposes here, it does not matter whether it was Michelson or Kelvin — an even more remarkable scientist than the American — who pronounced these words.

Peter Frasier, *Deep Blue, Ultra Low Temp Cryostat,* 1997

probable that most of the grand underlying principles have now been firmly established and that further advances are to be sought chiefly in the rigorous application of these principles [...]. The future truths of physical science are to be looked for in the sixth place of decimals."

In 1895 — one year after Michelson's categorical and, ultimately, erroneous words — Wilhelm Röntgen discovered X-rays and one year later Henri Becquerel discovered radioactivity, which no one knew how to make fit into the seemingly strong, solid and closed construction of known physics, which we now call "classical physics." Ultimately, prediction is risky. In the same vein, let us take a look at some scientific discoveries in physics that were genuine surprises.

The first is the discovery of the expanding universe. In November 1915, Albert Einstein (1879–1955) completed the relativistic theory of gravity — the General Theory of Relativity — that he had been pursuing for years. He then decided to apply it to the universe as a whole, to build a relativistic cosmology. Faced with the issue of finding a solution for the gravitational field equations that represented what he imagined the universe to be, he assumed that it was static and that matter was uniformly distributed in it. It is well known that his assumption that the universe was static forced him to modify these field equations for general relativity by introducing a cosmological constant, but what I would like to emphasise now is that he did not consider the possibility that the universe might not be static. Nor was such a possibility seriously considered by Russian mathematician and physicist Aleksander Friedmann, American mathematician Howard Robertson or English mathematician Arthur Geoffrey Walker — who found solutions for relativistic field equations that implied expanding universes. They all believed that these mathematical solutions were not in line with physical reality. The only one who did take it seriously was the Belgian priest and physicist Georges Lemaître (1894–1966), in an article entitled "A homogeneous universe of constant mass and increasing radius, which explains the radial velocity of extra-galactic nebulae," published in 1927 in the journal *Annales de la Société Scientifique de Bruxelles.* But he received neither the support nor the attention of his colleagues.

It was American astronomer Edwin Hubble (1889–1953) who discovered the now-famous expansion of the universe, a finding he published in 1929. Thus, *this phenomenon was not predicted,* even though there was a theoretical basis that would have permitted it. Instead, it was discovered through observation. The same can be said about astronomical discoveries, such as the discoveries of pulsars (Jocelyn S. Bell 1967) and quasars (from "quasi-stellar source"), radio sources revealing a large redshift whose existence was confirmed in the early 1960s. By contrast, black holes *were* predicted, by analysing a solution for the equations of general relativity (the Schwarzschild solution), even if many scientists doubted their existence (Newtonian equivalents had been proposed — and quickly forgotten — long before, first by the British astronomer John Michel in 1783, and then by Laplace in 1795). Some time passed before their existence was confirmed through experiment, but this has happened in the

twenty-first century. Binary systems have been found, one of which appears to be a black hole: V404 Cygni, consisting of a star with two thirds the mass of the sun and a black hole that is 12 solar masses. Another major surprise has been the observational discovery that only about 3 percent of the universe consists of ordinary mass, while 30 percent is an unknown type of matter (called "dark matter") and 67 percent is a form of energy that is also unknown ("dark energy").

We cannot discuss the possibility of predicting the scientific future without observing that no-one predicted quantum mechanics, the branch of physics behind much of the current technologised world. And this should not be surprising, since it is a theory whose foundations include sections as surprising as: (a) the description of physical objects by means of wave functions (defined in the field of complex numbers) whose square does not represent the subsequent history of the object in question, but rather the probability that it follows one particular history; (b) the collapse of the wave function (through the act of measuring/observing, one is likely to select one particular part of the wave function, i.e. of the reality *that unfolds*), and (c) Heisenberg's uncertainty principle.

In recent times — especially in certain areas of theoretical physics — it is not unusual to find articles discussing the future, speculating about it. This tendency was reinforced by the inaugural lecture given by Stephen Hawking (b. 1942) on 29 April 1980 as the new Lucasian professor. The shrewd (at least in terms of publicity) physicist gave the talk the attractive title *Is the End in Sight for Theoretical Physics?* Similarly, in a chapter entitled "Predicting the Future" in his book *The Universe in a Nutshell*, Hawking (2001) wrote: "The human race has always wanted to control the future, or at least to predict what will happen. That is why astrology is so popular."[2] It is therefore not surprising that when a group of physicists decided to celebrate Hawking's sixtieth birthday, they chose the theme "The Future of Theoretical Physics and Cosmology" (Gibbons, Shellard and Rankin 2003). Indeed, the book that resulted from this gathering contained chapters such as: "Our Complex Cosmos and its Future" (Martin Rees), "The Past and Future of String Theory" (Edward Witten) and "The Future of Cosmology: Observational and Computation Prospects" (Paul Shellard).[3]

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2. In the book, Hawking explains how information lost in the black holes may reduce our capacity to predict the future. He states, "The radiation from a black hole will carry away energy, which must mean that the black hole will lose mass and get smaller. In turn, this will mean that its temperature will rise and the rate of radiation will increase. Eventually the black hole will get down to zero mass. We don't know how to calculate what happens at this point, but the only natural, reasonable outcome would seem to be that the black hole disappears completely. So what happens then to the part of the wave function inside the black hole and the information it contains about what had fallen into the black hole? [...] Such loss of information would have important implications for determinism" (Hawking 2002, 121–122).
3. Martin Rees, an outstanding member of the British scientific community (Royal Astronomer, Master of Trinity College, and president of the Royal Society from 2005 to 2010, and knighted by Queen Elizabeth with the title of Baron Rees of Ludlow), is one of the scientists who enjoy speculating about the future, as shown by one of his books: *Our Final Hour*, subtitled *Is this our Final Century?* (Rees 2003).

One modern-day scientist who has devoted part of his time to predicting the scientific future is the high-energy physicist Michio Kaku (b. 1947), author of a somewhat-successful book *Visions:* significantly subtitled *How Science Will Revolutionize the 21st Century* (Kaku 1998). It would be interesting to analyse this book, like others of its kind, as the different papers included in the proceedings of a conference held at the beginning of the twenty-first century to consider what we can expect from the science and technology of the new millennium (Sanchez Ron 2002), but the aim of this article is not so much to address what the future will be like — not, of course, using written texts as general and as recent as Kaku's — but rather, by drawing on the history of science, to study predictions of the future of science made by scientists in the past. In a sense, such an aim brings to mind the quote from William Shakespeare's *The Tempest* at the beginning of this paper: "Whereof what's past is prologue, what to come / In yours and my discharge," which perhaps we can understand as history being a tool to predict the future, since its purpose is to analyse the prologue of what is to come.[4]

THE EVOLUTION OF THE SPECIES, ERASMUS OR CHARLES DARWIN?

The previous examples come from physics, the most mathematicised of the sciences and also the one that most quickly (apart from mathematics itself) had predictive theoretical systems. Here is an example taken from another scientific world: the world of natural sciences. Specifically, the question I want to raise is whether the concept of the evolution of the species was one of those predictions of future events I am considering. To do this, I will draw on Erasmus Darwin (1731–1802), who was a successful doctor, in addition to being a poet, philosopher and botanist, and his famous grandson, Charles Darwin (1809–1882). It is well known that Charles produced the theory of the evolution of the species, which he presented in *On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (1859), one of the greatest books of human history. Now, as we are often reminded, his grandfather Erasmus was one of the precursors of evolutionary theory. The basis for this claim may be found in a passage from his book, *Zoonomia; or the Laws of Organic Life* (1794–1796), a curious combination of facts and insights that contains paragraphs like this:

> "Would it be too bold to imagine, that in the great length of time, since the earth began to exist, perhaps millions of ages before the commencement of the history of mankind, would it be too bold to imagine, that all warm-blooded animals have arisen from one living filament, which *The great first cause* endued with animality, with the

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4. I was fortunate enough to first encounter this quotation in an article by Paul Forman (2002). However, the interpretation of it is my own.

power of acquiring new parts, attended with new propensities, directed by irritations, sensations, volitions, and associations; and thus possessing the faculty of continuing to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end!" (Section XXXIX, "On Generation," 4.8).

The question is to what extent we should consider that Erasmus predicted the existence of the evolution of the species. In my opinion, his prediction is not too different from that of the Greek atomists such as Leucippus or Democritus (fifth and fourth centuries BC), who held that matter is composed of atoms, i.e., indivisible particles, a thesis that Lucretius (99–55 BC) presented in his long poem, *De Rerum Natura (On the Nature of Things)*. The atom that ultimately produced twentieth-century physics bears little resemblance to that imagined by the Greek atomists, and in the same way — though perhaps on a lesser scale — the idea of evolution advocated by Erasmus Darwin does not resemble the one that his grandson laboured to produce. One of the points in support of the Darwinian theory of the evolution of the species was the struggle for existence that Charles took from the economist Thomas Robert Malthus, as the latter had set out in his 1826 work, *An Essay on the Principle of Population.* None of this appears in the writings of Erasmus Darwin, nor does the extensive and detailed collection of data that supported the ideas of his grandson.

And, since I am dealing with Charles Darwin, I will mention one of his *predictions* (i.e., visions of the future) that the subsequent development of biology seems to confirm: the prediction that all living beings present on Earth, just as their predecessors, come from a single, common, primitive life form. Charles was cautious on this point, but also clear. Thus, he wrote in *The Origin of Species* (Darwin 1859, 488–490):

> "When I view all beings not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Silurian system was deposited, they seem to me to become ennobled […] Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."[5]

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5. Interestingly enough, Erasmus Darwin (1796: Section XXXIX, "On Generation," 4.8) also speculated along similar lines: "Shall we then say that the vegetable living filament was originally different from that of each tribe of animals above described? And that the productive living filament of each of those tribes was different originally from the other? Or, as the earth and ocean were probably peopled with vegetable productions long before the existence of animals; and many families of these animals long before other families of them, shall we conjecture that one and the same kind of living filaments is and has been the cause of all organic life?"

HILBERT ON THE FUTURE PROBLEMS OF MATHEMATICS

A different kind of prediction and one much more successful than those I have mentioned so far is that used by the great German mathematician David Hilbert (1862–1943) in the famous lecture he gave on Wednesday, 8 August 1900 at the Second International Congress of Mathematicians in Paris. The talk was entitled "On the Future Problems of Mathematics" and it began as follows:

> "Who would not volunteer to lift the veil that hides the future in order to take a look at the progress of our science and the secrets of its further development in future centuries? In a field as fruitful and vast as that of mathematical science, what are the specific goals that the guides of the mathematical thinking of the future generations will try to meet? What will be the new truths and the new methods discovered in this field in the new century?
>
> History teaches the continuity of the evolution of science. We know that every age has its problems, which the next age will resolve or set aside as sterile, replacing them with others. If we want to predict the probable development of mathematical science in the near future, we need to review the unresolved issues and bring our attention to the problems identified at present that we expect the future to resolve" (Hilbert 1902, 58).

Hilbert was actually addressing the issues in mathematics that were unresolved at that time. He took his extraordinary mathematical knowledge both of the state his discipline was in and of its previous history and applied it to a selection of 23 problems he considered central to the future of his discipline. As noted by mathematics historian Jeremy Gray (2000), Hilbert's intentions were not simply "to lift the veil that separates us from the future, but help shape and direct that future. With his prestige and that of his University behind them — and Hilbert worked at the most powerful centre for mathematics in the world [the Institute of Mathematics of the University of Göttingen] — the problems he posed were always likely to be at the forefront of mathematical research, and so they became."[6] The history of twentieth-century mathematics cannot, in fact, be explained without considering the problems selected by Hilbert in 1900. Of course, not all mathematical research was directed along the lines he chose, but it is undeniable that to some extent his criteria formed the future, because in science a good part of the future is the effort used in solving problems within — to quote Thomas Kuhn (1962) — the "dominant paradigm." Returning to Gray (2000): "Of course

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6. Gray's book includes the text of Hilbert's 1900 lecture in an appendix.
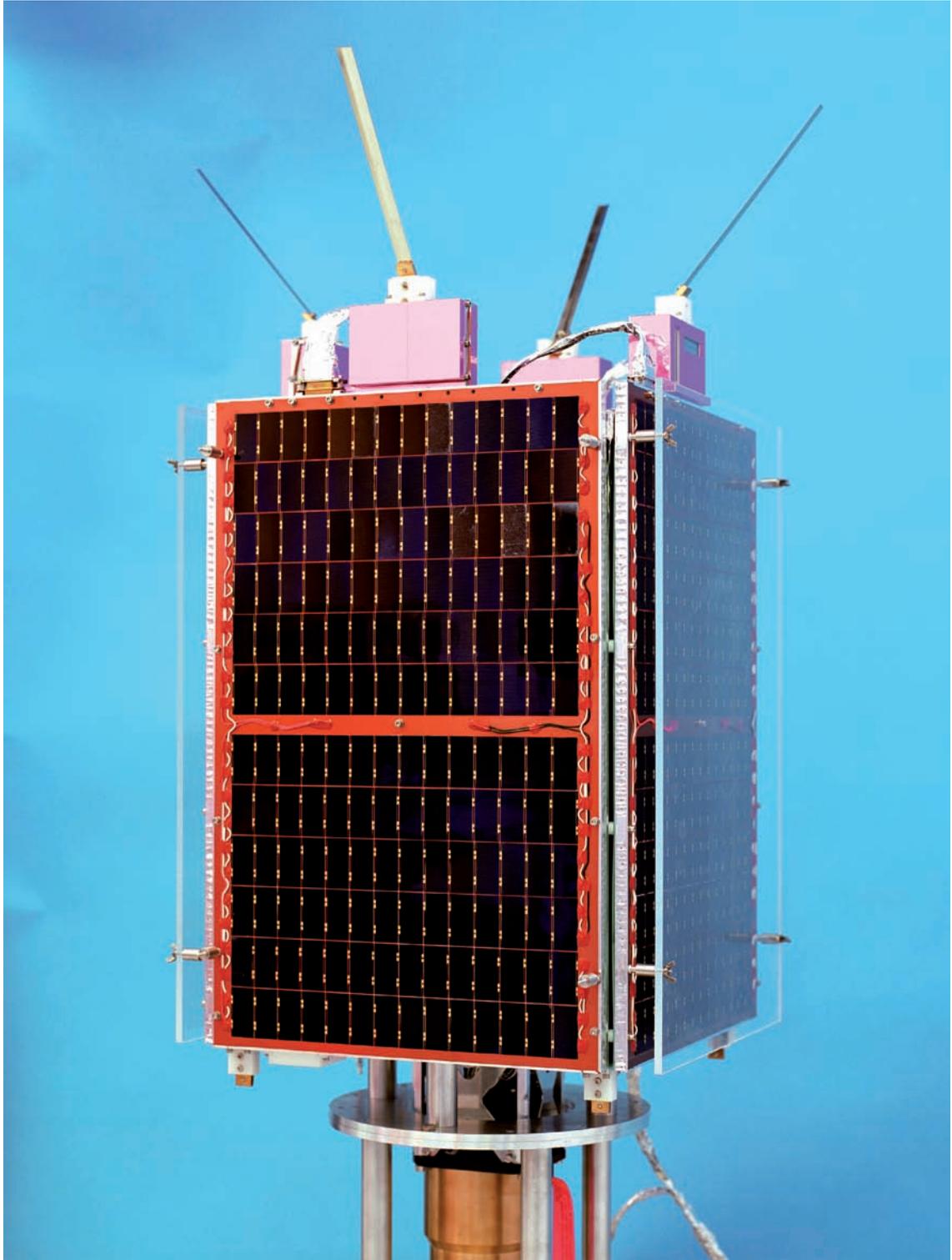
Peter Frasier, *Deep Blue, Communications Satellite,* 1997

some mathematicians have had no interest in these Problems; there is a great deal else to be done. Some mathematicians' contributions have been forgotten [...] Some problems have looked more exciting than others — that is only natural. But the list of those who have tackled the Problems contains many major mathematicians in the twentieth century. It is enough to cite some of the number theorists: Gelfond, Siegel, Artin, Takagi and Hasse. The names of Dehn, Bernstein, Koebe and Birkoff also are illustrious, and the Problems that survived to the 1950s and 60s drew the attention of Paul Cohen, Kolmogorov, Arnold and Zariski among others."

What Hilbert's conference teaches, and the place it occupies in the history of mathematics, is that at least a portion of the future — often most of it — is marked and in this respect occupied by the forecasts made by some about this future. Most of the time we emphasise how hitherto unpredictable developments — the *scientific revolutions* — determine the future. There are obviously good reasons to highlight this dimension of the future, but as the case of Hilbert shows us, this is not the only influence on the future. In fact, this type of bond that so heavily influences the future does not arise solely from mechanisms, such as the one exemplified by Hilbert. It also springs from others that are, shall we say, "institutional." A notable example in this area is provided by the post World War II support given by the US government (more specifically, its Department of Defense and, at the top, the Pentagon) to a number of physics disciplines: prioritising nuclear and electronic energies. This support had a decisive influence on the direction of research in physics, favouring the emergence of theoretical and experimental constructions as prominent as the Standard Model for high-energy physics. Without large particle accelerators — originally built in the US with the financial support of the military — would it have been possible to make discoveries as novel as that of quarks, or of the maser and the laser? In my opinion, it would not have been, or at least, or not so soon.[7]

Although the parallel is not complete, this dependence on the past — a stronger dependence than in other cases (we are always children of the past) — reminds me of what the Italian historian, sociologist and political scientist Benedetto Croce wrote in 1938, "Historical culture aims to keep alive the awareness that human society has of its own past, i.e., of its present, i.e., of itself; to supply whatever it needs for the path that it must choose, to make available whatever, on its part, may be of service to it in the future" ([1938] 1992, 183).

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7. I have addressed some of these questions in Sánchez Ron (2007, chapter 11). Also see Forman (1987).

TECHNOLOGICAL PREDICTIONS

Getting a glimpse of the future is more feasible in the field of technology than in science, as aptly pointed out by one of the great gurus of nanotechnology, Eric K. Drexler (b. 1955) in his well-known book *Engines of Creation: The Coming Era of Nanotechnology,* published in 1986. Drexler wrote:

> "Predicting the contents of new scientific knowledge is logically impossible, because it makes has no sense to claim to already *know* the facts that we *learn* in the future. Predicting the details of future technology, by contrast, is only difficult. Science is aimed at knowing, but engineering aims at doing; this allows the engineer to discuss future achievements without it being paradoxical. They can develop their devices in the world of the mind and the computer, before cutting the metal or even having defined all the details of a design. Scientists commonly recognise this difference between scientific prediction and technological prediction: they easily make *technological* predictions about science. Scientists can (and do) predict the quality of the images of the rings of Saturn from *Voyager,* for example, though not their surprising contents" (1993, 72).

Of course, even though technological predictions are more feasible, we can also find long lists of errors, as the distinguished aerodynamicist Theodore von Kármán (1881–1963) warned in an article published in 1955, entitled precisely "The Next Fifty Years," in which he cited the following prediction that had first appeared in a 1908 article in the journal *Engineering News:* "It is impossible to imagine that the air transport of cargo and passengers could enter into competition with surface transport. The field of navigation is therefore limited to military and sporting applications; while the latter are almost certain, those of the military are still questionable." (von Kármán [1955] 1975, 325).

In any case, there are many examples that show that it is indeed safer to make technological, rather than scientific, predictions. One source of significant predictions that refer to the digital world in which we live, the medium of the so-called information and globalisation society, is Nicholas Negroponte (b. 1943), founder and director of the Media Lab at the Massachusetts Institute of Technology, where he has been a professor since 1966. In 1995, he published a book — *Being Digital* — which, in retrospect, was spot on regarding much of what was to come. He wrote that, "As we interconnect with each other, many of the values of a nation-state will give way to those of both larger and smaller electronic communities. We will socialize in digital neighbourhoods in which physical space will be irrelevant and time will play a different role." (Negroponte 1995, 5). He also asserted that, "In the next millennium, we will find that we are talking as much or more with machines than we are with humans […]

Miniaturization will make this omnipresence of speech progress faster than in the past. Computers are getting smaller and it is very likely that tomorrow we will be wearing on our wrists what today we have on our desks and what yesterday took up an entire room." (Ibid., 176–177). Furthermore that:

> "The next decade will see cases of intellectual-property abuse and invasion of our privacy. We will experience digital vandalism, software piracy and data thievery. Worst of all, we will witness the loss of many jobs to wholly automated systems, which will soon change the white-collar workplace to the same degree that it has already transformed the factory floor. The notion of lifetime employment at one job has already started to disappear [...] As we move toward such a digital world, an entire sector of the population will be or feel disenfranchised. When a fifty-year-old steelworker loses his job, unlike his twenty-five-year-old son, he may have no digital resilience at all. When a modern-day secretary loses his job, at least he may be conversant with the digital world and have transferable skills." (Ibid., 269–271).
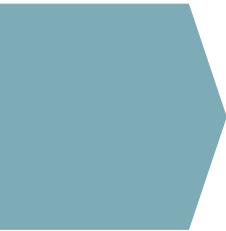
Predicting the contents of new scientific knowledge is logically impossible, because it makes has no sense to claim to already know the facts that we learn in the future. Predicting the details of future technology, by contrast, is only difficult

Naturally, not all of his predictions have proved correct — *or at least, not yet* — but, for many others, our only objection can that the future he imagined arrived sooner than he assumed it would.

Another example is provided by Eric Drexler, whom I have already cited above. In *Engines of Creation* he predicted what most consider today to be the new, right-around-the-corner, scientific-technological revolution.[8] His book asserts that, "Advancing technology may end or extend life, but it can also can change its quality. Products based on nanotechnology will permeate the daily lives of people who choose to use them. Some consequences will be trivial; others may be profound." (Drexler 1993, 304–305). He continues:

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8. In this respect, see a recent book by Mark Stevenson, *An Optimist's Tour of the Future*, where one can read: "It may sometimes sounds like science fiction. But it could radically reshape our future." (2011, 112). Nanotechnology and nanoscience deal with phenomena that are usually on the scale of 1 to 100 nanometres, with one nanometre being equal to a billionth of a metre (10^{-9} metres).

"Some products have effects as ordinary as simplifying housekeeping (and so substantial as reducing the causes of domestic quarrels). It should be no great trick, for example, to make everything from dishes to carpets self-cleaning, and household air permanently fresh. For properly designed nanomachines, dirt would be food.

Other systems based on nanotechnology could produce fresh food – genuine meat, grains, vegetables, and so forth – in the home, year-round. These foods result from cells growing in certain patterns in plants and animals; cells can be coaxed to grow in these same patterns elsewhere. Home food growers will let people eat ordinary diets without killing anything. The animal rights movement (the forerunner of a movement to protect all conscious, feeling entities?) will be strengthened accordingly.

Nanotechnology will make possible high-resolution screens that project different images to each eye; the result will be three-dimensional television so read that the screen seems like a window into another world [...] Nanotechnology will make possible vivid art forms and fantasy worlds far more absorbing than any book, game or movie.

Advanced nanotechnology will make possible a whole world of products that will make modern conveniences seem inconvenient and dangerous. Why should objects not be lightweight, flexible, durable and cooperative? Why can the walls not look like we want and transmit only the sounds we want to hear? Why should buildings and cars crush or roast their occupants? For those who so desire, the environment of daily life can resemble some of the most extravagant descriptions found in science fiction."

Something similar could be — and is — said about the role of nanotechnology in the medicine of the future.[9]

Although Drexler became one of the major prophets of nanotechnology, the true pioneer of the thought that led to it was one of the greatest physicists of the nineteenth century – one particularly loved and admired by his colleagues – Richard Feynman (1918–1988). In a lecture entitled "There's Plenty of Room at the Bottom," delivered at the annual meeting of the American Physical Society on 29 December 1959 (twenty-seven years before Drexler published *Engines of Creation)*, Feynman alerted scientists to the possibility of and interest in working on dimensions that were much smaller than were common at the time.[10] His lecture began as follows:

"I would like to describe a field in which little has been done, but in which an enormous amount can be done in principle. This field is not quite the same as the

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9. For a recent example, see Grossman (2012).
10. The meeting took place at the California Institute of Technology, where Feynman working, and it was published (Feynman 1960) in *Engineering and Science*, a quarterly journal founded in 1937 by Caltech's Public Relations Office to promote science.

others in that it will not tell us much of fundamental physics (in the sense of, "What are the strange particles?") but it is more like solid-state physics in the sense that it might tell us much of great interest about the strange phenomena that occur in complex situations. Furthermore, a point that is most important is that it would have an enormous number of technical applications. What I want to talk about is the problem of manipulating and controlling things on a small scale." (Feynman 1960, 22).

The scales considered by Feymann reached the atomic level: "I am not afraid to consider the final question as to whether, ultimately — in the great future — we can arrange the atoms the way we want; the very *atoms*, all the way down! What would happen if we could arrange the atoms one by one the way we want them (within reason, of course; you can't put them so that they are chemically unstable, for example)." (Ibid., 34).

Arranging atoms one at a time is just what nanotechnology has done and it is its very foundation. Of course in order to achieve this, there was something needed that Feynman also asked for in his lecture: microscopes that were better than the electronic ones then available. And they did arrive: in 1981, two physicists working at IBM laboratories in Zurich — Gerd Binning and Heinrich Roher — developed the scanning tunnelling microscope, an instrument that can image surfaces at atomic level. Without it, nanotechnology would still be a vague, barely defined dream, as it was when Feynman gave his famous lecture. And without him, Drexler could not have written his book.

These facts lead us to the following observation: even though technological predictions may be more certain, they need a scientific basis: Drexler's predictions about nanotechnology needed quantum mechanics and the scanning tunnelling microscope, while Negroponte's required quantum mechanics and the transistor. Therefore we can understand predictions that in our modern era of mobile phones amaze us, such as the one ventured in 1897 by William Edward Ayrton (1847–1908), Professor of Electrical Engineering and Applied Physics from 1884 until his death. He spoke at the City Guilds Central Technical College in London, before the British Imperial Institute:

"There is no doubt that the day will come, maybe when you and I are forgotten, when copper wires, gutta-percha coverings, and iron sheathings will be relegated to the Museum of Antiquities. Then, when a person wants to telegraph to a friend, he knows not where, he will call an electromagnetic voice, which will be heard loud by him who has the electromagnetic ear, but will be silent to everyone else. He will call "Where are you?" and the reply will come, "I am at the bottom of the coal-mine" or "Crossing the Andes" or "In the middle of the Pacific." (Ayrton 1884: 548, quoted in Marvin 1988, 157).
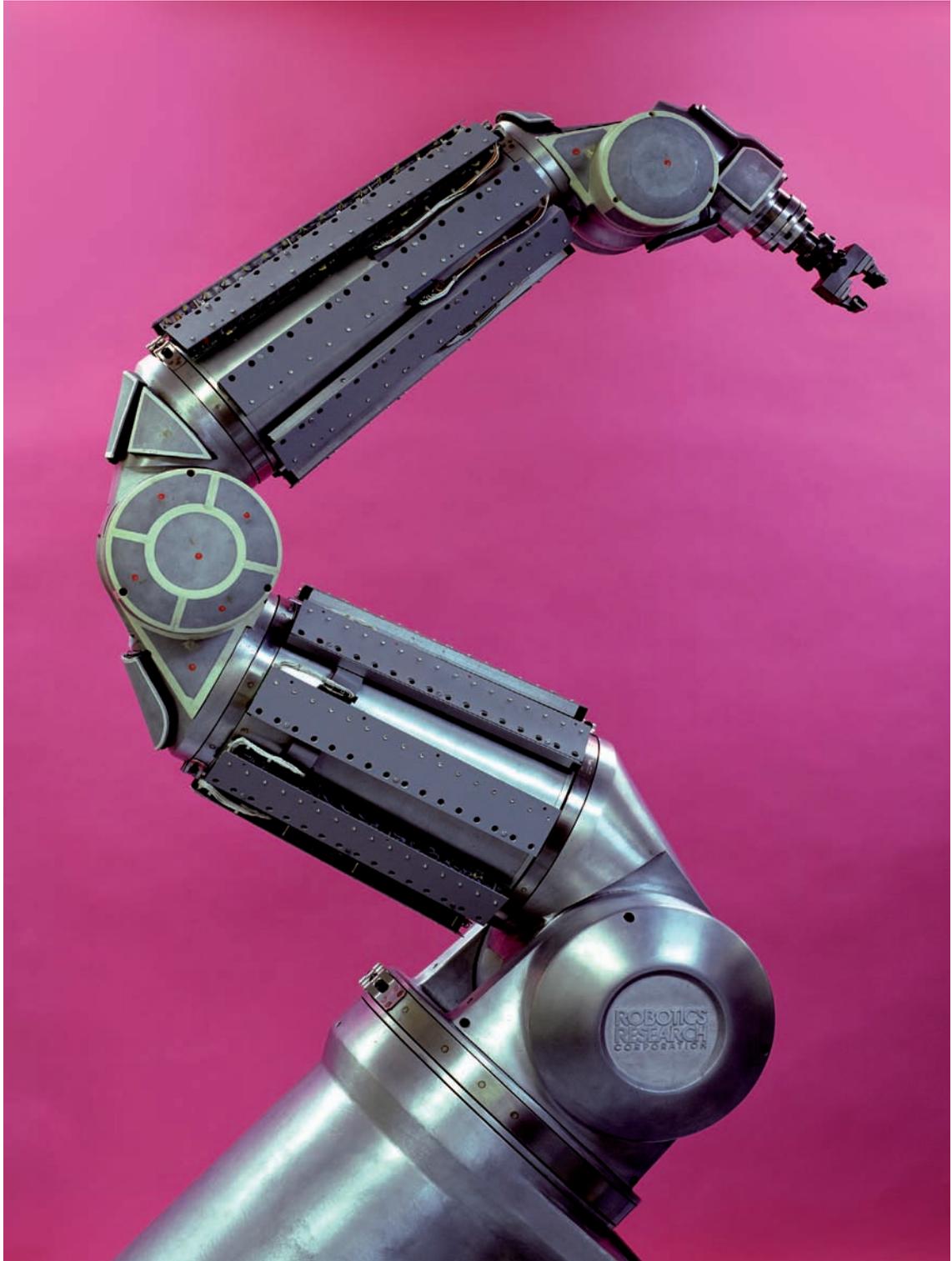
Peter Frasier, *Deep Blue, Robotic Arm CK Airbrush,* 1997

In fact, Ayrton's speculations were based on the support provided him by the new, electromagnetic world that had emerged from the work of Faraday, Maxwell and Marconi, among others.

SCIENCE VERSUS TECHNOLOGY

Before we continue — and since I have been talking about *technological* predictions when my initial intentions were to address *scientific* predictions — the intimate relationship between science and technology should be highlighted. It is possible to provide much evidence in favour of such a connection, which is often underestimated, arguing that the former is the *basic science* that, when applied, becomes *technology (applied science),* a connection which — if true — would make technology subordinate to science. But this is not the case, at least, not always. An authoritative example of this is that of thermodynamics: the branch of physics that deals with heat exchanges. Thermodynamics was born largely as a reflection on the functioning and possible improvement of the steam engines that led to the Industrial Revolution (see the classical work published by Sadi Carnot in 1824: *Réflexions sur la puissance motrice du feu et sur les machines propres a développer cette puissance*).

Among those who understood the dual and dynamic relationship between science and technology is William Thomson (1824–1907), better known as Lord Kelvin. He passed with fortune and pleasure through both domains, improving each. In a lecture at the Institution of Civil Engineers on 3 May 1883, Thomson noted: "There cannot be a greater mistake than that of looking superciliously upon the practical application of science. The life and soul of science is its practical application, and just as the great advances in mathematics have been made through the desire of discovering the solution of problems which were of a highly practical kind in mathematical science; so in physical science many of the greatest advances that have been made from the earnest desire to turn the knowledge of the properties of matter to some purpose useful to mankind." (1891, 86–87).

Translated into the question of whether technological predictions may have an effect on the future of science, I would have to say yes, they can have positive effects. The development of visionary technology programmes could entail having to solve unforeseen scientific problems, which benefits science. In the case of nanotechnology, for example, its development helps drive the study of macroscopic quantum effects, which for decades has barely been addressed.

A LONG-CHERISHED DREAM: ARTIFICIAL INTELLIGENCE

One of the oldest dreams that have long been cherished by humanity is that of creating intelligent machines (robots or otherwise). In his *Ars Magna* (1315), Ramon Llull (1232–1315) expressed the idea that reasoning could be artificially implemented in a machine; and how can one forget the efforts of Charles Babbage (1791–1871), who designed the first programmable machine even if despite his efforts he was never able to build one that worked satisfactorily? However, I will not hark back that far and instead I will limit myself to recalling some of the ideas and predictions of three of the most outstanding scientists of the twentieth century: Norbert Wiener (1894–1964), John von Neumann (1903–1957) and Alan Turing (1912–1954).

In an article published in 1936, Turing introduced the so-called "Turing machine," a theoretical contraption from which is derived the "universal Turing machine," a Turing machine that can emulate any other Turing machine. If there is any hope of getting machines to be "intelligent" in the sense that their reasoning and the results provided are indistinguishable from those of humans, these will be some type of computer and — since their operation is ultimately based on the Turing machine models — we can see that Turing certainly had something to do with the field of artificial intelligence.

Meanwhile, one of John von Neumann's many achievements was in the field of computers, to which he contributed with fundamental ideas on storage devices for instructions and data ("von Neumann architecture") that are used by almost all computers. He put these ideas into practice, contributing to the efforts that led to the construction (1944–1945) of ENIAC (Electronic Numerical Integrator and Computer), and then subsequently directing the design and manufacture of another computer — JOHNNIAC — which became operational in 1952. Another of von Neumann's contributions, which he presented in a lecture at Princeton in 1948, was an axiomatic theory of self-reproduction ("The General and Logical Theory of Automata"), general enough to encompass both organisms and machines (von Neumann [1948] 1966).

As for Norbert Wiener, surely it would suffice to say that he is known as the "father of cybernetics" (Wiener 1948), a discipline that can be defined as "the science of communications and automatic control systems in both machines and living things".

With these shallow and incomplete introductions out of the way, let us look at some of the predictions made by these three scientists in chronological order, starting with von Neumann. To do this, we will make use of the valuable testimony of the physicist and mathematician permanently installed at the Institute for Advanced Study in Princeton, Freeman Dyson (b. 1923). In an article devoted precisely to the future of science, Dyson (2011) recalled some of the Hungarian mathematical genius's ideas on the future of computers, taking advantage of the fact that he was at the Princeton Institute in the 1940s and 1950s when von Neumann was working on computers. Dyson noted that one of the aspects of computers of most interest to

von Neumann was their application to meteorology, and that he thought that as soon as atmospheric fluid dynamics could be simulated on a computer with sufficient accuracy, it would be possible to determine if the weather situation at a given time was stable or unstable. If it were stable, its future evolution could be predicted and, if unstable, it would be possible to introduce small perturbations to control its subsequent behaviour, e.g. via aircraft carrying smoke generators that could warm or cool the atmosphere. However, this prediction by von Neumann turned out to be completely erroneous for the simple reason — unknown at the time — that weather systems are chaotic in the sense discovered by Edward Lorenz (1917–2008) in 1963: small perturbations like those von Neumann sought to introduce into the atmosphere would only make their future behaviour even more unpredictable (let us recall that famous line by Lorenz, "The flap of a butterfly's wings in Brazil can set off a tornado in Texas.").[11] In other words, the future progress of science can ruin our predictions, including those of such outstanding scientists as von Neumann.

Another failed prediction by the Hungarian mathematician from Princeton referred to the size and number of future computers. He thought they would become increasingly larger and more expensive. He stated: "It is possible that in later years the machine sizes will increase again, but it is not likely that 10 000 (or perhaps a few times 10 000) switching organs will be exceeded as long as the present techniques and philosophy are employed. To sum up, about 10^4 switching organs seem to be the proper order of magnitude for a computing machine." (von Neumann 1948: 13, cited in Dyson. 2012, 303). According to one story — probably apocryphal — he was once asked how many computers would be needed in the US in the future, to which he replied, "Eighteen." I need not dwell on how wrong he was. The transistor dramatically changed the size, price and potential of the old vacuum tube computers: in 2010 one could buy a computer with a billion transistors (i.e., $10\,000 \cdot 10^5$). And it should not go unnoticed that the transistor was invented by John Bardeen, Walter Brattain and William Shockley in 1947 — during von Neumann's lifetime, when he was working on computers. Consequently, it is not only the future advances in science that can ruin our predictions, it is also quite possible that we do not know how to appreciate the consequences of developments that take place right next to us and during our own lifetime.

More aware of the possibilities opened up by the new electronics was Norbert Wiener who, in an informative book that was published in 1950 — *The Human Use of Human Beings* — predicted that monitoring equipment and, in particular, electronics that worked by feedback

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11. Actually, the original phrase is somewhat different: "Predictability: Does the flap of a butterfly's wings in Brazil set off a tornado in Texas?." It appeared as the title for the first part of a conference given on 29 December 1972 in a session on the Global Atmospheric Research Program as part of the 139th Meeting of the American Association for the Advancement of Science. It was distributed as a press note and was only published a number of years later as an appendix to a book that Lorenz wrote, entitled *The Essence of Chaos* (Lorenz 1993).

processes would lead to a second industrial revolution within just a few years. In a later article, he explained: "This second revolution would differ from the great industrial revolution at the beginning of the 19th century which replaced power as generated by men and by draft animals by the power of the machine; the second industrial revolution would replace human discrimination in its low levels by a discrimination initiated by mechanical sense organs and carried out by the mechanical equivalent of brains – that is, by machines made up of consecutive switching devices mostly of electronic character." (Wiener 1953; Masani 1985, 666). As the machines that he was thinking of were digital ("Electronic computers are particularly adapted to the scale of two" he wrote in the same article), there is no doubt that, although he could not imagine the specifics, Wiener foresaw the digital revolution we have been living for some time. Nevertheless, he was very wary of imagining that the growing skills of these electronic machines could be confused with the skills of humans: "[There is a] great obstacle to the extension of the mechanical age of communication and the automatic age of control to fields involving what used to be known as the 'higher human faculties'. It does not mean that there is anything absolutely different in nature between the human and the non-human, but merely that the performance of a non-human link in human relations can only be evaluated in human terms." (Wiener 1953; Masani 1985, 670–671).

Less cautious was Turing, who ventured to make a statement about when it could be argued that machines that actually thought had been built. The appropriate reference in this regard is an article he published in 1950 in the philosophy journal *Mind*, entitled "Computing Machinery and Intelligence" (Turing 1950), in which he wrote:

"I believe that in about fifty years' time it will be possible to programme computers, with a storage capacity of about 10^9, to make them play an imitation game so well that an average interrogator will not have more than 70 percent chance of making the right identification after five minutes of questioning. The original question, 'Can machines think?' I believe to be too meaningless to deserve discussion. Nevertheless I believe that at the end of the century the use of words and general educated thinking will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted." (Copeland 2004, 449).[12]

More than sixty years after Turing wrote his article, machines that think like humans have not yet arrived, but he was cautious enough for us to accept that there are now machines that approach having intelligence to the extent he had suggested. In my opinion, there is no doubt that, with their work and their predictions, von Neumann and particularly Turing and Wiener

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12. The "imitation game" to which he was referring consisted of having someone confront the problem of determining whether what was responding to his questions was a machine or a person. Naturally, he could not observe either of them directly, only their responses.

favoured not only the arrival of modern computers, but also the establishment of "artificial intelligence" (a term coined in 1955 by John McCarthy) as a field of great interest. In this sense, they influenced the future.

SOCIAL NEEDS AND PREDICTING THE FUTURE

There is probably no safer way to make a prediction about the future than by identifying current acute needs that must be resolved in the years or decades to come with the help of science and technology. An outstanding example of this type of prediction is provided by the aforementioned Freeman Dyson in his book *The Sun, the Genome, and the Internet* (1999), which was the outcome of a series of lectures he gave at the New York Public Library in the spring of 1997. Its central theme was "a model of the future whose driving forces are the Sun, the Genome and the Internet" (Dyson 2000, 17). Actually, they were not difficult predictions: as the twentieth century came to an end, it was obvious that the on-going molecular-biological revolution — the revolution of the double helix of the DNA, of recombinant DNA, the genome, cloning and stem cells — would radically alter our chances to influence living organisms (it was already doing so). In fact, before this scientific knowledge, thought was given to what advances in the biomedical sciences might mean for human nature and the mechanisms of reproduction. A well-known example is that of the novel by Aldous Huxley (1894–1963), *Brave New World* (1932), which describes a future world made up of immutable castes resulting from progress in the fields of biology, psychology and physiology. When one reads Huxley's subsequent book, *Brave New World Revisited*, in which he reviewed his predictions of 26 years earlier, one can see how — thanks to our knowledge of the genome — we are getting much closer to being able to do what, in 1931, Huxley assumed could be done:

> "In the Brave New World of my fantasy eugenics and dysgenics were practiced systematically. In one set of bottles biologically superior ova, fertilized by biologically superior sperm, were given the best possible prenatal treatment and were finally decanted as Betas, Alphas and even Alpha Pluses. In another, much more numerous set of bottles, biologically inferior ova, fertilized by biologically inferior sperm, were subjected to the Bokanovsky Process (ninety-six identical twins out of a single egg) and treated prenatally with alcohol and other protein poisons. The creatures finally decanted were almost subhuman; but they were capable of performing unskilled work and, when properly conditioned, detensioned by free and frequent access to the opposite sex, constantly distracted by gratuitous entertainment and reinforced in their good behaviour patterns by daily doses of soma, could be counted on to give no trouble to their superiors." (1958, Chapter II)
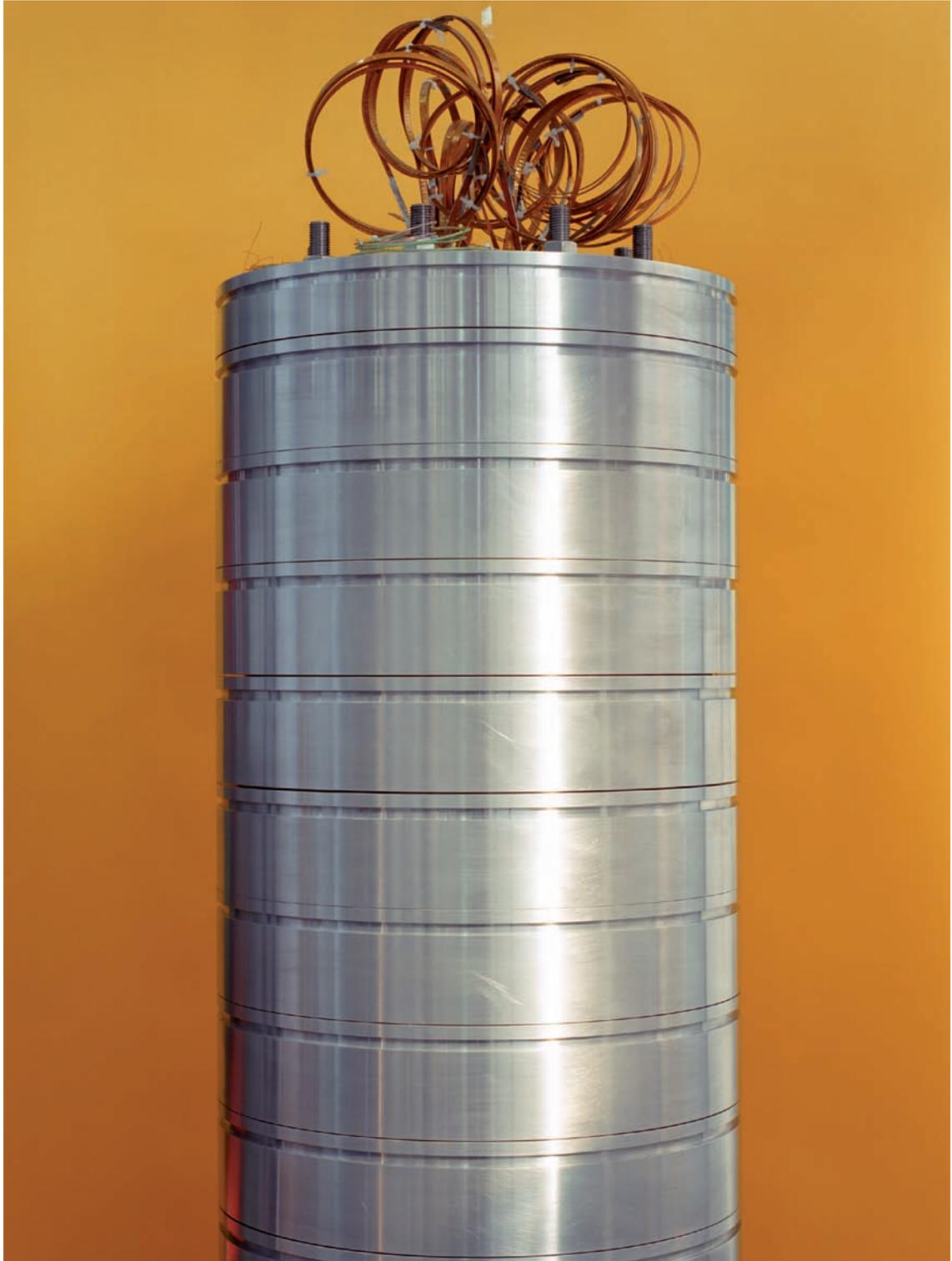
Peter Frasier, *Deep Blue, Super-Conducting Magnet,* 1997

Fortunately, though, instead of Betas, Alphas, Alphas Pluses or nearly subhuman beings, the science of molecular biology speaks of genetic engineering or gene therapies with very different goals.

By the late twentieth century, it was clear that the Internet was an unstoppable wave that would radically alter our ways and possibilities. Equally obvious was the need for future energy resources that would replace coal and oil, and that the radiation emitted by the Sun was the obvious and safer replacement. In fact, this is something that had been understood much earlier. In a paper published in 1876 in the Revue des Deux Mondes — translated into English soon after for *Popular Science Monthly* — Louis Laurent Simonin (1830–1886), Professor of Geology stated: "Future generations, after the coal-mines have been exhausted, will have recourse to the sun for the heat and energy needed in manufacture and in domestic economy." (Simonin 1876, 557–558). Simonin described a steam engine model that could apparently produce these effects, bar one that is now essential for us: the production of electricity from sunlight by means of cells and solar panels based on the photoelectric effect explained by Einstein in 1905.

Similarly, but now speaking explicitly of electricity, the British geneticist and evolutionary biologist John B. S. Haldane (1892–1964) wrote in his 1923 work, *Daedalus, or Science and the Future*:

> "As for providing mechanical strength, it is obvious that the exhaustion of our coal and our oil is only a matter of centuries [...]. Water power is not a probable substitute, on account of its small quantity, seasonal and sporadic distribution. It may perhaps, however, shift the centre of industrial gravity to well-watered mountainous tracts such as the Himalayan foothills, British Columbia, and Armenia: Ultimately we shall have to tap those intermittent but inexhaustible sources of power, the wind and the sunlight. The problem is simply one of storing their energy in a form as convenient as coal or petrol [...]. Even to-morrow a cheap, fool-proof, and durable storage battery may be invented, which will enable us to transform the intermittent energy of the wind into continuous electric power.
>
> Personally, I think that four hundred years hence the power question in England may be solved somewhat as follows: The country will be covered with rows of metallic windmills working electric motors which in their turn supply current at a very high voltage to great electric mains. At suitable distances, there will be great power stations where during windy weather the surplus power will be used for the electrolytic decomposition of water into oxygen and hydrogen. These gases will be liquefied, and stored in vast vacuum jacketed reservoirs, probably sunk in the ground. [...] In times of calm, the gases will be recombined in explosion motors working dynamos which produce electrical energy once more, or more probably in oxidation cells. Liquid

hydrogen is weight for weight the most efficient known method of storing energy, as it gives about three times as much heat per pound as petrol." (Haldane 2005, 41).

Wind turbines — the electricity-producing windmills Haldane thought of — are increasingly common across the world, and perhaps (or so some say) in the not-very- distant future, hydrogen will also be a widely used source of energy.

We might also recall a book that was very successful when it was published in 1964 — *Engineers' Dreams* — by frustrated rocket engineer (and subsequent science writer) Willy Ley (1906–1969). One of the dreams Ley addressed was "power from the sun." He wrote that: "Making gasoline out of sunshine is a procedure requiring three major steps along with the three basic raw materials. Step no. 1 would be the familiar one of converting sunshine into electric current by means of collectors, boilers, and generators. Step no. 2 would be the use of the electric current for decomposing water into its two constituent elements, hydrogen and oxygen. Step no. 3 would be the conversion of the hydrogen into the substance known to chemists as hydrocarbons (gasoline is one of them), taking the carbon from the carbon dioxide of the air." (Ley 1964, 184–185). Most pertinently, he went on to say that: "Most of the difficulty lies in the third step, and the main reason for the difficulties is that there is so little carbon dioxide in the atmosphere — only 0.03 percent of the total. Since the known industrial chemical processes resulting in hydrocarbons require reasonable pure carbon dioxide to work well, it is first necessary to concentrate it out of the air. This is not difficult, merely tedious and expensive […] because the carbon-dioxide content of the air near the ground is only 0.003 percent (carbon dioxide is virtually absent higher up), a million cubic feet of air must be processed for every gallon of gasoline produced."

Today, we see the difficulty Ley mentioned very differently, taking into account the increase in the levels of carbon dioxide that has occurred in the atmosphere due to industrial processes and the massive use of automobiles. Any procedure to remove carbon dioxide from the atmosphere is welcome and encouraged. At times our predictions about the future are thus affected.

SCIENCE FICTION AND SCIENCE OF THE FUTURE

The term "science fiction" has appeared but a couple of times in this article. In principle, this is reasonable because the predictions that appear in works of science fiction need not be scientific, and they may go beyond what is easily imaginable regardless of whether implementation may be near, far away or impossible. For example, the highly celebrated Jules Verne (1828–1905) and H. G. Wells (1866–1946) imagined spaceflight and submarines, alien

invasions and atomic weapons, but not an innovation such as the car, which would end up dominating virtually all societies. Despite all this, we must not underestimate this genre when analysing what was ventured in the past about the scientific future.[13] Consider, for example, that the physicist and one of the pioneers and promoters of a nuclear project in the late 1930s and first half of 40s, Leo Szilard (1898–1964), read Wells' 1914 novel, *The World Set Free,* the first work to predict atomic bombs. The physicist read the book in 1932, the year the neutron was discovered and one year before he himself would have the idea of a chain reaction that would produce an atomic explosion. Indeed, the utility of at least some works of science fiction can be defended, drawing on what many consider the first modern novel of the genre: *Frankenstein, or, the Modern Prometheus* by Mary Wollstonecraft Godwin, better known as Mary Shelley (1797–1851). I will quote and comment on the following passage in which Victor Frankenstein — the novel's main protagonist — reflects in the following terms:

> "When I found so astonishing a power placed within my hands, I hesitated a long time concerning the manner in which I should employ it. Although I possessed the capacity of bestowing animation, yet to prepare a frame for the reception of it, with all its intricacies of fibres, muscles, and veins, still remained a work of inconceivable difficulty and labour. I doubted at first whether I should attempt the creation of a being like myself, or one of simpler organization; but my imagination was too much exalted by my first success to permit me to doubt of my ability to give life to an animal as complex and wonderful as man. The materials at present within my command hardly appeared adequate to so arduous an undertaking, but I doubted not that I should ultimately succeed. I prepared myself for a multitude of reverses; my operations might be incessantly baffled, and at last my work be imperfect, yet when I considered the improvement which every day takes place in science and mechanics, I was encouraged to hope my present attempts would at least lay the foundations of future success." (Wollstonecraft-Shelley 1831).

The point I want to make is that scientists should read passages like this one (just like others in the aforementioned *Brave New World*, which has become current due to the development of molecular biology and the possibilities that this has opened up — genetic engineering, cloning), because they raise social issues that, while addressed by researchers, taken on different, deeper dimensions when addressed by great writers. And it is not just about social or ethical issues, but also about being able — as perhaps was the case of Wells — to present possibilities to scientists so that they ask themselves questions about their scientific

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13. On science fiction and the history of science, see Westfahl (2003).

basis, whether they are possible, or merely speculations without any further justification other than literary.

The last example I will offer is that of the novel by Isaac Asimov (1920–1992), *I, Robot* (1950). The famous Three Laws of Robotics that he included in this work may be a good guide if the predictions about robots with artificial intelligence come true:

"1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.

2. A robot must obey the orders given to it by human beings, except where such orders would conflict with the First Law.

3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws."

INTERDISCIPLINARITY AND SMALL SCIENCE

To finish, I will go somewhat beyond the role that I have tried to adopt throughout this article: the role of the notary who reflects on what has happened in the past with respect to scientific and technological predictions, a notary who makes — of course — comments here and there and tries to guide his clients. Now I am going to make a personal reading of what the history of science says about what scientific research will be like in the future, not the developments it will produce, but rather how scientific research itself will be carried out.

There are two guidelines that I believe will — with increasing intensity — lead science throughout this century and those to come. The first is *interdisciplinarity*, the meeting of groups of experts — not necessarily very numerous — in different scientific and technological disciplines who, provided with enough general knowledge to be able to understand each other, will collaborate to resolve new problems, problems that, by their nature, require this kind of collaboration. Remember that nature is one and recognises no borders. We are the ones who have established borders for practical reasons, constituting disciplines we call physics, chemistry, biology, mathematics, geology, and so on. But as we advance in our knowledge of nature, it becomes increasingly necessary to go beyond these boundaries and to become citizens of interdisciplinarity.[14]

The second guideline is what I call "Small Science" (as opposed to "Big Science"). This means research based on smaller groups compared to the colossal Big Science projects of the past 75 years, such the high energy experimental physics projects with their giant accelerators,

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14. I have written a book addressing these issues (Sánchez Ron 2011).

NASA's planetary research or the Human Genome Project in its initial design. Big Science is too expensive and too slow, even though interesting results can be obtained. Consider, for example, high-energy physics. Clearly, with large particle accelerators, we have made fundamental progress in our knowledge of the structure of matter, but it is no less obvious that fewer and fewer countries are able to afford their costs. The most powerful nation in terms of science and technology, the US, which had pioneered the construction of these accelerators, was also the

> **There are two guidelines that I believe will — with increasing intensity — lead science throughout this century and those to come. The first is *interdisciplinarity*, [...] The second guideline is what I call "Small Science" (as opposed to "Big Science"). This means research based on smaller groups compared to the colossal Big Science projects of the past 75 years**

first to realise the difficulties of this kind of research, cancelling the project for a Superconducting Super Collider that US high-energy physicists believed essential to continuing the development of the standard model. It was going to consist of an 84-metre-long tunnel, inside which thousands of superconducting magnetic coils would guide two proton beams so that, after millions of rounds, they would reach an energy twenty times higher than that achieved in existing accelerators. At various points along the ring, the protons of the two beams would collide, and huge detectors would monitor what happens. The cost of the project — which would have lasted ten years — was initially estimated at 6 billion dollars. After an eventful life and with part of the infrastructure work already done (the excavation of the tunnel), on 19 October 1993, following a long, difficult and ever-changing congressional debate both in the House and the Senate, Congress cancelled the project. Europe is one of the enclaves in which this type of Big Science still exists, as shown in the Large Hadron Collider (LHC) at CERN, the pan-European institution dedicated to high-energy physics, which in 2012 has detected the much-pursued Higgs boson. But how much longer can Europe maintain this expense that stretches over decades in order to achieve results? Another manifestation of these difficulties is the delay, if not the cancellation, of some of NASA's most beloved projects, such as sending astronauts to Mars. And also how projects much smaller than the Human Genome Project are obtaining better and faster results (it is true that this is thanks to the tools available, although it can be argued that the greater shortage of resources has encouraged small groups to devise faster and cheaper procedures). As Freeman Dyson has written (2011), "The future of science will be a mixture of large and small projects, with the large projects getting most of the attention and the small projects getting most of the results [...] As we move into the future, there is a tendency for the big projects to grow bigger and fewer. This tendency is particularly clear in particle

physics, but it is also visible in other fields of science, such as plasma physics, crystallography, astronomy, and genetics, where large machines and large databases dominate the scene. But the size of small projects does not change much as time goes on, because the size of small projects is measured in human beings […] Because the big projects are likely to become fewer and slower while the small projects stay roughly constant, it is reasonable to expect that the relative importance of small projects will increase with time."

Is this how it will be, or is this one more prediction that will not pass the test of time? Only the future, of course, will tell.

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Given the importance science has in our lives and societies, it is no small question to consider whether it is possible to predict the future of this discipline. Using the history of science as his main tool, Sánchez Ron analyses predictions made by a number of scientists about the nature of science and its future paths. Providing a wealth of examples from those who have practised this soothsayers' art, the author chooses cases that range from almost unremarkable predictions to those that missed the mark entirely, including predictions in mathematics (Hilbert), the theory of evolution (Erasmus and Charles Darwin) and artificial intelligence (Wiener, Von Neumann and Turing). The author also explores the relationship between science and technology, as well as addressing issues such as how social needs or science fiction affect predictions of the future of science.

BIOGRAPHY

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José Manuel Sánchez Ron (Madrid, 1949) graduated in Physics from the Universidad Complutense de Madrid (1971) and holds a PhD in Physics from the University of London (1978). Since 1994, he has been Professor of the History of Science at the Department of Theoretical Physics at the Universidad Autónoma de Madrid, where he previously held the post of Professor of Theoretical Physics from 1983 to 1994.

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In 2001 he received the Villa de Madrid's Premio José Ortega y Gasset de Ensayo y Humanidades, awarded for his book *El siglo de la ciencia* (Taurus, 2000). In 2004, he won a Casa de las Ciencias de La Coruña's Prisma award for the best scientific article published in 2003 for "¿Para qué la ciencia?" published in El País. In 2011, he was honoured with the Premio Internacional de Ensayo Jovellanos for his manuscript *La Nueva Ilustración: ciencia, tecnología y humanidades en un mundo interdisciplinar,* which was subsequently published by Ediciones Nobel (2011).

Sánchez Ron is the author of more than 400 publications, including 40 books.
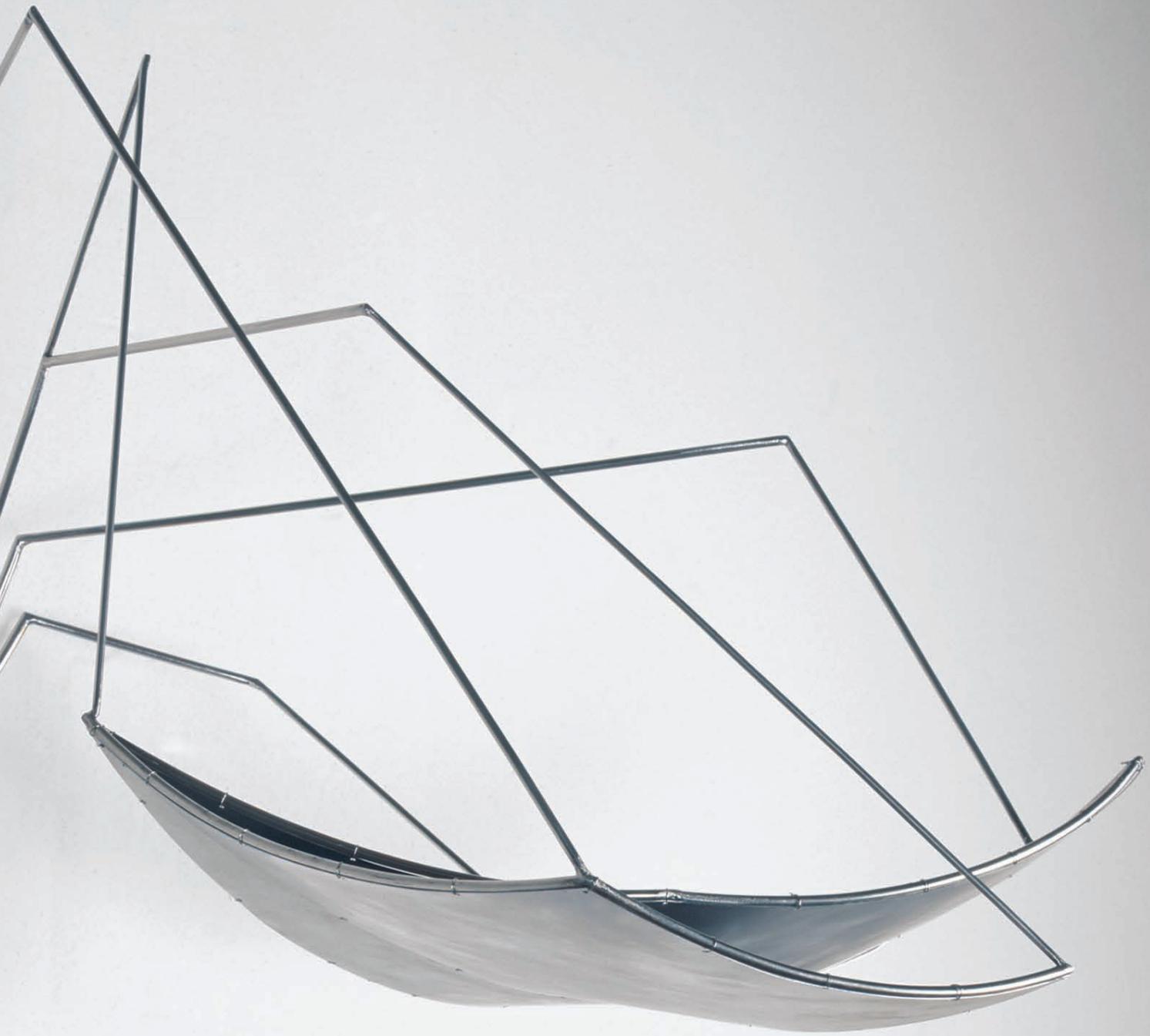
The Future of Artificial Intelligence and Cybernetics

Kevin Warwick

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INTRODUCTION

Science fiction has, for many years, looked to a future in which robots are intelligent and cyborgs — human/machine amalgams — are commonplace: *The Terminator*, *The Matrix*, *Blade Runner* and *I, Robot* are all good examples of this. However, until the last decade any consideration of what this might actually mean in the future real world was not necessary because it was all science fiction and not scientific reality. Now, however, science has not only done a catching-up exercise but, in bringing about some of the ideas thrown up by science fiction, it has introduced practicalities that the original story lines did not appear to extend to (and in some cases have still not extended to).

What we consider here are several different experiments in linking biology and technology together in a cybernetic fashion, essentially ultimately combining humans and machines in a relatively permanent merger. Key to this is that it is the overall final system that is important. Where a brain is involved, which surely it is, it must not be seen as a stand-alone entity but rather as part of an overall system, adapting to the system's needs: the overall combined cybernetic creature is the system of importance.

Each experiment is described in its own section. Whilst there is a distinct overlap between the sections, they each throw up individual considerations. Following a description of each investigation, some pertinent issues on the topic are therefore discussed. Points have been raised with a view to near term future technical advances and what

these might mean in a practical scenario. It has not been the case of an attempt here to present a fully packaged conclusive document; the aim has rather been to open up the range of research being carried out, to see what is actually involved and to look at some of its implications.

BIOLOGICAL BRAINS IN A ROBOT BODY

We start by taking a look at an area that might not immediately be at all familiar to the reader. Initially when one thinks of linking a brain with technology then it is probably in terms of a brain already functioning and settled within its own body — could there possibly be any other way? Well in fact there can be! Here we consider the possibility of a fresh merger where a brain is firstly grown and then given its own body in which to operate.

When one first thinks of a robot it may be a little wheeled device that springs to mind (Bekey 2005) or perhaps a metallic head that looks roughly human-like (Brooks 2002). Whatever the physical appearance, our thoughts tend to be that the robot might be operated remotely by a human, as in the case of a bomb disposal robot, or it may be controlled by a simple computer programme, or may even be able to learn with a microprocessor as its technological brain. In all these cases we regard the robot simply as a machine. But what if the robot has a biological brain made up of brain cells (neurons), possibly even human neurons?

Neurons cultured/grown under laboratory conditions on an array of non-invasive electrodes provide an attractive alternative with which to realise a new form of robot controller. An experimental control platform, essentially a robot body, can move around in a defined area purely under the control of such a network/brain and the effects of the brain, controlling the body, can be witnessed. Of course this is extremely interesting from a robotics perspective but it also opens up a new approach to the study of the development of the brain itself because of its sensory-motor embodiment. Investigations can in this way be carried out into memory formation and reward/punishment scenarios — the elements that underpin the basic functioning of a brain.

Growing networks of brain cells in vitro (around 100 000 to 150 000 at present) typically commences by separating neurons obtained from foetal rodent cortical tissue. They are then grown (cultured) in a specialised chamber, in which they can be provided with suitable environmental conditions (e.g. appropriate temperature) and nutrients. An array of electrodes embedded in the base of the chamber (a multielectrode array, MEA) acts as a bidirectional electrical interface to/from the culture. This enables electrical signals to be supplied to stimulate the culture and also for recordings to be taken as outputs from the culture. The neurons in such cultures spontaneously connect, communicate and develop within a few weeks,

giving useful responses for typically three months at present. To all intents and purposes, it is rather like a brain in a jar!

In fact the brain is grown in a glass specimen chamber lined with a flat '8x8' MEA which can be used for real-time recordings (see Figure 1). In this way, it is possible to separate the firings of small groups of neurons by monitoring the output signals on the electrodes. Thereby a picture of the global activity of the entire network can be formed. It is also possible to electrically stimulate the culture via any of the electrodes to induce neural activity. The MEA therefore forms a bidirectional interface with the cultured neurons (Chiappalone et al. 2007; DeMarse et al. 2001).

The brain can then be coupled to its physical robot body (Warwick et al. 2010). Sensory data fed back from the robot is subsequently delivered to the culture, thereby closing the robot–culture loop. Thus, the processing of signals can be broken down into two discrete sections: a) "culture to robot", in which live neuronal activity is used as the decision-making mechanism for robot control; and b) "robot to culture", which involves an input mapping process, from robot sensor to stimulate the culture.

The actual number of neurons in a brain depends on natural density variations in seeding the culture in the first place. The electrochemical activity of the culture is sampled and this is used as input to the robot's wheels. Meanwhile the robot's (ultrasonic) sensor readings are converted into stimulation signals received by the culture, thereby closing the loop.

Once the brain has grown for several days, which involves the formation of some elementary neural connections, an existing neuronal pathway through the culture is identified by searching
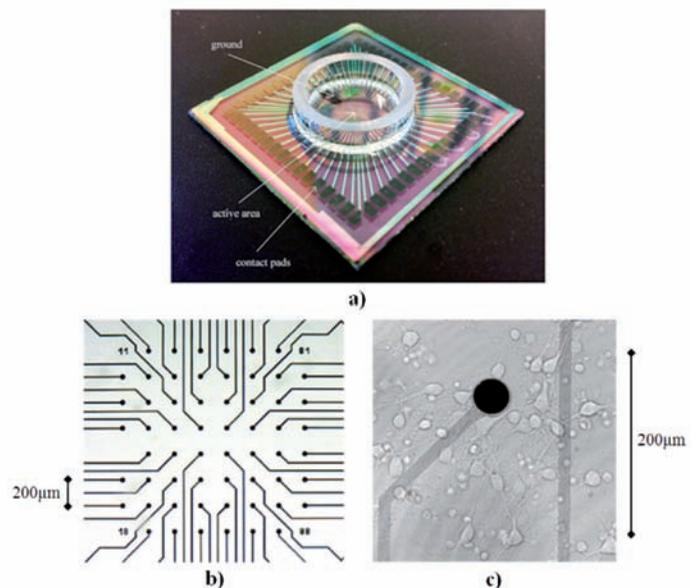
Figure 1. a) A MEA showing the electrodes. b) Electrodes in the centre of the MEA seen under an optical microscope. c) An MEA at x40 magnification, showing neuronal cells in close proximity to an electrode

for strong relationships between pairs of electrodes. Such pairs are defined as those electrode combinations in which neurons close to one electrode respond to stimulation from the other electrode at which the stimulus was applied more than 60 percent of the time and respond no more than 20 percent of the time to stimulation on any other electrode.

A rough input–output response map of the culture can therefore be created by cycling through all the electrodes in turn. In this way, a suitable input/output electrode pair can be chosen in order to provide an initial decision-making pathway for the robot. This is then employed to control the robot body — for example if the ultrasonic sensor is active and we wish the response to cause the robot to turn away from the object being located ultrasonically (possibly a wall) in order to keep moving.

For simple experimentation purposes at this time, the intention is for the robot (which can be seen in Figure 2) to follow a forward path until it reaches a wall, at which point the front sonar value decreases below a threshold, triggering a stimulating pulse. If the responding/output electrode registers activity, the robot turns to avoid the wall. In experiments, the robot turns
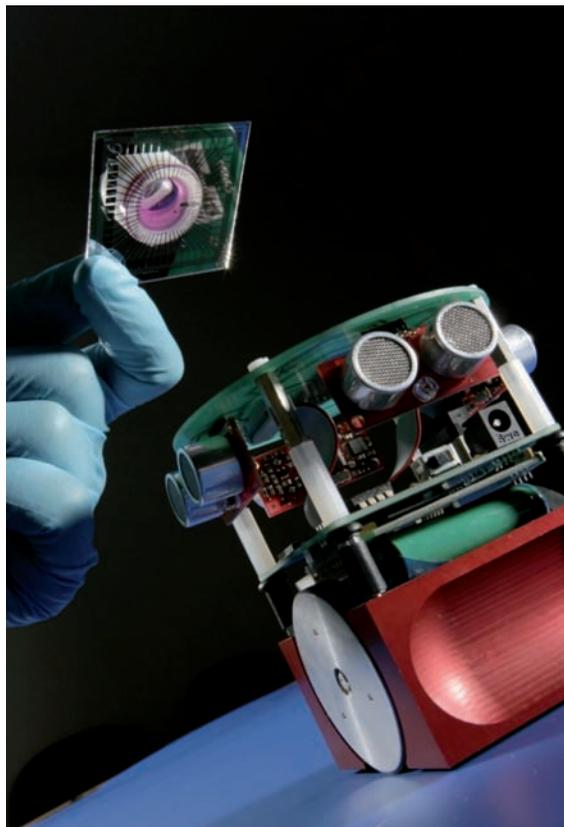
Figure 2. Wheeled robot body and brain together

spontaneously whenever activity is registered on the response electrode. The most relevant result is the occurrence of the chain of events: wall detection–stimulation–response. From a neurological perspective, it is of course also interesting to speculate on why there is activity on the response electrode when no stimulating pulse has been applied.

As an overall control element for direction and wall avoidance, the cultured brain acts as the sole decision-making entity within the overall feedback loop. Clearly one important aspect then involves neural pathway changes in the culture, with respect to time, between the stimulating and recording electrodes.

In terms of research, learning and memory investigations are generally at an early stage. However, the robot can be clearly seen to improve its performance over time in terms of its wall avoidance ability in the sense that neuronal pathways that bring about a satisfactory action tend to strengthen purely though the process of being habitually performed: learning due to habit.

However, the number of variables involved is considerable and the plasticity process, which occurs over quite a period of time, is (most likely) dependent on factors such as initial seeding and growth near electrodes as well as environmental transients such as temperature and humidity. Learning by reinforcement — rewarding good actions and punishing bad — is more in terms of investigative research at this time.

On many occasions, the culture responds as expected. On other occasions it does not, and in some cases it provides a motor signal when it is not expected to do so. But does it "intentionally" make a different decision to the one we would have expected? We cannot tell but merely guess.

In terms of robotics, it has been shown by this research that a robot can successfully have a biological brain with which to make its "decisions". The 100 000–150 000 neuron size is merely due to the present day limitations of the experimentation described. Indeed, three-dimensional structures are already being investigated. Increasing the complexity from two dimensions to three realises a figure of approximately 30 million neurons for the three-dimensional case, not yet reaching the 100 billion neurons of a perfect human brain, but well in line with the brain size of many other animals.

This area of research is expanding rapidly. Not only is the number of cultured neurons increasing, but the range of sensory inputs is being expanded to include audio, infrared and even visual stimuli. Such richness of stimulation will no doubt have a dramatic effect on culture development. The potential of such systems, including the range of tasks they could deal with, also means that the physical body could take on different forms. For example, there is no reason why the body could not be a two-legged walking robot, with a rotating head and the ability to walk around in a building.

It is certainly the case that understanding neural activity becomes more difficult as the culture size increases. With a three-dimensional structure, monitoring activity deep within the

central area, as with a human brain, becomes extremely complex, even with needle-like electrodes. In fact the current 100 000–150 000 neuron cultures are already far too complex at present for us to gain an overall insight. When they are grown to sizes such as 30 million neurons and beyond, clearly the problem is significantly magnified.

Looking a few years ahead, it seems quite realistic to assume that such cultures will become larger, potentially growing into sizes of billions of neurons. On top of this, the nature of the neurons may be diversified. At present, rat neurons are generally employed in studies. However, human neurons are also being cultured even now, thereby bringing about a robot with a human-neuron brain. If this brain then consists of billions of neurons, many social and ethical questions will need to be asked (Warwick 2010).
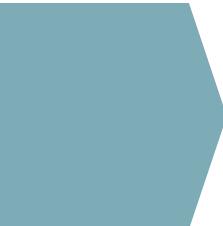
We regard the robot simply as a machine. But what if the robot has a biological brain made up of brain cells (neurons), possibly even human neurons?

For example, if the robot brain has roughly the same number of human neurons as a typical human brain, then could/should it have similar rights to humans? Also, what if such creatures have far more human neurons than in a typical human brain — e.g. a million times more — would they make all future decisions rather than regular humans? Certainly it means that as we look to the near future, we will shortly witness thinking robots with brains not too dissimilar to those of humans.

GENERAL PURPOSE BRAIN IMPLANTS

Many human brain–computer interfaces are used for therapeutic purposes, in order to overcome a medical/neurological problem — an example being the deep brain stimulation electrodes employed to overcome the effects of Parkinson's Disease (Pinter et al. 1999; Pan et al. 2007; Wu et al. 2010). However, even here it is possible to consider employing such technology in alternative ways to give individuals abilities not normally possessed by humans: human enhancement!

With more general brain–computer interfaces the therapy/enhancement situation is more complex. In some cases, those who have suffered an amputation or have suffered a spinal injury due to an accident may be able to regain control of devices via their (still functioning)

neural signals (Donoghue et al. 2004). Meanwhile, stroke patients can be given limited control of their surroundings, as indeed can those who have motor neurone disease.

With these cases, the situation is not straightforward, as each individual is given abilities that no normal human has — for example, the ability to move a cursor around on a computer screen using nothing but neural signals (Kennedy et al. 2004). The same quandary exists for blind individuals who are allowed extrasensory input, such as sonar (a bat-like sense). This doesn't repair their blindness but rather allows them to make use of an alternative sense.

Some of the most impressive human research to date has been carried out using the microelectrode array, as shown in Figure 3. The individual electrodes are 1.5 mm long and taper to a tip diameter of less than 90 microns. Although a number of trials using non humans as a test subject have occurred, human tests are at present limited to two groups of studies. In the second of these, the array has been employed in a recording only role, most notably recently as part of what was called the "BrainGate" system.

Essentially, electrical activity from a few neurons monitored by the array electrodes was decoded into a signal to direct cursor movement. This enabled an individual to position a cursor on a computer screen, using neural signals for control combined with visual feedback. The same technique was later employed to allow the individual recipient, who was paralysed, to operate a robot arm (Hochberg et al. 2006). However, the first use of the microelectrode array (shown in Figure 3) has considerably broader implications which extend the capabilities of the human recipient.

Deriving a reliable command signal from a collection of monitored neural signals is not necessarily a simple task, partly due to the complexity of signals recorded and partly due to the real-time constraints in dealing with the data. In some cases, however, it can be relatively easy to look for and obtain a system response to certain anticipated neural signals, especially when an individual has trained extensively with the system. In fact, neural signal shape, magnitude and waveform with respect to time are considerably different to other apparent signals (such as noise) and this makes the problem a little easier.

The interface through which a user interacts with technology provides a layer of separation between what the user wants the machine to do and what the machine actually does. This separation imposes a cognitive load on the individual concerned that is proportional to the difficulties experienced. The main issue is interfacing the human motor and sensory channels with the technology in a reliable, durable, effective and bidirectional way. One solution is to avoid this sensorimotor bottleneck altogether by interfacing directly with the human nervous system.

An individual human so connected can potentially benefit from some of the advantages of machine/artificial intelligence, for example rapid and highly accurate mathematical abilities in terms of "number crunching", a high-speed, almost infinite, internet knowledge base, and
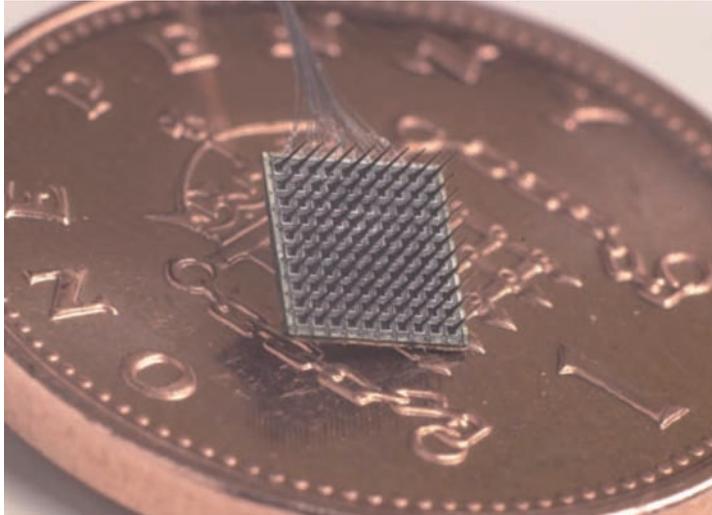
Figure 3. A 100 electrode, 4x4mm microelectrode array, shown
on a UK 1-pence piece for scale

accurate long-term memory. Additionally, it is widely acknowledged that humans have only five senses that we know of, whereas machines offer a view of the world which includes infrared, ultraviolet and ultrasonic signals, to name but a few.

Humans are also limited in that they can only visualise and understand the world around them in terms of three-dimensional perception, whereas computers are quite capable of dealing with hundreds of dimensions. Perhaps most importantly, the human means of communication, essentially transferring a complex electrochemical signal from one brain to another via an intermediate, often mechanical slow and error-prone medium (e.g. speech), is extremely poor, particularly in terms of speed, power and precision. It is clear that connecting a human brain, by means of an implant, with a computer network could in the long term open up the distinct advantages of machine intelligence, communication and sensing abilities to the implanted individual.

As a step towards a broader concept of brain–computer interaction, the microelectrode array (as shown in Figure 3) was implanted into the median nerve fibres of a healthy human individual (the author) during two hours of neurosurgery in order to test bidirectional functionality in a series of experiments. A stimulation current applied directly into the nervous system allowed information to be sent to the user, while control signals were decoded from neural activity in the region of the electrodes (Warwick et al. 2003). In this way, a number of trials were successfully concluded (Warwick et al. 2004), in particular:

1. Extrasensory (ultrasonic) input was successfully implemented (see Figure 4 for the experimentation).

2. Extended control of a robotic hand across the Internet was achieved, with feedback from the robotic fingertips being sent back as neural stimulation to give a sense of force being applied to an object (this was achieved between Columbia University, New York, USA and Reading University, UK).

3. A primitive form of telegraphic communication directly between the nervous systems of two humans (the author's wife assisted) was performed (Warwick et al. 2004).

4. A wheelchair was successfully driven around by means of neural signals.

5. The colour of jewellery was changed as a result of neural signals, as was the behaviour of a collection of small robots.

> **Many human brain-computer interfaces are used for therapeutic purposes, in order to overcome a medical/neurological problem — an example being the deep brain stimulation electrodes employed to overcome the effects of Parkinson's Disease. It is possible to consider employing such technology in alternative ways to give individuals abilities not normally possessed by humans: human enhancement!**

In most, if not all, of the above cases, the trial could be considered useful for purely therapeutic reasons, e.g. the ultrasonic sense could be useful for an individual who is blind; telegraphic communication could be very useful for those with certain forms of motor neurone disease.

Each trial can, however, also be seen as a potential form of enhancement beyond the human norm for an individual. Indeed, the author did not need to have the implant for medical purposes to overcome a problem but rather the experimentation was performed purely for scientific exploration. Therefore, the question arises: how far should things be taken? Clearly enhancement by means of brain–computer interfaces opens up all sorts of new technological and intellectual opportunities; however, it also throws up a raft of different ethical considerations that need to be addressed directly.

When experiments of the type described above involve healthy individuals who have no reparative need for a brain–computer interface, but rather the main purpose of the implant is to enhance an individual's abilities, it is difficult to regard the operation as being for therapeutic purposes. Indeed, the author, in carrying out such experimentation, specifically wished to investigate actual, practical enhancement possibilities (Warwick et al. 2003; Warwick et al. 2004).

From the trials it is clear that extrasensory input is one practical possibility that has been successfully trialled; however, improving memory, thinking in many dimensions and communicating by thought alone are other distinct potential — yet realistic — benefits, with the

Figure 4. Experimenting with an ultrasonic sense

latter of these also having been investigated to an extent. To be clear, all these things appear to be possible (from a technical viewpoint at least) for humans in general.

As we presently stand, to get the go-ahead for an implantation in each case (in UK anyway) requires ethical approval from the local authority governing the hospital in which the procedure is carried out, and, if it is appropriate for a research procedure, also approval from the research and ethics committee of the establishment involved. This is quite apart from Devices Agency approval if a piece of equipment, such as an implant, is to be used on many individuals. Interestingly, no general ethical clearance is needed from any societal body, yet the issues are complex.

However, as we look to the future it is quite possible that commercial influences coupled with the societal wishes to communicate more effectively and perceive the world in a richer form will drive a market desire. Ultimately, direct brain-to-brain communication, possibly using implants of the type described, is a tremendously exciting proposition, ultimately resulting in

thoughts, emotions, feelings, colours and basic ideas being transmitted directly from brain to brain. Whilst this raises many questions as to how it would work in practice, clearly we would be foolish not to push ahead to achieve it.

But then we come to the big questions. As communication is such an extremely important part of human intelligence, surely it follows that anyone who has an implant of this type will necessarily have a considerable boost to his or her intelligence. Clearly this will stretch intellectual performance in society with the implanted section outperforming those who have elected to stay as mere (unchipped) humans. Will this bring about the digital divide, an "us and them" situation, leaving regular humans far behind on the evolutionary ladder? Well, we'll just have to see!

NON-INVASIVE BRAIN-COMPUTER INTERFACES

For some, brain–computer interfaces of the type described above are perhaps a step too far at present, particularly if it means tampering directly with the brain. As a result, by far the most studied brain–computer interface to date is that involving electroencephalography (EEG) and this is due to several factors. Firstly it is non-invasive; hence there is no need for surgery with its risks of infection and/or side effects. As a result, ethical approval requirements are significantly less and, because electrodes are easily available, the costs involved are significantly lower than for other methods.

EEG is also a portable procedure, involving electrodes which are merely stuck onto the outside of a person's head and can be set up in a lab with relatively little training, little background knowledge and taking little time — it can be done then and there, on the spot.

The number of electrodes actually employed for experimental purposes can vary from a small number (4–6) to the most commonly encountered (26–30) to well over 100 for those attempting to achieve better resolution. As a result, individual electrodes may be attached at specific locations or a cap can be worn in which the electrodes are pre-positioned. The care and management of the electrodes also varies considerably between experiments from those in which the electrodes are positioned dry and external to hair, to those in which hair is shaved off and gels are used to improve the contact made.

Some studies are employed more in the medical domain, for example, to study the onset of epileptic seizures in patients; however, the range of applications is widespread. A few of the most typical and/or interesting are included here to give an idea of possibilities and ongoing work rather than to provide a complete overview of the present state of play.

Typical are those in which subjects learn to operate a computer cursor in this fashion (Trejo et al. 2006). However, it must be pointed out that even after significant periods of training

(many months), the process is slow and usually requires several attempts before success is achieved. Along much the same lines, numerous research groups have used EEG recordings to switch on lights, control a small robotic vehicle and control other analogue signals (Millan et al. 2004; Tanaka et al. 2005). A similar method was employed, using a 64-electrode skullcap, to enable a quadriplegic to carry out simple hand movement tasks by means of stimulation through embedded nerve controllers (Kumar 2008).

It is also possible to consider the uniqueness of specific EEG signals, particularly in response to associated stimuli, potentially as an identification tool (Palaniappan 2008). Meanwhile, interesting results have been achieved using EEG for the identification of intended finger taps, whether the taps occurred or not, with high accuracy. This is useful as a fast interface method as well as a possible prosthetic method (Daly et al. 2011).

Whilst EEG experimentation is relatively cheap, portable and easy to set up, it is still difficult to see its widespread use in the future. It certainly has a role to play in externally assessing some aspects of brain functioning for medical purposes (e.g. assessing epileptic seizures and neural activity during obsessive compulsive disorder) and surely these applications will increase in due course. However, the possibility of regular people driving around whilst wearing a skullcap of electrodes, with no need for a steering wheel, is not thought to be at all realistic; completely autonomous vehicles on the roads are much more likely.

CONCLUSIONS

In this chapter, a look has been taken at several different cybernetic enhancements and resultant types of artificial intelligence. Experimental cases have been reported in order to indicate how humans, and/or animals for that matter, can merge with technology in this way, which throws up a plethora of social and ethical considerations as well as technical issues. In each case reports on actual practical experimentation have been given, rather than merely some theoretical concept.

In particular when considering robots with biological brains, this could ultimately mean perhaps human brains operating in a robot body. Therefore, should such robots be given rights of some kind? If one was switched off, would this be deemed cruelty to robots? More importantly at this time, should such research forge ahead regardless? Before too long we may well have robots with brains made up of human neurons that have the same sort of capabilities as those of the human brain.

In the section on a general-purpose invasive brain implant as well as implant employment for therapy, a look was taken at the potential for human enhancement. Extrasensory input has already been scientifically achieved, extending the nervous system over the Internet and a basic

form of thought communication. So it is likely that many humans will upgrade and become part machine themselves. This may mean that ordinary (non-implanted) humans are left behind as a result. If you could be enhanced, would you have any problem with it?

Then came a section on the more standard EEG electrodes which are positioned externally and which therefore are encountered much more frequently. Unfortunately, the resolution of such electrodes is relatively poor and they are indeed only useful for monitoring and not for stimulation. Hence the issues surrounding them are somewhat limited. We may well be able to use them to learn a little more about how the brain operates, but it is difficult to see them ever being used for highly sensitive control operations when several million electrodes feed into the information transmitted by each electrode.

As well as taking a look at the procedures involved, the aim of this article has been to have a look at some of the likely ethical and social issues as well. Some technological issues have though also been pondered on in order to open a window on the direction that developments are heading in. In each case, however, a firm footing has been planted on actual practical technology and on realistic future scenarios rather than on mere speculative ideas. In a sense, the overall idea is to open up a sense of reflection so that the further experimentation which we will now witness can be guided by the informed feedback that results.

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WHERE IS THE LINE BETWEEN HUMAN AND MACHINE? THIS ARTICLE PRESENTS A SERIES OF GROUNDBREAKING EXPERIMENTS THAT MAKE ANSWERING THIS QUESTION VERY DIFFICULT INDEED. THE AUTHOR TAKES A LOOK AT SOME OF THE DEVELOPMENTS THAT ARE SET TO HAVE A DRAMATIC IMPACT ON THE FUTURE OF ARTIFICIAL INTELLIGENCE AND CYBERNETICS, FOCUSING ON INTERFACES BETWEEN TECHNOLOGY AND THE HUMAN BRAIN. FROM THERAPEUTIC TREATMENTS TO THE ENHANCEMENT OF NATURAL HUMAN CAPABILITIES, THE ARTICLE FOCUSES ON THE PRACTICAL APPLICATION OF ROBOTICS. YET THESE DEVELOPMENTS CANNOT AVOID RAISING FUNDAMENTAL ETHICAL QUESTIONS: WHAT RIGHTS WOULD A "ROBOT BRAIN" HAVE? WILL THE FUTURE BRING A "DIGITAL DIVIDE", LEAVING ORDINARY, UNENHANCED HUMANS BEHIND ON THE EVOLUTIONARY LADDER? ONLY TIME WILL TELL.

BIOGRAPHY

Kevin Warwick

University of Reading

Kevin Warwick was born in Coventry, UK and left school to join British Telecom at the age of 16. At 22 he took his first degree at Aston University, followed by a PhD and research post at Imperial College, London. He held positions at Oxford, Newcastle and Warwick universities before moving to Reading, at age 33.

As well as publishing 600 research papers, Kevin's experiments into implant technology have led to his being featured on the cover of the US magazine, *Wired*.

Kevin has been awarded higher doctorates (DSc) by Imperial College and the Czech Academy of Sciences, Prague, and he has received six Honorary Doctorates. He has been presented with The Future of Health Technology Award (MIT), he is an Honorary Member of the Academy of Sciences, St. Petersburg, and he has received the Mountbatten Medal and the Ellison-Cliffe Medal from the Royal Society of Medicine. In 2000, Kevin presented the Royal Institution Christmas Lectures, entitled "The Rise of the Robots".

Kevin invented an intelligent deep brain stimulator to counteract the effects of Parkinson's Disease. Tremors are predicted and a current signal is applied to stop them before they start. Another project involves the use of biological neurons to drive robots around; the robot brains are made of neural tissue.

Kevin is best known for his pioneering experiments involving a neuro-surgical implantation into the nerves of his left arm to link his nervous system directly with a computer to assess the latest technology for use with the disabled. He was successful with the first extra-sensory (ultrasonic) input for a human and the first purely electronic telegraphic communication between the nervous systems of two humans.

Paradise Lost? Paradise Regained?

Nanotechnology, Man and Machine

Sandip Tiwari

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*"Not well conceived of God; who, though his power
Creation could repeat, yet would be loth
Us to abolish, lest the Adversary Triumph"*
John Milton, *Paradise Lost*, Book 9

Eve has eaten the fruit. Adam must now decide whether to join her in sin or live without her. He cannot imagine living without Eve. Is God's warning a bluff or could Satan possibly be triumphant?

Nanotechnology gives the human ability to manipulate, control, and process at atomic and molecular dimensions. This capability has been gained rapidly in the past decades, and our knowledge and engineering at this dimensional scale continues to accelerate. Man can now change properties for use in the physical environment quite effectively. Some examples: lighter weight materials with increased strength used in vehicles or turbines; improved energy conversion or storage efficiencies as in batteries and photovoltaics; increased safety through improved filtration of water for heavy metals to bacteria; improved pollution control via catalysis for combustion effluents; communication ability that changes the feeling of time and space through mobile instruments; and an internet and computing environment that has made information more open and pervasive. Not long ago, typewriters abounded, often manned by pools of typists; information for most of the needs was accessed by phone or hand-written mail or a personal visit to the office, and commerce involved transactions with carbon copies. The openness of information, the easy communication while being mobile, commerce of

all kinds executed electronically — these are all physical changes that have taken place in a short period of about one human reproduction cycle and changed how man conducts private and public life. Ever increasingly, the world practices high frequency living, not unlike the money folks of Wall Street. The dependence and the possessiveness that man feels for mobile connectivity and the Internet even hints that man and machine may be more enjoined than man and man. *Man is being changed by machine*.

This change through creations in matter based on the building blocks from across the periodic table and its use in the physical environment is only the beginning. In the carbon-centric living world, we live longer because diagnoses are more sensitive: instrumentation such as MRI in its many forms, NMR, or PET or CT Scan probe in physically unreachable spaces; smaller versions probe localized regions; cochlear miniature implants and artificial joints made with strong materials aid the daily living of elderly; and medicine is now more specific to the cause of the ailment because we have very precise imaging capabilities in many signaling forms — mechanical, electrical, magnetic, and optical across the breadth of the electromagnetic spectrum. These multidimensional eyes are capable of looking down through the brain and body cross-sections, to tumors and even down to single molecules and single atomic bonds. Arguably, a synthetic cell has been created. Better understanding of biological interactions, including the genetic underpinnings, has been important to these developments.
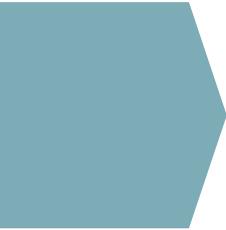
Nanotechnology gives the human ability to manipulate, control, and process at atomic and molecular dimensions. This capability has been gained rapidly in the past decades, and our knowledge and engineering at this dimensional scale continues to accelerate

Life and living is vastly more complex, and we barely understand it. Both digital interactions, such as in the genetic code, and analog interactions, such as in ionic triggering in synaptic interactions, underlie the fundamental behavior of the networks of interactions that make life in the presence of energy flow stable. Answers to difficult questions such as what is consciousness, what is the basis of various mental diseases or how do we make decisions are also getting within reach as instrumentation such as functional MRI, neural implants, and non-invasive electrical, magnetic and optical tools help us probe the brain. Learning from the living world, robots swim like fish, jump like insects, fly autonomously, drive cars like humans, almost achieve mammalian stability in walking and running in difficult terrain, recognize simple instructions by gesture or voice and perform repetitive tasks better. Information machines are becoming capable of learning the rules or algorithms of response, action, behavior and the

natural laws by recognizing the patterns in the data unsupervised. Neural implants allow the brain to directly control physical actions in prosthetics. These changes, in living, and in machines learning from the living, have harnessed the ability to elucidate and mediate the atomic and molecular scale interactions through biology and nanotechnology practices. *Man's outer and inner workings are being understood by man and machine cooperatively.*

This pattern of rapid change remains unending. This man-machine cooperation can certainly extend with the human harnessing machine in amelioration of diseases, or health defects, or just in repetitive menial tasks. With the pace of learning, and machines learning on their own, the day is not far, possibly by mid-century, when the distinguishability between man and machine may even be philosophical nit-picking. Machines, for all practical purposes, would qualify the intelligent behavior test of Turing where an object behind a curtain cannot be reliably distinguished between a machine and a human through a language conversation. Machine would be capable of building intelligence, drawing deterministic logical conclusions, asking questions, also probing connections, short and long, and analyzing by building reasoning with confidence of the non-deterministic variety — emotional, contextual and for the surprises. This machine has a human-like behavior. If achieved, this non-carbon form of machine would also be capable of being a third form, a silicon-human, where the "persona" of the finite life of the carbon-based form is imbued into the non-carbon based form for continuing the "living." *Man and machine may fuse.* Or, as most artificial intelligence community proponents argue, man is a machine, so, now machine forms fuse.

This is the "Garden of Eden" of mid-twenty-first century. Is this cataclysmic? Paradise lost? Paradise regained? Should Adam join Eve in this sin or live without her? Is Adam's reasoning that God may be bluffing, for He would never kill him nor would He want Satan to triumph rational? Such is the dilemma of the future as nanotechnology and biology progress. Like Adam, we will have to find our way. Do we find a path that is not black or white but gray? Is gray, weighing the odds, too far from the practices of the Wallace-Darwinian evolution through probabilistic events of mutations and the survival of the fittest?

This trajectory raises many questions and challenges for the world we inhabit and for our place in the universe. It goes beyond simple scientific, economic, social or cultural changes and the issues they raise. It affects humanity and its belief in its own uniqueness at its very core. Francis Bacon's remark, "Nature, in order to be commanded, must be obeyed," is particularly true for this path that technology may take. We must not destroy what we cannot create.

Even predicting the past is difficult. Questions such as when did humans first acquire language, or how many different migrations take place from Africa, or even when and if the events described in ancient texts — Rigveda or the Egyptian Book of the Dead, let alone older stories of Kesh temple hymn or the Epic of Gilgamesh — take place are continuously subject to revision. Predicting the future is worse in uncertainty. Nature follows a non-deterministic

probabilistic path under random and deterministic influences. With this caveat, let us explore the possibilities of the future given the developments in science and engineering of nanoscale as it relates to the physical, the life sciences and through them to humanity and the world. Much of nanotechnology's progress has been in the physical world, the one we create through the diversity of materials, natural and created, at our disposal. But, much is starting to happen in the natural living world, and the time is nigh where the two will increasingly connect.

Scientists and engineers appear to be at their creative best between the mid-twenties and end of the thirties of their life, perhaps because during these years they are up to date in the technical wizardry of their profession and have not yet accumulated the baggage of other responsibilities of their profession and life.

What might an infant born today see as an active professional and what might be the questions she has to grapple with? I will call this *creativeness cycle time*, and this is the timescale that I will explore.

One of the spectacular successes of physical engineering with reduction in dimensions is the variety of compact tools we employ in daily life — phones that provide near-instantaneous communication connectivity and quick answers to queries of static nature: finding directions, places for activities, and ease of commerce or physical planning for the joys of living: financial transactions, buying and selling of necessities, planning travel or listening to the personal musical favorites. Miniaturization has also benefited humans through healthcare. We spend less time in hospitals as a consequence of the reduced invasiveness of procedures, e.g. all the endoscopic procedures. Small sensitive instruments, rapid data transfer, robots and cell phones provide clever ways that make diagnosis and treatments, even physical procedures, possible remotely. This has relevance to both affluent and deprived communities. Miniaturization reduces costs and allows an expert to be more distant and diversely connected with the community. Inexpensive diagnostic kits, even paper based (Vella et al. 2012), coupled to the transmission of test results via camera-based cell phones to specialists, lets one reach the remotest of communities as mobile phones reach into all communities. One just needs to focus on inexpensive test kits utilizing nanoscale sensitivities that provide a number of common tests simultaneously and their availability through the rural stall. Such procedures are particularly useful for common ailments — malaria, cholera, malnutrition, and others. Advanced hospital instruments — NMR, MRI, CT and PET scans, confocal microscopes, even X-rays — that are useful in the more challenging diseases of cancer, brain, joints, tuberculosis and others are also subject to miniaturization (Sun et al. 2010 and Spector 2010). But, because these do require specialized knowledge of operation, they may be made available in the district hospitals.

The rich benefit from these trends too; after all, the cost of healthcare is a large economic cost in the society. Self-tests and less use of expensive infrastructure and human expertise are constructive avenues for reduction in these healthcare costs. There are a number of procedures

Thomas Struth, *Pharmaceutical Packaging. Laboratorios Phoenix, Buenos Aires,* 2009

that machines do better. Artificial joints require careful surface preparation and alignments and are best done robotically. Hard to reach places and small features are best handled by machines, e.g. the prostate and others by machines such as da Vinci.[1] These robots will proliferate. Machines such as Dr. Watson of IBM answer a lot of questions based on accumulated facts that have been fed to it and its ability to parse natural language. Such machines, even today, should be capable of much of the systematizing that a physician does. Machines should be able to analyze rapidly, draw inferences employing reasoning systems to determine information, genotype, phenotype, microbiomic and epigenetics needed, acquire it, and act on it using probabilistic reasoning just as the specialist does. With the learning capabilities that they will acquire, machines will become adept assistants to physicians initially, then replacements for most common tasks, and finally specialists. These are examples where machine is acquiring more and more capability as smaller elements proliferate and provide a

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1. See the minimally invasive surgical procedures with machine operating under physician control listed at
   http://www.davincisurgery.com/

capability to acquire, assimilate and from that ensemble sort data and important patterns buried in them.

Another consequence, particularly beneficial to infrastructure that makes our life easy and social, are a plethora of tools that collect time-sequenced data— sensors that acquire information on bridges, or of traffic density and patterns, or geological activity and of environment as exemplified in tsunami prediction, or the time-stamped health records of the living, and that look for patterns and trigger activity as a safety response.

The smallness itself still has a considerable intellectual distance to go. We will put together nature's rules to work more efficiently in the physical world. We will exploit the fundamental physical phenomena, that an electron has a single electron charge, or that magnetic flux has a corresponding flux quantum, to create forms of digitization that are much more efficient, where information is coded right at the source of a data in a more efficient form. Indeed, we should be able to exploit chaos and fluctuations by coupling to nonlinearities to achieve new devices that allow much higher sensitivity than is currently possible for uses such as noise-activated mechanical sensors or transmission bands for more efficient data movement. We will learn to transmit energy across the electromagnetic spectrum efficiently and wirelessly by using non-linearities, as well as we do along metal wires — balls of energy being transmitted similar to how tsunamis can move long distances without losing their rise and fall. We may even practice rudimentary forms of teleportation, and certainly secure forms of communication using principles of quantum mechanics. We will learn to make things smaller and smaller in medical instruments, in the process allowing negligibly invasive surgery where the physician will be able to see what she is doing while the organ, e.g. the heart, is still working in the midst of the procedure.
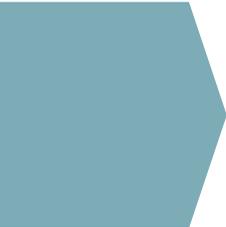
These changes, in the living, and in machines learning from the living, have harnessed the ability to elucidate and mediate the atomic and molecular scale interactions through biology and nanotechnology practices. The day is not far off when the distinguishability between man and machine may even be philosophical nit-picking

Easily visible as one consequence of this large accumulation of data through all these means is the increasing loss of privacy and the ability of private enterprises to troll and of governments to acquire data legally and illegally, just because it is there or because of intent, and because most individuals do not know how to protect themselves. This has a bipolar effect. Financial transactions can be followed, and roles of corporations and individuals in financial events identified; the center of communications, such as in a network of terror, can be

identified. But, in the same way, the transactions can be faked, and legitimate democratic protests squelched.

The common consequence underlying these activities is the generation of large amounts of data. Even in a decade, this data agglomeration in many different collections will be yottabytes or more. A yottabyte is 10 followed by twenty-four 0s of bytes; a byte being 8 binary digits or bits. A yottabyte is 80 binary digits (a yobibyte) in the number representation that machines employ. As a reference point for data, today's (2012) thumb drives carry at most 32 followed by nine 0s in the binary digital representation. Data, as mentioned here, has information buried in it or even at a higher level, knowledge which I interpret as the connections represented in the information. Much of this data is superfluous and irrelevant. The same temperature, say a room temperature of 20°C, can be written as 20 in decimal form (to a degree of Celsius accuracy), or 10100 in the binary form that the binary logic of digital electronics employs. Digital electronics uses computational engines that have precision in lumps of 64-bit precision these days, or 132 bit in rare instances, to represent data accurately. After all, data can be very large, theoretically infinite, and they need to be represented accurately. Much of this precision is of no use in the case of this temperature. On the other hand, we do not have enough precision and data of other forms. A hundred billion galaxies with a hundred billion stars in each galaxy in our universe are 10 followed by twenty-two 0s of stars. Let us assume that in a picture each star is just one spot, i.e., a pixel in a picture. Now let us suppose we want to store a number of pieces of data: intensity of light as a function of wavelength at each of these pixels. We need to identify the object, so there is data for that, and let us say we wish to capture at nanometer precision the optical spectrum over a reasonable wavelength range — about 10 followed by eight 0s of data points, because this information helps us identify some of the materials in the star and what happens to the light as it traverses the universe before reaching us. We have just formed 10 followed thirty-one 0s of data where each star is just a pixel and only a limited electromagnetic spectrum has been captured. Immense data, and buried in there is some information related to events that happened in the star millions to billions of years ago to get only an instantaneous snapshot! This is more than ten million yottabyte of data and we haven't really described much of what is happening in the universe in time or with any precision since each star is only a pixel. One could look at this problem another way in our own vicinity. Suppose we want to use the techniques of measuring strain, through deformation, as to when a bridge may fail, to assess when deformations accelerate leading to catastrophic failures. Let us collect data through about 10 000 autonomous sensors on the bridge, measure them every second over a year (a year has about 32 million seconds), measure expansion in three directions, and a few other characteristics such as temperature, etc., at each identifiable sensor. This is 10 000 x 32 000 000 x 3 x 10 = 10 followed by twelve 0s. In a country, say like USA, there is about one bridge every fraction of a square mile, i.e. about 10 million bridges, and

this creates 100 billlion billion (10 followed by twenty 0s) pieces of data. Just data collection on static bridges is this much in one country. Imagine what the data looks like when 4 cameras at every intersection produce 10 million pixels each of data every second in a country like England which likes to keep an eye out, or with the eavesdropping and snooping that goes on at the hands of companies and governments.

The challenge in this proposition is that while data is sacrosanct, as all scientists and engineers are taught, data is not information nor is it knowledge which puts the information in perspective. Data is subject to errors. A decade ago, we found that the measurement of ocean temperature had systematic error in a particular period because of a specific satellite sensor approach employed. How does one then compare this data to another set of data acquired through another approach, and the accumulation of such data? If one measures the temperature of the solid surface of the earth to the fifth place of fractional decimal every mile, is it as meaningful as of first place of decimal data every 0.1 mile or no decimal digit data so long as we measure it at the solid surface and also all the way down a mile into the oceans? The last is as much data as the second which is 100 times less than the first. However, the last provides depth data in the ocean, an area three times that of the solid surface, and whose energy movement through ocean currents is very central to earth's energy flow and hence global warming. Any weather prediction based on the first, even with its immense precision, is certifiably wrong.

This discussion points to an essential point: data is not information and information alone is not knowledge. Each of these is a higher and more actionable form that one can work with more efficiently. One can create a lot of meaningless data, e.g., by higher precision where the precision accuracy is meaningless if all the other inaccuracies — of the model, and of other data and information — are large. We are interested in actionable inference through knowledge. This needs a different perspective. We need to find answers to queries: what is important? What is important in making robust judgments that one can act on? When we cross a street with traffic there are numerous judgments that we make. What would the driver do? The answer probably depends on what kind of person is driving the vehicle. We can't judge that rapidly, so we employ heuristics, visual cues, man or a woman, the vehicle that person is driving, the region he/she represents that one can see in the license plates and the traits we associate with these cues. We start making guesses, sometimes right, sometimes wrong, where a number of characteristics are endowed on the person and the vehicle to make a judgment. As a person who lives in a small upstate New York town, Ithaca, more really a village, I behave differently in September, when all the new young folks from the urban areas of Long Island and New Jersey arrive, than in March or April, by which time they have some experience of the expectations of a rural college town community, so the influence of the environment and time in judgments also enters the decision-making.
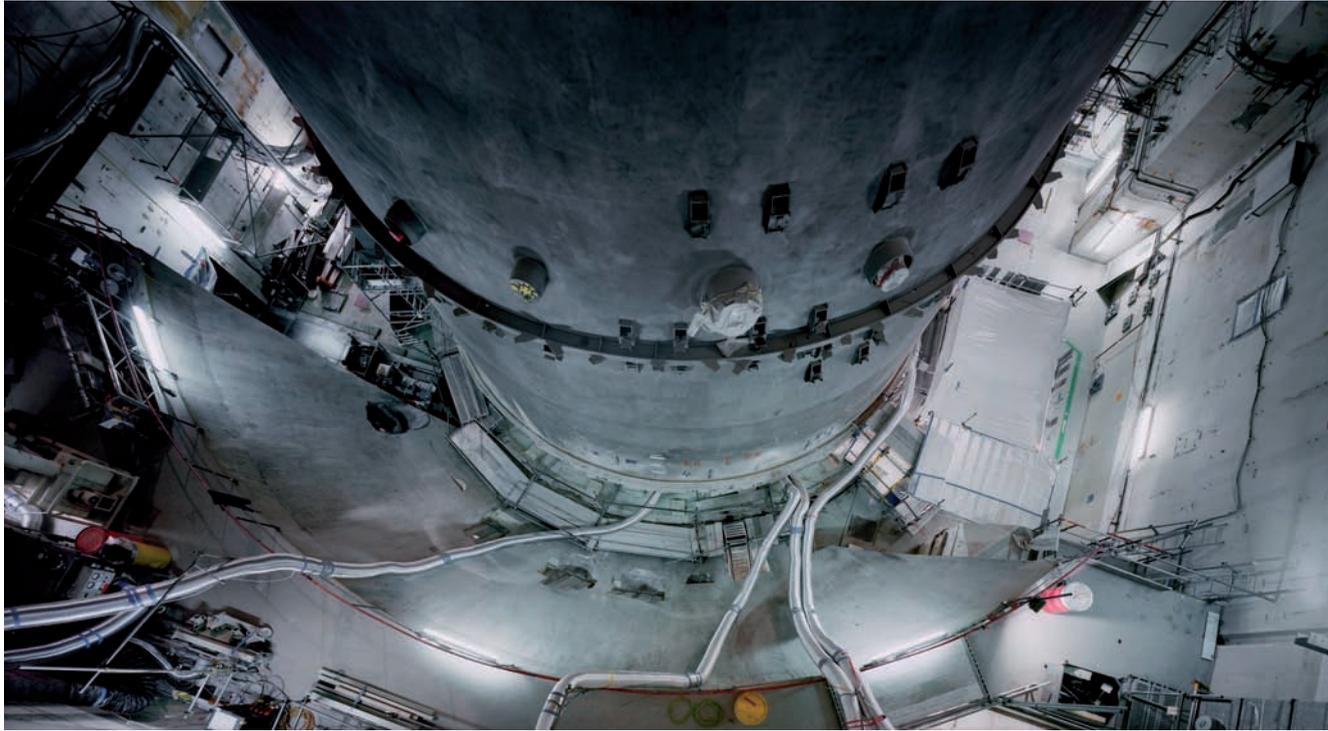
Thomas Struth, *Reactor Pressure Vessel Phase Out. AKW Würgassen, Beverungen,* 2009

We will learn better ways to handle such incomplete problems as we start moving away from the deterministic style of data processing to a non-deterministic approach of information manipulation and knowledge extraction. The proliferation of nanoscale physical elements and the data will force a new direction of information science — a move towards finding of short and long range connections, a development of theory of networks, irreducible representations, patterns, and robust answers, as close to the point of collection of data as possible, so that nanoscale developments can be harnessed at very low energy robustly. What this implies is that hardware, until now deterministic and binary digitized, will place much more emphasis on probabilistic approaches. Machines will use the data gathered to analyze autonomously to learn from it, see if predictions come true, and thus learn what collection of data connects to what inference. Such machines will be inherently safer — less prone to misbehavior even if the people operating them are incompetent. Intelligence will gradually imbue into machine as a result of the greater confidence and robustness accrued from predictions that increasingly come true. Information and knowledge extraction and accumulation at the source, agglomeration of this knowledge from multiple streams, learning and acting on this, and evolving, i.e., changing oneself based both on the knowledge, but also on changes taking place within oneself, will be

the themes of physical machines operating with increasing knowledge efficiency and reduced energy consumption in executing inferences and conducting tasks. Computers or robots, etc., will be difficult to recognize as the static form they currently have changes. They will be able to talk to us, question to get data, from it extract information, and thus build the knowledge that will make them smarter.

I will call such clever machines *Emergent Machines*.

This change in itself raises many profound questions. When is this machine in its actions distinguishable from human? In its intellectual capabilities, in probing, in finding connections, in finding patterns, in drawing conclusions, it should have capabilities that will be exceed the human median. After all, even simpler data mining and pattern recognition approaches have allowed Dr. Watson to win the answer challenge of factual questions, and for computers to win against chess champions. Can this machine be a liar, conniver, conservative, liberal, warmongerer? Can it have emotions? Certainly appears to me that this should be possible. These are characteristic responses based on accumulated experiences and innate tendencies, all mathematically representable and therefore machine programmable to extract from experiences.

The other major characteristic of the living is of metabolism and replication. We need energy flow to be dynamically stable. We reproduce. This former is certainly true for machine, it needs energy to work, reduce the energy and it can certainly employ mechanistic techniques to shut parts of it down or to slow itself to work with less. These are quite elementary tricks that machine learns easily. Reproduction is harder, but certainly possible. Hardware can program components to create new versions of hardware. The separation of hardware and software is a construct that has arisen because, at least until now, it has eased the process of creation of machines. My belief is that if it is possible in theory, it is possible in practice, and that this will be a main approach within the *creative cycle period.*

This theory of a self-replicating and energy consuming machine — a self-reproducing automaton — was originally described by von Neumann at the start of the modern computing era. The automaton requires a few different parts. One collects the resources of materials and energy to process and to execute the production. Another duplicates instructions by passively copying and for passing on to the first part. Both these parts receive instructions that control them for the action and the copying, and this controller keeps its received copy of the instruction for its own cumulative knowledge. Finally, this automaton has another unit that contains the specification — the building code, the design principles — that make the other three perform as a self-reproducing unit. In the present computing machines, the last is the software, and the machine processes the data under control guided by the software. Software can reproduce, but we normally don't reproduce hardware. There is no fundamental barrier to it, however.

In biology, this software and hardware machinery is intertwined. The proteins, and there are many of them, perform specific tasks of taking apart and assembling what is needed by the

living. Quite a bit of the body is protein, e.g., collagen throughout the body, others for blood vessels or lung tissues, others for transporting products, or metabolizing sugar, etc. The ribosome is the controller consisting of several RNA chains, including for transcription and messenger functions, and it is essential to the synthesis of proteins — highly complex long chain of molecules, whose action, reaction, and behavior we are still trying to understand. The linear DNA code is what this ribosome-based machinery converts into the production of the proteins by the transcription step which synthesizes messenger RNA followed by a translation to create the protein from the messenger RNA. This biology certainly as described here and believed in is an automaton. The physical and knowledge part of the machine are separated within the cell into DNA carrying the knowledge software code, and the rest is the physical machinery executing the code. So, one can see that the *Emergent Machine* certainly impinges in many characteristics that we usually associate with life sciences. The questions that this brings up are diverse.

One set of important questions will relate to the learning and awareness of what we observe all around us. How does this system's dynamics relate to information manipulation, its organization, and its long term existence through itself and through reproduction? What causes certain conditions to be more stable than others? In a flowing stream (Dyson 2007), when a child pokes a stick into an eddy, the eddy is lost. But, removing the stick lets the eddy form again. The child disturbs it again. But, again it forms. This is the fascinating game of life where life exists as a resilient pattern in energy flow. Imagine the network of airplanes and airports that moves human beings around. There is a snow storm in Chicago. Suddenly, travelers everywhere in USA start getting affected, even those travelling from Miami to San Francisco with flights cancelled and flights delayed. It could be because the plane that was to arrive from somewhere through Chicago didn't come, or that it got rerouted to a needier route, or that it was even another set of connective effects. But, the system is adaptive, once the storm passes, the network that moves humans around is restored. Nature is a complex dynamic system, we are a complex dynamic organization, and so is this connection of machines.

These characteristics are related to stability, appearing as emergent phenomena in presence of energy flow. With the flow of energy, machines learn and evolve increasing their capability and efficiency, and in the process achieving robustness in their inference capabilities in the presence of uncertainty. In this process they become autonomous systems that have the capability to understand, elucidate, even predict outcomes on complex problems with some confidence — how do all the interconnected causes and effects and relationships lead to global warming? How do different actions lead to different economic effects that cascade through the society? Our *Emergent Machines* will be able to tackle these.

This complex system theme, i.e., one where there are a large number of interconnected parts with their strengths and weaknesses of beliefs, of connections, exemplify the complexity of the

world in which we dwell. With nanoscale, it is this large relationship of interconnectedness of heterogeneous components that comes to pass. There is a diversity of sensors measuring medical, environmental, human, financial, economic and social characteristics, connected together in a global system. This complex system needs to be robust, so even with elements breaking in use, new ones being generated and connecting into this network, sanity and predictable behavior prevail. This robust operation of interconnected physical systems, central to our comfortable living, will be one of the achievements of this coming period.

Examples of biological complexity that we now understand include: gene regulatory networks for controlling cellular differentiation in developmental and tissue repair processes; the reestablishment of tissue structure and function following a substantial loss of tissue mass; and the processing of visual information in the cortex. The principles that these point to are the rewiring of modules (genes), high connectivity of components (adaptability and fault tolerance), feedback and feed-forward, and gradient-driven processes. That is, we are starting to understand the commonality of principles between the biological world and the principles needed as physical machines become as complex as the biological machines are. For example, 100 neurons can now be easily assembled on a semiconductor chip. It allows us the rudimentary capability to explore interesting/emergent behaviors that come about even in such small-scale assemblies.

These instances exemplify the capability made feasible by physical changes due to molecular and atomic scale control of the physical. We have applied several of these techniques over the past decade and longer in understanding and controlling atomic scale phenomena through atomic manipulation, such as using small cantilevers to pick up atoms and molecules and to place them elsewhere on a surface and to construct physical objects for using them. We know how to trap single molecules using optical tweezers so that we may characterize them in detail. We know how to measure many of their properties with exquisite precision through ultra-sensitive quantum-interference devices. We have also used similar techniques to build a microscopic world to assess their behavior. A laboratory-on-chip allows us today to carefully understand the behavior of chemicals, macromolecules, cells, bacteria, and others in a small environment under controlled condition. This lets us understand how bacteria communicate and collectively respond, for example, quorum sensing, how different chemicals affect living objects; safety, how proteins fold; and how some of the very complex phenomena of living happen.

It is not too difficult to visualize how these same techniques will lead us to experimentation in parallel with the randomness and mutations inherent in nature's processes, to understand the cause and effects, and to select the most beneficial of the mutations. That is, instead of using lifetime cycle, as our living world does in its Wallace-Darwinian survival of fittest, we conduct these processes in parallel, faster, to select the most useful ones for ourselves. We will be able to explore and utilize this evolutionary process through this post-Wallace-Darwin synthesis machine.
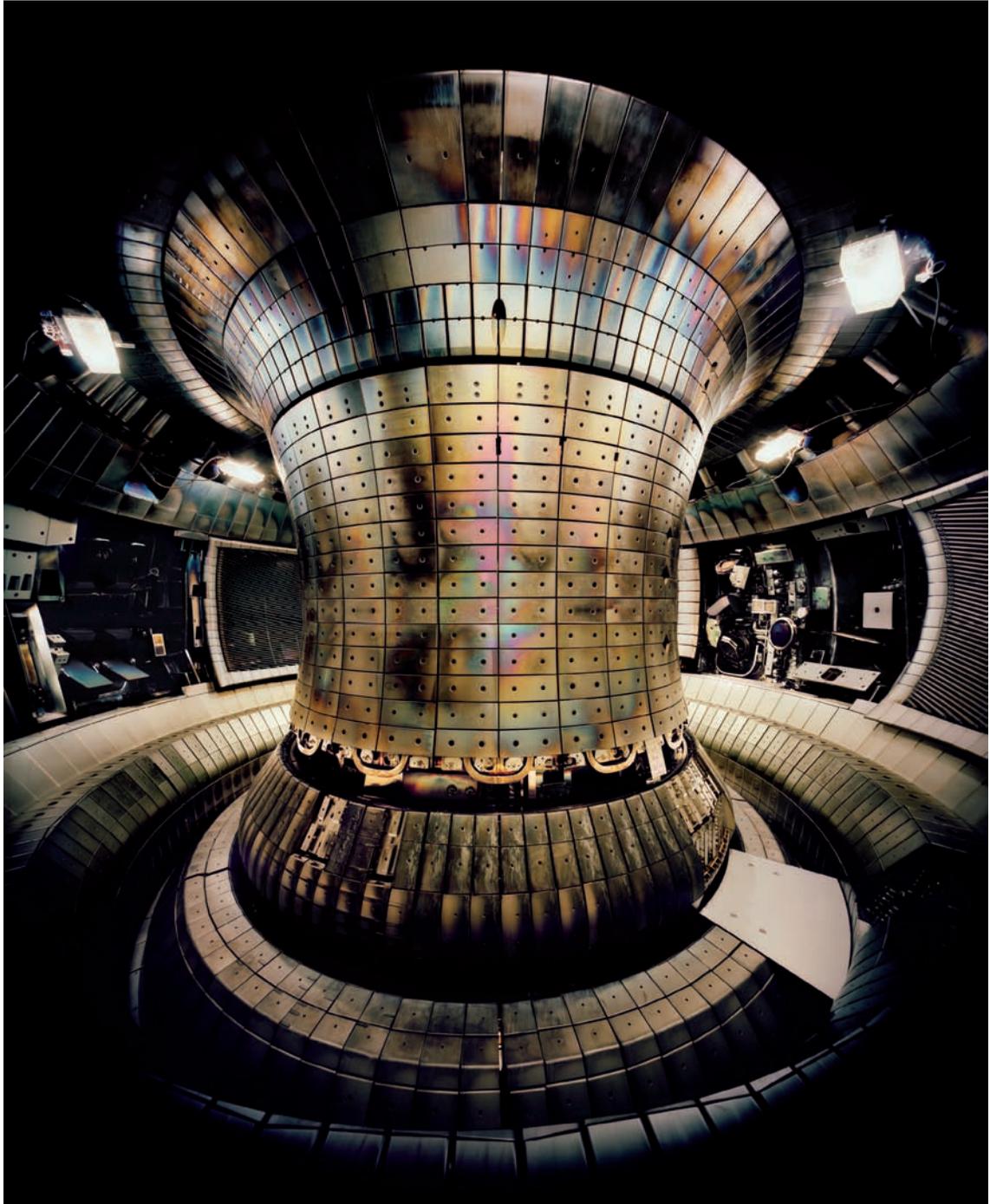
Thomas Struth, *Tokamak Asdex Upgrade Interior 1. Max Planck IPP, Garching,* 2010

I will call this tool *Evolution Machine*.

Its power is the ability of a machine to do compact systems-scale experiments of many interlinked active components — many changed genes coupled together, metabolic engineering, photosynthetic proteins, and numerous others.

Constructing small and large molecules will be a precursor to this *Evolution Machine* exploring and constructing answers to a variety of societal problems and its diseases with evolution as a constructionist addendum to the optimization practiced by engineering. Genetic changes will become practical to correct for diseases caused by genetics, e.g., color blindness or even blindness. It would be possible to endow characteristics man doesn't possess currently, e.g., sensitivity to the infrared region of the electromagnetic spectrum to the eye as in most nocturnal animals, or lower frequency or higher frequency audio spectrum to the ear as in bats and dogs. It will be capable of building complex genomes with properties useful for society. The use of enzymes in detergents is a good example of the utility of protein approaches to manufacturing that are very low cost. Vaccines are another important one. The latter are low volume and high cost. But, such examples are very few. Today's protein synthesis uses solid phase synthesis, peptide ligation, in vitro translation, non-ribosomal pathways, and cell-based systems, all slow producing low volume, except in the case of detergent assisting enzymes. Scalable controlled methods for protein synthesis through these *Evolution Machines* would enable new classes of proteins to be produced both for biomedical, e.g., diagnostics, therapeutics, and vaccine, and for industrial use, e.g., catalysts and self-healing materials, at large volumes and low cost.

Microorganisms are the simplest of organisms that are also likely to be the easiest to modify robustly through experimental multiple evolutionary genetic changes. Modify the photosynthetic machinery of the organisms to strongly couple to fuel production through metabolic engineering and we will be able to provide efficiency improvements in biofuels. This modification again will require multiple genomic changes so that the system as a whole is robust by balancing the multiple pathways that exist, and yet it provides efficiency in the photosynthesis process that currently bases itself on the photosystem I and photosystem II that convert light energy to chemical energy in plant molecules.

If the genetic language has truly been decoded, and the synthetic cell created (Gibson 2010) a useful engineering direction is to manipulate and program cells so that they can be made efficient living foundries — factories at cell scale. These would be particularly useful for the creation of high volume rapid vaccine creation, and possibly in finding new methods such as through proteins and autoimmune systems in fighting the emergent antibiotic immune diseases.

Many cellular functions are carried out by organelles. These perform functions within a cell similar to that of organs in the body. As examples of organelles, mitochondria make adenosine triphosphate (ATP), which is the energy transport chemical; splicosomes, a complex of

specialized RNA and protein sub-units, digest protein; golgi apparatus packages proteins inside cells before moving them; and cytoskeleton, a cellular scaffolding, generates force causing cell locomotion and muscle contraction. What we don't understand is how this machinery inside the cell works in detail. In our present approach in device technologies, we employ large-scale *in vivo* sensing and drug delivery or gene delivery to modify cells. We should be able to design ultra-compact nanoscale systems to understand the processes at cellular level — how nuclear pores work, measuring the ionic cellular machinery as it works, and following the longer timescale metabolic pathways. This would lead to the engineering of particle-based approaches for redesigning and augmenting cell functions, including cellular functions for ATP generation, extending the electromagnetic range over which cells respond, and thus enabling the tracking and manipulation of individual cells. The result would be techniques for the restoration of lost functions to cells, tissue/wound repair, bionic blood transfusions, cell-based sensors, and camouflage. Specificity in these approaches will let us tackle the myriad cancer forms and tumors effectively.
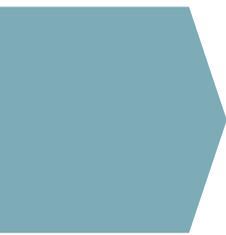
One of the spectacular successes of physical engineering with reduction in dimensions is the variety of compact tools we employ in daily life. Miniaturization has also benefited humans through healthcare

Evolution Machines will also allow us to explore methods for modifying plants. Plants, including the single and multi-celled algae, are perhaps a simpler and safer avenue to evaluate bioengineering before embarking on the more ambitious task of complex organisms. The *Evolution Machine* gives us a chance to modify plants for increased topsoil creation — a natural way to sequester carbon, produce energy efficiently by creating plants where the enzymatic conversions are easier, develop food source plants that use less water, modify plants that provide humans with a diverse diet, create plants that clean up fertilizer run-off in aquatic systems, and allow energy conversion through changed photosynthetic processes.

One would be able to explore further out beyond the immediate problems that humanity faces. Given a functional need, *Evolution Machine* would allow one to create methods for manufacturing that were most fit to survive, in the same way as an organism does, with properties that are useful. It would be scalable — it could produce one product or millions; adaptive — both the product and process would work within the constraints; repairable — it would be self-healing and correct errors as it encountered them; and it would be self-building — it would build the tools and the assemblies needed for the tasks.

These streams of speculation, of the machine as a parallel of living form, and of the ability to mimic and engineer nature to create new life forms, naturally leads to the more profound question of where does the inanimate end and the animate begin? The next fifty years will confound us by eliminating this as a normative question.

It will simply not be possible to distinguish between man-made and nature-evolved forms in the *creative cycle time*.

In this past decade, neural implants, prosthetics, and wired and wireless coupling for disease amelioration have demonstrated important successes in the coupling between information processing and living world. Implants can provide rudimentary gray-scale vision capability in cases of some eye diseases;[2] depression can be controlled by optogenetics (Deisseroth 2010), local brain exposure to light; epileptic fits appear to follow many hours of potential activity that can be monitored (Litt 2001) and presumably therefore one can act on it before the event; cochlear implants improve hearing; and prosthetics allow people to walk and under neural control perform simple tasks such as peeling bananas or drinking from a glass. Many of these are based on nerve signaling. Using the simple mathematical approach of correlations in prosthetics is now well accepted. These are all examples where man-machine fusion occurs in very rudimentary form. But, all this will change dramatically, when the young of today grow up with the integrated technical knowledge from the physical and the living world, and the symbiosis proceeds apace. They will know how to exploit rational trans-differentiation using gene regulatory networks and gene-interfering approaches to reprogram a differentiated cell for use in physical machines. The physical machines themselves will know how to incorporate itself in a cell and work with the complex forms that are created together through the fusion.

Using the *Emergent Machine's* advanced hardware and advances in neural assemblies, it will be possible to make radio-telepathy — the use of wireless connection to neurons for human activity — feasible. Using neural process learning, removing the effects of brain-based diseases and cognition repair will happen, bringing relief to individuals and families suffering the consequences of debilitating diseases such as autism, Parkinson's or Alzheimer's. Such non-invasive and invasive brain-computer interfaces, taking advantage of brain plasticity, would be a major engineering accomplishment for humans.

One fascinating thought along this speculative path is that if we really do have a good model in machine of the human construct — its emotions, personality, experiences — then we also have the means to have it live in a machine, where it would be indistinguishable in its response, such as in the Turing test, from the real form (Dyson 2007). In case of Alzheimer's disease, or loss of brain connection or function, or even death, one could "live" in a silicon-

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2. See http://www.telegraph.co.uk/science/science-news/9243223/Eye-implant-restores-vision-to-blind-patients.html describing vision restoration in two blind patients.

Thomas Struth, *Tokamak Asdex Upgrade Interior 2. Max Planck IPP, Garching,* 2009

human form. The program is installed in a robotic body and it takes over life and the responsibilities of the human.

This leaves us with a lot of breathtaking questions. When does it end? This is not a question I can comfortably respond to. I do believe that two facts of life will not change. Science will keep being unpredictable with new ideas and opportunities constantly arising. Engineering, with us as tool-making animals, will remain central to exercising our creativity. It is just that this creativity is slowly moving to the domain of physical complexity and of biological complexity. Fascinating questions will still remain. Among a few that will likely still be there following this time period that I have discussed are:

> • Will we understand why life is so immensely complicated? Will we understand living systems in a deep sense: stable, complex, dynamic? Will we understand emotions: romantic love or sadness? Will we understand the development of skills in

infants or the entangled play of moods, emotions, learning and understanding in the species? Will we be able to construct a mathematical predictive model of these? For example, will we be able to provide a complete mapping of the DNA "software" to the species? Today, we cannot even answer the question: why does a simple genetic modification change the species completely?

• The capacity to feel and relate to other people provides humans very unique capabilities when integrated with their intellectual activity. Will physical machines have this consciousness, free will, self-awareness, emotions, feelings, personalities, etc. — emergent characteristics we associate with the carbon life? In what way will they differ from carbon life? Will they suffer diseases such as depression or alcoholism?

• Are we humans going to get smarter, or will most of technology be used for repair? Who will be smarter? Man or machine, or will it be silicon-human?

• Will we be able to send an *Emergent Machine* or just the code of the automaton (the genetic code for the living, or the physical machine's code, or silicon-human's code) to outer space where it will create itself in the machine form, and thus achieve movement of synthetic life in the universe and through this will we finally find out if we are alone, or that there is nothing really unique about us?

• Will our belief in the Wallace-Darwin theory of natural selection as the basic mechanism of evolution — that life adapts itself to the given conditions on the planet — continue to stand? Or will our beliefs have to change towards the Gaia hypothesis that life doesn't just adapt to the conditions around it, but changes them so as to survive and perpetuate? How does technology fit into this? Where will social justice as our species' intellectual emergent outcome fit into this man-machine fusion? Is the silicon-human a new species in this evolution?

• If the human being's life becomes longer, how will the human body change? The design of the body for living longer cannot be the same as the seventy-eighty-year length it is appropriate for today.

And most important of them all: will it be paradise lost? Or will it be paradise regained? Only how we handle the perennial questions of sin and virtue, or the gray in between, with our acquired collective wisdom on this little speck of a planet in this giant universe, will unravel that. Only ethics, not discussed here, can fill the ever widening gap between technology and human needs that too is not discussed here. Are science, engineering and technology here to serve human needs, or to take an emergent path of their own? Only our actions — we Adams and Eves — will determine this future course as we transit through the gray regions of living.

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THE HISTORY OF PAST FIVE HUNDRED YEARS IS AS MUCH A CHRONICLE OF MANKIND USING MACHINES AS OF MANKIND BEING CHANGED BY MACHINES. WHEN THE BRITISH BROUGHT RAILWAYS TO INDIA, IT WAS TO CONTROL A DISTANT COLONY THROUGH THE EFFICIENT MOVEMENT OF GOODS AND TROOPS. BUT IT ALSO SPURRED THE BREAKING DOWN OF CASTE BARRIERS SINCE ALL TRAVELERS HAD TO OCCUPY COMMON SMALL SPACES. A FRONTIER RESEARCH AREA IN NEW MACHINES IS IN THE CONTROL AND MANIPULATION AT THE ATOMIC AND MOLECULAR SCALE — NANOTECHNOLOGY'S SCALE FROM WHICH PHYSICAL AND BIOLOGICAL PROPERTIES ARISE. THIS WILL LEAD TO THE DISAPPEARANCE OF THE DISTINCTIONS BETWEEN MAN-MADE AND LIVING THAT WE SEE TODAY. MAN AND MACHINE WILL FUSE, RAISING SOME OF THE MOST DIFFICULT EVOLUTIONARY AND ETHICAL QUESTIONS OF OUR HISTORY.

BIOGRAPHY

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Sandip Tiwari is Charles N. Mellowes Professor in Engineering at Cornell University. He finds particular joy in discovering scientific explanations, uncovering new phenomena, inventing new devices and technologies, and moving in directions that are of broader societal use. His research has spanned the science and engineering of semiconductor electronics and optics. His current research interests lie in the challenging questions that arise when large scales — such as those of massively integrated electronic systems, a complex system — are connected to small scales, such as those of small devices and structures that come about from the use of nanoscale, bringing together knowledge from engineering, and physical and computing sciences. In his personal life, he is also active in bringing openness, understanding and cooperation across this world through efforts in elementary through graduate education. A native of India, he was first educated in Physics before moving to Electrical Engineering, attending IIT Kanpur, RPI, and Cornell. After working at IBM Research, he joined Cornell in 1999. He has been a visiting faculty member at Michigan, Columbia, Harvard, Indian Institute of Science and Stanford. He was the founding editor-in-chief of Transactions on Nanotechnology, he has authored a popular textbook on device physics, and he led USA's national nanotechnology networks from 1999 to 2011. His work has been recognized by the Cledo Brunetti Award of the Institution of Electronic and Electrical Engineers (IEEE), the Distinguished Alumnus Award from IIT Kanpur, the Young Scientist Award from Institute of Physics, and the Fellowships of American Physical Society and IEEE.

Can Medicine Be Predictive?

José M. Mato

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There is a nautical chart attributed to Christopher Columbus, possibly drawn up in 1492 following the conquest of the Muslim city of Granada by the Catholic Monarchs, and obviously made before he set sail on the voyage that would lead to the discovery of America. The map stretches from the south of Scandinavia to the mouth of the river Congo, showing all the Mediterranean ports of Europe and Africa in detail. The enormous space that Columbus dedicated to the Atlantic Ocean is conspicuously lacking in detail. In all probability, this huge blank space served not only to mark the frontier of the known world and therefore the potential expansion of world knowledge — knowledge that would indeed double over the course of the following century. It also opened up a route for the imagination and the adventure of sailing through it, a route travelled by numerous sixteenth and seventeenth-century explorers who in most cases were destined to remain anonymous.

Columbus's portolan chart shows us where any geographical investigation would be carried out while there were still unexplored lands on the earth. In the same way, progress at the frontier of knowledge — be it in chemistry, physics or mathematics, or in more applied fields such as biology, geology, medicine, social science, or nature conservation — has been produced, since the beginning of time, by opening new routes for the imagination and setting out on adventures into the unknown in search of solutions based on hard facts, just like a geographical expedition to fill in an incomplete map. The scientist, as opposed to the philosopher or the ideologue, does not possess that quest for totality nor does he try to explain the world through a system.

Blanca Muñoz, *Espacio arrugado* (detail), 2000

The scientist progresses via modifications and additions to theories that already exist by delving into the details. Darwin did not invalidate the biological and geological knowledge of his day; he incorporated it to give it validity within the scope of the evolution of species through natural selection.

At the end of the twentieth century, however, a phenomenon appeared which might be called "genocentric." It consists in considering genes as the sole elements responsible for what we are and how we look. And we often forget that genes give few clues, not only to the personality and appearance of a person, but also to their state of health. We should be clear that in biology, when speaking of things such as genes, genotypes and genomes, we are not speaking of an objective physical reality — i.e., a phenotype — but of information. The genomes of two unrelated people are approximately a 99.9-percent match: they differ by just one part in a thousand. How is it possible that people so genetically alike can be so physically different? How can they have such diverse phenotypes, so that even genetically identical twins are not the same, nor have the same personality, nor suffer from the same diseases? Only a few decades ago, geneticists had to defend the idea that the development of any species was influenced not just by the environment but also by genes. The current situation has changed so radically that we now have to defend the idea that the environment and chance play a fundamental role in the risk of suffering common diseases, in the formation of personality, or in ageing.

Molecular biology, via the direct study of genes, has developed a deterministic concept of biology that rests on the principle of specificity. According to this concept, which has been crucial in the understanding of the function of genes and the proteins they encode, each genome has its corresponding unique three-dimensional structure — a unique phenotype. This way of thinking has given excessive value to the biology of systems, to a way of carrying out research in biosciences which consists in measuring everything (genes, proteins, metabolites) in a biological system in the hope that upon analysing this huge amount of information, new properties of the system will emerge which allow an integral understanding. This holistic focus, diametrically opposed to the reductionist method that has dominated and driven biomedical research for over 150 years, is simply a mathematical model — a way of understanding biology and trying to explain it through a theoretical construct.

The key question is: How can phenotype diversity be produced from a single genotype? The issue is that specificity is a qualitative, abstract term. In biology, the interactions between molecules (DNA, RNA, proteins and metabolites) are characterized not by exclusivity, but by the multiplicity of possible interactions between some molecules and others. The problem is that in biology we cannot carry out reverse engineering: it is not possible to discover how a cell works based on a mathematical system which incorporates thousands of measurements of its internal components, simply because there is no single solution, no predefined design. From this perspective, the human being (or any other organism) is no longer the fulfilment of a linear

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genetic program, but the result of an open process in which individuality springs from certain genetic information interacting between other information existing at that moment. This vision of biology allows an understanding of how multiple phenotypes can be formed from a single genome, and how environment and chance select, at each moment, one from among all the possible phenotypes.

The rise of systems biology is a temporary fad. Future scientific research in biology and biomedicine will continue to be dominated by the spontaneous response of the researcher towards a question, working directly on the cell components, solving direct rather than reverse problems, opening new routes for the imagination, and seeking a solution based on hard facts. From this vision of biology that seeks to solve problems, predictive medicine — currently so fashionable — is not realistic, because it is one thing to know that a certain gene mutation increases the risk of suffering some type of cancer in the general population (e.g. to 50 percent) and another thing to be able to tell a person whether they belong to the 50 percent who are going to develop the tumour or the 50 percent who are not. The fact that not all those with an identical mutation in the same gene will go on to develop a certain type of cancer is the greatest proof that biological reality is extremely complex, that within cells there are multiple

compensatory and adaptive mechanisms, that we need to distinguish clearly between a person's genome (the genotype) and their characteristics (the phenotype), and that biology is not deterministic, nor does it rest on the principle of specificity. It thus follows that illness is individual and medicine cannot be based on statistics.

Even in those diseases caused by mutations in a single gene, as in the case of phenylketonuria, the correlation between genotype and phenotype is not always close. Phenylketonuria is a rare hereditary disease caused by the presence in the body of toxic levels of an amino acid called phenylalanine, due to mutations in an enzyme called phenylalanine hydroxylase. Phenylalanine is an amino acid obtained from diet; it is needed to synthesize

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proteins in an organism. If not treated in time, the levels of phenylalanine increase in the bodies of those with phenylketonuria, in most cases causing severe and irreversible intellectual disability. Although the genotype predicts the biochemical phenotype (the concentrations of phenylalanine in the blood), it does not predict the clinical phenotype (the appearance of intellectual disability). Thus, some people with phenylketonuria and high plasma concentrations of phenylalanine display normal intelligence, and some siblings sharing the same genotype have different metabolic and clinical phenotypes. The mechanisms that cause these differences in cerebral pathogenesis, despite the presence of comparable concentrations of phenylalanine, are unknown. So even in the case of a monogenic disease such as phenylketonuria, where the effect of the genetic mutation is the accumulation of a specific amino acid, the pathogenic mechanism is complex at the metabolic and cognitive level, and it is not possible to predict intellectual disability from the genotype.

The differences between the genomes of two people are mainly variations in one gene, consisting of the substitution of one base for another in the DNA sequence. These polymorphisms of a single nucleotide in a gene receive the name of SNP (single nucleotide polymorphism). Around 12 million SNPs have been identified in the human genome. Each person's genome contains a unique SNP profile, a specific genotype, which is a result of genetic variation between individuals. During the last decade numerous studies have been carried out in which hundreds or even thousands of people have been genotyped using microarrays of up to 5 million SNPs, covering the whole human genotype, with the aim of identifying specific genetic

variants implicated in common conditions such as obesity, diabetes or hypertension, which are all associated with increased morbidity and mortality.

In practical terms, this research has provided little in the way of results. Let us analyse, for example, the case of obesity. Obesity is currently one of the most serious global public health problems because it is associated with some of the principal causes of death in the world such as diabetes, cardiovascular disease, and some types of cancer, and in recent decades it has reached epidemic proportions. According to the World Health Organisation,[1] around 1.3 billion people in the world suffer from obesity or are overweight — that is 18 percent of the global population. In the United States, this proportion is around 38 percent. Mexico has also surpassed 30 percent. Australia and the United Kingdom are at around 25 percent; and Spain, Germany and Finland have surpassed 15 percent. The countries with the slimmest populations are India, Indonesia and Japan.

Obesity is a result of an energy imbalance produced when people ingest more calories than they burn. How do genes influence obesity? Between 1969 and 1979, the percentage of adults in the United States who were not overweight remained stable at around 74 percent. Ten years later, in 1989, this percentage had gone down to 63 percent, and in 1999 only 39 percent of the adult population were slim, a percentage that according to the most recent data has now fallen to 34 percent. Clearly, most of the blame for this situation does not lie with the genes. A lack of physical activity and an excessive intake of calorie-rich foods are the main causal factors in the global obesity epidemic. However, not all people exposed to the same environment become obese, nor do they all suffer from the same obesity-related health problems, suggesting that some part of the weight difference between adults is linked to genetic factors. It must be made clear, however, that only on very rare occasions is obesity produced by the mutation of a single gene (monogenic obesity), and in the majority of cases obesity — as with other common conditions — is the result of multiple and complex interactions between genes, proteins and metabolites with diet and environmental factors, which are not well understood.

Through studies comparing thousands of obese and non-obese people, variants related with the development of obesity have been identified in around fifteen genes. In practical terms, what use is it for a person to know whether his or her genome contains one or more of these genetic variants associated with obesity? It is no use at all. If the person is slim, he or she must obviously carry on with the same lifestyle and pay no attention to the information. If the person is obese, two things must be made clear: 1) that it is impossible to know if the gene or genes in his or her genome have had any influence on their being overweight because, as we have said, biological events do not happen in a linear manner, and therefore we cannot

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1. WHO, http://apps.who.int/bmi/index.jsp

conclude that, for example, 5 kilos of excess weight in a person correspond to such and such a gene, and another 3 kilos correspond to another; and 2) that in any case, an increase in physical activity and a reduction in daily calorie intake will reduce weight.

The rapid advances in DNA sequencing technology have made sequencing of the whole genome of a person a technically and economically feasible objective. The X-Prize Foundation recently offered a 10-million-dollar prize to the first research team capable of sequencing the complete genome of 100 centenarians in 30 days at a cost of up to 1 000 dollars per genome, with an error of less than one base per million base pairs sequenced. What benefits could this technology currently offer for the health of the individual? To answer this question, it is important to emphasize that clinical reasoning is basically Bayesian. In other words, the predictive value associated with a diagnostic test varies when it is applied to populations with indices of prevalence very different to those of the studied condition. For example, in a person diagnosed with excessive levels of iron, the gene mutation known as HFF is a highly reliable predictor of a diagnosis of hereditary hemochromatosis. However, in a population that has not been preselected for high levels of iron, the presence of the same mutation confers only a slight risk of developing clinical symptoms. Equally, in a person diagnosed with hypercholesterolemia, the mutation of certain genes implicated in cholesterol metabolism is a highly reliable predictor of the diagnosis of familial hypercholesterolemia. However, in a population that has not been preselected for high levels of cholesterol, the presence of these same mutations has little predictive value regarding the risk of developing hypercholesterolemia. These results speak for themselves of the importance of interpreting the results of studies of genetic variations within an adequate medical context. Carrying out the routine sequencing of the genome in healthy people means separating the diagnostic test from the medical question, which could lead to the diagnosis of a clinical condition when in reality it does not exist (false positives). One example would be the erroneous diagnosis of hemochromatosis in a person with a low risk of developing the condition, simply because he or she shows a mutation of the HFF gene. Routine genome sequencing could likewise lead to the identification of false negatives — diagnosing people as healthy when they have non-genetic forms of a condition, or forms produced by mutations of other genes, the complex reorganization of chromosomes, etc. In practical terms, it is hard to see how the routine sequencing of the genome in healthy people could have a positive effect on the health of the individual.

Medicine, like insurance companies, works with general statistics, and experts base their conclusions and recommendations regarding public health policies on studies that conclude, for example, that obesity is a serious global public health problem and states must follow active policies that promote exercise and a good diet. But these studies can say nothing about the individual risk of being obese in one country or another. To draw an analogy, drivers involved in

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few traffic accidents are deemed to have a positive future and therefore enjoy a bonus on their insurance premiums. Conversely, drivers with a history of traffic accidents have a poor outlook so they pay a penalty regardless of where they live. In the same way, when the weight, blood pressure, glucose, triglycerides and cholesterol of a person are normal, his or her future is deemed good — and that is the received bonus; but if these parameters are not normal then his or her future is bad, and that is his or her penalty. Because it is not written in a person's genes that he or she cannot modify their lifestyles and reduce their weight, blood pressure, glucose, triglycerides and cholesterol, and thus improve their future. And neither is it written in a person's genes that they cannot be slim in the United States and obese in India. It is the phenotype (weight, blood pressure, glucose, triglycerides, cholesterol, etc.) and not the genotype that provides greater information regarding a person's future.

That is why medicine is individual, and it must adapt to the person and work with specific cases rather than with statistics. Let us take the case of breast cancer. Over 1.3 million women worldwide are diagnosed with breast cancer each year. Although in developed countries survival rates at five years following diagnosis increased from 40 percent in the 1950s to 86 percent in 2004, not all breast cancers are the same and some women fare better than others. When a

patient is diagnosed with breast cancer, the tumour(s) are classified into four different phenotypes according to how oestrogen receptors (ER positive), the progesterone receptor (PR positive), or any receptor from the epidermal growth factor receptor family (HER2 positive) are expressed on the cell surface. If none of the previous three are manifest, it is classed as triple-negative breast cancer. The study of a great number of cases has demonstrated that when tumours are governed by oestrogens, progesterone or HER2 there are effective treatments with a survival rate at five years of 93 percent, while for triple-negatives, conventional chemotherapy together with surgery and radiotherapy is the only available treatment, and survival is reduced to 77 percent. Clearly, knowing whether the tumour displays certain receptors (ER, PR or HER2) or not — i.e. knowing the tumour phenotype — is crucial in choosing the best type of treatment for each patient. It is the phenotype, the fact that the surface of the tumour cells expresses certain receptors (ER, PR or HER2), together with the clinical history of the patient, which determines the best treatment in each case.

Another example which clearly illustrates why medicine must be flexible and work with specific cases rather than statistics is that of lung cancer, a condition for which there is still no treatment. Every year, over 1.3 million people in the world die from lung cancer, making this the most fatal type of cancer ahead of stomach cancer (approximately 740 000 deaths a year) and liver cancer (approximately 700 000 deaths a year). We have discovered that around 5 percent of lung cancer cases are governed by a type of mutation that reorganizes a single gene that encodes a protein called ALK. Tests have shown that approximately 60 percent of ALK-positive patients respond well to treatment with a molecule which inhibits the activity of ALK and which is currently undergoing clinical research. The reason why 40 percent of the cases of ALK positive lung cancer do not respond to this treatment is unknown. This example teaches us that even in the most favourable circumstances in which the guiding principle has its origins in the mutation of a single gene, the lack of linearity in the chemical processes that govern human physiology and physiopathology produces a diversity of phenotypes indicating, once again, the need for medicine to be individual and to adapt to the person.

Research into the molecular basis of common chronic conditions such as obesity, hypertension, cardiovascular disease, cancer, and diabetes has become the main focus of genetic epidemiology. Consequently, there is renewed interest in studying the relationship between disease and racial descent. Numerous studies have documented differences in the frequencies of diverse common conditions — such as cardiovascular disease — in correlation with racial descent. Is this conclusion justified? Because if it is correct, this is where we should be looking for the genotypic bases of common diseases. Firstly, bear in mind that the current concept of race is based on the experience of naming and organizing populations found during the rapid expansion of European countries during the seventeenth century. It follows that we are dealing with a social construct with economic, legal, socio-political, and also biological

ingredients in various proportions that, due to this malleability, have been used to justify diametrically opposed objectives ranging from committing genocide to improving public health. Secondly, although it is possible to group people according to their geographical continental origin by analysing mutations on their DNA microsatellites, the relevance for health of these results has not been demonstrated. These microsatellites are DNA sequences with a high level of mutation, generally in non-coding DNA areas, where a small fragment is repeated consecutively. Microsatellites are used as genetic markers in paternity tests and in population studies, but it is not clear that these differences are relevant when it comes to health.
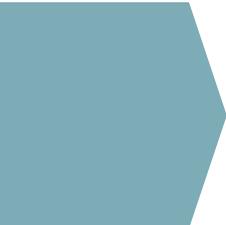
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Although it is true that many genetic diseases vary in frequency between populations, these diseases are generally rare and their frequency is unconnected to geographical continental origin, i.e. to racial descent. Let us consider Tay-Sachs disease, cystic fibrosis and thalassemia, three examples of rare diseases that occur with a greater frequency in some populations than in others. Tay-Sachs disease is a rare hereditary disease caused by the mutation of a gene that encodes a protein called Hex-A. Without this protein, neurons accumulate toxic levels of special types of lipid called gangliosides. This build-up affects the central nervous system, usually producing severe physical and mental disability that causes death after just a few years of life. Tay-Sachs disease is common in people of central European Jewish descent, but not among other Europeans nor in people descendent from Sephardic Jews: it is independent of racial descent. Now take cystic fibrosis, a rare hereditary disease produced by the mutation of a gene that encodes a protein called CFTR, which regulates the movement of chlorine and sodium ions through the epithelium membrane. The mutation causes thick secretions that obstruct and infect numerous organs, chiefly the lungs. Its frequency is also independent of geographical continental origin. And lastly thalassemia — a type of hereditary anaemia where the synthesis of one or more of the protein chains that make up haemoglobin is altered — is frequent in various populations from Italy to Thailand. It is not associated with a particular continent or race either.

Although we know very little about the genetic variants that predispose people to common chronic conditions, it is frequently assumed that minority groups — in general Blacks and Latin-Americans — are genetically more predisposed to suffer from any common chronic condition.

The globalization of common chronic conditions suggests, however, that variations in the state of health between populations are due more to differences in exposure to environmental causes than to genetic variations. Without the context provided by variables such as levels of education, socio-economic status, occupation, diet and place of residence, race is not useful in making predictions regarding health. In diverse European countries, the United States, Australia and Canada, there is a socio-economic gradient related with diet whereby people with a higher socio-economic status tend to have a healthier diet, characterized by a greater consumption of fruit, vegetables, skimmed milk, and a lower consumption of fats. Consequently, among women in richer countries, where a slim body is socially valued, there is a negative gradient between weight and socio-economic and educational level. However, for women in countries with other socio-cultural values and/or a medium or low economic level, it is more common to find a positive relationship between economic status and weight. Thus while in the United States or in Spain obesity is divided more or less equally among women and men, in Saudi Arabia, Algeria, Egypt or Russia the number of obese women is approximately double that of men.

There is an equally complex relationship between socio-economic status and other risk factors — such as tobacco and alcohol consumption and a lack of physical activity — associated with some of the diseases which result in higher mortality, including cancer, cardiovascular disease or diseases of the respiratory or digestive system. These data indicate that, taken together, the net effect of racial descent on the health of a person is small, and in no case is it greater than that imposed by economic or socio-cultural factors.

It is metabolism — the set of biochemical reactions taking place within an organism in order to keep it alive — and not genes that has the greatest influence on phenotype. The human genome contains around 2800 genes that encode the enzymes catalysing the biochemical reactions taking place in the human body. Thus, approximately 10 percent of a person's genes are dedicated to metabolism. These biochemical reactions not only allow a living being to grow, be differentiated, maintain its structure and reproduce. They also enable it to respond to environmental changes such as temperature, oxygen concentration, food, or the presence of toxic substances. An organism's metabolism is regulated on multiple levels in order to maintain stable conditions inside its cells regardless of environmental changes: a process known as homeostasis. Homeostatic imbalance is the basis of many diseases, not only in the most common ones such as diabetes or obesity, but also in others such as cancer, immunodeficiency, hepatic conditions and genetic disorders. In the human body, we have identified nearly 5 000 different metabolites, over 75 percent of which are lipids. The largest class of lipids is the phospholipids, which encompass more than 2 000 different molecular species. Following these in complexity are the triglycerides, with over 1 000 different species; then come the cholesteryl esters and the fatty acids, each with over 100 different species.
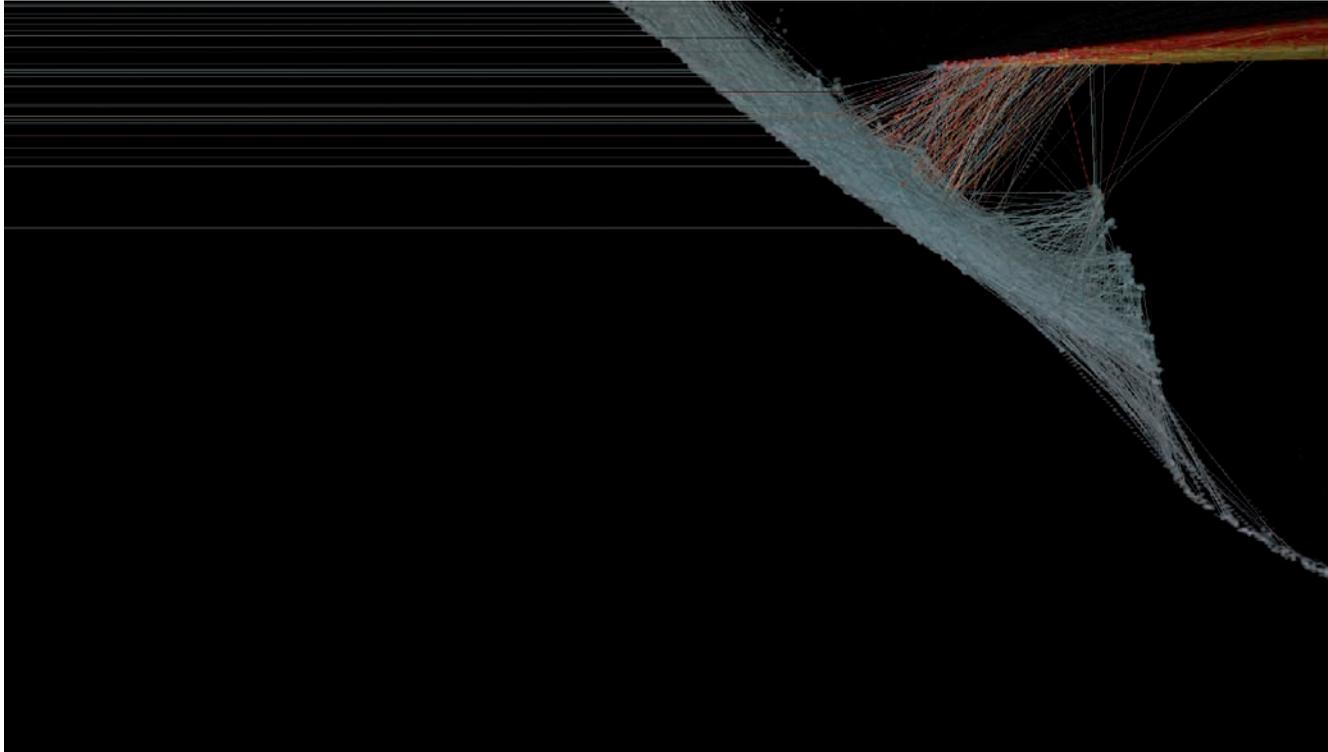
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The classical function of lipids is to form the lipid bilayer of membranes and provide energy: the oxidation of a gram of fat produces 9 kilocalories, while carbohydrates and proteins produce just 4 kilocalories per gram. Yet lipids also carry out other essential functions, such as regulating cell proliferation, differentiation and death, as well as oxidative stress and inflammation. The lipids carrying out these functions are known as lipid mediators. Key among the lipid mediators are the eicosanoids, a group of lipids with pro-inflammatory effects derived from arachidonic acid. The importance of the eicosanoids is clear if we consider that the anti-inflammatory drug aspirin works by preventing the production of eicosanoids. Moreover, prostacyclin, another member of the eicosanoid family, is used as a medicine in the treatment of portal hypertension, and as a vasodilator. Other lipid mediators derived from arachidonic acid are the lipoxins and the endocannabinoids. Lipoxins have anti-inflammatory effects, and endocannabinoids are lipids that attach to the same cannabinoid receptors upon which marijuana acts. In addition to having psychoactive effects, the endocannabinoids contribute to the regulation of the immune system and the development of portal hypertension, the chief complication in hepatic cirrhosis. Other lipid mediators are the resolvins and protectins, which derive from linolenic acid, also known as omega-3 fatty acid, and they receive the generic name

of docosanoids. To these we must add the lipid mediators derived from phospholipids, especially the platelet-activating factor or PAF and lysophosphatidic acid, plus those derived from the sphingolipids (ceramide, ceramide 1-phosphate, sphingosine, and sphingosine 1-phosphate) which regulate platelet aggregation, inflammation and anaphylaxis, in addition to the proliferation, differentiation and death of numerous types of cells. Finally there are hydroxycholesterol and oxycholesterol which, as their names suggest, are lipids derived from cholesterol. They also regulate important cell functions.

If we compare the small number of lipid mediators that have been identified (around fifty) with the 4 000 or so lipids present in the human metabolome and about which little or nothing is known of their biological function, it is reasonable to assume that among them are probably tens or hundreds of lipids whose biological properties go far beyond forming cell membrane bilayers or serving as fuel to generate energy. Moreover, the majority of lipid mediators that have been identified are derived from omega-3 and omega-6 fatty acids, and it is therefore likely that there are other unknown lipid families performing important biological functions. The coming decades are likely to see an acceleration in the identification of new lipid mediators, providing the basis for new treatments for a wide range of conditions from obesity, diabetes and cardiovascular disease to cancer and neurodegenerative diseases. In fact, it has recently been discovered that adminisering an unusual phospholipid called dilauroylphosphatidylcholine, or DLPC, has an anti-diabetic effect and improves the condition of fatty liver disease in mice.

Deciphering metabolic changes such as those produced during the growth of a tumour cell, and comparing them with those occurring during normal cell division, could help us develop new therapeutic procedures as yet unexplored. Over recent decades, cancer research has been chiefly dedicated to the study of cell division mechanisms, i.e. to identifying genes and proteins implicated in this process; only recently has more attention been paid to tumour metabolism. Unlike normal cells which generate the energy they need mainly through mitochondrial respiration (a process called oxidative phosphorylation), cancerous cells use aerobic glycolysis to obtain energy, a phenomenon named the "Warburg effect" after its discoverer, the great German biochemist Otto Warburg. Aerobic glycolysis is a less efficient way of generating energy from glucose than oxidative phosphorylation: while aerobic glycolysis generates two ATP molecules per glucose molecule, oxidative phosphorylation generates up to 36 molecules. How is this metabolic reprogramming in tumour cells produced? What is the advantage for tumour cells of having a less efficient metabolism, at least in terms of ATP production, than normal cells? The simplest explanation is that if tumour cells extracted maximum energy from glucose, they would not be able to use the carbon atoms from these molecules to produce biomass — the lipids, proteins and nucleic acids needed for growth. And don't forget, growth is the sole objective of a tumour cell.

In support of this hypothesis, numerous cases of metabolic pathway reprogramming have been discovered in cancerous cells, with this reprogramming resulting in greater biomass synthesis and reduced energy production. For example, an increase in serine synthesis has been seen in breast cancer cells. Serine is a non-essential amino acid synthesized from 3-phosphoglycerate, a metabolite of glucose. Serine is necessary not only for protein synthesis, but also for the synthesis of another amino acid called glycine. Glycine is in turn needed for protein synthesis, glutathione (one of the chief antioxidant molecules) and purines (essential in DNA and RNA synthesis): in other words, for biomass. Likewise in numerous tumour cells, including breast cancer cells, an increased synthesis and consumption of glycine has been observed. Indeed, we have seen that the flow from 3-phosphoglycerate to glycine is accelerated in various tumour cells. The synthesis of glycine requires the presence of tetrahydrofolate, or THF, a derivative of folic acid or vitamin B_9. It is no coincidence that since the 1950s, antifolates — a group of compounds that inhibit the synthesis of THF, the most well-known of which is methotrexate — have been used to treat various types of cancer, including breast cancer, as well as other conditions such as rheumatoid arthritis and Crohn's disease. Experiments have shown that blocking serine synthesis inhibits the proliferation of breast cancer cells, which seems to indicate opportunities for new "metabolic" therapies aimed at inhibiting serine and glycine synthesis in tumour cells.
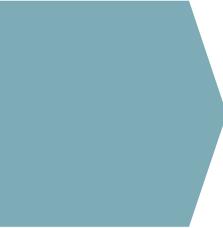
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Another interesting case of metabolic reprogramming is that which takes place in liver cancer. The tumour cells synthesize and consume less S-adenosylmethionine (SAMe) than normal hepatic cells. SAMe is a derivative of methionine, an essential amino acid (i.e. we cannot synthesize it ourselves) which is needed for protein synthesis. SAMe carries out various vital functions in the cell. One of them is to donate a carbon atom originating from the methionine (called the methyl group) in a great number of biochemical reactions known collectively as transmethylation reactions. Another function of SAMe consists in channelling the flow of the rest of the carbon atoms from the methionine to the mitochondria in order to be catabolized through an intricate series of biochemical reactions (the transulphuration pathway), thereby generating energy. SAMe synthesis is not the only reaction related to the metabolism of methionine that is reprogrammed in liver cancer cells. Liver cancer also sees a decrease in the

biosynthesis of sarcosine, a reaction that uses glycine and SAMe, and in the decarboxylation of SAMe, the first step in the synthesis of a group of compounds called polyamines. The reduction in SAMe biosynthesis and its role in synthesizing sarcosine and polyamines enables the hepatic tumour cells to redirect the metabolism of methionine towards the synthesis of proteins needed for growth. Experiments have shown the importance of this metabolic reprogramming, demonstrating that the genetic manipulations that block the metabolic axis linking methionine to sarcosine, via SAMe, are sufficient to induce the spontaneous appearance of liver cancer. These results point to opportunities for new therapies that aim to restore the metabolism of methanine in liver cancer. Tests have shown that treatment with SAMe reduces growth in hepatic tumour cells and induces their death.

When not accompanied by malnutrition, calorie restriction — diets that reduce the number of ingested calories — improves people's general health (including blood pressure, glucose, triglycerides and cholesterol) and increases longevity in many animal species including rodents. Although the effect of calorie restriction on longevity in primates, including humans, is open to debate, these studies are important because they can provide information regarding diet strategies that improve general health without the side effects produced by excessive weight loss. For example, when *Drosophila* flies are submitted to calorie restriction they live longer, even though their fertility diminishes (one of the side effects of excessive weight loss). But if methionine is added to the diet this side effect disappears. In mice, the restriction of methionine in the diet also increases longevity, while a severe deficiency of this amino acid produces malnutrition, fatty liver, inflammation, fibrosis, and liver cancer. These results indicate that methionine acts as a metabolic rheostat in mice, and both excessive and insufficient levels of this amino acid can affect health. This work also demonstrates that not all calories are the same and that what matters is the type of feeding. An understanding of how a diet restricted in certain nutrients can improve general health or increase longevity could help us identify therapeutic targets that offer the beneficial effects of calorie restriction with minimal side effects.

When we speak of metabolism, we immediately think of the thousands of biochemical reactions taking place within a person's body, but we usually forget the metabolic reactions performed by the micro-organisms living in the intestine. The intestinal microbiome is made up of 10^{13} to 10^{14} micro-organisms, whose collective genome contains at least 100 times more genes than our own genome. This microbiome contains thousands of genes implicated in the synthesis and metabolism of polysaccharides, carbohydrates, amino acids and lipids, as well as other compounds such as vitamins, isoprenoids and methane. Many of these molecules pass through the intestinal wall and circulate freely in the blood, together with those metabolites synthesized endogenously. In other words, human metabolism is a fusion of its endogenous metabolism with that of the micro-organisms living in its intestine. The case of trimethylamine
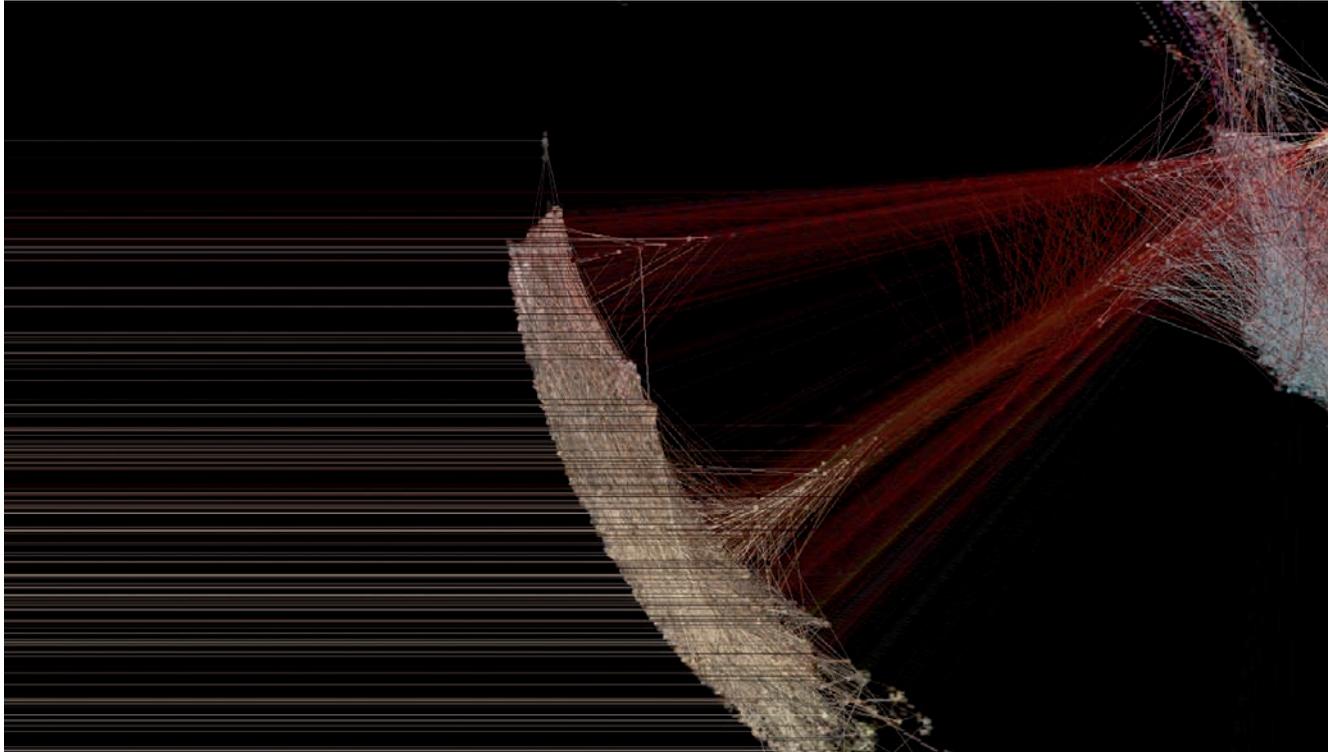
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(TMA) is a good example of this metabolic fusion. Intestinal flora — not endogenous human metabolism — can convert choline from phosphatidylcholine (the most common phospholipid in our diet) into TMA. In turn, a group of hepatic enzymes known collectively as FMOs oxidise TMA to TMA oxide, or TMAO. And TMAO activates the synthesis of cholesterol in macrophages which, in mice, promote the appearance of plaques in the arteries and the development of atherosclerosis. Although the impact of the microbiome on human health is subject to debate, changes in microbiome composition have been associated with obesity and certain inflammatory diseases. Therefore, the study of the microbiome and its metabolome provides enormous potential in the search for new diagnostic biomarkers and treatments.

The rapid advances in mass spectrometry and nuclear magnetic resonance technologies have made it possible to quickly and simultaneously determine and quantify around 1 000 different metabolites from a serum sample of a few microliters. In all probability, it will soon be possible to determine the complete metabolome — some 5 000 distinct compounds. How can studying the metabolome improve the health of the individual? The human metabolome is an ocean of biomarkers. In the future, studying the metabolome in biological fluids — serum, urine, faeces, sweat, tears — and tissue samples will provide biomarkers to

assist not only in the early diagnosis and prognosis of numerous complex diseases, but also in monitoring each individual's response to treatment. Of course, as we have established, there is no point in determining the concentration of thousands of phospholipids, triglycerides, cholesteryl esters and fatty acids in the serum or other biological sample from a person if the data are not then interpreted within an adequate medical context. The experience of diagnosing non-alcoholic fatty liver disease (NAFLD) teaches us that considering aspects that at first glance may appear of little relevance, such as the body mass index,[2] can be decisive when using metabolomics as a diagnostic tool. NAFLD is a progressive disease that ranges from the simple accumulation of fat in the liver (steatosis) to steatosis with inflammation, necrosis and fibrosis, a condition called non-alcoholic steatohepatitis, or NASH. Patients with NASH have a greater risk of developing cirrhosis and cancer of the liver: between 10 and 20 percent of people with NASH develop cirrhosis within 10 years. NAFLD affects 1 in every 4 adults in developed countries, and approximately 30 percent of those with NAFLD have NASH. Although the majority of people with NASH are obese, this disease is also found in slim people, but in a lesser proportion. Few people with NASH are aware they have the condition, as it presents few or no symptoms. Imaging techniques such as ultrasound or magnetic resonance can reveal the presence of fat in the liver, but they cannot differentiate NASH from simple steatosis. The hepatic biopsy, while considered the gold standard, is an invasive, subjective and costly procedure that is not exempt from complications (it carries a risk of death of 0.01 percent) and is prone to sampling errors. Due to these limitations and an increase in the prevalence of NAFLD (it is the most common liver condition in developed countries), the identification of biomarkers that allow the diagnosis of this disease is urgent and necessary. The study of lipidomics has identified a small group of lipids that allow us to distinguish between NASH and steatosis using a serum sample. Surprisingly, tests have shown that this lipid profile — the footprint that serves to diagnose NASH — is dependent on BMI: the lipids that serve to differentiate between NASH and steatosis are different in slim, obese or morbidly obese people. Therefore, carrying out routine metabolome testing to diagnose NASH in people who have no symptoms and who are not preselected using BMI or within an adequate clinical context could lead to false diagnoses.

The development of complex molecular tests based on DNA or RNA profiles, proteins or metabolites, carries a series of problems inherent to high-performance techniques where huge quantities of data are analysed. When thousands of molecules are examined using a relatively small number of patient samples, it is easy to find false correlations with the diagnosis of a certain condition or with the effectiveness of a treatment. Some years ago a group of

2. BMI, obtained by dividing the weight in kilos by the square of the height in metres.

researchers from the University of Duke in North Carolina published various works that concluded that certain genetic expression profiles — genome fingerprints — could predict the response to chemotherapy in a diverse range of cancers. As a consequence of this research, the university set up a clinical trial in which these genome fingerprints were used to guide the clinician in the treatment to be followed. Years later, various statistics experts found errors in the treatment of the published data, which invalidated the conclusions drawn. In the end the clinical trial was suspended, and some of the patients who had taken part in the trials, and families of patients who had died, sued the University of Duke and the researchers involved in the work. This case demonstrates how it is possible to be too hasty in taking tests based on genome research to the clinic and to the market. Inevitably, if we search among thousands of variables, we will find a group that correlates significantly with these thousands of variables plus one, such as responding or not to a certain treatment. In 2010, a genome study carried out in centenarians concluded that certain genetic variants were associated with exceptional longevity. This work had widespread and immediate repercussions in the media, but at the same time it was received with scepticism by geneticists. It was certainly an unexpected discovery to find that particular genetic variants had such a marked effect on as complex a characteristic as longevity. As was seen later, the results of this study were incorrect because its authors had not demonstrated sufficient rigour in obtaining the data and extracting their statistics. One year later, the authors retracted the conclusions of the work. These and other cases remind us of the importance of designing experiments correctly, avoiding technical errors, validating genome fingerprints using new blind samples (so that the researcher does not know in advance which samples belong to the patients who respond to the treatment) from different hospitals, and using adequate statistical tools. Genomics is not the only branch of life sciences that has quality-control problems, and works are all too frequently published in which massive quantities of data containing avoidable errors are handled.
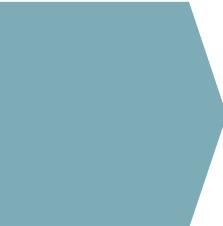
In the future, studying the metabolome in biological fluids and tissue samples will provide biomarkers to assist not only in the early diagnosis and prognosis of numerous complex diseases, but also in monitoring each individual's response to treatment

Scientific progress is underpinned by two firm beliefs: 1) that the checking by equals, or peer review, is the touchstone for determining the quality, credibility, and scientific rigour of a work or research project; and 2) that research corrects itself — scientific errors are always identified and corrected. What we usually forget is that self-correction in research does not just depend

on competition between researchers, but also on the connection between research and applications. In other words, if during the process of knowledge generation and translation — both in the academic world and in business — the maximum standards of quality, rigour and ethics which science demands are not met, then the results of this badly done research will never lead to new products and applications. There is evidence that the bias in scientific research in recent decades is not random: data show that the two pillars that support scientific progress — peer review and self-correction — are not working as well as they should. There is more tolerance of badly done science and, while there are many factors that contribute to explaining the high failure rate in translational research, this behaviour makes a negative contribution to the attainment of new diagnostic tests and medicines.

All high-performance technologies generate errors and systematic biases which to the unwary, untrained eye, or to one unfamiliar with the technology, could appear to be very interesting results, thereby leading to erroneous conclusions. Minimizing the frequency of these technical errors in the design of experimental protocols and in data analysis is a mission for all researchers, but mainly for the directors of doctoral thesis research, chief researchers and project heads, in the academic world and in business. High-performance techniques or "omics" have the potential to revolutionize medical practice in the coming decades, but it is increasingly clear that these problems will have to be addressed beforehand.

THE FACT THAT NOT ALL PEOPLE WITH AN IDENTICAL MUTATION DEVELOP A CERTAIN DISEASE SHOWS THAT BIOLOGICAL REALITY IS COMPLEX; THERE ARE COMPENSATORY MECHANISMS AND IT IS NECESSARY TO DISTINGUISH BETWEEN A PERSON'S GENOME (GENOTYPE) AND HIS OR HER TRAITS (PHENOTYPE). WHEN SPEAKING OF GENES AND GENOMES, WE ARE NOT SPEAKING ABOUT AN OBJECTIVE PHYSICAL REALITY — THAT IS TO SAY, A PHENOTYPE — BUT ABOUT INFORMATION. MOREOVER, THIS FACT REVEALS THAT BIOLOGY IS NOT DETERMINISTIC NOR DOES IT REST ON THE PRINCIPLE OF SPECIFICITY. THIS VISION ALLOWS AN UNDERSTANDING OF HOW MULTIPLE PHENOTYPES CAN BE FORMED FROM A SINGLE GENOME, AND HOW ENVIRONMENT AND CHANCE SELECT, AT EACH MOMENT, ONE FROM AMONG ALL THOSE POSSIBLE PHENOTYPES. FROM THIS PERSPECTIVE, IT IS EVIDENT THAT DISEASE IS INDIVIDUAL AND THAT MEDICINE CANNOT BE PREDICTIVE, BUT MUST ADAPT TO THE PERSON, WORKING WITH SPECIFIC CASES AND NOT STATISTICS.

BIOGRAPHY

José M. Mato

CIC bioGUNE

José M. Mato (Madrid, 1949) studied Chemistry at the University of Madrid and obtained his doctorate from the University of Leiden. He has developed his professional activities in the Jiménez Díaz Foundation, the Biozentrum at the University of Basilea, the University of Chapel Hill in North Carolina, the National Institutes for Health (NIH) in Bethesda, the University of Pennsylvania, the Thomas Jefferson University in Philadelphia, the Higher Council of Scientific Research (*Consejo Superior de Investigaciones Científicas*, CSIC) and the University of Navarra. He has been President of CSIC (1992–96) and is currently Director General of bioGUNE (Bilbao) and biomaGUNE (San Sebastián).

In 2004 he was awarded the National Prize for Medical Research for his work on the interrelation between metabolism and methionine, fatty liver and hepatocellular carcinoma (HCC). His research work led him to identify a group of genes implicated in the synthesis and catabolism of S-adenosylmethionine, and to outline its function during the accumulation of fat in the liver, cirrhosis and the development of HCC, as well as in other normal processes such as hepatic regeneration and differentiation.

José M. Mato is the author of over 250 publications, and the holder of various patents. His work has been recognized with many distinctions, including the CJ Kok Prize for excellence in doctoral work from the University of Leiden (1979); the GB Morgagni Medal for research in the area of diabetes and metabolic diseases (1989); the Lennox K Black International Prize for excellence in biomedical research, from Thomas Jefferson University (1994); and the Jiménez Díaz Commemorative Lecture (2011). He has participated in the creation of various companies, particularly OWL, a biotechnology company based on metabolomics.
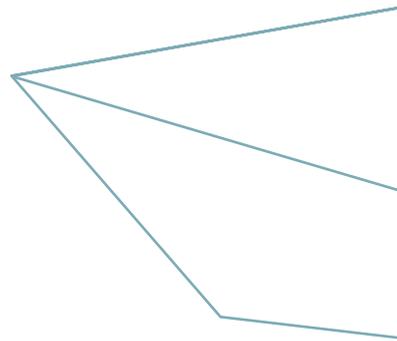
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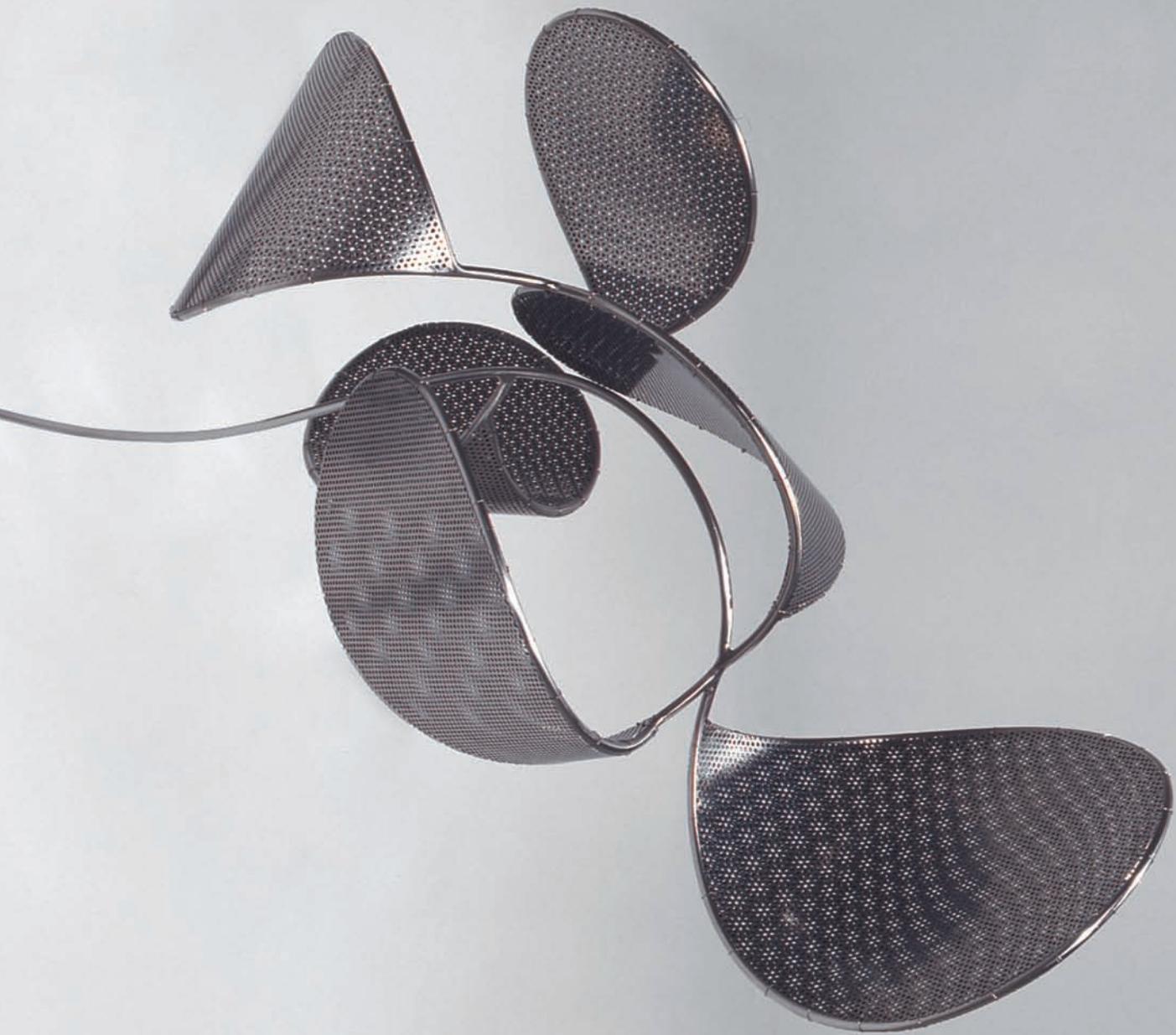
System Shift: Pivoting Toward Sustainability

Paul D. Raskin

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THE LARGER CHALLENGE

The world's dalliance with sustainable development has been rather platonic, beguiled by the idea and indifferent to the practice. Affirming sustainability in the abstract is an easy virtue: the call to bequeath an undiminished world to our descendants expresses a moral imperative that resonates with survival and empathic instincts deep in the human psyche. When these good intentions alight in the contentious sphere of public policy, however, the clamor of immediate self-interest often silences appeals for collective foresight and responsible action. Sustainability hangs suspended where grave crises gather in the lacuna between aspiration and deed.

When the Rio Earth Summit of 1992 adopted its optimistic Agenda 21 blueprint for a new century, the dream of a sustainable future reached an apogee. By contrast, the Rio+20 Summit of 2012 could muster only constricted vision and anodyne recommendations, bookending the world's two-decade descent from hope and commitment to intransigence and inertia. This triumph of inaction has bred a Zeitgeist of apprehension among citizens attuned to deteriorating conditions, while more apocalyptic spirits succumb to resignation and despair, even nihilism. Trepidation and ennui are certainly understandable responses to our contemporary predicament. Nevertheless, to paraphrase Mark Twain's comment on his own premature obituary, reports of sustainability's death are greatly exaggerated.

Still, any exploration of a renewed basis for hope must begin with clear-eyed acknowledgement of the dire circumstances we now confront. Scientific evidence keeps mounting that current patterns of development threaten to carry the global system beyond critical thresholds into a *terra incognita* of destabilizing social-ecological crises (Barnosky et al. 2012). A half century ago, environmental concerns remained local, immediate, and discrete — polluted air, dirty water, and toxic soils — and the solutions were and are relatively straightforward (though often not well implemented). Since then, anthropogenic disturbances — climate change and degraded ecosystems key among them — have expanded over space and time, becoming planetary in scale, long-term in scope, and highly complex. We have pushed the biosphere into an unprecedented, perilous state; the litany of potential impacts includes rising, acidified seas; disrupted weather; spreading disease; and compromised water and agriculture systems.
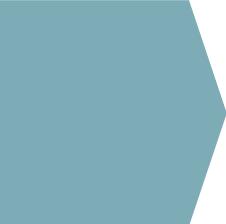
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Indeed, it seems the impacts have moved beyond potential and this turbulent future already has arrived. The rolling sequence of crises — extreme heat waves, droughts and floods, food insecurity, and financial instability, to name a few — of recent years gives immediacy and tangibility to long-term issues. As the dubious twenty-first century situation unfolds, such ominous developments likely will demand our attention with ever greater insistence, underscoring the profound imprudence of muddling on, feckless yet hoping for the best. With this awareness spreading and deepening, we can expect popular demand for a more vibrant and enduring form of development to gain urgency and traction.

But will mobilization for change come with sufficient speed and force to counter destabilizing trends? An immense discrepancy is opening between where we are headed and where we hope to go. Figure 1 illustrates the widening gap for two environmental problems (climate change and ocean acidification) and two social problems (inequity and poverty). The trend values take us deep into an environmental danger zone, far outside Earth's safe operating space (Rockström et al. 2009), while social disparity and destitution remain nagging problems (Raskin et al. 2010).

Hence, reaching sustainability requires a long-term political commitment to a systemic response to a host of interlocking environmental and social stresses. The broad challenges are well known: decarbonizing the energy system, improving resource-use efficiency, deploying

ecological farming practices, preserving ecosystem integrity, and alleviating poverty. The means for achieving these goals also are plentiful; policy analysts have proposed a multitude of regulatory, technological and economic solutions. In the main, their reports gather dust. The world is awash in sound, unheeded proposals.

That said, a variety of efforts — public education, policy advocacy, community programs, and corporate responsibility campaigns — have yielded incremental successes, ameliorative reforms that remain a valid component of any strategy. However, gradualistic tacking against the mighty headwinds of population growth, expansionary capitalism, a spreading culture of consumerism, and a dysfunctional global governance system remains a Sisyphean endeavor.

While these deep drivers of unsustainability persist intact, systemic deterioration will continue to overwhelm piecemeal reforms. Consequently, our focus must push beyond the proximate solutions of better technology and policy to alternative values and institutions, the ultimate drivers that can underpin the transition to a resilient and decent world. Revising the ways we live and live together on this crowded planet poses the larger challenge: the search for a sustainable future becomes no less than the search for a new civilization.

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Figure 1. Dangerous Trends

THE PLANETARY PHASE AND ITS POTENTIAL

Sustainability, itself a capacious concept, is best understood as embedded in a still larger idea, namely, the Planetary Phase of Civilization (Raskin et al. 2002). A phenomenon of singular consequence is underway; the emergence of some form of global society. Circuits of almost everything — goods, money, people, ideas, conflict, pathogens, effluvia — spiral round the

planet farther, thicker, and faster. This many-stranded ligature is binding a world of many places into one interdependent place (Anderson 2001).

The Planetary Phase is the offspring of the Modern Era. Sweeping aside the stasis and rigidity of traditionalism, modernity set in motion a revolutionary process of institutional and cultural transformation rooted in individual rights and free enterprise. Inexorably, it absorbed societies on the periphery during the long march to a world system. The industrial explosion sparked rapid expansion in production, knowledge, and population, at the price of harsh exploitation, brutal domination, and the degradation of nature. The twentieth century put the pedal to the floor, a "great acceleration" that has tripled world population since 1950 and increased the economy six-fold, with energy and material inflows and effluvial outflows soaring apace (Steffen et al. 2004).

The global reach of human affairs only continues to intensify. Footloose transnational corporations construct far-flung networks of production nodes and distribution channels. International finance generates oceanic flows of currency and capital, along with arcane, risky instruments of speculation. Humanity's ecological footprint, once diminutive, perturbs the whole biosphere. Pressures on oil, water, and land resources increase with shortages looming on the near horizon. Further, mobile populations spread old diseases and fractured ecosystems spawn new ones, raising the specter of new pandemics. The Internet links social and research networks — and criminal rings and cyber-terrorists, as well. Political fissures open between North and South, haves and have-nots, progressives and fundamentalists.

These many developments and upheavals are the birth throes of a nascent planetary formation. We can observe her fledgling shape and speculate about the kind of creature being born, but we cannot know her future. The global society that will consolidate from the turbulence of transition remains deeply uncertain and fiercely contested, beyond the ken of scientific projection and social prophesy. Looking through cloudy crystal balls, we can envision many possibilities, each a unique interplay of objective causes and subjective intentions. To a great extent, the outcome depends on how two fundamental uncertainties — socio-ecological crisis and human choice — interact and play out (Figure 2).

Although rigorous predictions are not possible, we can explore the terrain of the future by sketching plausible alternatives based on what we know from the evidence to date. These possibilities do not try to forecast what will be, but to envision what could be. Such long-range scenarios serve as prostheses for the imagination, illuminating potential perils and opportunities on the path ahead, thereby enriching our understanding of the present and guiding our steps forward. For this task, familiar depictions of the future, whether apocalyptic visions or business-as-usual projections, are too limiting. Offering a false choice between despair and complacency, these pinched images leave less familiar roads unexplored.

Nicole Dextras, *Deep Freeze*

To organize the bewildering menagerie of plausible possibilities, consider a simple taxonomy of alternative futures (Raskin et al. 2002). Imagine three broad channels radiating from the turbulent present into the imagined future: worlds of incremental adjustment, worlds of catastrophic discontinuity, and worlds of progressive transformation (Figure 2). This archetypal triad — evolution, decline, and progression — recurs throughout the history of ideas, finding new expression in the contemporary scenario literature (Hunt et al. 2012; Raskin 2005). We refer to these divergent directions for global development as Conventional Worlds, Barbarization, and Great Transitions.

Figure 2. Branching Trajectories

Conventional Worlds scenarios envision development as a gradual unfolding of technical innovation, market adaptation, and social learning. In these narratives, despite episodic setbacks of economic downturns, environmental crisis, and geopolitical conflict, the overall tendencies of conventional globalization persist. Economic interdependence deepens, dominant values spread, and developing regions gradually converge on rich-country patterns of production and consumption. In the neo-liberal "market forces" variant, powerful global actors advance the priority of free markets and economic expansion, emphasizing technological innovation to reconcile growth with ecological limits. In the "policy reform" variant, governments respond to nagging environmental and social problems with a comprehensive portfolio of initiatives.

The Conventional Worlds approach relies on a sequence of market adjustments and policy measures to nudge behaviors and technologies toward practices that reduce environmental pressure and social discord. It believes in — or sees no alternative to — preserving dominant institutions and cultural values. The problem is that such incrementalism leaves intact the underlying structures of socio-ecological stress: the expansionary force of market-based development, the resistance of vested interests, the intrinsic tendency toward economic inequality, and the spreading consumerist culture. Counteracting these pressures demands extraordinary vision and tenacity among world leaders, and that political will is nowhere in sight. Thus, in real historical time, over a quarter century of reform has failed to meaningfully mute, let alone reverse, unfavorable trends.

But let us assume for the moment that the Conventional Worlds pathway is plausible. Still, does this represent an appealing aspiration for civilization? To many, a world of perhaps ten billion consumers plying a globalized mall dominated by multinational corporations would seem a culturally impoverished vision. Thus, for Conventional World skeptics, these scenarios face the double-barreled critique of infeasibility and undesirability.

The second set of narratives, grouped under the rubric Barbarization, explores futures that might follow a failure of Conventional World to check destabilizing trends. In Barbarization scenarios, social polarization, geopolitical conflict, environmental degradation and economic instability reinforce one another, spiraling out of control. In the drift toward systemic crisis, civilized norms erode. One version of how this might play out — "fortress world" — envisions, in response to such upheaval, the rise of a powerful international alliance of governmental, corporate and military elements. Perhaps reluctantly, these forces of rectification impose a rough authoritarian order, creating a kind of global apartheid that finds elites in protected enclaves and an impoverished majority outside. In the "breakdown" variation of Barbarization, such effort proves insufficient to the task of stabilization so that waves of disorder spread out of control, and institutions collapse.

Great Transition alternatives, the third group of narratives, consider more elevated ambitions for the twenty-first century. They imagine ways the world might develop guided by values and institutions consonant with deep interdependence in a fragile world. In these scenarios, the Planetary Phase forges new categories of consciousness — humanity-as-a-whole, the wider web of life and the well-being of future generations. In synchrony, an ascendant suite of values — human solidarity, quality of life and identification with natural world — displaces the conventional triad of individualism, materialism and domination of nature. The broad shift expands understanding of the boundaries of citizenship, the meaning of the good life, and humanity's place in the biosphere. Solidarity becomes the foundation for a more egalitarian social contract, the eradication of poverty, and democratic political engagement. Human fulfillment in all its dimensions becomes the measure of development, demoting consumerism and the false metric of GDP. An ecological sensibility, based on empathy, becomes the affective basis for healing Earth.

Every age creates a unique constellation of values. The idea of individual and social progress has been the *sine qua non* of the modern era. People lived better than their parents and expected the same for their children, a progression toward the perfectibility of "man" and society — at least for the most buoyant beneficiaries. In the early twenty-first century, with confidence in the future shaken and rising expectations suspended, faith in progress seems the atavistic worldview of a simpler, naïve time. A culture of individualism conflicts with the need for collective enterprise to create new social arrangements in an interconnected world. The anthropocentrism that sees in nature a bottomless font of resources and sink for effluvia becomes dysfunctional in an epoch showing us the earth's limits. The association of

ever-greater consumption with rising human happiness loses its thrall in lives rich in things yet poor in time to pursue meaning. Values once consistent with the modernist project now seem more apt to yield not progress, but alienated lives, the erosion of community cohesion, and a compromised ecosphere.
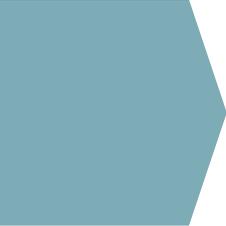
> The global society that will consolidate from the turbulence of transition remains deeply uncertain and fiercely contested, beyond the ken of scientific projection and social prophesy. To a great extent, the outcome depends on two fundamental uncertainties — socio-ecological crisis and human choice

The interregnum between the Modern Era and Planetary Phase is a breeding ground for crises that weaken the hold of the old consciousness. The rise of a new consciousness resonant with post-modern imperatives for extended affiliation, quality of life, and ecological resilience becomes possible, though of course not inevitable. The overarching carapace for a viable transition strategy depends on multiple efforts to articulate and propagate these incipient values. Educators, journalists, scientists, parents, and engaged citizens all have a role in spreading awareness, deepening understanding, and inspiring by example.

PATHS OF TRANSITION

Each Great Transition value corresponds to a domain of strategic action. The idea of human solidarity resonates with the need to generate a planet-wide political community rooted in the identity of global citizenship. Concern with human well-being directs attention to social changes and community experiments that lead to richer, more fulfilling lifestyles. The embrace of environmental sustainability, with its implied challenge to the growth-impulse of free market capitalism, brings into focus the need for a redesigned economy. In this section, then, we consider these strategic dimensions — identity, lifestyle, and institutions — in turn.

Over eons of social evolution, the spheres of community widened to embrace larger and more complex formations: families, clans, tribes, villages, cities, nations, and to some extent regions. Although particular circumstances differ, we each stand at the center of concentric circles of community (Heater 2002). Philosophers and prophets have long envisioned a ring of community that would encircle the whole human family. But cosmopolitanism remained an ideal divorced from real world history, which played out in the fragmented and antagonistic turf of tribes, fiefdoms, states, and empires.

In the Planetary Phase, the cosmopolitan abstraction has come down to earth, embedding the ethos of human solidarity in the calculus of interdependence — a condition for survival and precondition for a decent future. In many ways, the integral earth — common home of our imagined global community — seems a more natural boundary for grounding human affairs today than the arbitrary boundaries that came to delineate the imagined communities of nation-states (Anderson 1983). As national citizenship once transcended barriers within states, global citizenship may reduce divisions between them. This broader identity is basic to bridging the dangerous chasm between obsolete twentieth-century ideas and twenty-first century realities. The world-as-a-whole is becoming a single community of fate.

What, therefore, does it mean to be a global citizen? Citizenship is complex, even in its familiar guise of state citizenship. In the broadest sense, a citizen is a loyal member of a wider community that grants rights and entitlements to the individual while requiring that the individual fulfill responsibilities and obligations in return. Modern citizenship has changed and evolved in several historical waves (Marshall 1950). The eighteenth century extended economic opportunity through civil citizenship, conferring individual freedoms and acknowledging property rights. The nineteenth expanded political rights through democracy and the right to vote. The twentieth added a social dimension to citizenship through entitlement to minimum standards of welfare and economic security.

In the Planetary Phase, a fourth wave is reconfiguring citizenship, creating the basis for a new layer to its active meaning. Global citizenship carries both emotional and institutional dimensions. People become affective "citizens of the world" when their concerns, awareness, and actions embrace the whole of humanity and the ecosphere that sustains all life. Although this orientation is spreading among contemporary "citizen pilgrims" (Falk 1998), the full expression of global citizenship awaits the creation of institutions for democratic global governance.

Globalization has stimulated many supranational governance innovations including international bodies such as the World Trade Organization, negotiating processes such as the Framework Convention on Climate Change, and juridical venues such as the International Criminal Court. Rather than merely balancing the interests of competing states, together these scattered experiments could evolve to mold the foundation for a more mature form of governance beholden to the whole body politic. To date though, venues for the meaningful exercise of global citizenship are notably absent from the world stage.

One possible redress for the current anachronistic lack of representation could be developed by forming a bicameral United Nations to consist of the existing General Assembly standing for nations and a new World Parliament, elected through universal suffrage, for world citizens. A fledgling World Parliament might begin modestly as an advisory body, without the UN's official imprimatur, postponing steps to strengthen it to full legislative authority. Yet, even as an

advisory body, the parliament, as the only popularly elected global institution, would enhance accountability in the international system. By taking up transnational issues, it would offer a crucible for a global political identity to coalesce, its democratic structure anchoring a claim to authority in responses to crises.

A complementary approach not dependent on the cooperation of recalcitrant international bodies lies in the formation and spread of an explicit movement of global citizenship, a topic we return to below. The internal processes of such a movement would be a living experiment in democratic representation and decision-making, a homunculus of the supranational polity it envisions. Institutions forged in the struggle, ready-made and battle-tested, could segue into a new cosmopolitan governance system as part of a broader cultural and political rising.

The second value — quality of life — takes us from the macro-level of shaping a global demos to the micro-level of shaping a well-lived life. Most of us conduct our quotidian affairs, pursuing ambitions and managing disappointments, within the matrix of prevailing expectations and determinants. The norms and values we use to forge our identities and weigh our aspirations, and even evaluate our worth, are as natural and imperceptible as the air we breathe. Thus, we can lose sight of the historical contingency of cultural standards, which mutate and shift in the course of social evolution. The longing for material affluence and individual autonomy by the freewheeling denizens of contemporary society would be unfamiliar, perhaps offensive, to preindustrial sensibilities attuned to traditional lifestyles and group identities.

Transformative moments offer fresh occasions for perceiving and critiquing cultural assumptions. Core questions — What are we for? Who are we? How can we flourish? — are more apt to surface in times of social upheaval, when conventional ideas and cultural strictures lose their logic and sway. Such disorientation opens opportunities for new paradigms of meaning and fulfillment. At the cusp of the Planetary Phase, the ferment within subcultures seeking to downshift to lives of less stress and more time adumbrates a growing social challenge to dominant lifestyle aspirations.

The modern emphasis on material consumption as a measure of achievement and social status truncates ideas of happiness and fulfillment, elevating what psychologist Martin Seligman (2002) calls the Pleasant Life, while downplaying both personal development (the Good Life) and pursuit of some larger goal (the Meaningful Life). This hedonic pursuit is stimulated by a ubiquitous, arid advertising industry using sophisticated techniques to promote the mania for stuff and the worship of Mammon. But affluence alone hardly guarantees well-being, and, indeed, can be its undoing. Lives spent on the work-and-spend treadmill, refilling one's purse only to empty it again on ever more goods, may be rich in things, but poor in ways that matter. Rather than fulfillment, the pursuit of over-abundance can bring stress, angst, and emptiness. With the allure of "more" always beckoning everywhere, it is easy to forget, or never even really to know, the realms of nature, relationship, and imagination that give life meaning.

Nicole Dextras, *View*

In place of materialism, Great Transition strategies cultivate the idea and practice of time-rich lives of material sufficiency and qualitative abundance. In a world of shorter work weeks and at least adequate living standards for all, the well-lived life can come to embrace the quality of family, friendship, and community bonds; resonant experience of connection to nature; and varied opportunities for creativity. Fulfillment of such life choices would set the gold standard for development, something for affluent countries to turn toward and poor ones to reach for. Instead of replication of conventional practices, an enlightened development model would place human well-being at the center of its social vision, thereby leapfrogging the outmoded obstacle of the old industrial model.

Prioritizing quality-of-life values requires redesign of economic institutions, the third core strategic area. In the consumer society, the idea of "enough" is culturally seditious, undermining the sacred cow of economic growth. As the connection between the overstressed earth and

overstressed lives becomes increasingly self-evident, however, the critique of material wealth as a measure of individual well-being has connected with the critique of growing GDP as a valid measure of social well-being. In any case, a shift toward less intensive consumption patterns would necessitate a parallel shift on the production side of the supply-demand equation.

Such a downshift in our conception of the economy goes against the logic of competition and profit-maximization, embedded in prevailing institutions, that impels contemporary economies to privatization and growth. Efforts to promote social and environmental responsibility in corporate and financial sectors push back, but not surprisingly, make little headway against this powerful momentum. Redesigning economies to serve non-market goals — solidarity and citizenship, flourishing individuals and communities, and ecological health — takes us beyond reform to fundamental institutional change.

Therefore, a Great Transition strategy, understanding the economy as a means for attaining the goals of society, not an end in itself, must transcend the current system that places corporate profit before the enrichment of the collective treasuries of community and nature, individual privilege before the common good, and greed before generosity. With the collapse of twentieth-century socialism and, more recently, the erosion of strong welfare states, political-economic architectures have tended toward varieties of market capitalism. The Planetary Phase opens a new chapter in the project, as old as capitalism, of envisioning a viable alternative. The guiding doctrine for a new economy would broaden the venerable principles of modernity — equality, justice, democracy, and environment — to embrace global equity, universal rights, world democracy, and the integrity of the biosphere. In so doing, said doctrine would supersede the Conventional World vision where nation-states remain politically sacrosanct, expansionary capitalism economically hegemonic, and consumerism culturally dominant.

A sustainable economy, thus, would be designed to operate within the social goals and the safe limits of the Earth system, an economy-in-society-in-nature (Costanza et al. 2012). Sustainability goals defined at global and relevant sub-global scales would serve as boundary conditions, setting constraints on the aggregate material and energy flows into economies and effluvial outflows. The goals would be set to ensure the resilience of ecosystems, the preservation of biological resources, the control of toxic chemicals into the environment, and the integrity of the climate system. In light of inevitable scientific uncertainty, two guiding principles — precaution and adaptation — are warranted in quantifying such limits on aggregate anthropogenic stress on environments. The first injects a bias of risk aversion into the process of setting constraints; the second recognizes the provisional character of goals and, therefore, the need for periodic review and modification.

Such limits would define the physical envelope within which economies must function. Since the existing system has already grown beyond this container, in some cases dramatically so and

Nicole Dextras, *Storm*

drifting further off course, the sustainability transition poses sharp challenges to existing economic institutions (Steffen 2011). An expansionary drive has always been embedded in the DNA of capitalism — Schumpeter's "perennial gale of creative destruction" that is at once the system's genius and Achilles' heel, the engine of economic development and the generator of social and environmental distress. Profit-seeking entrepreneurs, prodded by competition, seek new markets, modernize production processes and devise new commodities. The financial sector plays its traditional role of lubricating the growth machine with investment funds, but with the explosion of speculative paper commodities this sector has become itself a source of growth to rival that of the "real" economy. All the while, governments work to maintain the vitality of the commercial sphere — or bail it out when that fails.

We inherit Conventional Worlds institutions forged in a world viewed as limitless. An economy for sustainability requires fundamental changes in this erroneous perspective at all levels: regulatory frameworks to align business behavior with nonmarket goals; re-chartered corporations with social purpose, not just profit, a fundamental bottom line; wide stakeholder participation so that workers and relevant community members have real say; and a financial system that suppresses speculative risk and makes consistent-with-sustainability a condition of approval for new investments. A varied mix of policy approaches would be employed across the diverse regions of a pluralistic Great Transition world, some emphasizing regulated markets, others privileging local approaches, still others tilting toward social ownership and control of capital (Raskin 2012). However implemented, deep metamorphoses in institutional structure would be precursors of the accelerated transformation needed in energy and transportation systems, metropolitan and industrial design, and agriculture and water-use practices.
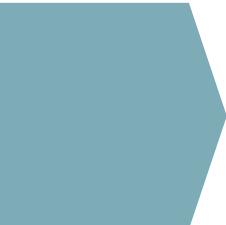
Global citizenship carries both emotional and institutional dimensions. People become affective "citizens of the world" when their concerns, awareness, and actions embrace the whole of humanity and the ecosphere that sustains all life

The unfolding of the Planetary Phase, with its discontents and unhappy prospects, will foster awareness and support for shifts on all three fronts discussed here — advancing a global political community, cultivating the art of living, and redesigning economic institutions. Together these broad arenas delineate the contours of a transformative strategy. Detailed quantitative simulation of Great Transition scenarios shows that these strategies would lead to environmental and social conditions well within the sustainability zone of Figure 1 (Raskin et al. 2010). Of course, possibility is not probability: the opportunity for transition will be squandered if forces of social change do not mobilize with sufficient speed, scale, and coherence. Even as visions of a just and flourishing civilization spur our critical imaginations and hopeful hearts, our dogged skeptical minds must ask: How do we get there from here?

Certainly, the work of policy formulation, social-ecological research, public education, and envisioning alternative futures must be pursued with renewed vigor, for all play critical roles. In addition to these efforts, though, strengthening collective action has become the essential, urgent element now needed for advancing positive transition. The recent stirrings of citizen engagement around the world give hope a point of departure; these streamlets could form a broad river of cultural and political change. For such hope to bear fruit, multiplying the numbers of citizen actions and amplifying their separate impacts becomes essential. At this critical

moment, the most important innovation lies in weaving these now-disparate change agents into an overarching project, a more unified and coherent movement.

HISTORICAL AGENCY: THE MISSING ACTOR

Who speaks for the Earth? Which historical agents can redirect the narrative arc of the twenty-first century? Which might be buoyed by the dynamic of change to the higher consciousness and social arrangements of a planetary age? Although each of the principal actors now on the global stage — multilateral institutions, transnational corporations, and civil society — has a role, none is a likely candidate to spearhead the transition.

The United Nations, a vast network of specialized agencies and affiliated organizations, serves as the hub of multilateralism. In the wake of World War II, the UN was created to secure world peace, while assuring human rights and spreading prosperity; the humanistic principles enshrined in its Charter, and expanded in the Universal Declaration of Human Rights of 1948, remain important ethical beacons. Going beyond universal ethics, many of its founders envisioned the UN as a new supranational level of governance that would represent the interests of "we the world's people," its staff a true global civil service with loyalty to the greater good. Instead, during the long Cold War and beyond, it became an arena of ideological struggle, with collective interests subservient to national interests (Hazzard 1990).

The task of building an institutional architecture adequate to contemporary challenges has faltered in the hands of reluctant, irresolute nations. Yet, although enfeebled, the UN speaks with the only legitimate, collective voice of the world's governments. In a Great Transition, the UN — reorganized, restructured, and likely renamed — would become an essential part of a governance system in which the dominance of states gives way in two directions: toward global decision-making where necessary, toward local democratic processes where feasible. For now, with the state-centric system deeply rooted and the UN showing no signs of self-invention, we must look elsewhere for a prime mover.

In the private sector, transnational corporations are the most powerful players propelling globalization toward a market-driven form of Conventional Worlds. The economy propagates through aggregation of individual corporate actions weakly constrained by regulatory frameworks. In fact, these large enterprises play a major political role in keeping it that way, investing vast resources to influence public perceptions and political decision-making. Although some organizations engage in efforts to make their operations more sustainable, their primary obligation to enrich shareholders limits the potential for the world of corporations to play a positive role in the transition. More plausibly, corporations may lead the resistance to efforts on behalf of a Great Transition.

Over recent decades, civil society has joined government and business as a third force on the international stage. This eruption of citizen energy and activism has weighed in on the full spectrum of social and environmental issues. Myriad non-profit organizations and citizen groups have altered the dynamics of international politics, engaging in intergovernmental deliberations, boycotting corporate miscreants, and mounting campaigns for human rights and sustainable development (Edwards 2011). Quieter, and perhaps most profound in their effect, their educational campaigns have spread awareness of critical issues.

Although civil society has been a vital force for sustainable development, rampant organizational and conceptual fragmentation has stifled its potential. Slicing the integral challenge into a thousand separate issues and turfs dissipates energy, fragments perspective, and undermines power. Dispersed victories here and there are overwhelmed by stronger processes of deterioration; thus, the wins cannot scale up to encompass a viable alternative path of development. At the most basic level, civil society as a whole lacks philosophical coherence, a shared understanding of the challenge and a holistic vision that can make "another world is possible" more than a slogan. Lacking an affirmative and unifying program, the civil sector remains an oppositional polyglot capable of winning important skirmishes, but losing the larger battle for a sustainable and just world.

These transnational actors — institutions, corporations, civil society — are not the only manifestations of the Planetary Phase. Earlier, we mentioned the shadow side, criminal networks, drug traffickers, arms dealers, and terrorists that also have globalized. At the same time, we find the dialectical negation of integration in the resistance of anti-globalization activists; the protectionism and xenophobia of nationally based interests; and the ideological reaction of fundamentalists to the hegemony of "modern" culture. The pull toward the ideological poles of hyper-globalization and particularism hollows out the middle ground where real solutions lie.

None of the principal actors now on the scene is likely to emerge organically from its chrysalis in the new form of a historical agent for transition. Our brief survey found government, business, and civil society interests too narrow and outlooks too myopic for the task. Indeed, these entrenched elements, with a stake in the status quo, would be as miscast for a revolutionary role as would have been feudal priests and aristocrats in leading the charge to modernity. Rather, it was the rising bourgeoisie that carried forward the earlier transformation. Now, we must look to an emergent social force forged by the Planetary Phase, one as systemic and inclusive as the challenge of shaping a planetary civilization.

We can discern the embryonic form of such a change agent in the growing chorus of concerned citizens alert to the dangerous global drift, and questioning our social arrangements, our ways of living on an increasingly fragile planet. The burning question becomes: Can this growing discontent sow a popular movement capable of channeling grievance into massive

Nicole Dextras, *Viw*

action for change? The critical actor missing from the world stage may stir in the wings, a global citizens movement (GCM) expressing the promise for a more harmonious and sustainable civilization. The crystallization of a massive GCM, though not imminent, will become more plausible as ongoing disruption erodes the legitimacy of conventional institutional structures and new visions spur collective action (van Steenburgen 1994; Dower and Williams 2002).

Like the system that spawns it, the GCM would need to become more than the sum of its parts, an integrated force rather than a mere aggregation of disjointed campaigns and projects. It would be a crucible for creating the vision and trust needed to underpin the society it seeks, an ongoing experiment, exploring ways of acting together on the path toward planetary civilization. The GCM, as a highly complex and dispersed developing formation, would need to adopt an open and exploratory process of collective learning and adjustment, a form of

association in synchrony with the multiple issues and diverse traditions seeking unified expression.

The top-down structure of earlier oppositional movements will not suffice in a post-modern world suspicious of authority and leadership; nor will its converse, faith that political coherence will arise spontaneously from below. A viable movement must eschew the seductive simplifications of both vanguardism and anarchism as it navigates between the polar pitfalls of rigidity and disorder. Building and maintaining normative solidarity in a movement of such diversity poses the greatest challenge. The pull to unity can come from a deepening sense of shared destiny, aided by communications technology that spreads information and shrinks psychic distance. Pushing against unity would be lingering suspicions, barriers of language and traditions, and intransigent inequities and resentments. The challenge now is to develop the organizational and affective foundations for collective action across the differences a global movement must circumscribe (McCarthy 1997).
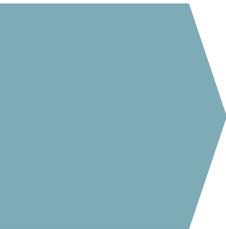
More than ever, we need the efforts of the past — campaigns for rights, peace, and environment; scientific research; educational and public awareness projects; local efforts to live sustainably to secure the shift to a just and sustainable mode of development. We urgently need a holistic vision and strategy: a global movement as the self-conscious agency for a Great Transition

There are no blueprints, though this much seems clear: a vital GCM must reflect the values and principles of the transition it seeks. It would be as global as need be and as local as can be, involving masses of people across gender, race, culture, class, and nation. To thrive, it must cultivate a politics of trust: a commitment to accepting differences while nurturing solidarity. Rather than a single formal organization, it would be a polycentric political and cultural rising, a network of networks attracting new adherents through local, national, and global nodes. It would work to enlarge spaces for public participation and cultural ferment, advancing supranational identity and institutions for an interdependent age, and integrating the panoply of environmental and social campaigns as separate expressions of a common project.

If a GCM remains latent, ready to be born, then giving it life becomes the urgent frontline project for shaping a twenty-first century civilization worthy of the name. Past struggles for systemic change, such as national or labor movements, have depended on sustained holistic effort to weave together disparate grievances and component movements into an overarching formation that spoke for all. Now, the GCM awaits effective initiatives — Margaret Mead's "small group of people" ready to change the world — for cultivating a common vision and strategy for the transition.

The nascent GCM, like all young movements, must overcome the fundamental dilemma of collective action: many sympathetic to its aims will not participate until they believe it can succeed, yet it can only succeed once people engage en masse. However, if a movement resonates powerfully with growing concerns, it can grow slowly, reach a critical mass, and then coalesce rapidly: beyond the tipping point lies a powerful force of change. A committed group of citizens, edging tenaciously forward and reaching out to multitudes of concerned people, can make all the difference.

More than ever, we need the efforts of the past — campaigns for rights, peace, and environment; scientific research; educational and public awareness projects; local efforts to live sustainably. All this is necessary, but not sufficient to secure the shift to a just and sustainable mode of development. We urgently need, as well, a holistic vision and strategy: a global movement as the self-conscious agency for a Great Transition. This would be a fitting answer to the question posed by tremulous lips everywhere: What can I do?

Facing a time of trouble, we are poised at an historical fulcrum between the world that was and the one yet to be. In stable periods, business-as-usual thinkers can, with a degree of justification, dismiss social visionaries as quixotic dreamers. In our turbulent moment, holding fast to obsolete mindsets and premises is the more utopian fantasy, while envisioning and working for a different world the more pragmatic course. If we prove too hidebound to accept the necessity of deep change or too cynical to think such change possible, we face the real danger of historical decline.

Such dystopian premonitions cannot be refuted in theory, only invalidated in practice. By taking the cultural-political leap of harnessing the potentialities of the Planetary Phase, especially by growing a systemic global movement, we can raise consciousness and community to the level of Earth. We can still pivot the trajectory of history toward a thriving civilization. This is the sustainable way.

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A SUSTAINABLE FUTURE REQUIRES PUSHING BEYOND THE MAINSTREAM SOLUTIONS OF BETTER TECHNOLOGY AND POLICY TO NEW VALUES AND INSTITUTIONS. THE SEARCH FOR SUSTAINABILITY HAS BECOME NO LESS THAN THE SEARCH FOR A RESILIENT AND DECENT CIVILIZATION. WE EXPLORE ALTERNATIVE SCENARIOS TO ILLUMINATE THE CHALLENGE AND GUIDE OUR PATH. THE INCREMENTAL ADJUSTMENTS OF CONVENTIONAL WORLDS FUTURES RISK DRIFTING TOWARD THE CALAMITY OF BARBARIZATION. BY CONTRAST, GREAT TRANSITIONS ENVISIONS THE EMERGENCE OF MINDSETS AND PRACTICES CONSONANT WITH AN INTERDEPENDENT AND VULNERABLE WORLD. IN THESE SCENARIOS, AN ASCENDANT ETHOS — HUMAN SOLIDARITY, QUALITY-OF-LIFE, AND IDENTIFICATION WITH THE NATURAL WORLD — DISPLACES THE CONVENTIONAL TRIAD OF INDIVIDUALISM, MATERIALISM AND THE DOMINATION OF NATURE. EACH DEVELOPING VALUE CORRESPONDS TO A DOMAIN OF STRATEGIC ACTION: NURTURING GLOBAL CITIZENSHIP, CULTIVATING MORE FULFILLING LIFESTYLES, AND REDESIGNING GOVERNANCE AND ECONOMIC INSTITUTIONS. WITH THE PRINCIPAL SOCIAL ACTORS NOW ON THE WORLD STAGE UNLIKELY TO SPEARHEAD SUCH A TRANSITION, ATTENTION MUST TURN TO THE *CRITICAL CHANGE AGENT NOW GESTATING: A GLOBAL CITIZENS MOVEMENT EXPRESSING THE PROMISE OF A MORE HARMONIOUS AND SUSTAINABLE CIVILIZATION.* GIVING IT LIFE HAS BECOME AN URGENT FRONTLINE PROJECT ON THE PATH TO SUSTAINABILITY.

BIOGRAPHY

Paul D. Raskin

Tellus Institute

Paul Raskin is the founding President of the Tellus Institute, a policy research organization on environment and development that has conducted thousands of projects throughout the world since 1976. In addition, Dr. Raskin founded the Global Scenario Group, the Great Transition Initiative, and the US center of the Stockholm Environment Institute. The overarching theme of his work has been developing visions and strategies for a transition to a sustainable and just future. Toward this larger aim, his research has spanned issues (energy, water, climate change, ecosystems, and development) and spatial scales (local, national, and global). In support of this program, he conceived and developed such widely used models as the Long-range Energy Alternatives Planning (LEAP) system, the Water Evaluation and Planning (WEAP) system and the PoleStar System, a framework for exploring integrated long-range scenarios. Dr. Raskin has published widely, serving as a lead author on the US National Academy of Science's Board on Sustainability, the International Panel on Climate Change, the Millennium Ecosystem Assessment, the Earth Charter, UNEP's Global Environment Outlook and numerous other international efforts. Dr. Raskin received a PhD in Theoretical Physics from Columbia University in 1970.

The Impact of Global Warming on the Distribution of Rainfall: A Historical Perspective

Wallace Broecker

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INTRODUCTION

The changes in rainfall to be generated by the ongoing rise in atmospheric CO_2 will likely have the greatest consequences for humans. This will be especially true for the Earth's dry lands where water is already in short supply. Isaac Held, recipient of the 2012 BBVA climate prize, has predicted based on theory and model simulations that the tropics will get an even larger fraction of global rainfall and that this increase will be at the expense of the adjacent dry lands. Although simulations carried out in linked ocean-atmosphere models confirm Held's prediction, they disagree widely regarding the details. Because of this, a group that I work with has set out to complement these simulations with evidence gleaned from past climate changes. By past, I mean changes that have occurred during the last 30 thousand years, a time period where radiocarbon dating allows us to correlate events occurring at different places on the planet. As shown in Figure 1, this period includes the Last Glacial Maximum (28 to 18 thousand years ago), the period of deglaciation (18 to 10 thousand years ago) and the Holocene interglaciation (last 10 thousand years). As I will show, two sets of millennium-long punctuations are particularly instructive. One is an oscillation centered at 14.5 thousand years ago (14.5 kyrs) and the other is the Medieval Warm–Little Ice Age oscillation in the latest Holocene.

Figure 1
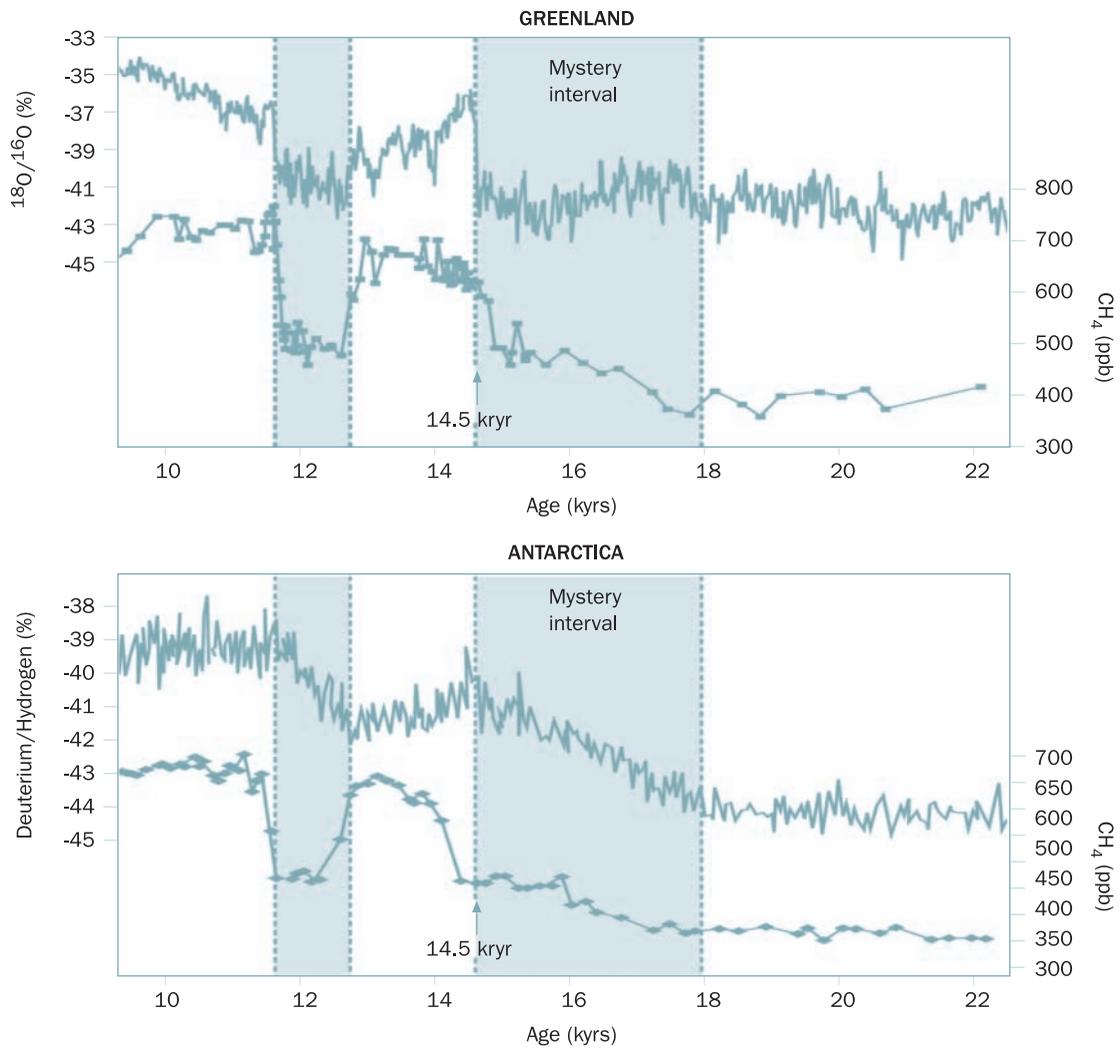
Comparison of the records for the isotopic composition of ice from cores drilled through the Greenland and Antarctic ice caps. These records serve as proxies for local air temperature. Also shown are records of the methane content of the air trapped in the ice. As the methane is mixed pole to pole quite rapidly, its temporal variations allow the isotope records at the two ends of the planet to be tightly correlated. As can be seen, during the period of deglaciation air temperatures in the two polar regions were antiphased.

During the demise of the last glaciation, large and abrupt changes in the pattern of global rainfall occurred. These changes appear to have been driven by shifts in the latitude of the tropical rain belt induced by out-of-phase expansions and contractions of the sea ice extent in the two polar oceans. These changes are recorded in three archives: 1) the size of closed basin

lakes, 2) oxygen isotope composition of cave stalagmites, and 3) the ratio of soil debris to marine shells in continental margin sediments. These records make clear that 14.5 kyrs ago the Earth's tropical rain belt underwent a dramatic northward shift. As a result, the Chinese monsoons strengthened and the southern fringe of Amazonia underwent a pronounced drying, as did the Middle East and the American West (see Figure 2).

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Figure 2

	Thermal Equatorial Moves North			Thermal Equatorial Moves South	
Western USA	Wetter	Dryer		Dryer	Wetter
Middle East	Wetter	Dryer		Dryer	Wetter
Bolivian Altiplano	Wetter	Dryer		Dryer	Wetter
Eastern Brazil	Wetter	Dryer		No info	No info
Equ. East Africa	Dryer	Wetter		No info	No info
China's Monsoons	Weaker	Stronger		Stronger	Weaker
N.W. China	No info	No info		Dryer	Wetter
	16.0 14.5 12.5			MW	LIA
	Age (kyrs)				

Documented hydrologic changes that occurred about 14.5 kyrs ago and between the Medieval Warm (MW) and the Little Ice Age (LIA). As can be seen, the latter are in the opposite sense of the former. During the MW–LIA transition, the thermal equator and its associated rain belts were shifted to the south and at 14.5 kyrs, the thermal equator shifted to the north.

One might ask, what does this have to do with the next one hundred or so years? Simulations of the ongoing rise in the atmosphere's CO_2 content show that the Northern Hemisphere will heat about twice as fast as the Southern Hemisphere. Hence, if, as the model simulations suggest, a doubling of CO_2 were to warm the Earth by 3.6°C, then the Northern Hemisphere would warm by about 4.8°C and the Southern by about 2.4°C. The extra warming in

the Northern Hemisphere would cause the thermal equator and its associated rain belts to move northward. The question then becomes whether rainfall changes that occurred 14.5 kyrs ago can be used as a guide to those to be generated by global warming.

Once again I turn to historical evidence to answer this question. It is based on rainfall changes that occurred during the Medieval Warm–Little Ice Age oscillation. In this case, the thermal equator appears to have moved to the south. Although the consequences were much smaller in magnitude, as outlined below, they were opposite in sign to those associated with the larger northward shift that occurred at the midpoint of the deglaciation. Since the forces driving these two shifts were quite different, their consistency strengthens the argument that global warming will bring about a repeat of the consequences of the northward shift of the thermal equator. And, of course, we all know that the annual north-south shifts in the position of the thermal equator create a pronounced rainfall seasonality.

PRECIPITATION ARCHIVES

The most dramatic and easily understood precipitation archive is the record of changes in the size of lakes that have no outlet to the sea. Of these, the Dead Sea and Great Salt Lake are the best known. The water that reaches them by direct rainfall and by river runoff is lost entirely by evaporation from the lake surface. Hence, at times when rainfall was greater (or evaporation smaller), the lakes increased in size and depth. As the ages of these raised shorelines can be determined by radioisotope dating, chronologies of past lake size can be constructed. The changes in lake size recorded by these abandoned shorelines are surprisingly large. During the Last Glacial Maximum, the Dead Sea was about four times larger and Great Salt Lake about eight times larger than prior to the Industrial Revolution (i.e., before human interference). So large were these lakes that it stretches credibility. Increased rainfall coupled with decreased evaporation fall way short of explaining these expansions.

It turns out that a very powerful amplifier mushrooms changes in rainfall into the observed very large responses in lake size. It involves the dependence of the fraction of rainfall that runs off from the landscape into rivers on the amount of rainfall. For the Great Salt Lake and the Dead Sea drainage basins, currently only about 10 percent makes it to rivers. The rest either evaporates from the soil or is transpired by plants. Were the precipitation in these areas to double, the fraction of runoff would increase by threefold (i.e., from 10 to about 30 percent). Hence, the lakes fed by these rivers would receive six times more water each year!

This powerful amplifier applies not only to closed basin lakes but also to manmade reservoirs and dams. As changes in rainwater input to the catchment basin will be greatly amplified, so too will the amounts of water available for irrigation and electrical power generation. To the extent that

agriculture in the world's dry lands depends on river water captured in reservoirs, this amplification will increase the impacts of changes in rainfall. In the case of the Nile, these changes will not only impact Egypt's food supply but also the amount of electrical power generated at Aswan.

Just before the 14.5 kyr northward shift of the rain belts, the Dead Sea and Great Salt Lake were at their maximum sizes. But, as Great Salt Lake had breached its outlet and was overflowing to the sea, it no longer recorded changes in rainfall. However, a number of other closed-basin lakes in the Great Basin of the western US recorded the conditions at this time (see example in Figure 3). A photo of one of these lakes is shown in Figure 4. They were all significantly larger than during the Last Glacial Maximum. At that time the combined area of all the lakes in the Great Basin was about 10 times that in 1850 AD (i.e., before the onset of agricultural diversions).

The response of these Great Basin lakes to the northward shift of the thermal equator was dramatic. They rapidly shrunk from their largest size to their smallest. The Dead Sea underwent a similar shrinkage. Further, the size of Lake Titicaca, a large closed basin lake situated in the northern part of Bolivia's Altiplano had a similar time history. Fifteen thousand years ago it overflowed to the south creating a three-times-larger lake in the now dry "solar" of the southern Altiplano. Then about 14.5 kyrs ago, this megalake dried up. This very wet to very dry transition is the result of a northward shift in the position of Amazonia (see Figure 5).

The record for East Africa's Lake Victoria merits consideration. Today it overflows into a branch of the River Nile. But prior to the 14.5-kyr event, not only did it cease to overflow but surprisingly it dried up. Evidence for its desiccation comes from four sediment cores. Each bottoms out in a soil. The lake sediment resting on top of this soil has an age of about 14 kyrs. Bursts of sound sent down from the lake surface bounce off this dense soil. In this way it was shown that the soil extended to the deepest part of the lake. Hence at the same time that the Dead Sea desiccated, dry Lake Victoria came back into being. This suggests that discharge of the River Nile was weak prior to the northward shift and became stronger afterward.

Less easily understood is the record kept in cave deposits. It is contained in the ratio of heavy oxygen (^{18}O) to light oxygen (^{16}O) in the calcite deposited on stalagmites. The oxygen isotope composition of the water dripping from the cave ceiling onto the stalagmites matches the annual average for local rain. Thus temporal changes in the isotopic composition of the cave calcite provide a record of those in rainfall above the cave. As monsoonal rain has a quite different isotopic composition than non-monsoonal rain, stalagmites record how the monsoons have changed in strength. An analogy involving the contrast between a drizzle and a thunderstorm will help to understand how this works. A drizzle involves the removal of only a very small fraction of the moisture contained in the parent cloud. A thunderstorm removes a very large fraction. The consequence is that the oxygen isotope composition of the thunderstorm water will be very close to that of the water vapor in the cloud. By contrast, as the vapor

pressure of heavy water ($H_2^{18}O$) is slightly less than that in light water ($H_2^{16}O$), the drizzle water will be enriched in the heavy isotope relative to the cloud. Monsoon rains are akin to thunderstorms, and non-monsoonal rains to drizzle. Hence, the variations with time in the isotopic composition of cave calcite (i.e., $CaCO_3$) are related to the fraction of the cave water supplied by monsoon rain.

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Figure 3
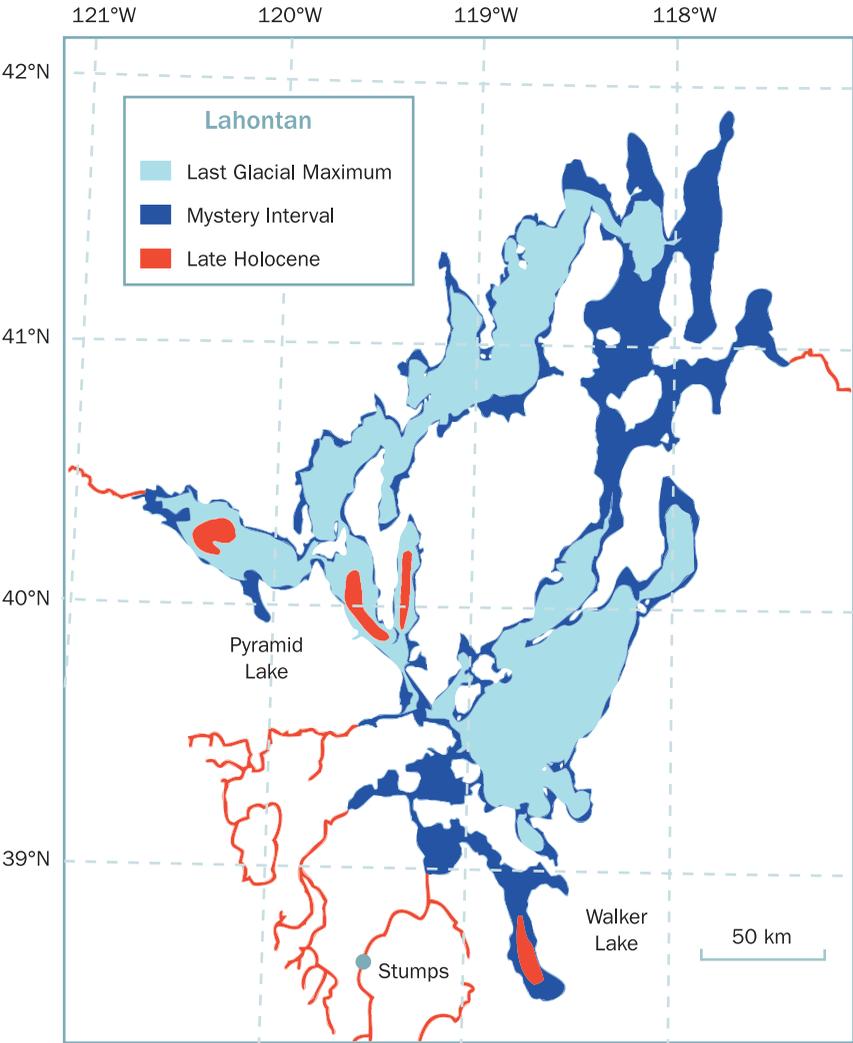
Map showing the changes in size of Nevada's Lake Lahontan. As can be seen, when the first explorers arrived, four tiny remnants of this once large lake remained. One of these (the twin to Pyramid Lake) has since gone dry as the result of diversions of water for agriculture. Note that just prior to the 14.5-kyr northward shift of the thermal equator, the lake was even larger than it was during the Last Glacial Maximum.

Figure 4

Photo of Nevada's Pyramid Lake. In the foreground is the pyramid formed by hot springs beneath the lake surface during episodes when the lake was much deeper than now. In the background is Anaho Island. As can be seen, it is ringed with shorelines formed when the lake was much larger and deeper. The highest of these shorelines is just below the island's summit.

Figure 5

Current location of Amazonia (green) with respect to the seasonal boundaries of the tropical rain belt. Although narrow over the ocean, the rain belt is much broader over land. The red symbols show the locations of four records. Two—the triangle and circle—are for continental margin sediments; the third, a diamond, is for the lake on the Altiplano and the fourth, a square, is for a stalagmite in a now dry cave. Just prior to 14.5 kyrs ago, the rain belt shifted to the south of its present position bringing extra rainfall to the three southern locales. Then, at 14.5 kyrs it shifted back to the north.
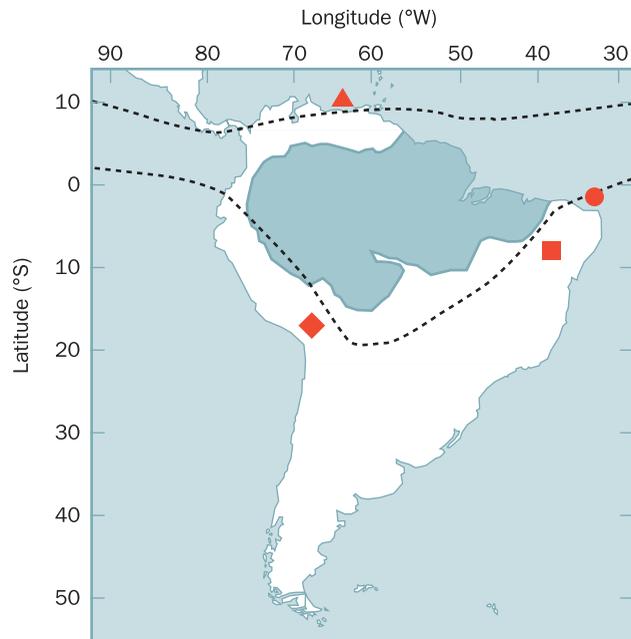
Larry Edwards, an isotope geochemist at the University of Minnesota, pioneered the use of this archive. His entrée was the development of a highly precise means for determining the age of cave calcites. It is based on ^{230}Th, a 75 thousand-year half-life product of the radioactive decay of uranium. He hit pay dirt when he obtained oxygen isotope records for precisely dated stalagmites from Chinese caves. These records extend back several hundred thousand years. He found that the ratio of $H_2^{18}O$ to $H_2^{16}O$ slavishly follows the 20 thousand-year precession of the Earth's spin axis. The impact of this cycle is to change summer insolation. What Edwards found is that during times when summer insolation in China was stronger than average, the contribution of monsoon rainfall was greater (see Figure 6).

Our interest lies in millennial-long departures from this cyclic behavior. As can be seen in the blow-up of the Chinese stalagmite record for the last 25 thousand years (Figure 6), the deglacial time interval is punctuated by departures from this smooth 20 thousand-year cycle. Of particular interest is the strong intensification of the monsoons centered at 14.5 kyrs ago. Thus, at the same time as the supply of water to lakes in western USA, the Middle East and the Altiplano plunged, monsoon rainfall in China became stronger.

> **If, as the model simulations suggest, a doubling of CO_2 were to warm the Earth by 3.6°C, then the Northern Hemisphere would warm by about 4.8°C and the Southern by about 2.4°C. The extra warming in the Northern Hemisphere would cause the thermal equator and its associated rain belts to move northward**

Caves are ubiquitous. Hence, during the next couple of decades, the monsoonal record will be extended worldwide. Indeed, a cave in southern Brazil has already shown that the precession cycle is, as expected, the reverse of that in the Northern Hemisphere. I say "reverse" because at the times when summer insolation is stronger than average in the Northern Hemisphere, it is weaker than average in the Southern Hemisphere. As discussed below, during the Little Ice Age (1300 to 1850 AD) the monsoons in the Northern Hemisphere were somewhat stronger and those in the Southern Hemisphere somewhat weaker than average.

Rivers deliver the products of continental erosion to the sea. The greater their discharge, the more debris they carry. This material is largely deposited along the continental margins where it is mixed with the shells produced by marine plankton living in the overlying water. As the rain rate of shells remains more nearly constant with time than the widely varying supply of debris from rivers, the ratio of erosional debris to marine calcite in the sediment provides a qualitative measure of river discharge.

Sonja Braas, *Forces 04,* 2002

Figure 6
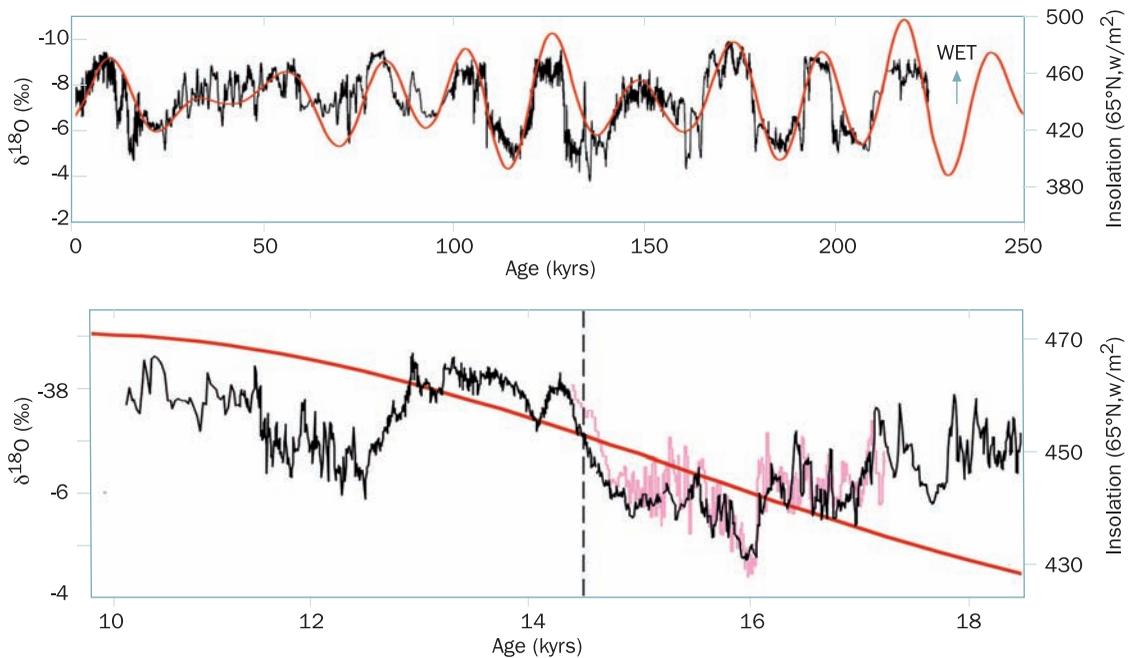
Oxygen isotope record for stalagmites from China's Hulu Cave. Superimposed (in red) is the record of July insolation at 65°N. As discussed in the text, the more negative the $\delta^{18}O$ value, the stronger the monsoons. Hence their strength is being orchestrated by changes in summer insolation created by cyclic changes in the Earth's orbit. As can be seen, the peaks in summer insolation are spaced at intervals of about 20 kyrs. Shown in the lower panel is a blow-up of the record for the deglacial time interval. The smooth 20-kyr cycle is interrupted by pronounced deviations. These correspond to shifts in the thermal equator. Paramount among these is the shift toward stronger monsoons centered at 14.5 kyrs.

A comparison of the sediment record for the Atlantic margin off Brazil with that for the Caribbean margin off Venezuela provides convincing evidence for the northward shift of the Amazonian rain forest 14.5 kyrs ago. At this time, off Brazil, the ratio of continental silicate to marine carbonate underwent an abrupt tenfold decrease. By contrast, off Venezuela, the delivery of continental debris underwent a substantial increase.

Of interest in this connection is the record in a cave from the dry lands of eastern Brazil (see Figure 5). A burst of stalagmite growth occurred during the time of Lake Titicaca's great expansion and came to a halt when this lake desiccated. The drying that terminated stalagmite growth is consistent with the large drop-off in river discharge into the adjacent Atlantic. Both were caused by the northward shift of the Amazonian rain belt.
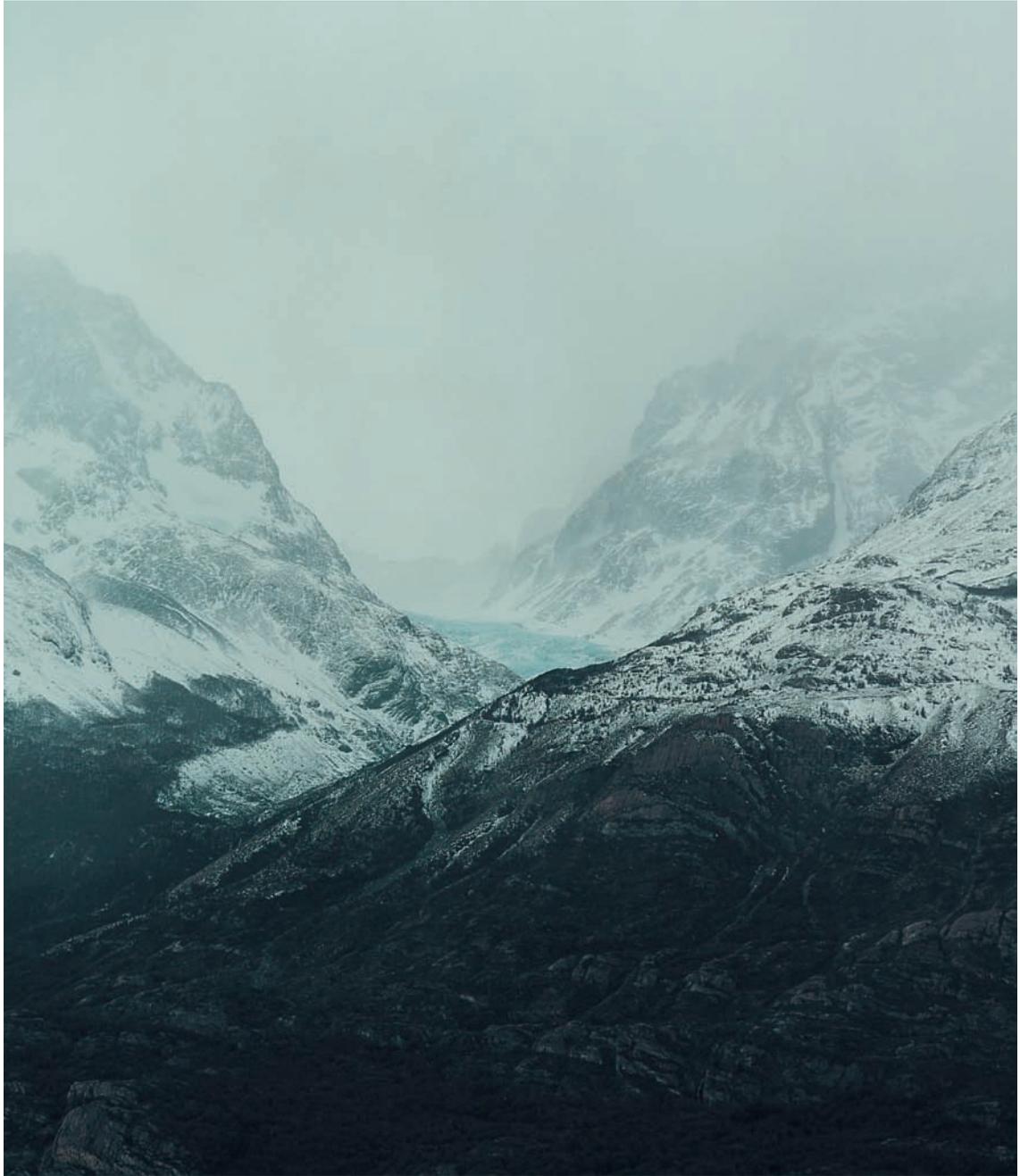
Sonja Braas, *Forces 31,* 2003

WHAT DROVE THE NORTHWARD SHIFT?

As mentioned at the beginning of this chapter, the shifts in the position of the thermal equator were driven by alternating expansions and contractions of the extent of sea-ice cover in the two polar oceans. When the expanse of north polar sea ice became smaller, that in the south polar region became larger. This caused a net warming in the Northern Hemisphere and a net cooling in the Southern Hemisphere and, as a consequence, the thermal equator and its associated rain belts moved to the north.

The question then becomes what caused the flip-flops in sea-ice cover? The short answer is that the driver is what I refer to as the "bipolar ocean seesaw." The long answer requires a bit of background regarding how the deep sea is "ventilated." I say "ventilated" because it is equivalent to blowing fresh air into a stale room. The waters that sink from the surface into the interior of the ocean carry oxygen gas (i.e., O_2). They replace the in situ water that has become stale as the result of O_2 utilization by the creatures — large and small — that live down there.

14.5 kyrs ago the Earth's tropical rain belt underwent a dramatic northward shift. As a result, the Chinese monsoons strengthened and the southern fringe of Amazonia underwent a pronounced drying, as did the Middle East and the American West

The ocean is like a layer cake of waters of differing density. As these density differences are primarily related to temperature, the ocean becomes ever colder with depth. The coldest surface waters in the ocean are found in polar regions. Hence the deep sea is "ventilated" from these polar waters.

A complication to this otherwise simple story is that salt is a secondary densifier of sea water. Because of this, the waters destined to sink to the abyss must be both cold and salty. As we shall see, it is salt that drives the bipolar seesaw.

In today's ocean, about half of the deep sea's ventilation occurs in the northern Atlantic and about half in the Southern Ocean. The water sinking in the north flows down the deep Atlantic to the tip of Africa where it takes a sharp left and joins the rapidly flowing circum-Antarctic current. This current acts as a very efficient "Mixmaster" blending the Atlantic input with a roughly equal amount of deep water descending along the margins of the Antarctic continent. It is the mixture of these two waters that ventilates the deep Indian and Pacific Ocean.

Sonja Braas, *Forces 11,* 2002

Although interrupted by a few burps, this mode of deep-sea ventilation appears to have remained steady during the last 10 thousand years (i.e., the Holocene). However, this good behavior was absent during much of the last glacial period. The bad behavior was most pronounced during the period of deglaciation when war between the two deep-water sources was the rule rather than the exception.

Imagine what would happen if a large slug of fresh water were to be dumped into the northernmost Atlantic. It would dilute the salt content of the surface waters to the point where winter sinking could no longer occur. The northern Atlantic would become much like today's Arctic and the northern Pacific where surface pooling of fresh water prevents deep-water production.

Now, if the north polar region was colder than it currently is, then in the aftermath of the flood, sea ice would form during the next winter. The reason this region is currently ice-free is that heat brought to the surface from the underlying water column prevents ice formation. If the region was covered in ice, solar radiation would be reflected by the ice back to space and the heat carried by any warm water reaching this area would be trapped beneath the ice. Instead of being warmed by the Sun and the Gulf Stream, northern Atlantic winters would be more akin to those in Siberia!

In order to understand what went on at the southern end of the ocean, we must consider what drives deep-sea ventilation. Just as the rate of ventilation of the stale air in a room depends on the strength of a fan, deep-sea ventilation depends on the rate at which heat from the warm upper ocean "diffuses" to the abyss. This heat reduces the density of the resident deep water and in this way creates a "density vacuum", which allows polar surface waters to sink into the deep sea.

Now imagine what would happen if the northern Atlantic source waters were to be shut down by a flood of fresh water. Unless something boosted the rate of deep-water production in the Southern Ocean, the density vacuum created by the downward seepage of heat would not be filled. Although the details are not understood, there is evidence that the consequent readjustment of conditions in the Southern Ocean reduced the extent of its sea-ice cover. This warmed the Southern Hemisphere reinforcing the southward shift in the thermal equator.

One might ask, what was the origin of the fresh water necessary to squelch deep-water formation in the northern Atlantic? The answer is, of course, the huge ice caps in Canada and Scandinavia. During the course of the glacial period, destabilization of the several-kilometer-thick ice over Hudson Bay caused the ice sheet to collapse, sending an armada of icebergs through Hudson Straits into the northern Atlantic. The melting of these bergs provided the freshwater lid. Another source was lakes formed by the melting of the southern ice front. If the water in these lakes were to breach the ice dam that held them in place, huge amounts of water would escape to the sea.

Sonja Braas, *Forces 12,* 2002

We know from our paleo archives that once turned off, after a lapse of 700 years or so deep-water production in the northern Atlantic sprang back into action causing the sea ice to disappear and the Northern Hemisphere to warm. Perhaps a gradual build-up of salt resulting from a net export of water vapor through the atmosphere from the Atlantic to the Pacific led to this renewal or, perhaps it was something internal to the ocean. We are not sure. But from our records, we know that these turn-ons were abrupt. They happened over just a few years.

During the course of the last glacial period and its demise, the switching on and off of deep-water production in the northern Atlantic moved the thermal equator and its associated rain belt back and forth. I am focusing on the shift 14.5 kyrs ago because its consequences were the most dramatic and also the best documented.

BUT IS THE 14.5-KYR SHIFT A RELIABLE ANALOGUE FOR WHAT IS TO COME?

One could argue that the coming CO_2-induced shift will be quite a different "kettle of fish." First of all, it will be gradual rather than abrupt. Second, even though the Arctic's sea-ice cover is likely to disappear, there will be no corresponding growth of sea ice in the Southern Ocean. Third, there is unlikely to be a large-scale reorganization of the ocean's circulation.

There is, however, evidence that supports the idea that we are in for a repeat of the rainfall shifts which occurred 14.5 kyrs ago. It comes from what is known as the Little Ice Age, a 500-year-long cold snap between about 1350 and 1850 AD. During this half millennium, sea-ice cover around Iceland increased, mountain glaciers in Europe and North America reached their largest size in the last 8 thousand years, and the tree line in Siberia retreated to the south. Based on measurements on ice cores from Greenland, the northern cap of our planet cooled by about 1°C. It is referred to as the Little Ice Age because the cooling was only about one-tenth that for the Big Ice Age (i.e., the Last Glacial Maximum). The Little Ice Age was preceded by a 400-year-long period known as the Medieval Warm. It was during this time interval that Eric the Red and his Viking band occupied southern Greenland.

Although smaller in amplitude, the Medieval Warm–Little Ice Age oscillation produced rainfall changes akin (but, in the opposite sense) to those that occurred 14.5 kyrs ago. Studies of sediment cores from small lakes on equatorial-zone Pacific islands suggest that the rain belt moved 500 miles to the south. This conclusion is based on the observation that although lakes on islands within the rain belt overflow to the sea, those on the islands outside its reaches are closed. The sediments in these two types of lake are very different. Hence, cores taken in these lakes record shifts in the latitude of the rain belt.

As shown in Figure 7, stalagmites from a Southern Hemisphere cave in Peru record a strengthening of the monsoons during the Little Ice Age, while those in a Northern Hemisphere

Sonja Braas, *Forces 22,* 2003

cave in China show a weakening. This is consistent with a southward shift of the thermal equator.

Evidence for changes in the sizes of closed basin lakes between the Medieval Warm and Little Ice Age has proven difficult to come by. As the drying that occurred during the 14.5-kyr northward shift, then it would be expected that these lakes increased in size from the Medieval Warm to the Little Ice Age. The problem is that if the shorelines formed during the Medieval Warm are currently underwater; hence, they are inaccessible for study. In any case, for the Dead Sea there is a suggestion of a pronounced Medieval Warm low stand but its timing is only roughly bracketed. Although no direct evidence exists on the Altiplano, the remains of settlements in the adjacent Atacama Desert suggest wetter conditions prevailed during at least part of the Little Ice Age.
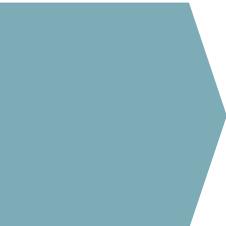
> **The warming of the Earth by manmade CO_2 will create large changes in water availability in the Earth's dry lands. Yes, there will be winners as well as losers. However, if Isaac Held is correct, the winners will be a minority**

In the case of the Great Basin Lakes, there is direct evidence for low stands of Walker Lake and Mono Lake during the Medieval Warm. The reason that they can be directly documented is that the manmade diversion of the streams feeding these lakes caused their levels to fall, exposing otherwise inaccessible shorelines. Scott Stine of the University of California found a way to directly document the timing of these low stands. He found stumps of Jeffrey Pine projecting above the surface on the West Walker River (see Figure 8). The stumps had more than 100 growth rings. As Jeffrey Pines cannot survive root submergence for even several weeks, these stumps document century-long periods when the river was dry. Radiocarbon measurements reveal that there were two such century-long droughts separated by a few decades. Stine went on to demonstrate corresponding drops in the level of Walker Lake. He did this by collecting the remains of woody plants from the shore zone exposed as a result of the diversion of the Walker River. He showed that during the two droughts the lake shrunk to less than half its pre-agriculture size.

Although little information exists regarding the history of closed basin lakes in China, one of my colleagues, Aaron Putnam, documented that China's currently largely dry Lake Lop Nor occupied its largest shoreline during the Little Ice Age. It was roughly eight times larger at that time. Further, he radiocarbon-dated the wood from fossil poplar trees found between the dunes of China's vast Taklamakan Desert, demonstrating that they grew during the Little Ice Age.

Figure 7

Stalagmite records for the last 2 kyrs. One is from China (green) and the other from Peru (blue). They look very similar until one notes that the scales are reversed. Hence, during the LIA, the monsoons were weaker in China and stronger in Peru. This is consistent with a southward shift of the thermal equator.

So the suggestion is that all of the Northern Hemisphere dry lands lying poleward of the monsoon zone underwent a dry Medieval Warm to wet Little Ice Age change. However, as the evidence remains spotty, more research is needed to confirm this observation.

Although no major reorganization of ocean ventilation occurred during this oscillation, it appears that during the Little Ice Age, the wedge of Southern Ocean that underrides the deep water produced in the northern Atlantic was forced to retreat. Today, and during the Medieval Warm, this wedge extended all the way to Bermuda. During the Little Ice Age, it was absent. But, as were all its other impacts, this change in the ocean was small potatoes compared with those associated with the last glaciation.

There is no consensus as to what drove the Medieval Warm to Little Ice Age climate change. Based on the analysis of air trapped in bubbles in polar ice, we know that neither CO_2 nor any of the other greenhouse gases changed significantly. Modelers have attempted to blame the Little Ice Age cooling on a combination of excess volcanic activity and a weaker Sun, but in my opinion, their case is far from convincing. Instead, I suspect that this oscillation reflects changes of the heat budget of the ocean. So vast is the ocean's heat content that a slight imbalance between its uptake and release of heat could easily produce the small Medieval Warm–Little Ice Age climate change. Perhaps during the Medieval Warm, the ocean was giving

off more heat than it absorbed and during the Little Ice Age, it absorbed more heat than it released.

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Figure 8

Stumps projecting above the water in the West Walker River (see Figure 3 for location). Each stump has more than 100 growth rings. As Jeffrey Pine is killed by root immersion, this river must have been dry during the century-long growth period. Radiocarbon dating shows that there were two such century-long droughts separated by a few decades. Both fall within the bounds of the MW.

CONCLUSIONS

Based on the similarity between the consequences of the large northward shift of the thermal equator which occurred 14.5 kyrs ago and those associated with the much smaller southward shift which occurred during the Little Ice Age, I suspect that the northward shift to be generated by global warming will bring about similar changes in rainfall in the Earth's dry lands. If so, the western United States and the Middle East will become drier. The Nile will receive more water. The Amazonian rain forest will shift to the north drying out eastern Brazil and the Bolivian Altiplano. China's monsoons will strengthen. But I should be humble. The factors influencing where and how much it rains are highly complex. This is why the global models designed to predict these changes give such a wide range of results. But one thing is for sure. The warming of the Earth by manmade CO_2 will create large changes in water availability in the Earth's dry lands. Yes, there will be winners as well as losers. However, if Isaac Held is correct, the winners will be a minority.

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Model simulations of the response of the Earth to the ongoing global warming predict that the Northern Hemisphere will heat up about twice as fast as the Southern Hemisphere. If so, the thermal equator will undergo a northward shift. By analogy to a shift that occurred about 14 500 years ago, this will strengthen monsoon rains in China, increase the discharge of the Nile, make more arid the dry lands in the 35 to 45°N latitude belt and shift Amazonia to the north. Evidence in support of this prediction comes from the small southward shift of the thermal equator that accompanied the transition from the Medieval Warm to the Little Ice Age.

BIOGRAPHY

Wallace Broecker

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Wallace Broecker is the Newberry Professor in the Department of Earth and Environmental Sciences at Columbia University and a scientist at Columbia's Lamont-Doherty Earth Observatory. He is author of over 450 journal articles and 10 books, including the seminal textbook, *Tracers in the Sea*, which he co-authored with Tsung-Hung Peng, and his 2010 publication, *The Great Ocean Conveyor, Discovering the Trigger for Abrupt Climate Change*. Broecker has received numerous awards over his career, including the Crafoord Prize, the Vetlesen Prize, and the 2009 BBVA Foundation Frontiers of Knowledge Award. In 2008, he was awarded the Balzan Prize for outstanding achievement in science. He is a Fellow of the American Academy of Arts and Sciences and the National Academy of Sciences. He is also Foreign Member of the Royal Society, and a Fellow of the American and European Geophysical Unions.

Broecker's research interests encompass Pleistocene geochronology, radiocarbon dating and chemical oceanography, which includes the record of climate change contained in polar ice and ocean sediments. He developed the notion of a global "conveyor belt" connecting global ocean circulation, and he has made major contributions to the science of the carbon cycle and the use of chemical tracers and isotope dating in oceanography.

Rethinking Urban Landscapes. Self-Supported Infrastructure, Technology and Territory

Mitchell Joachim and Melanie Fessel

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URBANEERING UTOPIA, A NEW PROFESSION FOR THE DESIGN OF CITIES

Who is the primary authority in the making of Utopia or any extraordinary future city? Urbaneering is a burgeoning discipline based on urban design that can negotiate the complex mix of technology, theory and practice that embraces the re-invention of the city to exceed the needs of the planet. Today, this nascent interdisciplinary field is in a state of radical development.

Sparks of utopian reflection throughout human history have been indispensable in evolved societies (More 1516). Utopias, for the most part, are a necessary paradigm. Utopias display maximal solutions to existing real world problems. They tackle upheaval with orderly retribution. In nearly all variations, Utopias are deliberately excessive. They overshoot the answer to a crisis to accentuate the problem.

Society needs a psychological frame of reference (Lasswell 1930). It's helpful to depict Utopia like a personal membership to a health club. What is the perfect picture of a physique? Why do we need to exercise? Aspirations to appear like a certain idyllic athlete or supermodel sustain our work-out objectives. Many of us understand we cannot be converted into the unattainable airbrushed automatons that decorate voguish magazines. Yet these portrayals provide a common measurement to reflect on our inadequacy. And in some instances, this false imagery makes us admire the precious imperfections and confines of reality.

Instead of aims to be grandiose and ideal, the goal shifts to be earnest and good (Collins 2001).

One catalyst to reimage the good city is based on the establishment of a patently new field that trumps the outmoded agenda of urban design. Kevin Lynch (1960) originally conceived urban design as "City Design" in the late 1950s at MIT. It has not been significantly upgraded to meet contemporary insights. Lynch couldn't have ever imagined more recent factors of change: Google, social networks, ubiquitous smart phones, climate dynamism, energy addictions, global economic calamities, etc.

Throughout the developed world, urban design is at an impasse, unable to mend the rift between theory and practice, and stuck in cryptic arguments, such as the one between "Landscape Urbanism" and "New Urbanism." Landscape Urbanists deploy concepts that favor the landscape over architecture in order to plan a city (Waldheim et al. 1997). On the contrary, New Urbanist schemes promote historical pedestrian-centered neighborhood developments (Calthorpe et al. 1993). The dissimilarity between the two approaches is of interest to almost no public body beyond architects, planners and their ilk. Think of the neo-traditionalist town extension of Poundbury near Dorchester endorsed by New Urbanist Prince Charles, versus the high-tech interactive open space zone of Schouwburgplein in Rotterdam of the Landscape Urbanists: West 8. Both of these urban fractions have their merits yet fail to coalesce on a holistic idea of the future city. Moreover the public — everyday citizens who occupy theses spaces — invests precious little time in understanding the minutiae. For them, it's an archaic clash between tradition and newness. Urbaneering embraces both and more.

Urbaneering undertakes a diverse range of projects as a prescription for maximal design. It practices totalized schemes that rethink all scales of involvement from the doorknob to democracy. Its projects can range from new materials, transportation systems and open spaces, to buildings, cities, and surrounding regions. Currently, a few Urbaneers have shaped phytoremediation ponds, living woody plant structures, rooftop farms, soft cars/buses, urban junkspace, and city-wide action plans. To inspire interdisciplinary innovation, Urbaneers encourage people to switch roles; architects must design cars, automotive engineers must devise eco-systems, and ecologists must draw up buildings.

At the core of Urbaneering is a variety of utopian agitation that dispels the defunct myths of modernism with equitable objectives. An Urbaneer replaces implausible rules and master planning with suggestive memes and polemical models. It is hard to argue with amorphous memes like "city beautiful," "garden city," or "smart growth" (Burnham and Bennett 1909, Calthorpe and Kelbaugh 1989). The public can rally themselves around these open-ended symbolic gestures and phrases. Since the meme is not fully explicit, the concept leaves room for broad cultural interpretations. It's almost exactly what communities yearn for: the freedom to define their own urban spaces.

The Urbaneers' aim is to support people to become part of an advanced intellectual initiative framed on the recalibration of the city. Projects such as Canary Wharf, Potsdamer Platz, NYC Highline, Masdar UAE, and Tianjin China already demand fresh directives. The new profession of Urbaneering provides them in astonishing collaborative ways.

In the past, urban design has mostly been interdisciplinary, but it has not been revamped since its formal inception. Urbaneering involves city design in a huge range of new ideas, including crowd-sourcing, DIY projects, localized energy, shared transport, e-government, high-throughput computation, biotechnology, and ecology. Urbaneers focus as much on cities' ecosystems and infrastructure — areas ripe for improvement — as well as on more conventional subjects such as buildings and parks.

What does Urbaneering look like? Form follows anything as long as no shape is unmotivated. Diagrams that combine ecology and urbanity called "Ecograms" serve to prioritize design directives. Light and air are one of many causal factors that respond to context in these Ecograms. Equally, encapsulation of program is correctly orchestrated via any low-energy embodied volumes or dense generic loft spaces. Highly malleable, these spaces support growth, with elaboration and magnification of character at its limits. These are Ecograms of rampant plurality in which lifestyle is elective and fluid. Depending on the nerve with which the Ecogram pressures, the reinvention and re-privatization of consequences could prove to be illimitable.
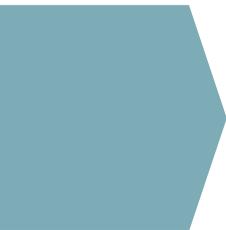
Urbaneering is a burgeoning discipline based on urban design that can negotiate the complex mix of technology, theory and practice that embraces the re-invention of the city to exceed the needs of the planet. Today, this nascent interdisciplinary field is in a state of radical development

Beyond utilizing the Ecogram, Urbaneers have a set of proficiencies that merge previously disparate occupations. The discipline is home to almost any recombined professional activities, as long as they meet the constantly changing needs of urbanization. An excellent historical example of someone who now would be an Urbaneer is Frederick Law Olmsted (1822–1903), the nineteenth-century activist who combined journalism, social action and landscape architecture to a single political end (Beveridge and Rocheleau 1998).

The next city needs a new breed of communicator. A person skilled in the art of cities beyond the typical utopists, planners, civil engineers, and architects in the present day. These fields need a multifaceted filter of reason to incorporate a profound knowledge of place. An Urbaneer posits the solutions to municipal problems that normally take multiple disciplines to

solve. Urbaneers look to merge the edification and expertise needed to reform the city of today for the Utopia of tomorrow.

BROOKLYN URBANEERING

What is the key objective for ecological cities? A primary assertion for the next city is that all necessities are provided inside its accessible physical borders. In this intensified version, all vital needs are supplied for its population. In this city, food, water, air quality, energy, waste, mobility, and shelter are radically restructured to support life in every form. Infrastructure is celebrated as the new center.

The strategy includes the replacement of dilapidated structures with vertical agriculture and housing merged with road networks. Former streets become snaking arteries of livable spaces embedded with renewable energy sources, soft cushion-based vehicles for moving, and productive green rooms. The plan uses the former street grid as the foundation for up-to-the-minute networks. By reengineering the obsolete streets, we can install radically robust and ecologically active smart pathways. These operations are not just about a comprehensive model of tomorrow's city, but an initial platform for discourse. Urbaneers expect the future will necessitate marvelous dwellings coupled with a massive cyclical resource net.

RAPID RE(F)USE, 3-D FABRICATED POSITIVE WASTE ECOLOGIES

Imagine our colossal municipal landfills as sensible resource sheds to build our future urban and peri-urban spaces. What kind of effort is required to reuse their bountiful contents? Now that the bulk of humanity has chosen to settle in urbanized areas, waste management needs a radical revision.

For hundreds of years we designed cities to generate waste. Now it is time that we begin to design waste to regenerate our cities. What are the possibilities for urban environments after our aged infrastructure is recalibrated? How might urban intensification and waste mix? Terreform ONE's supposition is to reallocate resource streams to flow in a positive direction (Mitchell et al. 2012). In this case, waste is not faintly recycled through infrastructural mechanisms but instead up-cycled in perpetuity.

America is the lead creator of waste on the earth, making approximately 30 percent of the world's trash and tossing out around 0.8 US tonnes (0.72 tonnes) per US citizen per year (EPA 2008). Ungracefully, our American value system is somewhat distressed. It seems value has devolved into rampant waste production: megaproducts scaled for super-sized franchise brands,
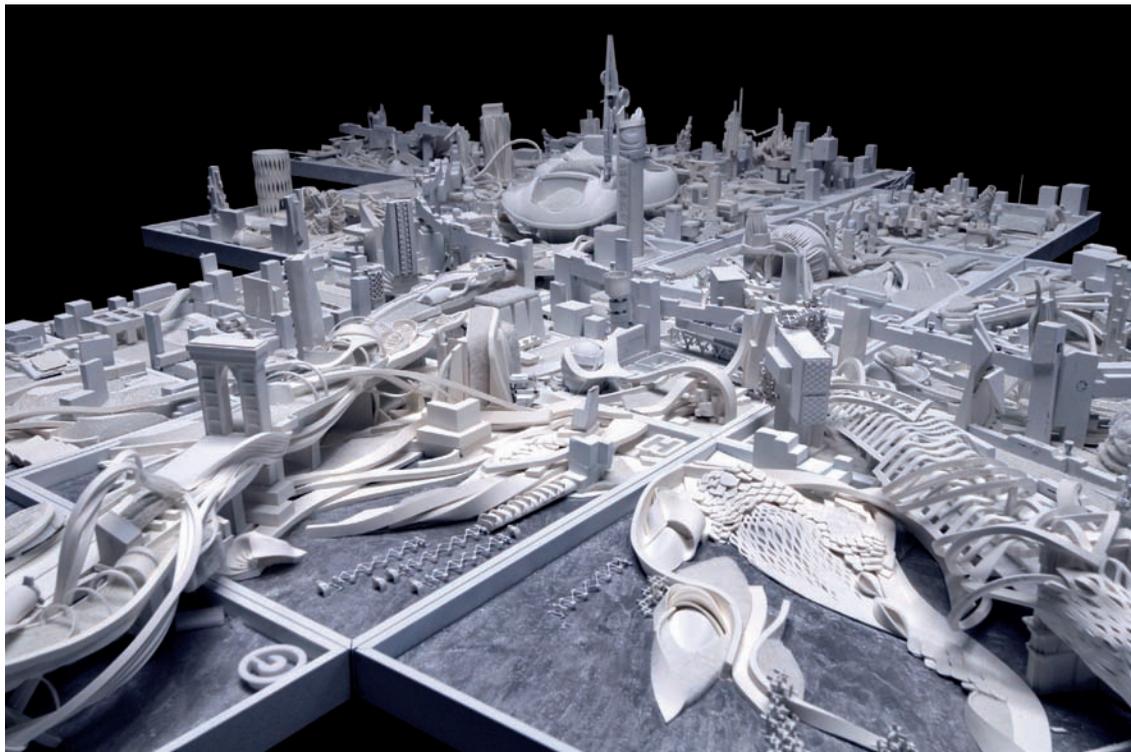
Brooklyn Urbaneering 2110, city of the future

big-box retail, XXL jumbo paraphernalia and so on. The US mindset is thus encapsulating a joint race for ubiquity and instantaneity. Where does it all end up? Heather Rogers affirmed in her investigative book *Gone Tomorrow* that throwing things away is unsustainable (2006, 54–67, 104–32). The first step we must take is reduction — meaning a massive discontinuation of objects designed for obsolescence. Then we need a radical reuse plan. Our waste crisis is immense. What is our call to action?

One such dilemma lurks in New York. New York City is currently disposing of 36 200 US tonnes (32 840 tonnes) of waste per day (Cohen 2008). Previously, most of this discarded material ended up in Fresh Kills on Staten Island, before operations were blocked. Manhattan's inhabitants discard enough paper products to fill a volume the size of the Empire State Building every two weeks. Terreform ONE's Rapid Re(f)use and Homeway projects strive to capture, reduce and redesign New York's refuse infrastructure. The initiative supposes an extended city reconstituted from its own junked materials. The concept remakes the city by utilizing all the trash entombed in the Fresh Kills landfill. Theoretically, the method should produce, at minimum, seven entirely new Manhattan Islands at full scale. New York City's premier landfill

was started by Robert Moses and driven by apathetic workers and machines (Moses 1951). Now, guided by a prudent community with smart equipment, we must reshape it.

How could this work? Outsized automated 3-D printers could be modified to rapidly process trash and to complete the task within decades. These potential automatons would be entirely based on existing techniques commonly used in industrial waste compaction devices. To accomplish this job, nothing drastically new needs to be invented. Most technologies are intended to be off-the-shelf. Instead of machines that crush objects into cubes, compaction devices could benefit from adjustable jaws that would craft simple shapes into smart "puzzle blocks" for assembly. The blocks of waste material could be predetermined, using computational geometries, in order to fit domes, archways, lattices, windows, or whatever patterns would be needed. Different materials could serve specified purposes: transparent plastic for fenestration, organic compounds for temporary decomposable scaffolds, metals for primary structures and so on. Eventually, the future city would make no distinction between waste and supply.

Admittedly, this meta-design theme is not entirely novel. At approximately the same time that Rapid R(e)fuse was initiated, the feature film *WALL·E* was conceptualised. The film profoundly infused Terreform ONE's research agenda.
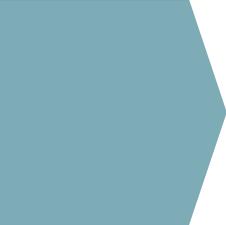
Urbaneering undertakes a diverse range of projects as a prescription for maximal design. It practices totalized schemes that rethink all scales of involvement from the doorknob to democracy. Its projects can range from new materials, transportation systems and open spaces, to buildings, cities, and surrounding regions

EXCURSION TO DISNEYLAND

Inspired by an equal interest in fictive productions of tomorrow such as Disney's Tomorrowland, Terreform ONE visited the Walt Disney Imagineering (WDI) headquarters in Glendale, Southern California. The group had prepared a presentation that would unpack a comprehensive view of its version of the future: a world free of carbon loading in the atmosphere and abundant in self-sufficient lifestyles. As architects invested in an ecological future vision, the team had meticulously crafted cities within the rubric of a socio-ecological domain — rethinking the design of entire systems, from doorknobs to democracies.

When Ben Schwegler, mastermind and chief imagineer, pulled back the proverbial curtain to reveal WALL·E, the group was crestfallen. Disney had beaten them to it. WALL·E was perfect — almost: a tightly packaged, solar-powered, curious, obedient, evolved, robotic trash compaction and distribution device. His name is an acronym: Waste Allocation Load Lifter Earth

Class. Left behind by mankind, he toils with trillions of tonnes of non-recycled inner-city trash. Not only is WALL·E a highly advanced rubbish manager, he is also a mechanized and inventive architect. He accomplishes his immense tasks while remaining completely adorable. Not easy to do.

WALL·E's life is a tale of an ultramodern trash compactor in love. Ceaselessly, he configures mountains of discarded material. Why pyramids of trash? WALL·E's daily perpetual feats seem almost futile. Disney omits exactly why he is programmed to pile refuse — and there is the shortcoming.

FUTURE WASTE AND PAST CITIES

Collaborators at Terreform ONE were interested in exploring a deeper motivation for stacking refuse. Similar to the Disney film, what if the refuse was refabricated to become real urban spaces or buildings? If it is plausible to adapt current machinery, how much material is available? At first sight, any sanitary landfill may be viewed as an ample supply of building nutrients. Heavy industrial technologies to compact cars into lumber or to automatically sort out garbage are readily available. Other technologies, which would make possible the articulation of specific forms, are also available if scaled in larger sizes. Three-dimensional printing has exhausting capabilities if adjusted to larger scales. This is where Terreform ONE's city began.

The envisioned city would be derived from trash: not ordinary trash, but "smart refuse". A significant factor of the city composed from smart refuse is "post-tuning". Unitized devices would not immediately adapt. Integration into the city texture would be a learning process. In time, the responses would eventually become more attenuated to the needs of the urban dweller. This city is envisioned from trash, but each individual component would be enhanced with a modicum of CPU power. Brief durational events would endow these "smart units" with experiences needed for their evolution.

The main objective for the city of Rapid R(e)fuse is to establish a smart, self-sufficient, perpetual-motion urbanism. It has been advocated that perpetual motion cannot exist. Perpetual motion defies the laws of thermodynamics and energy conservation, since it would necessitate a machine that produces more energy than it consumes. Cities, unlike machines, are similar to a complex ecology.[1] Ecology is capable of achieving a continuous harmonious state, or even

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1. "Cities are not machines and neither are they organisms, and perhaps resemble them even less – Rather then communities of non-thinking organisms undergoing inevitable phases until they reach a certain iron limit – cities are the product of beings capable of learning. Culture can stabilize or alter the habitat system, and it is not clear whether we wish it to be otherwise." (Lynch 1984, 26–7).

Homeway; the great suburban exodus

further, a positive intensification. If ecological models are productively everlasting, urban models can logically follow.

Architects have ruminated over improbable instruments of physics since the Middle Ages. In the thirteenth century, evidence of the perpetuum mobile was uncovered in the sketchbooks of French architect Villard de Honnecourt (Bowie 2006, 32–49). What if the Rapid R(e)fuse city was like an instrument that produces more energy from renewable sources than the energy it consumes? In this case, "nothing can be thrown away". Every bit would be a vital piece of stored energy, poised to be reused in a cyclical nutrient stream (McDonough 1998, 5–57). Rapid R(e)fuse is imagined as a city without a tail pipe; a city that not only has zero impact, but a positive contribution towards the natural surroundings.

John Fitzgerald Kennedy once declared: "Our problems are man-made, therefore they may be solved by man."[2] The matter posed on the table is not only about solving our ecological issues,

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2. John F. Kennedy, during a speech at The American University, Washington, DC, June 10, 1963.

but also about returning to a system of perpetuity. This is the only possible future for a truly breathing, interconnected, metabolic urbanism. Cities have passed the age of industrialization and entered the age of recovery. After this great cleansing, we may transition into a greater order: "positive waste". Here is an order that captures our socio-ecological needs: not Utopia, but a place where everything is precious and nothing is disposed of.

ENVISIONING ECOLOGICAL CITIES

How should urban design foresee new instrumentalist technologies for cities? For 150 years, the innovation of the elevator has done more to influence urban design than most urban designers. Elevator systems had incredible success in the creation of compact and greener cities. Imagine what the advent of the jet pack will do for cities. Urban design is greatly altered by such devices. For instance, automobiles have defined limits in cities for almost a century. Unlike the elevator, however, the car has arguably caused more problems than it has solved.

Perhaps it is time for urban design to rethink technologies to fit cities, not constrain them. As a wide-ranging discipline, it can effortlessly illuminate the technological potentials for cities. Urban design will successfully situate itself through the production of future macro-scaled scenarios predicated on innovative devices.

Physicist and polymath Freeman Dyson has said that the best way to comprehend our near urban future is to examine science fiction, not economic forecasts. In his experience, sci-fi is good for decades of technological fulfillment. Unfortunately, economic forecasts are only accurate within five to ten years. Most of these predictive economic models are quantity based and find it difficult to extrapolate the qualifiers associated with creativity. Sci-fi is a phenomenal way to chronicle our plausible urban future that should not be dismissed by urban designers.

Dyson (1988) is certain that the urban era of information will soon transition into "the age of domesticated biotechnology." In his novel, *Infinite in All Directions*, he states: "Bio-tech offers us the chance to imitate nature's speed and flexibility." He envisions a realm of functional objects and art that humans will "grow" for personal use. According to a New York Times article on Dyson, "The Civil Heretic," he also believes that climate change is profoundly misstated. "He added the caveat that if CO_2 levels soared too high, they could be soothed by the mass cultivation of specially bred 'carbon-eating trees'" (Dawidoff 2009). He is not concerned with predicting the future but rather with expressing the possibilities. These expressions are founded along societal desire lines as a kind of relevant optimism. Therefore Dyson measures the wants of civilization and advances our expectations.

At some level, urban design engages this position that promises a better tomorrow. Numerous practitioners and urbanists mildly suffer from this invariable search for direction and clairvoyance. Alex Krieger (2009) strongly asserts the broadly defined vocation is more of a scrupulous sensibility than an exclusive authority. The profession is torn between many incompatible agendas, weighty theories and oversimplified applications, ivory towers and new urbanism, developer brands and radical ecologies, and vernacular forms and futurology. One of my research group's chief directives is about shrewdly locating the intersection of technology and urbanism, especially under the rubric of ecology. Our projects range from highlighting the possible effects of self-sufficient cities to studying flocks of jet packs. These ideations keep us thriving as urban design researchers. It is our supposition that the prospective ecological city is about extreme solutions to an extreme predicament. Our future fundamentally depends on the immensity our solutions envision.

Envisioning is by definition a view or concept that evolves beyond existing boundaries. This notion of foresight may be interpreted in many different ways, each foregrounding particular ideations and processes describing the next event. Here in America, we need these radical new visions to assist in solving our current global calamity. As of now, the

earth's climate endures an unremitting state of trauma. We seek precise prescriptions that cover a wide scope to alter this massive dilemma. To paraphrase, John F. Kennedy said: "If man created problems, man can solve them." This future vision unfolds a truly breathing, interconnected metabolic urbanism. How does it reify from statistics to architectural form? What does the future look like for America's cities? How do technological devices affect these functions?

For a popular audience, Disney sci-fi film *WALL·E* enabled society to anticipate one conceivable future. The film is set in a generic city that is completely buried in trash. Humans have abandoned life on earth for off-world dwelling, leaving being one lone solar-powered robot to clear the rubbish. Part of the message of the film is that technology alone can't solve humanity's "affluenza," yet the film's powerful computer-generated visuals encourage us to confront our colossal wastefulness and rethink the city.
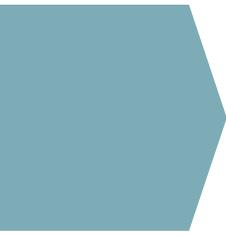
> **For centuries, cities have been designed to accommodate the theater of our human desire. We have joined the ranks of those delivering a new sense of the city, one that privileges the play of nature over anthropocentric whims. We are constantly vying for a profound clairvoyant perspective**

We foresee strategies for people to fit symbiotically into their natural surrounds. To achieve this, all things possible are considered. We design the scooters, cars, trains, and blimps, as well as the streets, parks, open spaces, cultural districts, civic centers, and business hubs that comprise the future metropolis. For centuries, cities have been designed to accommodate the theater of our human desire. We have joined the ranks of those delivering a new sense of the city, one that privileges the play of nature over anthropocentric whims. We are constantly vying for a profound clairvoyant perspective. We desire to preview a likeness of our collective future yet untold.

Our foresight of ecological design is not only a philosophy that inspires visions of sustainability but also a focused scientific endeavor. The mission is to ascertain the consequences of fitting a project within our natural environment. Solutions are derived from numerous examples: living material habitats, climatic tall building clusters, and mobility technologies. These design iterations succeed as having activated ecology both as a productive symbol and an evolved artifact. Current research attempts to establish new forms of design knowledge and new processes of practice at the interface of design, computer science, structural engineering, and biology.

EXTRATERRITORIALITY NEXUS, A NEW GENEALOGY: INVESTIGATIONS ON CITIES THROUGH REDEFINING EXTRATERRITORIALITY IN THE CONTEXT OF ECOLOGY

We no longer map territories, but territories map us. Humanity is inscribing its vast impacts on the Earth's surface; these new engraved territories have no boundaries, they portray who we are, what we have done and where we are moving.

Within these global networked shapes and their interrelations they unveil our ever-changing cities and landscapes. These immeasurable human impressions are so complexly woven, that it is becoming increasingly difficult to maintain a distinction between nature, culture and the built environment. Fragmented exceptions defined as geographically autonomous zones of extraterritoriality disseminate these interacted figures. What are the unconditional opportunities that lie within these confined processes?

Utopian thought has been critical to our evolution and will be a necessary paradigm to envision an interconnection on extraterritoriality and ecology as a novel scenario of experimentation that challenges an innovative discourse beyond a conduit of sustainability. The investigations described by extraterritoriality nexus are centered on the comprehension of new approaches to the reification of the city. This may be best accomplished by further understanding these fragmented emerging ecologies of exception, and how they relate to architecture and urban design, as concise instruments in the development of society. In order to verify this vision in a socio-ecological realm, beyond a world of net-zero motivations as described by sustainability advocates, the aim is to structure an inquiry of mutable urban conditions as they pertain to global crisis and phenomena. There are a number of questions that come to mind addressing this predicament. How can we integrate and reinvent the already existing political mechanism of extraterritoriality as a tool of exception to address social and ecological disturbances that are prevailing our urban landscapes? What can we learn and extract from our past conceptions of cities and humanity? When confronted with any utter urban calamity from Port-au-Prince, to New Orleans, to Fukushima, what is the extent of architecture impact, if any? After the destruction of Fukushima, and many places like it, the bona fide intervention of architecture has been ineffectual. Events occur with such speed and complexity today that nothing remains certain. Large numbers live in a world where local economies and cultures are tightly bound into global ones through which effects ripple with enormous velocity and consequence (Sassen 1996).

Natural and synthetic disturbances are dynamisms of immense force that set apart worlds. Governmental guidebooks and laws around the world map out detailed solutions for rescue operations in crisis scenarios. Hazard mitigation plans, military scenarios, and crisis strategies are instrumental directives that provide society with a safety mechanism to prevent and overcome the dangers created by forces of natural disasters, fire, mudslides, earthquakes,

hurricanes, flooding, and tsunamis as well as crime, violence, acts of terror, war, and destruction. Planned in every detail it enables their creators to satiate society with a constant answer for unpredictable demands that relate to the influence of natural and societal instabilities on our built environment.[3]

Post the traumatic event of 9/11, the act of terror is still desensitizing our resilience to conquer new challenges. The effects of catastrophe on the built environment and its inhabitants continue to intrude everyday life. New York City provides a significant locus to analyze the politics of shock and terror. A city of immigrants, many of whom are connected to other cities that have suffered catastrophe, New York citizens have a unique contribution to offer to the many urgent projects of reimagining cities around the world today. To address the devastating destruction by the events that took place on September 11, 2001, the call for entries to rebuild the World Trade Center site resulted in the world's largest architecture competition with the most amount of entries in history. The immediate urgency to restore and recover from such damaging incidents is implied (Columbia University 2011).

If we are going to study cities then we should also study that which is radically anti-city. Threats against our cities are measured in terms of armed gangs or moments of staged terrorist assaults as well as disturbances created by natural disasters; hovering over all of this is still the apocalyptic thought of something that could simply annihilate cities altogether. Nuclear catastrophes mark the only true long-term marker of human presence on earth. Weapons created by geology, minerals made all together unearthly, post-terrestrial, through anthropological intervention form a destructive power that turn them into a ubiquitous anti-landscape, something that no geography, built or natural, can resist.

The worst nuclear disaster to strike Japan since a single bomb fell over Nagasaki in 1945 occurred in the spring of 2011, at the Fukushima nuclear power plant following the epic tsunami (Hirose 2012). The wide release of radiation, and fear of same, has forced the Japanese and others all over the world to reflect on what happened to the country in 1945, and the continuing threat of nuclear weapons and energy today. On August 6, 1945, the first atomic bomb was dropped from an American plane on the 245 000 residents of Hiroshima, Japan. Most of the city was destroyed and thousands of its inhabitants died. Some of its citizens survived and suffered the debilitating effects of terrible burns and radiation illness. The lives of six of those survivors are recounted in the days following the bombing. *Hiroshima*, John Hersey's journalistic masterpiece (1989), tells what happened on that day. More than six decades after the events in Hiroshima, a new activism of survivors of the bombing is campaigning against nuclear power, which has provided most of their country's energy needs. Survivors, who are now called

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3. City of Los Angeles, "Hazard Mitigation Plan."

hibakusha, have become the targets of politics and the peace movement. The radioactive fallout in Fukushima, Japan as the most recent nuclear disaster reminded everybody that there are no boundaries for threats. The fallout, triggered by an earthquake that set off a tsunami heading towards the coast of Japan and destroying the nuclear power plant in Fukushima, was just the beginning of a keychain that will affect all future life on earth and beyond. Three elements — buildings, communications, and transportation — constituted the immediate effect of the disaster on the city. A further ominous phase of the disaster appeared after news of the first explosion at the Fukushima Daiichi nuclear power plant unwrapped. Power cuts, product shortages, radiation and health warnings followed this information, emphasized by uncertainties about the actual aftermath of this impact. Within a week the nuclear cloud arrived at the coast of California continuing its journey cross-country heading towards Europe and Asia. Carried by Aeolian forces and strong ocean currents, the effects of the threat are immeasurable and its longevity is implied. This period of suffering, restraint and sobriety was reminiscent of the struggles of the postwar years, and even further back to the years after the massive earthquake that destroyed Tokyo in 1923. Despite their difficulties, the reconstruction years were times of energy and aspiration, when a new city and a new nation were built.

Architecture was the immediate response to the threat of nuclear weapons by designing fallout shelters as a critical part of civil defense strategy of the 1950s and 60s (Monteyne 2011). In an era of nuclear weapons, the federal government — tasked with protecting American citizens and communities — relied on architectural expertise in order to survey, design, and build fallout shelters. During the height of the Cold War, architects and urban planners became instrumental to the importance and efficacy of both purpose-built and ad hoc fallout shelters, which granted them expert status. Architecture for civil defense planning in the United States was, ultimately, a failure due to a lack of federal funding, contradictions and ambiguities in fallout shelter design, and growing resistance to its political and cultural implications. Yet the partnership between architecture and civil defense influenced the perception and use of urban and suburban spaces. The result of this bunker architecture was a philosophy of building and urbanism that shifted focus from nuclear annihilation to urban unrest (US Department of Defense 1961).

The future will not be the same as the past but disruption on the one side sparks legacies of feedback on the other. Hip Hop, a cultural movement during the 1970s in New York City, in many ways comes out of a disruption — the disruption of a neighborhood and community in the Bronx through massive highway infrastructure that would soon segregate their neighborhood, leading newly formed gangs to resonate this impact through acoustic portraits of its interrupted built environment. Robert Moses was the lead figure for these massive urban renewal projects and practices in mid-twentieth-century New York City (Caro 1975). Facing the destruction of another local neighborhood in 1961, community activist Jane Jacobs (1992) organized

Super docking in the Brooklyn Navy Yard. View of the clean technology industrial waterpark

grassroots efforts to block urban-renewal project for the Greenwich Village, which were instrumental in leading to the cancellation of the Lower Manhattan Expressway.

Events all over the world identifiable as volatile social, political, economic and ecological disturbances are impacting the world's fragile ecosystem and ultimately influence how we reimagine cities around the world today. Comprehending unstable processes and environments is an attempt for a new and suggestive contemporary global order that recognizes a continuous spatial flow of extraterritorial zones and utilizes their exception as a progressive tool for envisioning our future. An investigation on extraterritoriality emerges as a nexus for explorations of ecological and social disturbances as an active tool to re-invent and re-imagine our cities and vast networks today. The framework for this emergence defines our history, present and future: the impact to recognize these processes, as a positive impulse to regenerate new emergent landscapes of emergency, has to be created.

Extraterritorial places are positioned outside of the sovereignty and jurisdiction that surrounds them or that are contiguous to them. International ownership treaties demarcate

airports and ports, international waters, international seabed, the Moon, outer space, international zone, the United Nations, Antarctica, extraterrestrial real estate. These spaces aspire to be worlds within themselves, and they provide vivid evidence of the weakness, resilience, or violence that these enclaves carry. Jurisdictionally ambiguous, they are infused with myths, desires, and symbolic capital (Easterling 2007). The condition of extraterritoriality, which is defined by its segregation, transforms these hybrid spaces into spaces that attempt to create long envisioned utopian places and a radical new socio-ecological order. These new characteristics of our time could envision the power of new intense transformations and processes of global connectivity, where the cultural collision and segregation provide new techniques for a discourse on the political composition of our urban landscapes (Weizman, Franke and Keenan 2005).

THE NECESSITY OF ALL SCALES: PLANETARY DESIGN IN THE AGE OF GLOBALITY

Globalization has a final outcome; it is not unending. Without recourse, humanity is headed into the age of globality, the final state of the globalization process. Globality is the endgame, an all-inclusive terrestrial status. In this fully connected world, populations will compete with everyone, everywhere, for everything at all times in all scales. Vast networked communication linkages will reverse developing world economies and cause developed nations to partially corrode if not yield. A conceivable state of planetary equilibrium ought to influence the major sectors of industry, commerce, resource management, infrastructure, technology, energy, and governance with profound transformations. What is design like in this saturated condition of globality?

   The American economist, Jeremy Rifkin, infers that the modern age has been characterized by a "Promethean spirit," a restless energy that preys on speed records and rapid solutions, unmindful of the past, uncaring of the future, existing only for the moment and the quick fix (Rifkin 2000). The earthly rhythms that characterize a more pastoral way of life have been shunted aside to make room for the fast track of an urbanized existence. Lost in a sea of perpetual technological transition, contemporaneous people find themselves increasingly alienated from the ecological choreography of the planet. Humanity expects jet airliners to collapse the space of a continent in a matter of hours. We have partly lost our sense of scale, time, and distance.

   Scale also determines our profound connection to place. Yi Fu Tuan's environmental conjecture (1974) conveys knowledge and love of place with descriptions, maps and itineraries enabling people to appreciate their location as do aborigines or animals. Such literature also enlivens the experience of everyday places with new facts and rhetorical devices that can recalibrate familiar environs to keep alive a sense of the undiscovered country of the nearby.

These texts direct both official and intuitive knowledge toward "topophilia," the love of place. The intention is to expand our sense of the land, not to confine it to one size. We are in need of terrain propinquity, not dislocation.

Already the disasters at Chernobyl and Fukushima have demonstrated long-reaching influences on worldwide environmental health and ultimately on global financial markets. Effects of scale become constantly transferred between the irreducible and the colossal. Small changes ramify into massive results and vice versa. Globality operates in all scales simultaneously without privileging one form. Its very nature implies measureless shifts in size. Ideas of thinking inside strict categories of scale are defunct and counter-intuitive. Charles and Ray Eames (1968) provided the perfect case. Illustrated in the *Powers of Ten*, scale is conveniently defined in neat square-shaped frames. The point of their animation is to bridge the different perceptions of scale cohesively. Their concept is to empower individuals to visualize the ranges of observation melded as one. Unfortunately, a few viewers also interpret this to mean you actually should bracket places and things in specific scales. That's a common oversight of their *Powers of Ten* message. Nothing happens in only one frame of space/time. Framing can help to study a phenomenon at a particular moment but things always stir. Moreover, artificially binding a place to a numerical scale is to some extent random and arbitrary. What law declares measures must be in units divisible by ten? In his lectures, Jamer Hunt points this out nicely by making a reference to the film *This Is Spinal Tap*. One scene in particular shows the actor, Christopher Haden-Guest, referring to his guitar amplification equipment with a volume knob that goes to eleven. Within the central idea of this farcical narrative, scale is portrayed as being truly capricious.

Rem Koolhaas and Bruce Mau (1995) intended an emphasis on scale in the book, *S, M, L, XL,* yet also alluded to the in-between thresholds and differentiation of projects. A false read of *S, M, L, XL* is to suppose that the Office for Metropolitan Architecture's (OMA) works fit cleanly into categories measurable by an orderly unit. What exactly is designated a "small" project: a door hinge detail, an elevator, a wooden deck addition? More notably, what "small" project does not have significant impacts on an extra-large scale? Everything has consequent ramifications. Rem and group of course are fully aware, but may have failed to communicate its grandiose message in the title. Similar to *Powers of Ten*, it underscores an explicit simplification in degrees of change. Urbanism cannot be compiled into tidy categories defined by size. Design needs to break out of the emblematic question of size, especially as it relates to one planet. One size does not fit all; rather, all sizes fit one.

Visualizing in one scale is markedly problematic. An analysis comparing the views of Johann Wolfgang von Goethe and Isaac Newton best demonstrates this assertion. Goethe (1970) pioneered a comprehensive lucid description of color within a perceptual human context. He ardently conveyed that colors were defined by an inseparable relationship called *Zur Farbenlehre* [Theory of Colors]. One color cannot be reduced to a single element. It requires a setting of
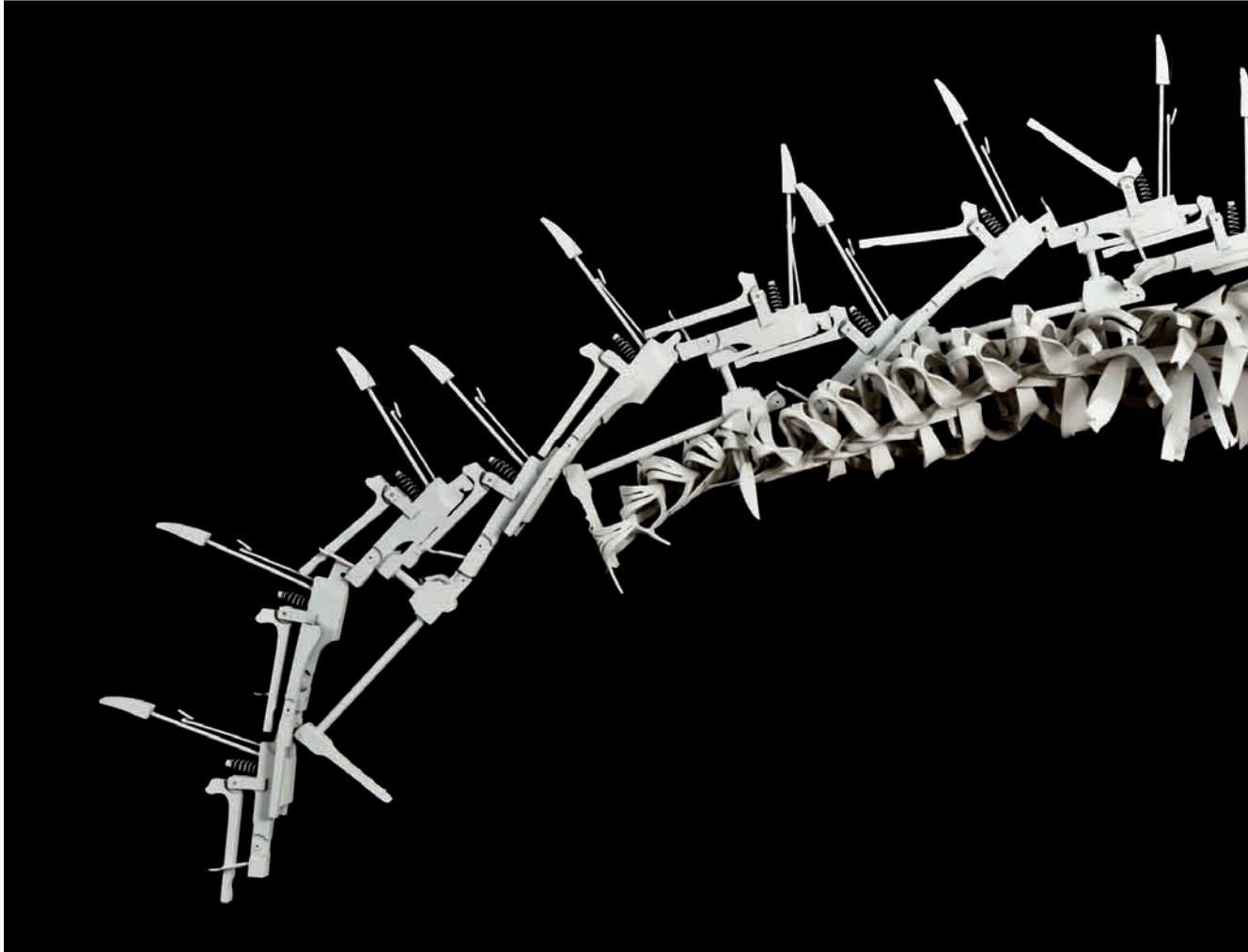
Extraterritoriality in the context of ecology. Composition and speculation conditions on unstable processes

other colors and circumstances to be fully perceived as an observable phenomenon by humans. He proclaimed that to identify blue you need to, at some level, recognize red, orange, yellow, and the entire spectrum. Newton (1730), in opposition, treated color analytically and saw each color as discrete wavelengths in an optical spectrum. Newton surmised that it is absolutely possible to observe one color disconnected from its domain. Every color has a particular frequency and can be defined as such. While both thinkers are correct, the problem design professionals have with scale is identical. Scale can be Newtonian and viewable at one frame of unitized reference. However, scale is best perceived holistically in relationship to other scales in order to understand its true phenomenon.

Most archetypal designers tolerate a proclivity to divide concepts up into specific units. That is intended to help comprehend or visualize the problem better. However, this is inherently misguided. Design is a prescience that affects all disciplines and cannot be conceptualized as a bracketed or contained field. The condition of globality and scale asserts a restructuring of the design professions as we know them. This requires a new breed of designers who can speculate and produce at the nano-scale level up to feats of geoengineering and beyond. These thinkers can be referred to as planetary designers.

As a globalized meta-Pangea community, design is obliged to be pervasive. It simply cannot regulate itself to any one scale or project scope. If so, its relevance and instrumentality are

greatly diminished. The principal operations of scale and systems that deploy it restrain and confuse the complicated reality of design problems. The more it is used, the more designers fail to envision the whole picture. Computer-aided design is part of this dilemma, both a solution and a quandary.

Most design software unwittingly forces designers into forms of measure. As soon as the file opens, designers are asked to define the units of measure, view ports, and scale. The same is not true when an individual picks up a pencil. Freedom to draw and therefore conceptualize without boundaries is practically inestimable. To paraphrase Frank Stella, "artists don't think in units."

The processing capacities of computers distort the implications of measure. Software allows for seemingly limitless flexibility. Operators can shift from the smallest possible detail to the largest components. It is possible to zoom endlessly outwards into entire regions. On one level, this is a tremendously effective visualization capacity. Consider the design of a rail spike and its connection to the track: zoom onto the tracks themselves and further out to all the trains on those tracks and advance past Penn Station and finally out of the entire New York City metropolitan region. This is an acutely impressive tool. However, the software does not make any distinctions about the conventions of physics and natural forces that govern each zoomed layer. In many cases the current limitations of memory also fail to provide all the essential detail within each consecutive zone. Furthermore, the material and chemical behavior of the objects and places are not described in relationship to each other beyond geometric location. Admittedly, the current trend is to restructure computation to account for these missing characteristics. Envision a computer program that fully simulates the ecosystem of the earth and all the associative quantum mechanics. It would be a Jorge Luis Borges map of the world in such vast specificity that it would correlate to the exact size of the world at 1:1 (Borges 1975).

Additional scenarios of scale in relation to the planet are depicted in *The End of Nature* by Bill McKibben (1999). He marshals the latest scientific evidence about the greenhouse effect, the depletion of the ozone layer and a harrowing array of other ecological ills, and unmistakably explains the frightening implications of the destruction cities have wrought on our planet. He questions ecological hysteria and reasonable scientific forecasts. Within either approach, *The End of Nature* has a philosophical position. McKibben declares confidently about the meaning of these changes, about the wretchedness of life where there is no escaping mankind. Although for centuries civilization has pillaged and polluted the earth, in the past those aggressions were relatively localized; now, with the globality shifts caused by greenhouse gases and ozone depletion, man and cities have altered the most elemental processes of life everywhere. Nature itself has been tainted, becoming the equivalent of a vast heated room. By turning nature into "an artifact" or by-product of economic development, society has lost something of profound importance: nature as a quasi-celestial source of ultimate meaning and value. It is this loss

that McKibben refers to as an apocalyptic calamity. The ending of nature is something independent of, larger than, and uncontrolled by man. In this nihilistic world every measurable space has been touched by human interference. Here, even the right of all life to breathe has been impacted.

Multiple designers and planners have become concerned in recent years with revealing "truth windows" into nature to avoid its end. They highlight ecological processes in their designs so that the users of the environment may experience, comprehend, and appreciate the scales of those processes aesthetically. In practice, revelation of ecological process has meant everything from capturing storm water on the surface of the land before it drains away into sewers, to planting a row of trees in an urban plaza where a creek once existed. In addition, the ecological processes that are revealed may themselves be truly natural, in the sense that they could continue to subsist without the management of society, or they may be deeply artificial, engineered systems that need relentless supervision if they are to persist in an urbanized context. Ultimately, the intention is make the scales of ecology visual and thereby expose an alleged spectacle of beauty otherwise unseen.

> **Our future in architecture recognizes that there is an immeasurable ecological quality that goes well beyond the borders of the building site. Architecture in the future or architecture even now must be understood without a solitary scale. It must be planetary, the extent of which contains the outer edges of the atmosphere all the way into the deep regions of inner space**

Our future in architecture recognizes that there is an immeasurable ecological quality that goes well beyond the borders of the building site. It is clear that ecological principles comprise a web of interconnected concepts, and a breathing, healthy metabolism has to fit inside. Thus, architecture in the future or architecture even now must be understood without a solitary scale. It must be planetary, the extent of which contains the outer edges of the atmosphere all the way into the deep regions of inner space.

The new sophisticated field of geoengineering, for instance, exemplifies the lack of scale comprehension. In geoengineering, exertion is made on the scope of an entire continent. Geoengineers produce efforts equivalent to the Panama Canal as everyday feats. When looking at consequences and devices that can cause change at the regional level, we must look not at the region itself but the entire hemisphere, various megalopolises, as well as the smallest biological system. We must realize there is a kind of hubris, an unlimited bravery and power in conquering nature. Designing modifications at continental scale does infer accidents will be unmatchable.

The issue of scale seems rampant in the discussion and polemics of ecological cities. Scale is a pervasive term in engineering, architecture, urban studies, and design. It serves as a constant and definitive point of reference to help elucidate a given project although not without fault. We have separated our professional disciplines, project scopes, and programmatic language in terms of size, a redundant supposition in the age of globality. How designers can play a significant role in this expansive territory and live up to our proleptic merit is worthy of understanding further. Designers' responsibility is to re-tool the middle ground, the in-between, and the nexus points. In this case, infrastructure with applied innovative ecological directives becomes the penultimate goal, before completely reforming the world. Operations of infrastructure shape a broad range of circumstances. Infrastructure in all dimensions and extents is the actual frontier. Next to implemented technological, social, and ecological solutions from other disciplines, design innovations are rapidly being diminished if not surpassed by other competitive fields. We designers must take action and modify our stance on all scales and morphologies in order to have a positive effect on the global community. Our hypothesis is first and foremost based on one succinct predicate, the end of scale.

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THROUGHOUT THE DEVELOPED WORLD, URBAN DESIGN IS AT AN IMPASSE, UNABLE TO MEND THE RIFT BETWEEN THEORY AND PRACTICE. THIS ESSAY EXPLORES URBANEERING, A NEW PROFESSION THAT CAN RE-INVENT AND NEGOTIATE THE COMPLEX MIX THAT ENCOMPASSES THE NEXT CITY. IT PRACTICES TOTALIZED SCHEMES THAT RETHINK ALL SCALES OF INVOLVEMENT FROM THE DOORKNOB TO DEMOCRACY. TO INSPIRE INTERDISCIPLINARY INNOVATION, URBANEERS ENCOURAGE PEOPLE TO SWITCH ROLES; ARCHITECTS MUST DESIGN CARS, AUTOMOTIVE ENGINEERS MUST DEVISE ECO-SYSTEMS, AND ECOLOGISTS MUST DRAW UP BUILDINGS. THE NEXT CITY NEEDS A NEW BREED OF COMMUNICATOR: A PERSON SKILLED IN THE ART OF CITIES BEYOND THE TYPICAL UTOPISTS, PLANNERS, CIVIL ENGINEERS, AND ARCHITECTS IN THE PRESENT DAY. IT IS THROUGH THIS APPROACH THAT URBANEERS SEEK TO REFORM THE CITY OF TODAY FOR THE UTOPIA OF TOMORROW.

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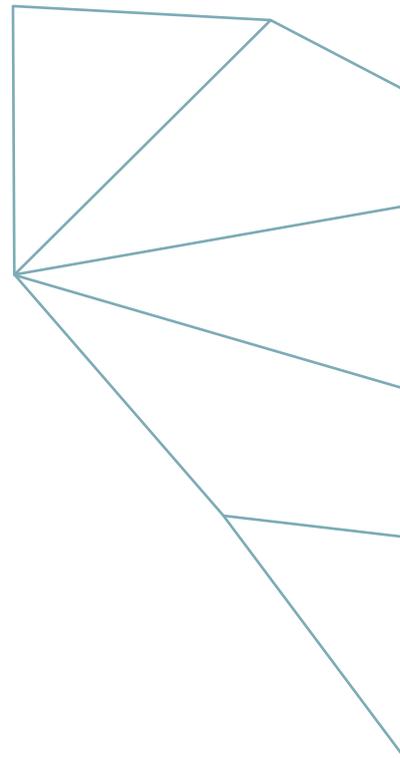
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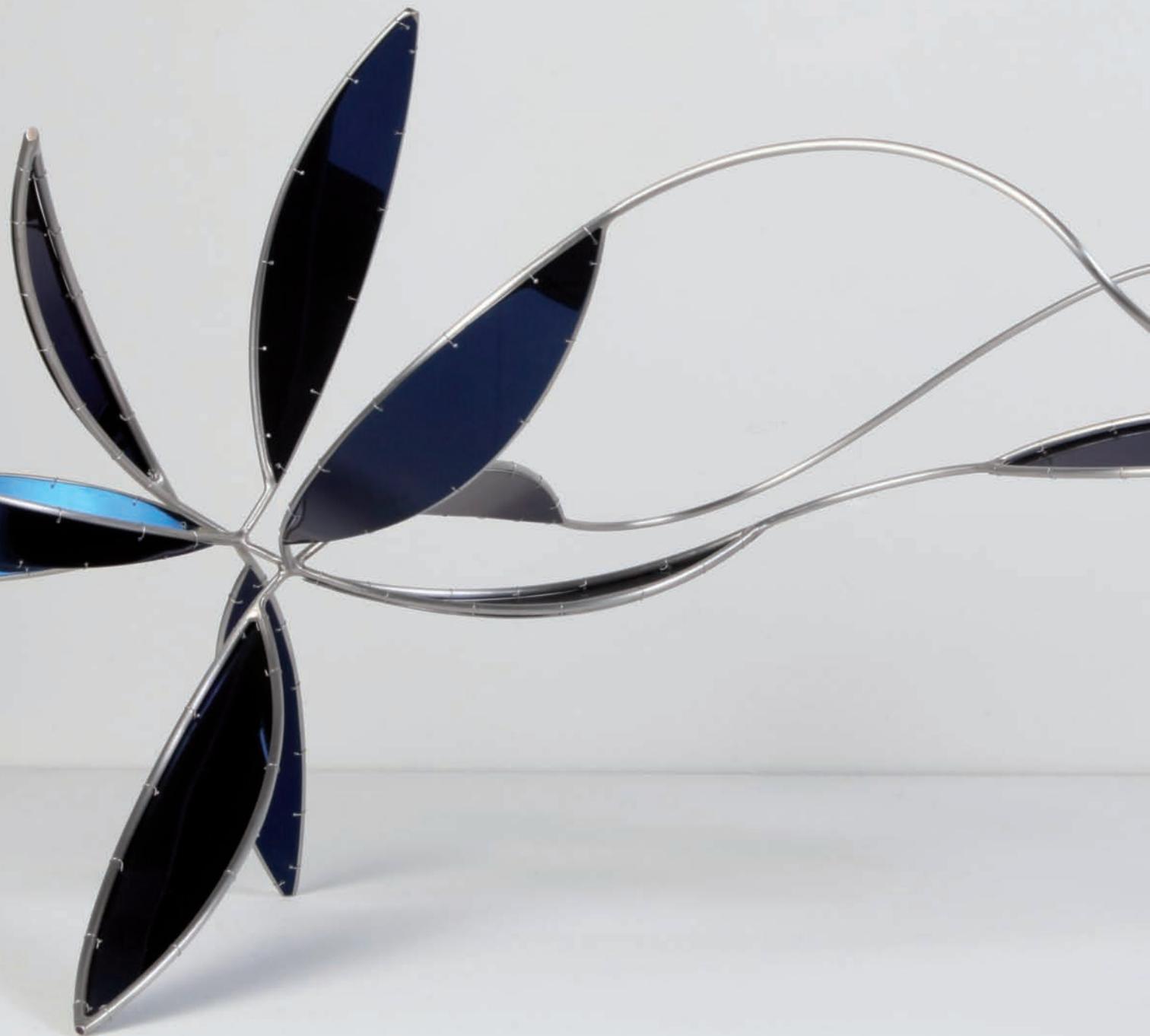
The Challenges of the End of the Demographic Transition

Joaquín Vial, Clara Barrabés, Carola Moreno[1]

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INTRODUCTION

The twentieth century was a decisive one in the history of humanity, marked by a demographic explosion and an unprecedented improvement in living standards of most of the world's population. It was also the century in which we realised that we inhabit a closed ecosystem; therefore, environmental limitations were no longer local problems but global ones. The last century was also noted for the culmination of the so-called "Great Divergence" (Pomeranz 2000), where the bulk of material economic progress was concentrated in a small group of countries now considered developed; meanwhile, the rest of the world grew, but much more slowly. A gradual convergence process only began to take root in the final decades of the century, led by China and other Asian countries.

The twenty-first century is the period in which we will have to struggle with the consequences of these phenomena. First and foremost, world population will continue to grow significantly, even though growth will be concentrated in the countries and groups that currently have lower levels of income. The income convergence process is consolidating, and it now impacts several billion inhabitants in

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Blanca Muñoz, *Géminis II* (detail), 2006

developing countries, rather than the hundreds of millions in developed countries as was the case in the twentieth century. However, there is a very real risk that Malthusian restrictions will reappear, especially in the fields of fossil fuels and possibly in food, and the impact of human activity on the climate could thwart the material progress of humanity, possibly even endangering its very survival (Livi-Bacci 2012).

A second consequence is that the proportion of old people in the global population is set to increase dramatically, first in the most economically advanced countries, but followed closely by the rest of the developing world.

Another significant change is that the globalisation so widespread in the goods and financial services market may well impact the job markets with greater force. Currently, most skilled workers face a global market in some professions (e.g. health services and mining) and migration restrictions have been relaxed for these sectors. But we will also see migration driven by demographic imbalances: the richest countries will see their working-age populations diminish and their proportion of elderly people increase dramatically, so they are going to require immigrants. Traditionally, these people have come from nearby poor countries (from Latin America to the US, from the countries adjoining the Mediterranean to the north of Europe) or from countries with colonial links. But future migrations will not be limited in the same way because lower transport costs allow them to come from very distant regions, from very poor countries that still have high rates of population growth and a multitude of young people looking for opportunities.

In short, the world in the coming thirty or forty years will be very different from the present one, or the one that our parents and grandparents knew. The abovementioned changes will require very dramatic adjustments affecting not just the quality of life of future generations, but also their very existence. Over these decades, humanity will face challenges without precedent, except perhaps those faced at the start of the "Atomic Age." We will explore some of these challenges later.

COMPLETING THE DEMOGRAPHIC TRANSITION

One of the most dramatic changes of the twentieth century was the increase in the population. The century began with a little more than 1.5 billion inhabitants, of which just over one third lived in what we now consider to be developed countries. At the close of the century, world population had exceeded 6.1 billion and fewer than 20 percent lived in that same group of developed countries.

The latest United Nations demographic forecasts point to a world population that is continuing to grow; it is set to reach over 9.3 billion by the middle of the twenty-first century and

exceed 10 billion at the end of it. Whilst these forecasts appear fairly certain for the next twenty or thirty years (due to the inertia of demographic phenomena) the reliability of the figures drops when we look beyond this period. What is clear is that this growth will be concentrated in developing countries, and that the present group of developed countries will represent a smaller proportion of the world's population.

The Industrial Revolution set humanity on a path of progress towards better living conditions, bringing about a demographic revolution. This phenomenon is the result of the so-called *Demographic Transition* (DT) that began with the economic and social advances brought with the extension and consolidation of the Industrial Revolution and its processes of urbanisation (Livi-Bacci 2012). Previously, the global population had grown at an almost imperceptible rate (an average of 0.6 percent since the start of the Christian Age), with cycles marked by famines, wars and plagues, and slow technological advances. It was a "Malthusian" world with limited progress, frequently marked by catastrophes that meant following generations had to cope with severely limited resources (Clark 2007).

The pre-DT period was characterised by very high birth rates as well as high rates of infant mortality because of food shortfalls, and generally poor hygiene and sanitary conditions. The start of the DT was marked by a drop in infant mortality rates thanks to small improvements in hygiene and food for mothers and newborn babies. The current DT process[2] started at the end of the eighteenth century in the most advanced European countries, gradually spreading towards the periphery of the continent at the turn of the nineteenth century. It reached the rest of the world at the beginning of the twentieth century, although in regions with the most underdeveloped economies in Africa and central Asia, the transition began in the middle of the last century. This first stage was characterised by a sharp increase in the growth rate of the population.

A second stage then began, usually taking a more gradual form marked by a drop in birth rates: for countries that were the pioneers in this process, these lower birth rates are largely explained by the fact that more children survived per family. Other increasingly relevant factors were the urbanisation process and the growing numbers of women joining the job market, which along with newly available contraceptive methods and cultural changes that made maternity an option rather than a destiny. Population growth was highest at the start of this second stage.

The DT ended when the population stabilised thanks to lower birth rates prevailing over lower death rates. This occurred with significant overlap because there was a long period in which the total number of reproductive-age women kept increasing, even after fertility rates (the

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2. Livi Bacci (2012) distinguishes at least the two previous transitions: when organized hunter-gatherer clans formed, and when sedentary populations settled and developed around agriculture.

average number of children per woman, over the course of their lives) fell below the levels needed to keep the population constant. One characteristic of this transition is that towards the end of the second stage when the population had stabilised, the proportion of the elderly among the total population increased rapidly, while the number of children fell. As the most numerous generations reached advanced ages, there were fewer children: this is population ageing. The situation is exacerbated by increased longevity thanks to better health care and food, especially in the early stages of life, as well as advances in medicine (Fogel 2004).

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Graph 1. Determining factors of the Demographic Transition

Source: Livi-Bacci (2012)

At the start of the twenty-first century, we see that most developed countries (DCs) have already ended their DT, and most middle or low-middle income countries (MIDCs) have already seen their fertility rates fall below replacement levels (which is around 2.1 children per woman). This means these countries are a few decades away from completing the process. By contrast, a group of very poor countries (VPCs), currently with more than 600 million inhabitants, are still in the first stage of the transition or barely at the start of the second one. This means that over half the total global population growth of this century will be concentrated in VPCs.

The initial stages of the DT produced the "demographic explosion" of the twentieth century. The twenty-first century will mark the end of that transition, seeing the population stabilise and then age. This trend will first hit the most developed countries; countries that

are economically further behind may reach the end of their DT towards the close of this century.

The graphs below demonstrate the difference between birth and death rates for the three groups of countries according to their level of development. We have chosen four countries that represent these three groups in some way, plus China, which as we will see, is having a very unusual DT.

The most advanced DCs in terms of DT are Japan and the southern European countries. We will elucidate many of the changes and challenges this group of countries is facing, taking the examples of Japan and Spain. One notable difference between both these countries is their very different immigration patterns, which have allowed them to defer the impact of this process. The MIDCs that are at a very advanced stage in their DT will be represented by Mexico, while Ethiopia is our example of a country still in the initial stages of DT.

The graph on the left shows that DCs are reaching a stage at which the population stops growing.[3] The MIDCs reached the point of maximum difference in the second half of the sixties, and they should finish their DTs in the middle of this century. By contrast, VPCs have spent less time at the point of maximum difference and their DTs are slower. This is why, according to the UN central forecast, they will not complete their DTs this century.

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Graph 2.1. Global panorama, by group of countries

Graph 2.2. Selected countries

Source: United Nations 2011

Source: United Nations 2011

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3. The United States is the main exception to this rule, partly thanks to immigration and the fact that the first generation of immigrants have higher birth rates.

One case that merits a separate mention is that of China. With its almost 1.3 billion inhabitants, it represented over 20 percent of world population at the start of this century yet at the same time it is undergoing the most accelerated DT process on record. The explanation lies in the introduction of quotas of children per family at the beginning of the 70s, which

The twenty-first century is the period in which we will have to struggle with the consequences of these phenomena: world population will continue to grow significantly, and there is a very real risk that the impact of human activity on the climate could thwart the material progress of humanity, possibly even endangering its very survival

culminated in the official one-child policy. This means the population will reach its absolute maximum in just under 15 years' time. The population will then fall and the proportion of the elderly in the total population will soar. Levels of income in China are still relatively low, despite the spectacular growth rates of recent decades, but its "demographic window" is closing rapidly, without there yet being an inclusive and solvent social security system. Because of its size, China's overall political and economic development will depend on how the country tackles these challenges and on its success or failure.

Graph 3.1. Population growth by group of countries, according to development (thousands of people)

The poorest countries
Developing countries, excluding the poorest
Developed countries

Source: United Nations 2011

Graph 3.2. The population growth of China by age group (thousands of people)

65 or +
15-64
0-14

Source: United Nations 2011

The graphs below offer a clearer picture of the challenges that the different groups of countries are facing because of changes in the age composition of their respective populations, which in turn are a consequence of the different stages that they are at in their DTs.

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Graphs 4. Dependency rates and their composition, by group of countries according to development

Graph 4.1. Developed countries	Graph 4.2. Non-poor developing countries	Graph 4.3. Poorest countries

Source: United Nations 2011   Source: United Nations 2011   Source: United Nations 2011

These contain the dependency rate (the number of young and old people as a proportion of the working-age population) broken down into children and old people, together with their expected evolution over time, according to UN forecasts. Workers in DCs, unlike those in other countries, are facing an increased burden, chiefly because of the greater proportion of elderly people.[4]

Dependency rates are alleviated in VPCs fundamentally because of falling birth rates. However, their proportion of elderly people will start to increase in the second half of this century. In the other developing countries, home to most of the global population and with a growing proportion of income, we see that the relief deriving from the reduction in young people is rapidly offset by the increase in the number of elderly people. These figures are very much

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4. Note that the UN forecasts represent a recovery of the birth rates in those countries, which keeps the child dependency rate stable. However, if these rates do not rise, child dependency will fall somewhat, but at the expense of a subsequent increase in old-age dependency rates.

slanted by the accelerated ageing of China, but the situation is common to this group, with a gap of one or two decades.

Clearly, the DT challenges are different for each group of countries. VPCs lack infrastructure; basic services such as health and education are precarious and coverage is deficient. Social security is a privilege, so the central concern is to cope with the large number of children and young people who require health and primary education, and then grant them access to jobs. However, these countries also need to lay the foundations for social security institutions. Policies on birth control and childcare will be key to achieving individual economic development as well as avoiding global social and environmental disasters.

At the other end of the spectrum, DCs must confront the changes arising from population ageing, with its consequent impact on job markets and the demand for services, especially in health and extended care. These countries may have the institutional capacities to move forward, but most of them need to make significant adjustments to ensure the solvency of their social security systems. Moreover, the growing political weight of the largest age groups could complicate these changes. These countries will require migrant workers, although they will definitely maintain or even restrict their selection criteria.
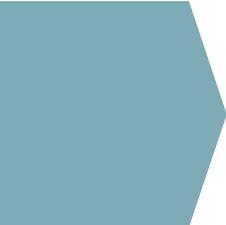
The twenty-first century will mark the end of the demographic transition, seeing the population stabilise and then age. This trend will hit the most developed countries first; those that are economically further behind may reach the end of their transition towards the close of this century

MIDCs still have a window of opportunity of a few decades in which they must try their hardest to make the most of the growth stimulated by their increasing working-age population — who will be at their peak in terms of saving capacity — in order to build inclusive and solvent social security systems. At the same time, they need to invest in educating large groups of young people to help them navigate the increasingly demanding job markets they will face. Meeting these complex and very diverse demands will create a great deal of tension in countries that are not yet rich and with institutions that are often precarious. Those who make progress on these fronts can aspire to join the DCs this century. Those who fail could fall into zero-sum equilibrium, with average income levels, and many social and political tensions.

In essence, there are four aspects to the demographic evolution, both in terms of its timing and its geography, that are set to transform the world as we now know it. In "The shift in the global economic map," we analyse the changes in the economic power map and growth hotspots. Right now, over 80 percent of the global population and practically 100 percent of the

population increase forecast for the twenty-first century are concentrated in developing countries. These countries are closing the gap in terms of living standards, measured by income per capita. This process is in its early stages and there is a long way still to go, but the global economic weight of these countries is already changing radically, displacing the focal points of demand that promote economic growth. Meanwhile, this is putting unheard-of pressure on resources and on the planet's capacity to absorb waste. At the same time, the increase in the proportion of the elderly, a phenomenon that is more accentuated in developed countries, will also affect global consumption patterns for goods and, above all, for services.

In "Impact on job markets" we will review the impact on the job markets. Countries in the advanced stages of DT will have to tackle challenges springing from the growing scarcity of manpower, especially of young people; they will also have to meet the needs of an older population who will need to stay in active employment for longer. By contrast, VPCs — which are still facing a significant increase in their working age populations — will have to educate their young people and then create jobs that facilitate economic development. MIDCs will face the unprecedented challenge of a scarcity of manpower in the coming decades, which could hit the two extremes of the job market: the most skilled workers and workers with fewer options who are willing to take any job just to contribute to the family income. These differences in the evolution of local job markets will promote a greater globalisation of employment opportunities.

In "Ageing and the risks for the social security system" we analyse the challenge of adapting social security systems to the massive increase in the proportion of retired people as compared to assets. The richest countries that adopted their distribution systems at the beginning of the twentieth century now find their solvency under threat; developing countries have to build social protection systems that are sufficiently broad and solvent so as to meet the needs of an elderly population that will increase dramatically in the coming decades.

These changes will have profound consequences on the distribution of power and the possibilities for conflict, a topic we explore in "Some political consequences of global ageing."

THE SHIFT IN THE GLOBAL ECONOMIC MAP

All medium and long-term predictions highlight the important role emerging economies are going to play in promoting global economic growth over the coming decades. Over the next fifteen to thirty years, many of these countries will bridge the economic gap — measured by average income per inhabitant — between them and current developed economies. The 2008 economic crisis not only revealed this phenomenon; it has also magnified it.

To quantify these effects, we projected income evolution by country and country distribution across different income bands, measuring the mass of consumers resulting from the process of

economic and demographic change. We combined this with United Nations' demographic projections, enabling us to estimate the number of inhabitants per country who exceeded a gross annual income of USD 10 000 (in 2012 currency) by country and by groups of countries.[5]

More DCs in the final stage of their DTs, such as Japan, will see their relative weight in the global economy decline.[6] Living standards in these countries will remain high, but their contributions to the increase in global demand will be marginal. Consumers will increasingly concentrate their spending on services such as health and entertainment, and they will spend less on others such as formal school education and transport. A higher proportion of older people also means that more people will stop saving for their retirement and will start to withdraw their savings to finance their consumption. This will have a considerable impact on the distribution of savings in the world and therefore of current account deficits and surpluses. Globally, the biggest net savers today are China, Japan and several emerging countries from Asia, along with oil-exporting countries, Germany and the Nordic countries. By contrast, the US, southern Europe and many emerging countries receive savings from overseas, which they use to finance their current account deficits. This map is almost certainly going to change, partly because Japan, Germany, China and other surplus countries are more advanced in their DTs.

Then we have the MIDCs,[7] which are fairly advanced in their DTs but still have between twenty and thirty years of positive growth of the working-age population ahead of them. Income distribution in these countries is usually quite unbalanced, and most of their people are in the low and middle-income categories. However, a combination of economic and demographic growth will probably spark a large increase in the mass of consumers, as economic growth translates into better job opportunities and higher real salaries. The protagonists of this change will be urban middle-aged families, with few children possibly of school or university age. Therefore, their consumption patterns will be even more focused on clothing, transport, education and eating, both outside the home and in. Over the projection period, the relative demand for services will increase, approaching the consumer patterns of developed countries such as Spain.

As we mentioned in the previous section, China, an MIDC, is taking its own path due its great size, fast economic growth and very unusual demography. This means it is now entering the final stage of its DT: its working-age population will soon start to dwindle, and the number of people aged 60–65 years old will increase dramatically. At the same time, nearly half a billion consumers with middle- and high-level incomes will emerge in China over the next twenty years. This phenomenon is extraordinary because of its scale and the

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5. For further details see Moreno and Vial (2010).
6. This group contains most of Europe, Canada and certain Asian countries such as Japan and Singapore.
7. This group contains most of Latin America and emerging Europe, as well as China and others in emerging Asia.

characteristics of these consumers, most of whom will be people who have recently crossed the poverty threshold. Therefore, demand will be focused on basic consumable goods and durables, rather than on the services and expensive, sophisticated durables popular in better-off countries.

Right now, over 80 percent of the global population and practically 100 percent of the population increase forecast for the twenty-first century are concentrated in developing countries. These countries are closing the gap in terms of living standards, measured by income per capita. This process is in its early stages and there is a long way still to go, but the global economic weight of these countries is already changing radically

The MIDCs will take on a bigger role in the coming decades, thanks to their unique combination of large population, highly dynamic economies and population growth. Our estimates indicate that in the next twenty years, over 60 percent of the growth in global GDP will come from this part of the world. This is a reversal of the situation seen in the second half of the twentieth century, when three quarters of the world's economic growth came from developed countries.

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Graph 5. Contribution to global economic growth by group of countries, according to development
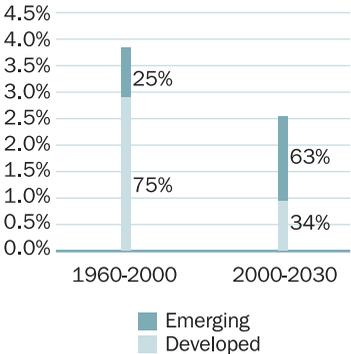
Source: Moreno and Vial 2010

This shift in the gravitational centre of the global economy will also place a lot more pressure on the planet's resources, as well as on its capacity to absorb the waste

generated by increased human activity. Technical progress managed to ease this tension for much of the twentieth century, but this was only possible because economic progress was highly concentrated in a group of countries that represented less than 20 percent of the global population. As progress spreads and grows, extending to over 70 percent of the global population, the tension between economic progress, population increase and the planet's capacity to cope will be very great. Although this is a global phenomenon that will affect all of humanity — so all countries will have to contribute towards achieving a sustainable balance over time — our chances of success will hinge on what happens in the emerging countries.

Lastly, we have the VPCs, which are at an early stage of their DTs, and which will see almost half the world's population growth this century. A large majority of the population in countries such as Ethiopia are too poor for the country to have a critical mass of consumers with acquisitive power from the middle or upper classes. Their consumption will revolve around food and some basic services; any increases in income will mainly be used for these purposes, whether improving their diet, buying more clothing, or accessing basic services such as education, drinking water and sanitation. Their chances of development will depend on finding productive niches geared towards exports that are competitive enough to attract foreign investment. At global level, their economic burden will reduce and they are candidates for providing cheap manpower to more advanced countries through migration.

Another factor influencing the evolution of the global demand for goods and services is linked to ageing populations, something that we have already touched upon. There is evidence that the changes in consumer patterns over the course of a person's life, in particular during old age, are a universal phenomenon. Practically all of the surveys on family budgets in Europe (developed and emerging, see Eurostat), the US, the UK, Japan and Latin America, bear witness to this. However, there are variations because of other factors involved such as income, cultural differences, tastes and preferences (which change over the course of an individual's life), the relative availability of goods and services and the institutionality of each country (European Commission 2005). Harris and Blisard (2002) estimate that income-food elasticity increases significantly with age, especially for those aged over 65: using surveys on family budges in the US they found that elasticity was 0.12 for people aged 65–74 and 0.21 for those over 75. The evidence for Germany (Deutsche Bank Research 2003) points towards significant expenditure in housing and health, and also in transport and entertainment items. The latter are more sensitive to income levels, and therefore possibly the impact on middle-income countries such as Mexico or those with lower levels, is more limited.

However, of all the changes observed in the spending patterns of those aged 60 and above, healthcare is the single most important item.

Graphs 6. Impact of ageing on spending patterns in selected European countries

Graph 6.1. Health
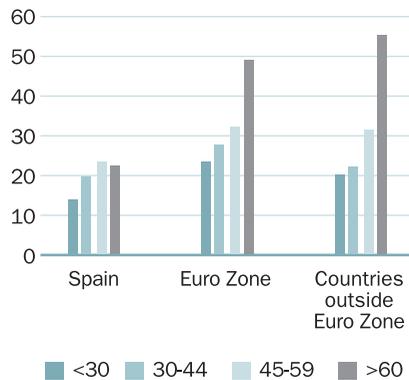
Graph 6.2. Transport
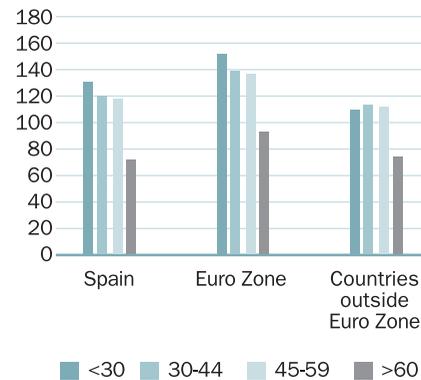
Source: EUROSTAT

Source: EUROSTAT

The lighter burden of children, young people and young adults reduces the relative importance of spending on formal school education, transport, restaurants and hotels, as well as on clothing and footwear.

IMPACT ON JOB MARKETS

Another area that will be affected by these demographic changes is the functioning of the job markets. The challenges facing developing countries will be very different from those of developed countries, precisely because of their different DT phases.

The DCs at an advanced stage of their DTs are going to face shortages in their young work forces, along with an increase in the number of old people, many of whom will have to extend their working lives. The MIDCs will still need to improve the coverage and quality of their education systems, and strengthen the qualifications and specialisation of their plentiful and still growing manpower.

In addition — as we shall see later on — developed countries are starting to face serious problems regarding the sustainability of their pension systems as a consequence of their ageing populations. There is also a delay in people entering the job market because of the increase in the average number of years people spend studying: this makes the prolongation of working life in countries with ageing populations practically inevitable.

Graph 7. Total Population 15-64 years of age
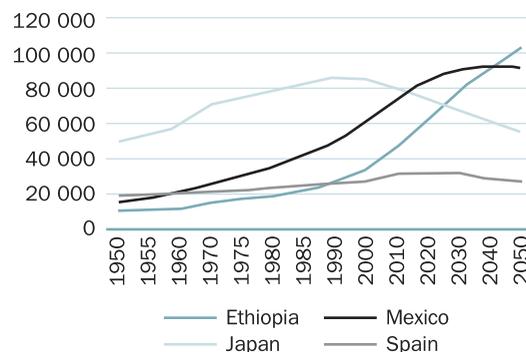
Source: United Nations 2011

As shown in graph 7, Japan has seen a fall in its working-age population since the beginning of the century; Spain is now witnessing the same trend. By contrast, developing countries that are further behind in their DTs will start to suffer from this phenomenon in twenty or thirty years' time, while the poorest countries such as Ethiopia are around fifty years away.

In DCs, key factors will be the absolute reduction in the working-age population and the delay in entering the world of work. These countries will suffer a shortage of manpower and they will receive immigrants — as has occurred in recent decades — but with some differences compared to the current situation. This is because they will not only require low-skilled manual workers to take on the tasks that are unattractive for local workers; they will also require more skilled professionals and technical workers. Right now, we are seeing a rise in engineers, computer specialists, and health and sales professionals (Manpower Group 2011). This phenomenon will be accentuated by increased demand for extended care services and, in general, for all services demanded by the elderly.[8]

All developed countries will have to implement the right mechanisms to extend the working life of their citizens. Employability in old age is not homogeneous. Data from the OECD and the European Commission demonstrate that employability is much higher for workers with more qualifications because this type of "human capital" does not deteriorate as much as physical capability does, for example. In the OECD average, 86 percent of companies are in favour of extending the working lives of their employees, but only the most highly skilled ones, which could lead to problems of inequality.

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8. As Fishman (2010) describes, the solvency of the systems that provide fundamental services for old people may well rest on attracting low-cost migrant workers to carry out most of the tasks.

For countries in the intermediate stage of their DTs, the challenge is to help their young people integrate into more demanding job markets, while at the same time reducing the obstacles and disincentives to the formalisation of their job markets. The latter factor is key to successfully building systems to protect income in old age. These countries will be the focal point of the increase in global economic activity, generating job opportunities for the most highly skilled. That is why these countries will play a vital role in globalising job markets, as they will experience increasingly higher migratory flows in both directions (incoming and outgoing). On the one hand, their most highly skilled workers will have opportunities in DC job markets, but they in turn will also require highly skilled workers wherever there are shortfalls in local markets. One current example of this is the extraction industries such as mining and oil, where global markets of workers are already functioning, something that has been facilitated by the traditional presence of multinational companies in these activities. Mexico is an interesting case: while poor peasants migrate to the US, very often temporarily, the country also exports and imports highly skilled professionals and executives who work in commercial and services companies. These countries will probably start to feel immigration pressures from lesser-skilled workers from poorer countries or regions that have been devastated by natural disasters or armed conflicts.
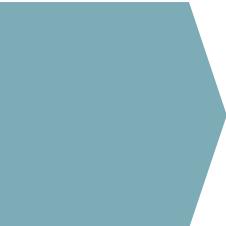
> **All medium and long-term predictions highlight the important role emerging economies are going to play in promoting global economic growth over the coming decades. Over the next fifteen to thirty years, many of these countries will bridge the economic gap — measured by average income per inhabitant — between them and current developed economies**

In VPCs, the situation will be different: the great challenge will be to provide health and education to young people and to create attractive conditions to entice investments that offer reliable and well-paid work to the new generations. There is no doubt that these countries will be the main source of emigrant workers in other parts of the world and their transfers of earnings, via remittances to their families, will continue to play a significant role in helping to alleviate extreme poverty amongst their relatives.

Time will tell, but it is very likely that we are at a turning point in the evolution of job markets, and that we are indeed heading towards a much more globalised job market. The world as a whole — particularly DCs — is facing a profound paradox: while almost 40 million workers are out of work according to data from the ILO (2012), it is very difficult to find workers with specific qualifications and skills to fill existing vacancies. This imbalance in the job market seems set to continue over the coming decades. Part of it will be covered by migration, but it is

also very likely that temporary or distance work systems will be implemented, thanks to greater connectivity. Meanwhile, large companies are already getting ready to transform their general processes, business and organisational models as well as their policies for training and re-skilling workers towards the most sought-after specialisations.

In geographical terms, the demand for workers is even more noticeable in emerging countries thanks to their higher growth rates. Perhaps the most spectacular change is occurring in Asia: over the next decade, demand for new workers in Asia is expected to increase by 22 percent, followed by Latin America (13 percent), the Middle East (13 percent) and Eastern Europe (10 percent) (Oxford Economics 2012).

Furthermore — as we have already remarked — the next decade will see emerging countries improving access to quality education. The highest annual growth in the talent pool, measured as the fraction of the population holding higher education qualifications, occurs in India (7.3 percent) followed by Brazil (5.6 percent), Indonesia (4.9 percent), Turkey (4.7 percent) and China (4.6 percent). The US and Canada, with rates of 1.4 and 1.3 percent respectively, lead the annual growth rate among professionals of the G7 economies.
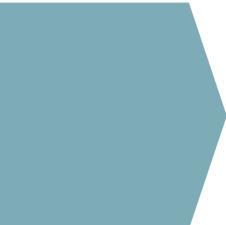
> **The level of public spending on protecting the elderly will increase by around 4 percentage points of the EU GDP over the next fifty years. Traditional distribution systems will have to undergo at least two changes: new parametric adjustments to reduce the value of pensions under the defined benefit modality; and a more significant role for individual defined contributions**

Therefore, the impact on the global distribution of technical and professional capabilities will be dramatic. At present, 54 percent of university graduates come from the most buoyant emerging economies (E7: Brazil, China, India, Indonesia, Mexico, Russia and Turkey) compared to 46 percent in the industrialised world (G7: Canada, France, Germany, Italy, Japan, the UK and the US). In the coming decade, this percentage will probably reach 60 percent for MIDCs.

AGEING AND THE RISKS FOR THE SOCIAL SECURITY SYSTEM

The social security system as we know it today is a quite recent invention. It dates from the end of the nineteenth century, when Germany introduced its workers to a mandatory system of contributions in order for them to receive pensions once they reached the age of 70. At that time, life expectancy at birth in DCs was around 50 years of age, a figure very much influenced by high rates of infant mortality. The idea of levying a charge on workers in return for providing a

secure source of income in old age once they stopped working seemed both revolutionary and very reasonable. Moreover, it was not too onerous at a time when the work force and salaries were growing rapidly and the over-65 population was just a small fraction of the total population. At the beginning of the twentieth century, the life expectancy of a 65-year-old worker in the US was 72, and the over 65s represented less than 10 percent of the working-age population, as shown in graph 8.1. and 8.2.

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Graph 8.1. Life Expectancy in the US in the 20th century
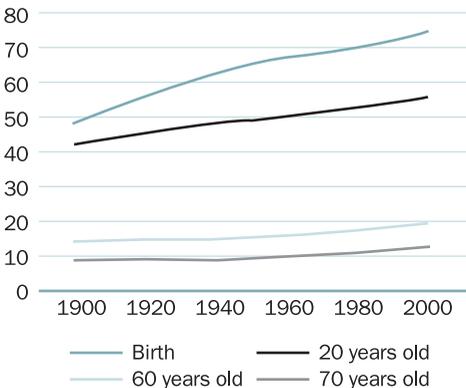
Graph 8.2. Dependency rates of the elderly in the US (population over 65 years old/ population between 14 and 64 years old)

Source: US Bureau of Census. Historical Statistics
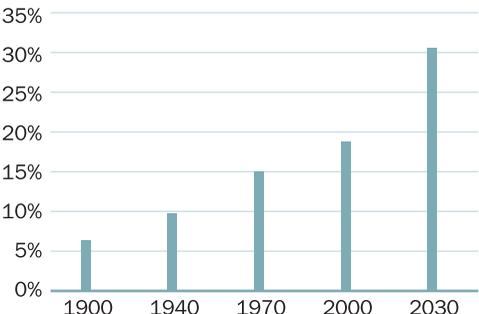
Source: US Bureau of Census. Historical Statistics

This changed radically during the course of the twentieth century. By the end of the century, life expectancy at 65 had risen by around 50 percent, while the proportion of the elderly as compared to those of working age had almost doubled. Yet fundamental parameters such as retirement age, contribution rates or the replacement values of pensions had not changed significantly. During the twentieth century, these systems offered income security and a standard of living in old age that were unprecedented in the history of humanity. It is true that this mechanism was limited to the developed countries and to certain privileged minorities in developing countries, but it was clearly the paradigm to imitate. The nightmare of an old age where people had to work until they died — or live dependent on the support of their closest family members — was replaced by the dream of a "golden old age" that had previously been the reserve of the very rich. The coverage of the pensions system, measured by the percentage of the work force that regularly contributes to them, exceeds 80 percent in most DCs, reaching

95 percent in Japan. Spain is at the lower end, with 69 percent (Pallares-Millares et al. 2012). However, the basic arithmetic of this income security does not add up: the other factor supporting this coverage is a high level of commitment of financial resources, as high as 8.8 percent of GDP in Japan and 8.0 percent in Spain in 2007 (Ibid.).

In VPCs such as Ethiopia, social security is a privilege enjoyed only by groups of public employees, and payment is so unreliable that it is very difficult to collect taxes and social security contributions. While we do not have the figures for coverage in Ethiopia, most countries in sub-Saharan Africa have pension coverage rates of between 1 and 12 percent of the workforce, with the exception of Mauritius (53 percent) and Zimbabwe (20 percent) (Ibid.).

Amongst the MIDCs, China is a special case. Coverage there is similar to that of other countries with an equal or lesser level of development, reaching almost 30 percent of the workforce. It covers public employees, the armed forces, the employees of large corporations and almost no one else; even so, public expenditure on pensions is 2.5 percent of GDP. The coverage problem is especially serious due to the speed of the DT, which means that China has to deal with an increase in retirement-age people from 2 million a year 12 years ago, to around 7 million a year at the end of this decade. The situation will stabilise at this level until the middle of this century. In other MIDCs, such as in a large part of Latin America, coverage rates are low because job markets are precarious. This means that only a small proportion of the population contributes to financing social security. In Mexico, for example, coverage barely reaches 27 percent of the workforce — one of the lowest levels of the region — whereas just in Uruguay, Colombia and Chile does it exceed 55 percent (Ibid.).

DT has generated significant increases in the old-age dependency rate, which has made social security an increasingly suffocating burden for governments. For countries in the European Union, the European Commission's *Ageing Report 2012* estimates that the public expenditure associated with care for the elderly amounted to 25 percent of GDP in 2010, with the biggest spending on pension payments (11.3 percent), followed by health (7.1 percent) and then extended care (3.8 percent). The OECD, using different methodology (OECD 2012), estimates that EU expenditure on pensions for that year amounted to 9.1 percent of GDP, while in the US it was just 4.6 percent — one of the lowest of the OECD.

The highest health costs derive from the fact that costs per capita increase significantly with age. In the US, it is estimated that the annual cost per capita of someone aged 65 is more than four times the annual mean cost from birth to 40 years of age (Alemayahu and Warner 2004). If this average figure is extrapolated for the whole population of the most developed countries, the health costs of the over 65s would go from representing just under 50 percent of healthcare spending to just over 60 percent, assuming prices stay the same.

The picture is much more diverse in developing countries. This reflects the fact that most are at an earlier stage of DT, they have varying degrees of certainty in their job market

(coverage) and also their social security systems are based on alternative models — something we will come back to shortly.

Three types of answers have emerged to these problems, which are setting the foundations of the social security system of the future:

- Parametric changes in distribution systems: This is the most common approach. It usually consists of a combination of increases in the statutory retirement age, tougher requirements for early retirement, and formulas for calculating less "generous" benefits, including rules about index-linking pensions. Most European countries are taking this route.

- Incorporating defined contributions into parts of the system: The traditional systems described above (of distribution, defined benefit or pay-as-you-go) all stipulate that those who have a right to a pension thanks to their contributions receive an amount defined by a formula usually set by law. However, in recent years we have seen the introduction of defined contribution mechanisms. These are essentially voluntary individual savings accounts in which workers accumulate funds that can only be withdrawn at retirement. Employers may also contribute to these funds, especially in the case of complementary defined pension plans offered by companies. These funds are invested in the financial markets and the interest is accumulated in the fund, which is why they are also known as individual capitalisation systems.

- Finally, some countries have opted to replace the distribution system with another one in which obligatory saving is managed under the modality of defined contributions in individual capitalisation accounts. This change was first introduced in Chile in 1981; since then, various Latin American and Eastern European countries have adopted it. In this system, private companies are in charge of account and fund management. The retired people of the twenty-first century will face greater financial risks in old age because of the financial crisis in the traditional social security system and the need to resort to savings mechanisms that do not guarantee a predefined pension. The security of interest in old age that we saw in developed countries in the second half of the twentieth century is not viable in the twenty-first century, with its much less favourable demography and where an increase in contributions would entail a loss of unsustainable competitiveness in the face of emerging countries with younger populations.

A great source of uncertainty facing traditional distribution systems is the difficult surrounding financial environment. In spite of the parametric reforms implemented in recent years, circumstances will not improve in the future. Moreover, the economic downturn of recent years has undermined the solvency of many developed countries, forcing harsh fiscal

adjustments, so the outlook for traditional social security systems' "defined" benefits appears less than rosy. Calculations published in the *Ageing Report 2012* (European Commission 2012) show that the level of public spending on protecting the elderly will increase by around 4 percentage points of the EU GDP over the next fifty years, in spite of the adjustments that have already been made. This seems difficult to resolve in current conditions and, almost certainly, the traditional systems will have to undergo at least two changes: new parametric adjustments to reduce the value of the pensions under the defined benefit modality; and a more significant role for individual defined contributions, which may become obligatory and be subject to tax relief. The end result of this will be that middle and high-income workers will face old age with more volatile levels of income that are less secure than those of the current generation of retired people, at least for sums above the minimum that can be guaranteed by the defined benefit system each government can sustain.

The elderly are facing several risks in terms of individual capitalisation: one is the scarcity of contributions, caused by employment instability, unemployment or voluntary redundancy — something more common in women with young children. A second risk is a financial one, associated with the changes in the value of the accumulated funds due to fluctuations in profitability. These two factors are very important while people are accumulating funds. Then once a person reaches retirement age, he or she can usually opt to contract a life annuity with a life insurance company, in which case there is a risk that the latter could go bankrupt. The other option is to gradually withdraw their funds, but the financial risk persists and then there is the risk of longevity — the probability of outliving the funds, despite applying one of the retirement programmes based upon accepted actuarial tables. Governments intervene to reduce those risks, whether by financing minimum pensions for those who do not manage to make enough contributions, or by establishing insurance policies or guarantees to cover the bankruptcy of the insurance companies. However, there is always an element of residual risk.

Faced with these problems and regardless of the type of pensions system, the great mitigating factor is the possibility of postponing retirement. As we saw in the previous section on changes in the world of work, this may become much more common in the future, thanks to the scarcity of workers associated with ageing, new technologies that facilitate distance learning, and a greater utilisation of partial work shifts.

MIDCs, whose pensions system coverage is limited by precarious job markets, are facing the multiple challenge of constructing inclusive pensions systems, providing a minimum level of coverage guaranteed by the State to the poorest retired people who cannot reach the minimum pension levels, and at the same time generating incentives for formalising job markets. Several countries in this group are constructing mixed systems: minimum pensions guarantees backed by the State and defined contribution mechanisms to finance pensions with replacement rates appropriate for middle and high-income workers. The balance is difficult because in many

countries these mechanisms coexist with very generous defined benefit plans, as is the case among public sector workers, or for employees of Mexico's state oil company (PEMEX). On the other hand, most of those countries have limited capacity to set levies on private incomes and the tax ratio seldom exceeds 20 percent of GDP. Meanwhile they are still facing the challenge of extending the coverage and quality of education, in order to assist the newest generations of young people.

China is an extreme case in this group, owing to its scale and the speed of its demographic change. Points in its favour include the willingness the government has shown to experiment with different pension models and to rapidly implement an extensive system combining many of the elements described above. MIDCs are facing a race between economic growth and rapid population ageing. As Jackson and Howe (2004) describe so well, developed countries first got rich and then grew older, with Japan perhaps the last country to manage this just in time. The current MIDCs are running a serious risk of growing old before they grow rich, which could be a source of great tensions, and their growth expectations may be frustrated.

Finally we have the VPCs, which do not yet have systems to protect income for old age and where the population will continue to grow rapidly over the coming decades. These countries do not generally have the income or institutional soundness to build systems of this type, as their resources are scarce. Their main priority is still to establish education and health systems that put the development of young people first, so they can aspire to future economic growth. However, as far as possible, they need to start building inclusive social security systems, with incentives aimed at promoting saving and labour stability, precisely to foster rather than hinder the economic growth process. Some authors such as Sachs (2005) have argued in favour of providing economic aid so that these countries can start implementing self-sustaining growth processes. Part of that aid should support the construction of inclusive social security institutions and preventing these institutions from becoming profit mechanisms for groups closest to power, which could end up stunting the progress forecast for these countries (Acemoglu and Robinson 2012). If they fail, the fall in the fertility rates that usually accompanies economic growth will probably be postponed; this means these countries will maintain high levels of population growth, multiplying the risks of humanitarian and ecological disasters, which could have global implications.

SOME POLITICAL CONSEQUENCES OF GLOBAL AGEING

The demographic explosion of the last two and a half centuries is largely explained by the wider availability of resources, thanks to technological and economic advances, and especially to the use of fossil energies in the production and transportation that came with the Industrial

Revolution. At the start of the twenty-first century, the developing countries that are home to over 80 percent of the world's population are entering a process of accelerated economic growth, gradually closing the income gaps that separate them from the most advanced economies in the world. Yet there are indications that our globally finite resources could once again limit human activity and, ultimately, put a brake on population growth. Food, energy and metal prices have risen notably since the middle of the previous decade. What first seemed to be the usual price cycle for raw material prices has now convinced many people that we have entered a "super-cycle," caused by problems in meeting the developing world's increasingly higher demand for these resources. However, there are also global threats arising from the planet's limited capacity to absorb waste and emissions without affecting key variables such as the climate (Wilson 2002; Sachs 2008).
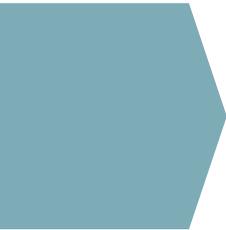
Today, it seems reasonable to assert that humanity has reached an intensive stage in the exploitation of the planet's capacities. Additional increases in the population and improvements in living standards require profound technological changes that expand the planet's current capacities or reduce the adverse effects of human activity

Some of these problems, especially those linked to the scarcity of resources, were resolved in the past through technological advances. This made it possible, in most cases, for the price of raw materials to maintain a downward or constant trend over very long periods. Whilst the potential scarcity of today's traditional energy sources (hydrocarbons) would appear crucial owing to the latter's involvement in all human activity, innovation does appear to be responding to high energy prices. There is therefore reason to feel confident that technology will be able to provide the answers, even if it is not currently clear when or what form these answers will take. By themselves, limited resources do not seem to be the obstacles that could radically change the demographic panorama of this century.

However, pollution and its potential climatic impacts are more difficult problems to tackle. Its effects are cumulative and slow to reveal themselves. Moreover, external factors often prevent pollution-related costs from being adequately reflected in prices, and therefore people, companies and governments do not have direct incentives to change. These problems are exacerbated both because they are global and because there are no supra-national bodies with regulatory and executive powers to tackle them. Scientific research into these issues is also very recent and there are still many grey areas.

Today, it seems reasonable to assert that humanity has reached an intensive stage in the exploitation of the planet's capacities. Additional increases in the population and improvements

in living standards require profound technological changes that expand the planet's current capacities or reduce the adverse effects of human activity. Since these technological changes do not occur smoothly or universally, it is highly likely that conflicts over resources will increase over the coming decades. It is also likely that countries or communities will suffer climate-related catastrophes. These events will not be evenly distributed and they will affect different countries and communities in different ways depending on their levels of economic development, demographic profiles and geography.

For countries with the most advanced DTs and which mostly belong to the DCs (China and Russia being the most important exceptions), the greatest challenge will be properly balancing the demands for greater social protection in old age with the changes needed to achieve sustained increases in productivity. One sphere where these tensions will show is in the tax sector. The evidence of the last two decades, especially in Japan and Europe, is that the disagreement about fiscal resources usually results in greater spending on health and social security, which is at least partly offset by reductions in defence spending. As some analysts have highlighted, this may widen the gap in military capabilities between the US and the rest of the developed countries, thanks to the fact that the US is under less pressure from its ageing population (Jackson and Howe 2008; Haas 2012). However, the current US supremacy may become increasingly less effective in non-conventional conflicts in faraway areas which require large troop deployments, such as may be the case with crises over scarce local resources (water, food).

Another issue for these countries — one currently felt in Japan — is the balance between the demands of an elderly population, which is increasingly more numerous and carries greater political weight, and those of younger families whose priorities are biased by longer horizons of reference. Recent press releases concerning Japan have highlighted the preferences of its pensioners for a strong Yen that makes their consumption cheaper, which conflicts with the interests of workers who see their jobs and salaries threatened by the loss of competitiveness. Disagreements surrounding the reconstruction of the regions devastated by the 2011 tsunami are also reported: the elderly are pressing for fast reconstruction with little change, while younger couples are willing to wait longer in exchange for improvements in the urban environment.

China and Russia, for their part, will face great tensions arising from the rapid growth in the proportion of their elderly and the reduction in their working-age populations in absolute terms. At macroeconomic level, this is almost certainly going to mean a relative fall in national saving and a rise in consumption, with a potentially positive impact on global imbalances but with unclear effects on national economic and social circumstances. The demand for greater coverage of social provisions, health and extended care for the oldest people is going to generate significant tensions that will affect the capacity to design and implement institutions,

as well as the allocation of tax resources. In these conditions, it is very hard for these countries to maintain their current rates of investment and military expenditure. Furthermore, they are vulnerable to the effects of climate change and they will need to use increasing amounts of resources to adapt to these effects. The biggest question mark lies over whether, in this context, they will be able to maintain high growth rates.

For the rest of the MIDCs in the final stages of their DTs, the situation varies greatly, but they share some positive features: they still have a couple of decades of "demographic window" ahead of them in which the working-age population will be growing in absolute terms, whilst the pressure for extending coverage in the educational system will start to fall. Their middle classes will become ever more prevalent and the youth bulge will dissipate, lessening the risk of social unrest and the breakdown of the democratic systems (Madsen 2012; Urdai 2012). However, they are also vulnerable because of their insufficient social security coverage and, in some cases, the potentially negative impacts of climate change and their dependency on certain natural resources. The size of this group — and the fact that it will see 40 percent of the increase in the world's population and over half of the worldwide GDP growth in the next forty years — means that whatever happens in this segment will be crucial to how the map of economic and social power will evolve over the century, as well as to how successfully we will contain and adapt to climate change. Globally, the struggle for resources and the drive to make human development sustainable will unfold in this group of countries.

Lastly, we have the group of countries where DT is just beginning: the poorest countries on the planet. This zone may well see the biggest conflicts over resources and the largest environmental disasters, both because of its vulnerability to the climate (since many of its people subsist on agriculture) and because of the weakness of its institutions and the lack of resources needed to adapt and mitigate these problems. Although they are still not under pressure to extend social security on a massive scale, they are under pressure to feed their people, make health provisions and educate on a large scale, in the face of their growing number of children. Moreover, many of them are still facing several decades with a high proportion of young people, which could mean that tensions will turn more easily into armed conflicts. It is difficult to see how these countries can resolve these problems by themselves and move ahead without help from the rest of the world.

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THE WORLD DEMOGRAPHIC TRANSITION IS COMING TO AN END, BUT IN DIFFERENT PERIODS AND AT DIFFERENT SPEEDS. AS A CONSEQUENCE OF THIS HETEROGENEOUS PROCESS, THERE IS STILL SOME RESIDUAL GROWTH IN WORLD POPULATION THIS CENTURY. THIS WILL BE DISTRIBUTED IN EQUAL PARTS AMONGST THE POOREST COUNTRIES AND THE REST OF THE DEVELOPING COUNTRIES. THE MOST DEVELOPED COUNTRIES WILL LOSE RELATIVE WEIGHT IN ECONOMIC AND DEMOGRAPHIC TERMS, THEIR WORKING-AGE POPULATIONS WILL SHRINK AND THE BURDEN OF OLD PEOPLE ON THE TOTAL POPULATION WILL INCREASE TO UNPRECEDENTED LEVELS. THIS WILL CAUSE CONSUMPTION PATTERNS TO CHANGE, WITH AN INCREASED PROPORTION OF SPENDING ON SERVICES, ESPECIALLY HEALTH AND CARE FOR THE ELDERLY. IN A FEW DECADES, PRECARIOUSNESS IN JOB MARKETS WILL EXERT HEAVY PRESSURE TO INSURE INCOME FOR THE GROWING MASS OF WORKERS WHO REACH RETIREMENT AGE. FINALLY, THE POOREST COUNTRIES, WITH EVER-HIGHER BIRTH RATES, MUST FIRST CONCENTRATE ON PROVIDING THE BASIC SERVICES FOR THEIR GROWING POPULATIONS OF CHILDREN AND YOUNG PEOPLE, AND THEN START TO BUILD INSTITUTIONS THAT PROVIDE SECURITY TO OLD PEOPLE. THIS MUST ALL BE PROVIDED AMIDST GROWING PRESSURE FOR BETTER USE OF THE PLANET'S RESOURCES AND IN THE CONTEXT OF THE EARTH'S LIMITED CAPACITY TO ABSORB THE IMPACT OF HUMAN ACTIVITY, WHICH WILL ADD FACTORS OF TENSION AND CONFLICT OVER THE COURSE OF THIS CENTURY. THE SURVIVAL OF HUMANITY ITSELF DEPENDS ON FINDING REAL SOLUTIONS TO THESE CONFLICTS.

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Predicting the Economic Future Through Convergence: The Case of China[1]

Daniel Altman

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In economics there are few axioms and fewer laws. The science, if it can be called that, lacks the certainty of mathematics and the elegance of physics, which may be why quite a few run-of-the-mill mathematicians and physicists turn out to be excellent economists.

But economics does come close to these other disciplines in its mapping of individual decisions and economic growth. Models of economic growth, in particular, will look familiar to physicists, as they sometimes appear to mimic the motion of particles influenced by forces like gravity. These models, which became popular during the 1980s and have endured since then, are usually called "neoclassical" because they draw heavily on "classical" mathematical and statistical techniques developed much earlier, in the 1920s.

From the neoclassical models arose perhaps the only relationship that economics has been able to establish between the prospects for growth of different countries. That is not to say that the models gave birth to a law. Rather, they suggested a relationship that, when tested in the real world, appears to hold true: convergence.

The idea of convergence began with the simplest models, in which there was little to distinguish between economies. In these models, it looked as though every economy was on the same path of growth. Some had a head start, and these were the wealthy ones. The others, however, would catch up to the leaders eventually. In fact, the further behind they

Blanca Muñoz, *Espacio combado* (model), 1998

were, the more quickly they would close the gap. As time passed, the workers in every economy would be heading toward the same average level of productivity, and thus, in a world of competitive markets, the same wages and material standards of living.

Plenty of observable evidence indicated that this theory might be right. Countries that lagged far behind the leaders — the poorest ones — could make dramatic leaps forward by making basic improvements in public health, education, and infrastructure, which would eventually allow them to move their people off the land and into cities, where they could take advantage of the economies of scale implicit in industrial production. Moreover, the laggards could copy technologies from the leaders rather than having to develop them on their own, leapfrogging through economic time. As they began to compete head-to-head with the leaders in the highest-value markets, however, their progress would naturally slow.

Yet this simple form of convergence didn't seem to be happening in many parts of the world. African countries, for example, actually lost ground to the rich West in the second half of the twentieth century. And some countries that appeared to be catching up to the West for a few decades, like Japan, hit a wall before they reached the same standards of living, falling inexplicably short of the target. Indeed, as the theory of convergence became canonical in economics textbooks during the 1980s, bestselling books predicted that Japan would pass the United States to become the world's greatest economic power. That never happened, and today few economists would predict that it ever will.

So economists re-examined the theory of convergence. They decided that the basic idea could still be correct, but with a caveat: countries' living standards could converge in the long term, but only if they had similar economic foundations. Those foundations were the deep factors whose importance was easily perceptible yet hard to quantify. Some were immutable, like geography or cultural traditions; landlocked countries could not easily get access to the sea, nor could countries accustomed to strong rulers suddenly forget their history. Others, like legal philosophies and the depth of ingrained corruption, could be changed, though only with great effort and over the course of years. Together, these deep factors created the backdrop for all economic activity. The economy could rise and fall with its usual cycle, but the deep factors determined the economy's potential to grow in the very long term, decades or even centuries into the future.

Countries that shared several of these deep factors could be put in the same "convergence club," meaning that the basic dynamic of convergence could be expected to hold between them. Only by changing one or more of the deep factors could a country jump from one club to another, thereby changing its target for living standards and its long-term path of economic growth. In the late twentieth century, Japan hit a wall because it didn't have the same deep factors underpinning its growth as the United States. Its markets weren't as competitive, and the bureaucracy governing its business environment was more cumbersome. It wasn't in the

same convergence club, and, even at its full potential, it couldn't be expected to catch or pass the United States.

This new theory, called conditional convergence, has endured in the mainstream of economics, in large part because of the strength of the empirical evidence that supports it. Early calculations showed that, controlling for population growth and the rate of investment in capital goods, per capita income in a sample of 121 countries did appear to converge over time (Mankiw, Romer, and Weil 1992). A later study showed that, conditional on their ability to export, East Asian economies seemed to converge towards similar income levels; those with lower standards of living tended to grow faster (Fukuda and Toya 1995). Conditional on having similar economic and political institutions, African countries in the post-colonial period also displayed convergence (Murthy and Ukpolo 1999). These studies divided countries into convergence clubs in different ways — after all, you can slice and dice the world's economies however you want — but the distinguishing characteristics in each club were important enough to influence the members' economic futures.
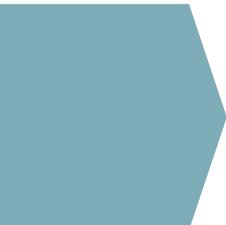
Despite the dramatic changes in the Chinese economy since the late 1970s, there are still vast differences between China and these wealthier economies that are likely to hold China back. Some of them might be changeable within the next couple of decades, and some of them might not

An exploration of conditional convergence becomes particularly interesting when you consider what it means for the future. If you can figure out what club a country is in, you can essentially see its future by looking at other members of the club that sit further along the convergence path. Today, the country whose economic future raises the biggest question marks is China. Can it continue to grow so rapidly? Will its living standards ever catch up to those of the United States and Western Europe, or even those of the wealthier countries in East Asia?

Until the late 1970s, China was languishing in one of the lower-productivity convergence clubs. The Cultural Revolution had eliminated or literally put out to pasture many of the country's best minds, and China's massive yet ill-conceived industrial mobilizations — backyard steel-smelting, for example — had yielded little fruit. The country was largely shut out of overseas markets through a combination of regulations and the poor quality of its output. Starting after World War II, China had steadily lost ground to its industrializing neighbors (Pettis 2008). Having chosen a unique set of economic institutions, in which central planning of the economy was mixed with the atomization of industrial production in thousands of villages, China was arguably in a convergence club all its own — and not a very fast-moving one.

Szymon Roginski, *Shanghai 15,* 2008

That changed when Deng Xiaoping, who began to take over the central posts in the Chinese government after the death of Mao Zedong in 1976, initiated a series of economic reforms. He reached out to foreign leaders, began to open China to overseas markets, allowed more Chinese students to study abroad and even laid the groundwork for the return of small, private entrepreneurship. As his regime continued, the state tacitly gave more and more day-to-day control of finance and industry back to the market by allowing private companies to operate and grow, even when their existence seemed to contravene official dictums (Chang 2008).

These reforms made a fundamental difference to China's growth, and the productivity of its workers started to catch up to that of local heavyweights like South Korea and Japan. But is drawing level with South Korea or Japan an attainable goal, or will China come up short, just as Japan did in its pursuit of the United States? The answer depends on whether China is in the same convergence club as its neighbors.

Szymon Roginski, *Shanghai 37,* 2008

The answer is probably no. Despite the dramatic changes in the Chinese economy since the late 1970s, there are still vast differences between China and these wealthier economies that are likely to hold China back. Some of them might be changeable within the next couple of decades, and some of them might not.

Two factors that economists regard as particularly important to convergence in incomes, especially as poor countries close the gap with rich ones, are openness to trade and the ease of starting a business (Aghion and Howitt 2009). China has done much to open its markets since Mao's death, but it still has a long way to go. Details of the trade agreements that helped it to join the World Trade Organization in 2001, such as by how much its exports can undercut the prices of domestically produced goods in the United States and Europe, are still being disputed today. And though China marched right in when other countries swung open their doors to its boatloads of cheap manufactured goods, it has not yet opened its own markets to the same extent.

When it comes to opening a business, China ranks even further behind. The World Bank's annual study of environments for entrepreneurs, appropriately called "Doing Business," ranked China 151st out of 181 countries in the category "Starting a Business." The ranking, based on a survey of the experts and business people surveyed by the bank, compares the time and money needed to start up a small business in different countries, encompassing both the burden of bureaucratic procedures and the legal requirements for financing. In China, an entrepreneur would need to have financial capital on hand amounting to more than 130 percent of the average annual income in order start a business. In 91 other economies, from Afghanistan to Zimbabwe (and including heavyweights such as the United States, Japan, and Germany), no such requirement exists. China may be the world's second-biggest economy, but there are very few places in the world where it's more difficult to hang out one's shingle for the first time.
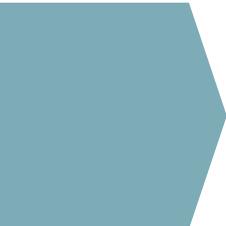
It may be a stretch, to assume that China's hierarchies will flatten out, or that its government will substantially reduce its presence in many sectors of the Chinese economy, a presence that can crowd out private ventures and deter foreign investment

Making China's business environment even more challenging is a pervasive lack of transparency. China's complex bureaucracy has allowed corruption to become entrenched, and the government has been known to use the legal system to bully foreign companies. Economic data are regularly revised and contested; as a recent video series presented by *The Atlantic* pointed out, even estimates of the country's population vary by hundreds of millions of people.[2] In part because of these factors, business negotiations in China tend to be based more on personal relationships and trust than on numbers and contracts (Sebenius and Qian 2008).

These factors can be fixed. China has a strong central government that can institute new regulations quickly and enforce them with an iron fist. In time, China can become as encouraging an environment for new investment, both by foreigners and by its own people, as any other industrialized country. There are other factors, however, that are not so easy to alter. In the very long term, these factors may turn out to be the most important ones.

Confucianism is perhaps the leading influence on Chinese business practices, or at least the single factor that most distinguishes Chinese practices from those of other countries (Ministry of Culture of the People's Republic of China 2003). The teachings of Confucius date back

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2. *On the Frontlines: Doing Business in China*, written by Bob Schapiro and produced by Dovar Chen (2009).

centuries, and they are deeply ingrained in Chinese society. The Chinese government has even embraced them in recent decades alongside its official communist ideology; the *People's Daily*, the influential state newspaper, called for an understanding of Confucianism's "precious business philosophies" in 1996 (Chen 2001). Yet some of its central tenets, though they may have benefits at the social level, are not necessarily conducive to economic growth.

Confucian ethics teach that one should value the collective over the individual. Though Confucius himself did not view the supremacy of the collective as a justification for conformism — he was more of the opinion that individuals could shine within the collective, as long as the collective remained harmonious — his ideas became distorted in modern China (Bell 2008). According to Daniel Bell, a scholar of Chinese philosophy at Tsinghua University in Beijing, Confucianism was melded with Chinese authorities' legalistic inclinations to lend a legitimizing cultural resonance to their strict imposition of law and order. A second and related tenet of Confucianism could be termed propriety, or an adherence to ceremony or tradition; it encompasses the "respect for elders" that is a hallmark of many East Asian civilizations. In Confucianism, this deference belongs not just in family relationships but also between ruler and subject, master and servant, and employer and employee.

Together, these tenets of Confucianism — and the way they have been interpreted by the Chinese authorities in recent times — have helped to maintain rigid hierarchies in Chinese businesses. Even Confucius, Bell concedes, did not believe that young people should engage in critical thinking. First, they had to learn the teachings of their elders. They had to attain more seniority within the collective before they could begin to challenge established ideas and innovate.

These hierarchies within the collective can be problematic in a mature economy. As the management researchers Fang and Hall (2003) point out, when Chinese managers make decisions, the consequences of those decisions must cascade down through many levels of corporate hierarchy, perhaps being diluted along the way; this time-consuming process can reduce a company's ability to react quickly to changing business conditions. Meanwhile, incompetent managers can stay in their jobs simply because of their seniority. The ideas of junior workers are rarely implemented, even if they have the temerity to raise their voices, because their proposals get stuck on the way up the chain of command. In a country where starting a new business is difficult, the problem is exacerbated; young workers frustrated with the Chinese system might try to emigrate rather than striking out on their own as entrepreneurs.

The combination of these two tenets is implicit in the bulk of large Chinese firms, because the government — the ultimate "elder" that supposedly represents the collective — has a controlling interest. It is not always a healthy interest. Maximizing profits is not necessarily the government's only goal; if it were, the government would sell its interest in companies when

Szymon Roginski, *Shanghai 43,* 2008

doing so would yield the biggest payoff (Clarke 2003). Research shows that government-dominated companies pay lower dividends and have a less healthy cash flow (Bradford, Chen, and Zhu 2007). The same is true for companies with complex, hierarchical ownership structures. Publicly traded Chinese companies can have as many as five classes of shares, while American companies rarely have more than two or three (Qi, Wu and Zhang 2000).

There is one other cultural current that runs just as deeply as Confucianism. Through books, films and classes, Chinese people learn a very particular story of the birth of their nation, in which the great struggle through the millennia has been to unite the enormous land mass and diverse ethnicities of China into one nation. Those who sought to carve China into smaller kingdoms are usually the villains; those who sought to unite it are the heroes. Those heroes are often merciless and violent, like the Qin emperor Shi Huang, who cut a bloody swath across China with armies of tens of thousands of men as he united seven kingdoms into one empire in

Szymon Roginski, *Shanghai 47,* 2008

the third century BC. That empire eventually fell apart, but the next rulers to unite China — the Sui — were just as ruthless. And so the story goes all the way up to and including Mao. The message is clear: to be united and realize the dreams of a great Chinese nation, the Chinese people need strong rulers who brook little dissent.

The message carries through to the boardrooms of Chinese companies, which tend to concentrate the instruments of power in the hands of a single strongman who unites the three most important roles in the company: chief executive, chairman of the board, and representative of the Chinese Communist Party (Opper and Schwaag-Serger 2008). The boss thereby represents the interests of the government, which is often the biggest stakeholder, but common shareholders are marginalized.

Not surprisingly, the narrative of uniting disparate kingdoms to form a single, stronger empire also has echoes in the growth strategy of Chinese companies. Some of the biggest, like the

appliance maker Haier, have grown at astonishing rates by gobbling up their smaller competitors. Doing so can generate economies of scale and lower prices for consumers, but, if one company becomes the unchallenged industry leader, then that company will have little incentive to innovate or cater to changing preferences.

The rhetoric of some Western politicians suggests that they believe China will eventually embrace democracy and transparency, perhaps after a long period of economic opening. Yet that will not necessarily change all of the deep factors that are limiting China's growth; the links between political institutions and the economic climate are not always so strong. For example, South Korea, despite becoming a democracy, still has a very Confucian culture with the attendant repercussions for innovation and corporate hierarchies. Russia, another large country long governed by a strong central authority (be it a tsar, Joseph Stalin, or Vladimir Putin), has essentially tried democracy and rejected it over the past twenty years; corruption and government strong-arming of foreign companies continue unabated. Sweden, for decades a democratic country, maintained heavy state involvement in the economy until the turn of the millennium.

It may be a stretch, therefore, to assume that China's hierarchies will flatten out, or that its government will substantially reduce its presence in many sectors of the Chinese economy, a presence that can crowd out private ventures and deter foreign investment. Indeed, three decades after its "Open Door Policy" began, China's government is still heavily involved in virtually all of its big companies. This involvement amounts to actual ownership and control, in contrast to the government-led coordination and protections for private companies that helped industries to grow in South Korea, Japan, and Taiwan during the twentieth century.

In addition, the government is unlikely to rein in the massive bureaucracy that allows it to maintain control of municipalities thousands of miles from Beijing, even though that very bureaucracy is often what stands in the way of new businesses. It may also be reluctant to increase the transparency of its legal system, since that same lack of transparency can be used to hamper and curtail the activities of foreign companies at the government's whim.

All of these factors will combine to lower the target for material living standards in China — or, to put it more technically, they reduce the level of per capita income toward which China is converging. With these factors in place, China simply is not in the same convergence club as the United States. More likely, it is in a club along with other nations that share at least some of its cultural grounding, legal framework, history of state involvement in the economy, industrialization patterns and climate, perhaps including Vietnam and Kazakhstan. As these examples suggest, countries do not have to be the same size to be in the same convergence club. The deep factors that underpin economic growth set the achievable limits for material living standards; those limits can be similar in countries of various sizes.

This is not to say that China is incapable of progress. One study completed in the late 1990s suggested that younger managers in Chinese companies were more individualistic than

those of previous generations, a characteristic that could help to promote innovation in the long term (Ralston et al. 1999). By now, many of those young managers are undoubtedly in positions of power. But there are simply too many deeply ingrained differences for China's people to attain the same incomes as their Western counterparts at the end of its current growth spurt. Those incomes ultimately depend on workers' productivity; you are paid for what you produce. Chinese workers, even with access to the latest gadgets and manufacturing techniques, cannot be as productive as American or European workers if they do not have the same entrepreneurial opportunities, a transparent regulatory framework, strong legal protections, efficient corporate structures, and the ability to innovate.

> **China may just manage to catch the United States and become the world's biggest economy. But it will hold onto the title for only a few years before the United States, growing more quickly in both population and the productivity of its workers, passes China again**

In the neoclassical model, only economies with similar deep factors can expand at the same rate when they settle into their steady growth pattern. If China's deep factors are inferior for the purposes of economic growth, then it will begin to lose ground. In other words, its average incomes will start to fall behind those of the world's economic pacesetters. The Chinese people, having become substantially richer relative to the rest of the world, will slowly become poorer again.

So, what does all this mean? First, consider the conventional wisdom. Several years ago, a Goldman Sachs report predicted that China would overtake the United States as the world's biggest economy in 2041 and would continue to widen the gap for many years afterwards (Wilson and Purushothaman 2003). In 2048 the amount by which China extended its lead every year would slowly begin to fall, in percentage terms, but only by a tiny amount each year. More recently, the British author Martin Jacques predicted that China would replace the United States as the world's main superpower, Shanghai would overtake New York as a financial center, and the yuan-renminbi, China's currency, would supplant the dollar in world markets.[3]

Now, consider an alternative scenario that encompasses the points made earlier in this chapter, namely that: 1) China is not converging to the same living standards as the world's wealthiest nations; 2) China's economic growth will stabilize sooner than expected, and

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3. Paraphrased from Jacques's comments on BBC World News on June 25, 2009; Jacques is the author of *When China Rules the World: The End of the Western World and the Birth of a New Global Order.* New York: Penguin Press, 2009.

3) China's long-term economic growth rate will be lower than those of the world's established economic leaders. A reasonable prediction might be that China's growth stabilizes by 2050 at the latest, having grown more slowly than Goldman Sachs predicted; its population grows no faster than that of the United States; and its long-term growth rate in average incomes is slightly lower than that of the United States, say 1.5 percent versus 2 percent. Under these conditions, China may just manage to catch the United States and become the world's biggest economy. But it will hold onto the title for only a few years before the United States, growing more quickly in both population and the productivity of its workers, passes China again.

As a result, investors and entrepreneurs who have seen unlimited potential in China will be sorely disappointed. With lower material living standards, Chinese people will never be able to buy as many goods and services as their wealthier counterparts in the United States and Europe. The Chinese market will be immense, but it will not eclipse the world's other major economies. Moreover, the risk to shareholders and creditors implied by corruption, lack of transparency, and the Chinese political system will no longer be offset by the reward of huge profits. The fad for Chinese securities will slowly but surely peter out. In the long march of economic history, China's moment will be impressive, but brief.

This is not to say that China is doomed to inferior economic growth and living standards forever. Even the most deeply ingrained traditions can change over the course of decades, or in a shorter period of time if disruptive or revolutionary forces are in play. In Eastern Europe, for example, the collapse of state socialism and the Soviet bloc left several countries with a blank slate. They held onto their culture, but they were free to choose some of the bedrock institutions of their economies all over again. But as Japan's example goes to show, holding onto culture — and other deep factors — can keep the limits to growth in place.

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Deep factors ranging from climate to legal institutions create the backdrop for all economic activity. Countries that share several of these deep factors can be put in the same "convergence club", meaning that the poorer will catch up to the richer in a race toward the same potential level of living standards. Only by changing one or more of the deep factors can a country jump from one club to another, thereby changing its target for living standards and its long-term path of economic growth. This theory, called conditional convergence, has clear implications for today's economic powers in the next several decades. For example, though China may soon become the world's biggest economy, its growth may later slow to the point that the United States catches it again. Without changes to its deep factors, it may follow the path of Japan, whose growth slowed markedly at the close of the twentieth century.

BIOGRAPHY

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Daniel Altman is an economist and internationally best-selling author. He teaches economics at New York University's Stern School of Business and serves as chief economist of Big Think. He is also a columnist for *Foreign Policy*. In addition, Altman is the founder and president of North Yard Economics, a nonprofit consulting firm serving developing countries, and Emerging Design Centers, a new venture that will found product-design workshops in poor communities around the world.

Altman has written economic commentary as a staff writer at *The Economist*, *The International Herald Tribune*, and *The New York Times*, where he was also one of the youngest-ever members of the editorial board. In between stints as a journalist, he was an economic advisor in the British government. He is a member of the Council on Foreign Relations and the expert advisory board at Dalberg Global Development Advisors, where he previously served as director of thought leadership.

Altman was born in Connecticut and received his undergraduate and doctoral degrees in Economics from Harvard University. He has lived and worked on four continents and is a citizen of the United States, Canada, and the United Kingdom. His most recent book is *Outrageous Fortunes: The Twelve Surprising Trends That Will Reshape the Global Economy* (Times Books, 2011), which has been published in eight foreign editions.
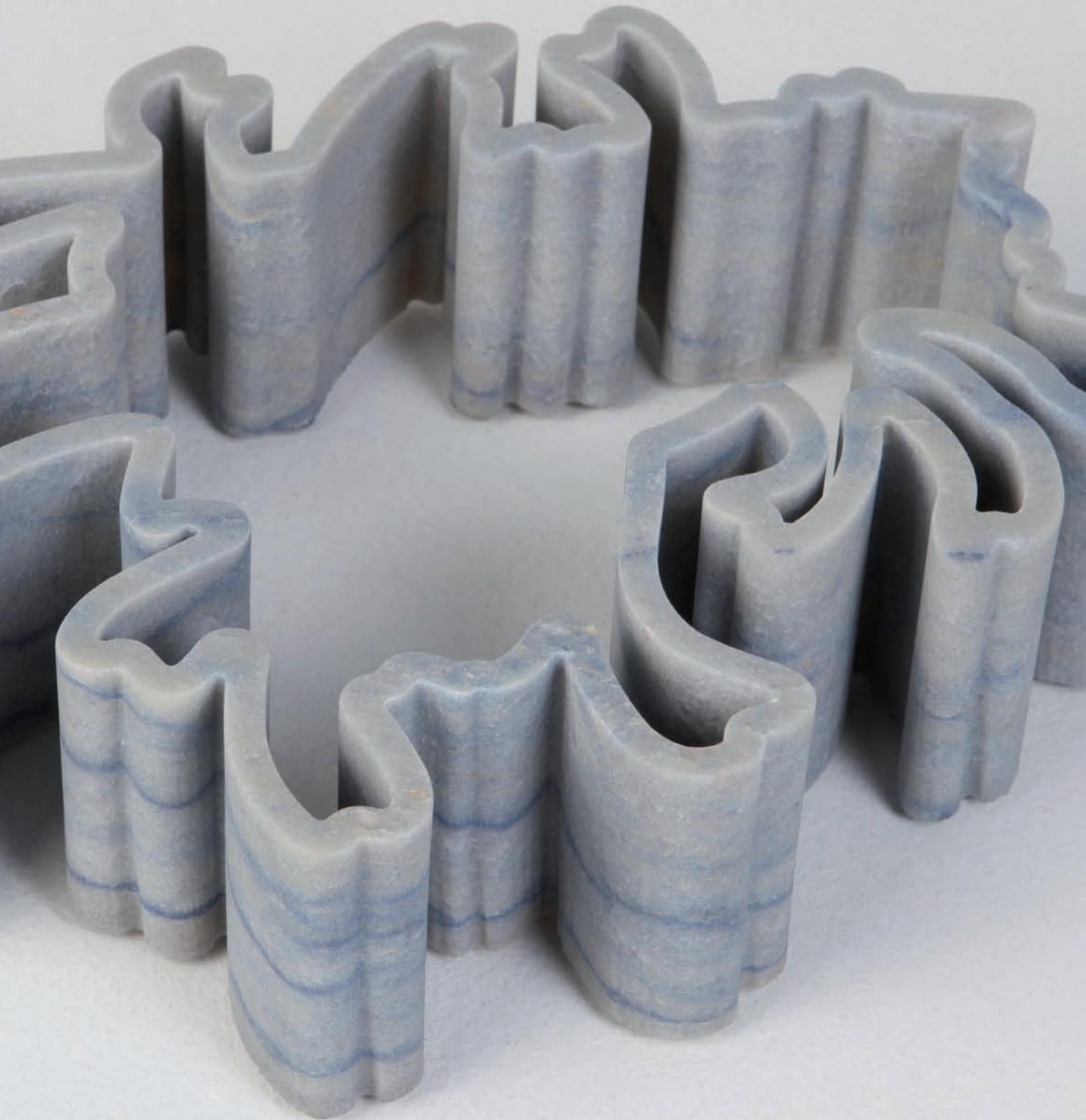
The Future of International Relations: A Symbiotic Realism Theory

Nayef Al-Rodhan

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Hans Morgenthau once wrote that: *" [I]nternational relations is something not to be taken for granted, but something to be understood and to be changed and, more particularly, to be changed beyond the present limits of its political structure and organization. Here lies indeed the ultimate theoretical and practical justification for our interest in a theory of international relations."*

The field of International Relations (IR) today contains several general frameworks that seek to explain the workings of international relations and, to varying degrees, to contribute to efforts to move beyond the apparent confines of the current system. These approaches provide a variety of visions of the world, the most familiar of which is the realist view.

It is realism that has set the boundaries of the discipline, which has meant that IR has traditionally been concerned with the study of the inter-relationships between states. The conception of the world offered by realists is easy to grasp. Rational, calculating, and egoistic states are the most important actors in a nonhierarchical international system.

States' survival strategies are based on amassing power and forming alliances against any state that threatens to upset the existing balance of power. Power politics is the name of the game and the game is zero-sum. That is, one state's gain is another state's loss. Moreover, under conditions of scarcity and international anarchy, morality is regarded as a statesperson's folly.

I am under no illusion that morality and peace are possible without an overarching central and just authority or a benevolent hegemon. Given the powerful and innate survival instincts and drivers of behavior,

philosophers through the ages have recognized that some kind of central authority to prevent/arbitrate conflict and guarantee justice, security, peace, and prosperity is necessary. IR scholars are some of the most recent actors to attempt to grapple with these issues and to offer counsel to states in their relations with others.

Yet, as the discipline's dominant paradigm, realism emphasizes only some of the aspects of human nature that might motivate state behavior. Most realists assume that fear, reputation, and self-interest constitute the strongest motivating factors behind the actions of states. These impulses are thought to exist *a priori*.

In other words, interaction with other states is thus not expected to alter significantly a state's preferences, interests, or posture *vis-à-vis* their counterparts. Moreover, other possible motivating factors, such as the desire for justice, compassion, or legal responsibility, are assumed to be less important drivers of state behavior. An extremely narrow conception of human nature, therefore, underpins the realist worldview.

What is clearly missing from the realist paradigm are the substrates of human nature that require some concept of the perceptual frameworks and norms that inform relations between actors. I maintain that insights from neurobiology provide a more complete understanding of both human beings and states, and their relations.

Neurobiological conceptions of human nature are much broader than those of realism. A person's ego, for example, is not understood simply as the driver of domination and the pursuit of power, but also as the driver of a number of other traits, including the need for a positive identity and a sense of belonging. If such factors are taken into account, our understanding of human behavior, as well as the behavior of states, is substantially altered.

Realism's state-centrism also leads to a conception of the global system that is too narrow, resulting in the neglect of numerous non-state actors that help to account for the dynamics and relations inside the global system. Moreover, limiting the study of IR to the distribution of material capabilities between states neglects other types of power and motivators of action that constitute identities other than that of the rational, egoistic sovereign state — such as ethnic and gender identities. In my view, the conception of the global system must be widened and, moreover, an idealist dimension must be added to its ontology (i.e., what exists).

THE PROBLEMS OF REALISM

Human nature in a realist vision of the world is driven by fear, reputation and self-interest, with very little place allotted to free will and, thus, for the capacity to alter one's nature. Any moral behavior that may be displayed is thought to result from self-interest rather than altruism. Since the state is believed to be the most important political unit, these characteristics are

transposed to the level of the state. A state is thought to be above all concerned with its own survival, which it attempts to secure through the accretion of power.

However, as one state accumulates power it makes others insecure and encourages them to do the same. In the absence of an overarching authority structure capable of guaranteeing the security of states, a permanent security dilemma is believed to be generated, and security competition becomes part of the natural order of things.

Realists believe that the security dilemma can be limited by a balance of power. The neo-realist scholar Kenneth Waltz, for example, contends that wherever two or more major powers exist, a balance of power will prevail. In his view, states tend to balance a growing power in order to prevent it from upsetting the status quo. Indeed, according to Waltz, the correct subject of study for IR is the study of the balance of power under conditions of international anarchy; and thus "high politics," such as war, military alliances, and so on. The distribution of military power is thought to determine change and transformation in the international system.
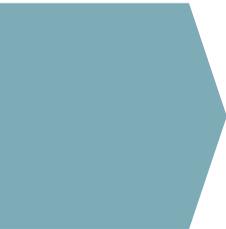
States' survival strategies are based on amassing power and forming alliances against any state that threatens to upset the existing balance of power. Power politics is the name of the game and the game is zero-sum

Since states are considered the principal actors in international politics, and they are presumed to be rational egoists, moral values are thought to belong solely to the domestic sphere. The self-interest of states negates agreement on universal moral principles.

Similarly, cooperative arrangements between states are thought to survive only for as long as states perceive them to be in their interest, and multilateral institutions are thought to exist at the whim of the interests of the major powers.

Yet, human nature is composed of a greater number of facets than those emphasized by realism. As is pointed out in symbiotic realism, the realist conception of human nature neglects those elements that require an ability to capture the manner in which perceptions and norms may alter behavior and may, indeed, be at least partly constitutive of self. This indicates that shifts in the distribution of military power may form only one explanation for change and transformation within the international system. Norms and perceptions are also likely to account for change and transformation.

Moreover, states can no longer ensure their security simply through self-help. Many of the threats that they face originate not from other states, but from non-state actors, many of whom may act transnationally. The increasing attention devoted to culture, for instance, reflects the importance

of large collective identities in global politics. We cannot afford to negate the importance of cultural issues in a world marked by increased human mobility and communications. When images can be broadcast simultaneously in various areas of the globe, the treatment or activities of a group could affect those of fellow members of the group in other countries.

Moreover, the dangers posed by non-state actors are in many instances non-military in nature. Today, national security analysts count the consequences of global warming, such as extreme weather and water shortage, as well as the spread of infectious disease, cyber-attacks on critical infrastructure, and so on, as potential threats to security.

High politics is therefore not necessarily the most effective focus of global politics. Moreover, events in one area of the world can have an almost immediate impact in another due to the rapidity and availability of information flows. Addressing the dangers posed by non-state actors requires cooperation with other states and a different range of "security tools" — not just military means.

Given that security and prosperity are highly dependent on cooperative relations with other states, we cannot assume that relations between states are necessarily principally governed by competition. Increased interdependence means that absolute gains are possible and that global politics ought not to be *a priori* zero-sum as realism suggests. This implies that even if a state possesses a disproportionate degree of power, other states may not form alliances against it. Indeed, it is far more likely in today's world that they would ally themselves with the most powerful state, if that power were constituted primarily through capacities other than solely military power.

Realists also assume that state power is derived from the control of resources. The need to control resources derives from the assumption that resources are scarce and that there exists no overarching authority to regulate their distribution. Competition for resources is, thus, presumed to be omnipresent. Yet, the validity of this assumption needs to be re-evaluated, given that technological advances may provide alternatives to currently scarce resources.

While natural resources, such as oil, remain highly relevant to a state's situation in the global environment, a number of other "capacities" are also significant, as I have explained (Al-Rodhan 2009a). *Meta-geopolitics,* as I term it, ought to consider a number of facets of state power, including social issues and health, domestic politics, economics, the environment, science and human potential, military and security issues, and international diplomacy.

SYMBIOTIC REALISM AND THE INTERLOCKING DIMENSIONS OF AN INTERCONNECTED WORLD

Symbiotic realism makes clear that the realist perception of competitive state relations, in which states are primarily concerned with relative gains in a self-help system, does not stand up to scrutiny. My conception of human nature tells us that perceptions are as important as
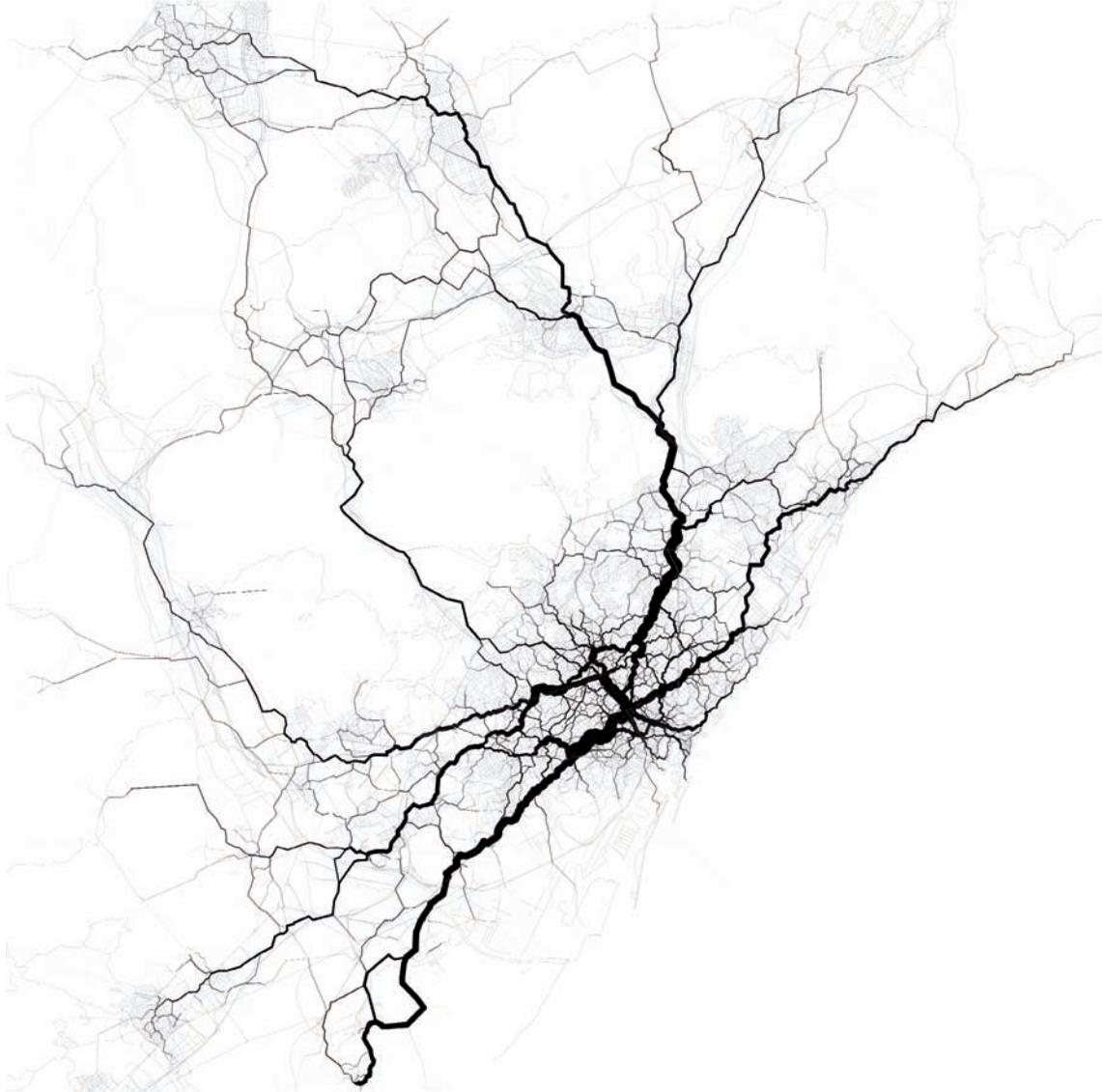
Eric Fischer, *Barcelona*

material capabilities as motivators of state behavior. Moreover, given increased interdependence, states can engage in symbiotic relations, that is, they can take part in a relationship of mutual dependence that allows one state to gain more than another without deleterious effects.

This has several implications for realists. First, it means that absolute gains are possible and that the "game" of international relations is not necessarily zero-sum. Second, it implies

that even when a state is accruing a disproportionate amount of power (i.e., material capabilities), there is no reason to assume that other states will form alliances in an attempt to balance against it. Third, it implies that a responsible hegemon should accommodate the interests of other states and avoid threatening behavior or, as a number of neo-realist scholars have recently suggested, engage in a type of "offshore balancing."

Moreover, some aspects of a state's power may come from their capacity to lead through consent rather than coercion, which necessarily involves cognitive and normative schemes as well as material phenomena. This implies a type of hegemony. Symbiotic realism's sensitivity to perceptual schemes and norms enables it to explain, as traditional realists cannot, why the US can lead without having to confront alliances of European states that attempt to balance against it. It can also suggest ways to avoid resistance to its overwhelmingly superior position in the global system.

A dual ontology also enables symbiotic realism to capture the sense in which large collective identities, whether substate or suprastate, are fluid rather than fixed entities: they are continually adapting to changing environments. Globalization is a key dimension that is helping to rapidly alter people's environment. As a result of advances in technology, people can now be instantly connected with each other and images can be transmitted in no time across the globe, often with serious consequences. Human mobility has also intensified as people migrate to find work in other countries and travel with increasing ease from place to place.

What this means is that large collective identities are rubbing up against other large collective identities much more than was previously the case. This can cause members of these entities to feel threatened, disoriented, or marginalized. Large collective identities are, therefore, significant to the dynamics of the global system.

The neurobiological predilections of human nature indicate that the well-being of human beings depends in part on the possession of a positive identity and a sense of belonging. They also tell us that cultural arrogance and exceptionalism, which taken together may increase insecurity and the likelihood of conflict, are equally possible.

In a world in which human mobility is increasing and communications have enabled images to appear simultaneously in multiple areas of the globe, it is essential that human beings feel respected and valued, and that excesses, such as cultural arrogance, are guarded against. Today, we face the collective challenge of successfully managing relations between the cultural groups within societies and promoting at the very least peaceful coexistence between civilizations. Symbiotic realism argues that synergy should be the guiding principle in the search for better ways to manage culturally pluralistic societies and relations between cultures.

Transcultural synergy refers to a situation in which a plurality of cultures and civilizations has a net effect that is greater than that predicted on the basis of knowledge of the likely effects of individual cultures and civilizations. Indeed, it is possible that each large collective identity can

provide the stimulus to other collective identities that face similar challenges presented by the same tendencies of human nature and the same contexts of global anarchy and globalization.

Symbiotic realism attributes an important role to human nature. It adopts a broader conception of human nature informed by the insights of neurobiology. Within this view, people may be driven by basic instincts or higher aspirations. When survival is at stake, basic instincts take precedence. However, once basic needs are satisfied, humankind is capable of acting morally. Yet, it is important to remember that I am referring to the majority of people and that the moral capabilities of individuals also depend on upbringing, education and personal experience.

Clearly, the existence of governance mechanisms makes moral behavior more likely under international anarchy. Indeed, if people are generally capable of acting according to moral standards only when their basic needs are met, good global governance structures are essential.

In my view, states remain central actors in the global system. Yet, I do not assume that they are unitary actors that base their actions on rationally calculated interests. Some parts of the state may be involved in transnational networks, forming part of a governance structure that goes beyond the boundaries of the state but, at the same time, does not constitute a world state. State interests and preferences may also be modified by repeated interaction with other states. Both of these factors suggest that order may exist even in the absence of a sovereign world state.

In addition, military capabilities alone may not be enough to indicate a threat. There must also be a perception that a state's possession of military capabilities represents a threat. The security dilemma that is thought to exist in an internationally anarchic world order is thus not automatic and is likely to depend as much on threat perceptions as on actual military capabilities.

However, a focus on states is not sufficient, and a more comprehensive conception of the global system was sought for my theory. I consider large collective identities, whether subnational, transnational or supranational, to be important actors. They should not be conceived in a static way, but as fluid entities. They are not homogenous, but are likely to contain contradictions.

Moreover, a lack of attention to exchanges and instances of borrowing between geo-cultural domains can lead to cultural arrogance and the belief that each geo-cultural domain is self-sufficient, and that encounters with others implies conflict. Yet, if we look at the history of human civilization it becomes clear that cultures and geo-cultural domains have always overlapped and intersected in ways that cumulatively constructed human civilization. Awareness of this interconnectivity and mutual debt is essential as a means of undercutting arguments, such as Huntington's clash of civilizations thesis, that only risk becoming self-fulfilling. It is also

a highly useful means of "deconstructing" the exclusionary civilizational identities on which a great deal of history has been written.

In a highly interconnected world, multilateral institutions are important actors. While they are all too frequently held hostage to the whims of the most powerful states, this is often because of the manner in which institutional mechanisms and arrangements reflect power relations within the global political system. As is noted above, the Bretton Woods institutions and the UN were established by the victors of World War II and clearly reflect that fact.

Nevertheless, these institutions have a vital role to play in mediating relations between states as well as providing the means through which to tackle an array of problems that cannot be dealt with by any one state alone or through state-centric paradigms (e.g. health, environmental degradation, migration). They still form the central public elements of global governance and, as such, there is a greater possibility of holding them accountable, at least to their members. Multilateralism is also crucial for burden-sharing between states, and the need to find cooperative solutions to policy challenges. In addition, these institutions have played a key role in diffusing norms and principles.

NGOs also contribute to global governance and their role needs to be captured within a theoretical framework. Their memberships are transnational actors rather than states. This means that they are not subject to the same constraints as multinational institutions and, indeed, can claim to be more capable of representing people or causes that may be neglected by mainstream politics. Yet, NGOs were not only created to represent the less fortunate in society. Companies have come together to help to establish common standards, and professional bodies have developed transnational connections, forming organizational bodies to help them achieve their objectives.

Transnational corporations are generally understood to be firms that are based in one country and operate in another. However, they are also understood as companies that have affiliates abroad. Although they have existed since the nineteenth century, their phenomenal growth has been under way since the late twentieth century and is related to a restructuring of the global political economy.

Market deregulation and technological advances have created new possibilities for companies wishing to practice regulatory arbitrage. One of the consequences of this is that health and safety standards, and arguably wages, are under downward pressure, contributing to a decline in standards and well-being. This may be especially true of those working in sectors that rely on a heavy presence of foreign companies.

Symbiotic realism also classifies women as actors in and of themselves in order to make them more visible. Women are affected by and, at the same time, help to shape the global system in ways that may be quite different from those of men. At the most basic level, they have different access to health care and education. A recent Geneva Centre for the Democratic

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Control of Armed Forces report documents that the mortality rate of women is higher due to inadequate access to health care, for example. Reduced educational opportunities can also affect women's life expectancy. Lack of education could, for instance, increase the risk of death during childbirth as well as that of undernourishment. In short, women are a specific kind of actor and are all too often hidden from view because of what the traditional international relations paradigm has allowed one to "see."

Symbiotic realism identifies the environment as a "reactive actor," because it responds, albeit in a non-conscious and non-rational way, to human activities. While human beings have affected the environment since the time they first appeared, the past century has been unprecedented in terms of their impact. This degree of human activity — particularly economic activity — in conjunction with population increases is prompting the environment to react in specific ways that are presently affecting and are likely to help shape the future global order. It is therefore essential to recognize the role that the environment plays in the international sphere.

Indeed, the environment is reacting in ways that may affect the sustainability of the present level of human civilization. Global climate change caused, according to the majority opinion in the scientific community, by the emission of greenhouse gases such as carbon dioxide is likely
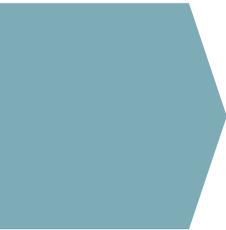
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to result in a temperature rise of 2–9 degrees over the next fifty years. This will accelerate the melting of the polar ice caps, causing sea levels to rise. As a result, whole communities could be displaced and island states may disappear completely.

One of the difficulties of reducing environmental damage is the transnational nature of its impact. Moreover, damage to the environment is connected to practices that are embedded in the global political economy. Many actors that contribute to environmental degradation are the non-state actors that are hardest to regulate, most notably corporations. Successful regulation of the environment will require governance mechanisms that will have to be agreed multilaterally and in some instances transnationally, as well as enforcement mechanisms.

Adopting a dual ontology helps us to capture the substrates of human nature more adequately. I concede that human beings are, indeed, motivated by the satisfaction of human needs, ego, and fear. Yet, there are also ways in which inter-subjective meanings structure facets of ego that require idealist ontology. We need to be sensitive to the ways in which a person's specific cultural, gender, and class identities, for instance, shape the way in which they experience the same thing or, in other words, to be able to acknowledge that there are many "truths."

As a subset of technology, information and communications technology (ICT) is also considered to be a "reactive actor" by symbiotic realism. ICT has altered the rapidity with which

information and images can be diffused across the globe. The consequences of advances in this area have been felt in relation to global economic and financial market activities, travel and transportation, the increased relevance of the media and of public diplomacy, and the growth and risks related to cyberspace and the "blogosphere," to name just a few. Regulation of ICT is difficult because of its widespread accessibility and the decentralized nature and potential anonymity of its users.

THE DYNAMICS OF THE GLOBAL SYSTEM

According to symbiotic realism, the dynamics of the global system are the outcome of four interlocking dynamics — the neurobiological substrates of human nature, global anarchy, interdependence, and instant connectivity. Actors thus exist in particular conditions determined by the "state of nature" (SON).

Individuals

Human beings are driven first and foremost by the satisfaction of their basic needs, including food, shelter, physical security, belonging and a positive self-identity. They are, thus, motivated by their emotional self-interest. Until their basic needs are satisfied, they are unlikely to be guided by conscious moral frameworks. Human insecurity and exploitation are likely to exist in an SON. As mentioned above, women both affect and are affected by the dynamics of the global system in gender-specific ways determined by their reduced/lack of status in many spheres of life.

States

In an SON, states are likely to pursue their own self-interest, perceived as ensuring their own survival in conditions of international anarchy. National interest may, however, be defined not only by the external environment, but also by domestic actors or "penetration" by other states. Stephen Walt (2005) argues that "domestic political penetration" by other states helps to shape US foreign policy for the worse. ICT may also penetrate domestic politics in states and help to shape policy stances. Balancing behavior as a result of threat perceptions may also constitute part of state behavior in an SON.

International Organizations

In an SON, cooperation between states within multilateral institutions is limited. States are, moreover, likely to be hostages to major powers, which are over-represented and enjoy privileged positions in multilateral institutions. Cooperation will prevail when it is in the perceived interests of these powers. NGOs have a greater ability to act impartially. They sometimes help to fill the

vacuum left by multilateral institutions. They also play a significant role in terms of raising consciousness and agenda-setting.

Large Collective Identities

The basic need of human beings for a positive identity and belonging can, if not met, lead to exceptionalism, exclusion and alienation. The history of imperialism, cultural arrogance and exceptionalism that unfortunately persists today can lead to a sense of injustice and lack of recognition by those who feel pushed to the margins of global history. Increased interdependence and instant connectivity may add another dimension. Migration in the context of the global division of labor may bring people into close contact with "strangers" against a backdrop of socio-economic inequalities. Without sufficient awareness of different traditions and cultural values, this can lead to tension, particularly when exploited by those who wish to breed mistrust and fear for their own personal ends.

Transnational Corporations (TNCs)

Without rules and regulations that specify otherwise, TNCs practice regulatory arbitrage. By relocating or establishing strategic alliances with other enterprises, they can move from one country to another where conditions are deemed more favorable. This capacity may result in a steady decline in labor conditions as governments seek to attract or keep TNCs on their territories. Thus, in an SON, TNCs may contribute to increased exploitation and to the pursuit of profit at all costs.

Environment and Natural Resources

In an SON, a legal framework regulating activities that affect the environment is notoriously difficult to negotiate on a multilateral basis. These activities are embedded in the socio-economic and political structures of states. Ensuring economic prosperity forms part of the state's national security considerations, which makes it particularly challenging for states to act on the basis of long-term considerations that may imply short-term costs on the part of companies. The scarcity of natural resources may also be aggravated by inadequate management strategies on the part of states.

ICT

The enforced regulation of ICT is particularly difficult because of mass and instant access. Cybercrime is developing faster than the capacity of law enforcement agencies to combat it. As I noted in *The Emergence of Blogs as a Fifth Estate and Their Security Implications*, if cyberspace is insufficiently regulated, it can become a vehicle for personal attacks as well as state insecurity and intolerance.

FOREIGN POLICY CHALLENGES

A great many of the foreign policy challenges faced by states today are the result of the emergence of norms that challenge traditional and narrow conceptions of state sovereignty, such as those centered on the individual as a subject of security. In addition, relative power remains a concern for states, but the context in which states act requires cooperation and a considerable degree of burden-sharing. Finally, finding the right balance between peaceful unity and respect for cultural differences is a challenge for states in the present context.

Individuals

The 1948 Universal Declaration of Human Rights extended liberal political and civil rights to include economic and cultural rights. It enjoys widespread support, but people's human rights are still not universally respected. Challenges are posed by the conflicting principle of state sovereignty. Human rights are conceived as universal rights that belong to all individuals, although the continuation of particularistic national identities continues to compromise such rights, due to a lack of openness to international human rights pressure.

The international norms of sovereignty and non-intervention are more vigorously supported than those of human rights. There are, nevertheless, different interpretations of the scope and implications of sovereignty and non-intervention, and it is this fact that is likely to determine the extent to which the leaders of a particular state perceive a contradiction between sovereignty and international human rights norms.

Another matter alluded to above is the claim that human rights are not compatible with some non-Western cultures. In some instances, people may not be fully aware of cultural sensitivities, what may be feasible and when, and which actors may be best placed to progress particular rights, such as those of women.

States

As is explained above, states in the realist paradigm are assumed to pursue their own material interests within an anarchical international system. These are, moreover, assumed to be concerned with relative as well as absolute gains. There is a tendency therefore for states to engage in short-term calculations of national interest. These calculations are assumed to be reached by rational assessments of the costs and benefits of various options. Yet, national interests may be derived through other mechanisms.

Walt (2005) proposes a slight modification to the realist viewpoint. He stresses the capacity of other states to penetrate the US domestically and influence foreign policy choices. Walt argues that this helps to account for foreign policy decisions that do not further the long-term interests of the US.

The notion of domestic penetration also highlights the way in which big business, for example, may influence domestic political decisions and thus it reinforces the importance of taking steps to minimize the role of money in politics. Transnational actors may also succeed in influencing the policies of national governments. Transnational corporations provide the most obvious example of this. What these instances imply is that the boundary between what has traditionally been thought of as "domestic" and "international" is artificial, and that it is no longer helpful to think in these terms.

Walt maintains that, historically, states have tended to try to balance the states that threaten to disrupt the existing balance of power. Yet, the relative absence of attempts by European states to balance the US in the post-Cold War era indicates that this assumption may not hold under all circumstances, and that there is no necessarily systematic nature to it. Walt's answer to this is that rather than focusing on the shifts in power — conceived primarily in military terms — balance of power theorists ought to place threats at the center of their analysis. Thus conceived, there is no reason to expect European states to engage in balancing behavior in relation to the US.

In his view, the evidence suggests that states do not demonstrate a tendency to balance against rising powers that are not perceived as threatening. The significance of this should not be overlooked. It implies that if interstate relations are marked by good relations, the accumulation of power by one state need not imply instability. Moreover, it also highlights the importance of confidence-building measures and engagement in international relations. By not equating power with threat, Walt calls for a return to the US strategy of "offshore balancing," which involves convincing others of the legitimacy of one's policies.

Walt's argument is useful to the extent that it calls into question the realist assumption that changes to and transformations of the international system are caused by shifts in the distribution of military power. Moreover, it also challenges the realist notion that gains are relative and therefore that international politics is a zero-sum game. Moreover, increased interdependence would tend to buttress this argument, given that states can only make gains in some instances by coordinating their responses.

Liberal international relations theorists would argue that the realist assumption that states are more concerned with relative gains is premised on the assumption that the "game" is played only once. They stress that where a game is repeatedly played, cooperative relations may be preferred. This implies that long-term absolute gains are given precedence over short-term relative gains. Iterative relations enable the leaders of states to perceive the long-term absolute gains from cooperative relations as fairly certain.

Prioritizing absolute gains over relative gains within the liberal perspective relies on there already being repeated relations. Where states are poorly integrated into the multilateral arrangements that might provide the means with which to influence outcomes that affect them, we might expect relative gains to be privileged.

Eric Fischer, *London*

Where a state uses its resources to engage in bargaining rather than to secure long-term cooperation with other states, relative gains are likely to be emphasized. In such instances, short-term gains are privileged over longer-term gains. This may be driven by the domestic political situation. If a regime or a country's leaders seek to bolster their legitimacy by short-term gains, it may be unlikely that gains will be deferred.

There is also the variable of the accountability of leaders to their publics. Whether leaders are seeking immediate electoral gains may have an impact on their calculations. It may also be

that the long-term gains are small or uncertain. If a state feels that it has little capacity to affect its long-term benefits, it may opt for maximum short-term gains.

International Organizations

It is important that multilateral solutions are favored over unilateral solutions. For most states this is likely to be the case given the transnational nature of many policy issues and the futility of trying to address them alone. Yet, this may not be the case for states that are inadequately integrated into the multilateral system and maintain a highly particularistic conception of national interests. Unilateral responses to problems are even more damaging to the credibility of multilateral institutions. An added challenge to multilateral institutions stems from their unrepresentative nature. These institutions may therefore be regarded by many as lacking in legitimacy and reflecting the preferences of the dominant states.

Large Collective Identities

Foreign policy choices may negatively affect transcultural relations by fuelling the grievances of members of large collective identities. Policies that create or sustain injustices experienced by a group are unlikely to be in the long-term interests of a state. This is because the need for a stable identity and for a sense of community is vital to human dignity. If people or members of one's community suffer persistent humiliation, the appeal of extremism is likely to be greater. Even ordinary citizens may condone terrorism, for example, as a means of punishing those actors that they perceive as responsible for sustaining the status quo. The difficulty for the state is to achieve the appropriate balance between societal cohesion and solidarity, and the preservation of cultural identities.

Environment and Natural Resources

Environmental degradation does not only affect a country's economic growth, it affects its security too. Environmental degradation may contribute to conflicts over resources, the displacement of people, the destruction of livelihoods and damage to health. The interconnection between the environment, political economy and security means that protection of the environment should form part of a country's policy considerations, not simply in the area of development but also in the area of security. Successful management of the natural resource base on which a country's political stability rests is a foreign policy concern.

ICT

New technologies mean that news can be transmitted at a much faster pace than before — either through 24-hour news channels or using the Internet. This has meant that the media is often used by policymakers to diffuse messages. However, in some instances, this may prompt

policymakers to respond too rashly to events. The public may also rely on Internet news sources that are not mediated by journalists who may at least make some effort to corroborate their stories. Policymakers need to be aware of such sources.

Widespread access, anonymity and the speed with which information can be diffused through the Internet also pose challenges to efforts to prevent it from being employed for nefarious means, such as spreading hatred and inciting violence. Efforts to regulate ICT need to be balanced with the need to allow freedom of expression. Public authorities must find equilibrium between efforts to prevent violence, hatred and intolerance, and efforts to allow freedom of speech.
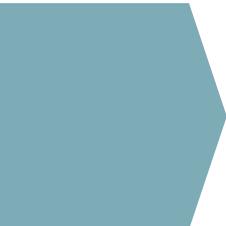
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THE WAY FORWARD

Symbiotic realism provides a normative framework to help guide policymakers in a world that is driven by the dynamics created by the substrates of human nature, formal anarchy, interdependence and instant connectivity.

Individuals

The promotion and protection of human rights must form part of the promotion of security. Yet, this needs to be done in ways that are culturally sensitive and empowering. A people-centered conception of security would provide a framework for the consistent promotion and protection of human rights broadly defined. Human security defined as freedom from want and fear is broad enough to include political, civil, socio-economic and cultural rights. Yet, human security ought to include the promotion of a positive sense of self as well.

While human rights offer an effective means of promoting the well-being of the individual, efforts to promote human rights may be viewed with suspicion. It is therefore important to remember that "humility, understanding, patience, dialogue, and time are all crucial aspects of encouraging the emergence of endogenous convictions, players, and process that take into account historical and cultural specificities" (Al-Rodhan 2009a). Placing the emphasis on human dignity may provide a means of promoting the fundamental principles underlying human rights in a way that is compatible with all moral lexicons.

The State

International anarchy does not have to imply perpetual insecurity, competitive relations and relative rather than absolute gains. Despite the absence of an overarching authority structure, governance mechanisms that regulate state relations do exist, for instance, in the form of international law and soft law comprising good practices and standard setting. There is thus governance without a world government, however imperfect this may be. Moreover, increased interdependence between states means that absolute gains are more likely to be recognized.

Indeed, increased interdependence makes symbiotic relations between states possible. Employed in relation to state-to-state relations, symbiosis may be understood as an interstate relationship in which one party benefits more than the other party, but does not have to imply a serious disadvantage for the less fortunate state let alone an absolute loss.

If there is no "logic" within the international system that implies a perpetual security dilemma, there is no reason to assume that morality has no place in global politics. States often comply with humanitarian norms, and they have reacted to enforce anti-genocide norms, even in the absence of enforcement mechanisms. Moreover, as is suggested above, interaction between states is repeated, implying that greater trust and shared norms may help to reduce insecurity in an anarchic international system.

Symbiotic relations do, nevertheless, depend on a prior degree of integration. In terms of political integration, the leaders of states need to calculate that the long-term absolute gains bring more than the short-term relative gains, and that they have the capacity to influence decisions that affect them. This implies that states need to be well represented in multilateral institutions and arrangements. The accountability of leaders to their public is also likely to reduce short-term calculations. Good governance, which entails accountability, should be promoted, but in a way that is sensitive to local political and cultural structures.

Large Collective Identities

Greater efforts need to be made to construct a shared consciousness based on the compatibility of fundamental moral principles. Synergy is suggested as a guiding principle for states faced with the challenge of successfully managing culturally plural societies. Intra-civilizational synergy should be sought. Synergy occurs where the effect of two entities, influences or agents is greater than that which could have been predicted from the known effects of each.

Synergy relies on there being a certain degree of transcultural understanding. Dialogue and engagement are essential parts of foreign policy. Active measures to promote the spread of knowledge aimed at encouraging peaceful transcultural relations should also be employed.

Rapid changes are underway that are altering traditional structures and reference points. However, the focus in the West, particularly in relation to Islam, is often on extremism. Yet, the

peaceful and moderate majority should not be confused with extremist groups. Combating extremism will rely on addressing its root causes, and reducing poverty and marginalization. The appeal of the extremist has to be dented. Solutions to the problems of extremism that are indigenously conceived are likely to be more successful than those imposed from the outside. There should therefore be a constructive effort made to support and help finance local initiatives aimed at reducing the appeal of extremism.

The promotion of justice also needs to form an important part of foreign policy. Injustice can lead people to feel alienated from their societies. Those who seek to propagate extremist ideologies are most likely to be successful wherever injustice exists and there are no apparent mechanisms to remedy that injustice. Greater justice needs to be promoted.

International Organizations

Multilateral institutions need to be more representative so that all member states feel that they constitute an effective forum in which they can further their interests in a cooperative manner. Similarly, the special privileges attributed to major powers must be eliminated so that multilateral institutions are not perceived as mere instruments of the powerful. It is also important that the less powerful members of an institution are included in the design process for any reforms. In order to encourage such states to opt for cooperative relations, policymakers need to support measures to ensure that all members of multilateral institutions are represented.

The Environment and Natural Resources

Protecting the environment and promoting sustainable development require cooperation and burden-sharing between states, multinational institutions, NGOs, social movements and the scientific community. The scientific community will play a key role in presenting information on the impact of environmental degradation in a clear and scientific manner to policymakers and the general public. States need to publicly fund studies on the environment so that scientists and the public can make informed choices and hold politicians accountable. Yet, the capacity of politicians to curb environmental degradation is sometimes constrained by the role played by money in electoral and political systems. The influence of industrial lobbies needs to be reduced.

Investment in substitutes for natural resources that are likely to run out in the near future needs to be made now. Reducing the depletion of natural resources also requires lifestyle changes, particularly in the developed countries.

ICT

The 2003 Additional Protocol to the Council of Europe's Convention on Cyber Crime provides a model for enacting legislation that makes the spread of hatred and incitement to violence via the Internet a criminal offence. Regional efforts to regulate ICT ought to be coordinated with

global efforts. There is also a need to engage in dialogue over the normative basis for regulation, as well as what constitutes the "right balance" between efforts to regulate the harmful use of the Internet and the right to freedom of expression. The tools with which to survey and encourage greater responsibility on the part of Internet users, such as bloggers, also need to be developed. Bloggers, for example, could be required to reveal their real name when they register, but use a pseudonym when they write.

CONCLUSIONS

Based on my conception of human nature and globalization in a nonhierarchical global system, I propose a more comprehensive vision of the dimensions and dynamics of our interconnected world, which I call *symbiotic realism*. In this approach the major actors are believed to be: 1) the individual; 2) the state; 3) large collective identities; 4) international organizations (multilateral institutions and NGOs); 5) transnational corporations; 6) the environment; 7) natural resources; 8) women; and 9) ICT.

Symbiotic realism seeks to go beyond the state centrism of realism to focus on the predilections of human nature, global anarchy, interdependence and instant connectivity. It identifies a number of non-state actors such as large collective identities, international organizations and transnational corporations as important in helping to shape the global system. Foreign policy challenges include overcoming the tension between narrow conceptions of state sovereignty and international norms that shift the focus to the security of the individual.

We might also imagine an increasing tension arising between the principle of state sovereignty and concern for the protection of the biosphere. Unequal power relations between states and a continued emphasis on relative gains also pose considerable challenges to the need for cooperative and coordinated responses to today's problems, which require an emphasis on burden-sharing and absolute gains. In addition, there is a need to achieve a correct balance between respect for cultural specificities and the identification of common fundamental values.

Symbiotic realism's focus on the four dimensions mentioned above offer a paradigm with which to overcome these challenges. It suggests that emphasis should be placed on the promotion of human dignity, symbiotic relations between states premised on absolute gains, the promotion of justice and transcultural synergy.

Symbiotic realism recognizes the difficulty of engaging in moral behavior in the absence of an overarching just authority or a responsible hegemon. Innate survival instincts and motivators of behavior have prompted IR scholars to wrestle with these issues in an effort to offer guidance to states in their relations with others. I point out, however, that realism identified only some of the important motivators of human nature and of states.
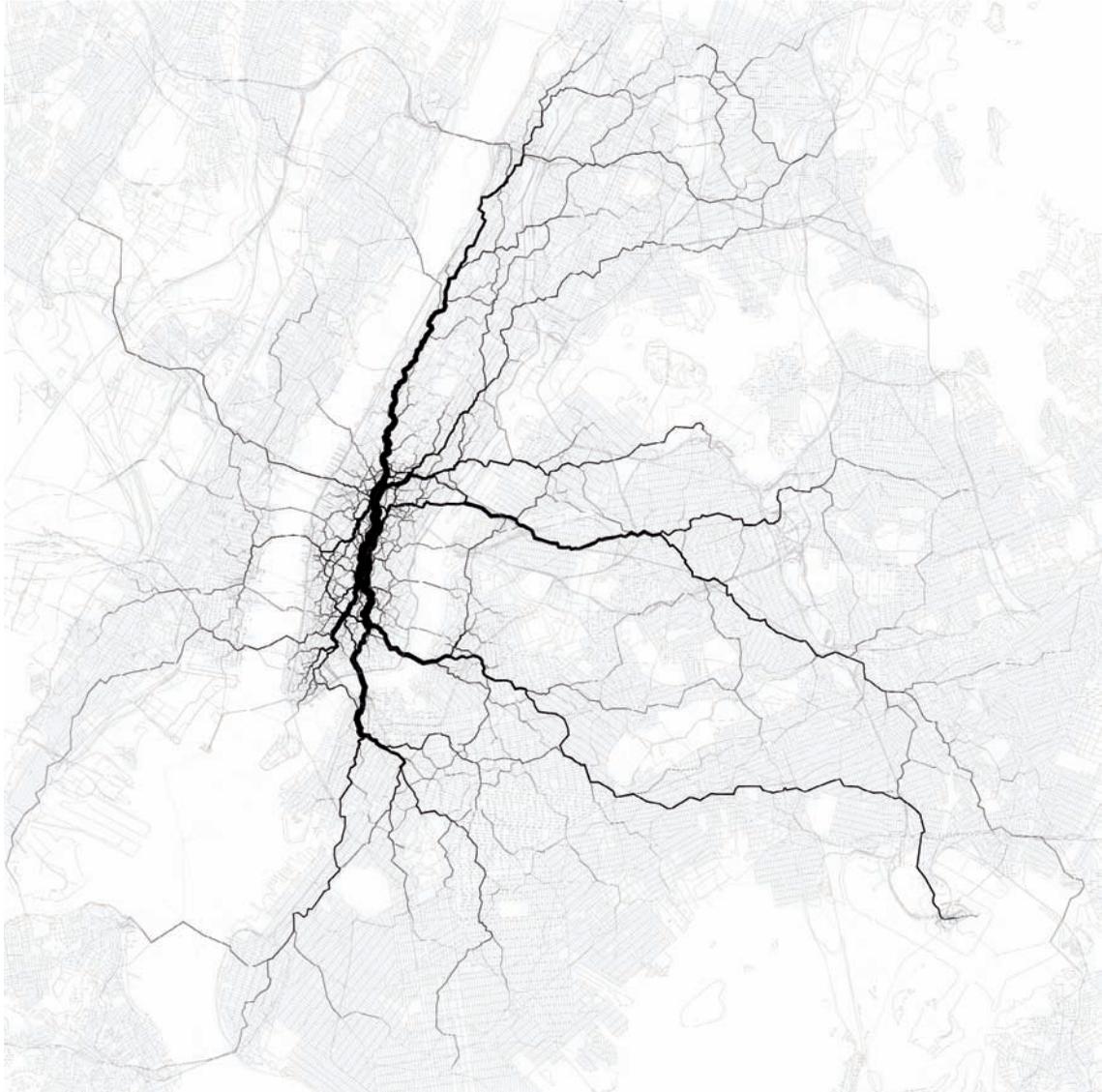
Eric Fischer, *New York*

Substrates of human nature that require recognition of the importance of perceptual frameworks and norms are lacking. Insights from neurobiology, I contend, provide a more complete picture of the predilections of human nature and have important implications not only for how I conceive of individuals and states, but also for how I identify relevant actors and the significance of international anarchy. I also argue that the interdependence and instant connectivity linked to globalization are central to gaining an understanding of the implications of human nature and global anarchy.

Specifically, symbiotic realism helps to explain why the US, for example, can lead without having to confront alliances from other major powers. It also indicates that a hegemony based on consent may provide the best means at present of mitigating the consequences of the interlocking dimensions of human nature, globalization, and global anarchy.

A dual ontology also enables symbiotic realism to capture the sense in which large collective identities, whether substate or suprastate, are fluid entities that are continually adapting to changing environments, part of which entails rubbing up against other collective identities as a result of instant interconnectivity and intensified human mobility. Collective identities are significant to the dynamics of the global system because human beings have a desire for a positive identity and a sense of belonging, but are also capable of cultural arrogance and exceptionalism, which taken together may heighten insecurity and the likelihood of conflict.

Symbiotic realism outlines a governance structure that takes into account the predilections of human nature as I define them, together with global anarchy, an intensified interdependence, and instant interconnectivity. At the individual level, it proposes a domestic governance structure that includes, but goes beyond, traditional liberal rights to incorporate dignity, inclusion and freedom from fear and want.

At the interstate level, it proposes a symbiosis, which refers to situations in which a relationship of mutual dependence can allow one state to gain more than another without causing insecurity. This implies, first, that absolute gains are possible and that the "game" of international relations is not necessarily a zero-sum one. Second, it suggests that under conditions of interdependence, states are unlikely to engage in balancing behavior. Third, this implies that a responsible hegemon should accommodate the interests of other states and avoid threatening behavior.

At the global level, I suggest that states should work together multilaterally — with international organizations — in order to advance a more just and environmentally sustainable global order. At the transcultural level, I argue that relations between diverse cultures should be guided by the principle of synergy, which implies that a plurality of cultures and subcultures will have a greater net effect than any one geo-cultural domain alone.

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REALISM HAS DOMINATED THE STUDY OF INTERNATIONAL RELATIONS AND A GREAT DEAL OF FOREIGN AND SECURITY POLICY THINKING. IN GENERAL, STATES ARE ASSUMED TO BE UNITARY RATIONAL EGOISTS, BEHAVING ON THE BASIS OF RATIONALLY CALCULATED DECISIONS ABOUT OUTCOMES THAT MAXIMIZE SELF-INTEREST. IN ORDER TO ENSURE THEIR CONTINUED SURVIVAL, A STATE'S PRIMARY CONCERN IS THOUGHT TO BE TO AMASS POWER AND TO FORM ALLIANCES AGAINST ANY STATE THAT THREATENS TO UPSET THE ESTABLISHED POWER BALANCE. IN THE ABSENCE OF AN OVERARCHING AUTHORITY CAPABLE OF ENFORCING COMMITMENTS, MANAGING CONFLICT AND PROVIDING SECURITY, MORALITY IS BELIEVED TO HAVE NO PLACE IN INTERNATIONAL RELATIONS. BASED ON HIS CONCEPTION OF HUMAN NATURE, GLOBALIZATION, AND THE INADEQUACY OF REALISM, IN A CONNECTED, INTERDEPENDENT, NON-HIERARCHICAL WORLD, NAYEF AL-RODHAN PROPOSES A MORE COMPREHENSIVE THEORY OF THE DIMENSIONS AND DYNAMICS OF OUR GLOBAL SYSTEM, CALLED *SYMBIOTIC REALISM.* IN THIS THEORY, I EXPAND THE GLOBAL UNITARY ACTORS TO INCLUDE: 1) THE INDIVIDUAL; 2) THE STATE; 3) LARGE COLLECTIVE IDENTITIES; 4) INTERNATIONAL ORGANIZATIONS (MULTILATERAL INSTITUTIONS AND NGOs); 5) TRANSNATIONAL CORPORATIONS; 6) THE ENVIRONMENT; 7) NATURAL RESOURCES; 8) WOMEN; AND 9) INFORMATION AND COMMUNICATIONS TECHNOLOGY. THE FUTURE OF INTERNATIONAL RELATIONS NEEDS TO BE SEEN THROUGH THIS SYMBIOTIC REALISM FRAMEWORK, TO INSURE A MORE JUST AND SUSTAINABLE GLOBAL ORDER FOR ALL INDIVIDUALS, STATES AND CULTURES.

BIOGRAPHY

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The Future of Global Cooperation: What is missing? What could be successful?

Claus Leggewie

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At the beginning of the twenty-first century, the world is confronted with a kind of a cooperation paradox. It is popularly believed that cooperation is something in which individual and collective actors pursuing common goals engage, while actors who have differing world views and pursue conflicting objectives are disinclined to cooperate. Until 1990, during the East-West conflict, however, two opposing blocs faced each other, although there was cooperation between them. Militarily, they were armed to the teeth; ideologically, they were worlds apart; and socio-economically, the development of society under capitalism was incompatible with that under communism. But the two power blocs were united by the goal of preventing the Cold War from escalating into a nuclear conflict, causing collective self-destruction.

The intensity of the antagonism did not, then, exclude peaceful co-existence under the banner of mutual deterrence. In this game it was clear that the two sides were in the same boat. And that neither could eliminate the other without running the risk of going under itself. The 1962 Cuban missile crisis showed how close the world had come to the abyss, and in Southeast Asia, Central America and the Middle East the tension was eased in proxy wars, again without it coming to a global conflagration. From the late 1950s, the policy of détente dominated, without the capitalist and communist models being abandoned.

Today the reverse paradox prevails. The world, having meanwhile become multipolar and new powers having emerged, is — if the proclamations of the G8 and G20 summits or the UN negotiations are to

Dionisio González, *The Theater of the World. Aldo Rossi. 1979*, 2011

be believed — essentially in agreement on such general objectives as green growth and fair trade, limiting climate change and the extinction of species, reform of the financial markets and the eradication of poverty and hunger. Such commentators on our times as Francis Fukuyama have therefore revived Hegel's rhetoric on the "end of history."

Despite all the normative and ideological convergence, alas, the instruments, institutions and actors needed to turn the consensus into reality are lacking. An example of this is the "two-degree guard rail," the international community's intention, endorsed by almost every country in the world, to limit man-made global warming to two degrees (compared to the pre-industrial level). However, in the absence of globally binding agreements the world is, in fact, heading for far more than two degrees of warming and so for dangerous tipping points that threaten the existence of humankind in much the same way as a confrontation with nuclear weapons (which is, moreover, still within the bounds of possibility).

Why is this? Are there insurmountable differences of interests, do people see and judge the situation in the world differently, are they pursuing different values? The prisoner's dilemma commonly encountered in game theory tells us that even players with the opportunity to cooperate and so win together will betray each other if each is unaware of the other's choice and therefore distrusts him.

Rather than short-sighted benefit maximisation, other commentaries on our times see cultural differences as causes of cooperation refused. Whether "culture" is an obstacle to or accelerator of cooperation depends not least on precisely what this term is taken to mean. Those who consider it to be a substance that is indissoluble and transplanted only with difficulty will tend — like the eminently political scientist, Samuel P. Huntington — to assume there to be a *clash of cultures*; if, on the other hand, cultural difference — not only between ethnic and religious groups, but also between genders and generations, between top and

bottom, the rich and the poor, mentalities and environments — is regarded as the norm for relations in modern society, efforts will be made to create conditions under which these different worlds can best achieve shared objectives. (One may be frustrated to observe — more than twenty years after the Rushdie case — how easily *agents provocateurs* on both sides, most recently the producers of a stupid anti-Muslim video in the US and the mob stirred up by fanatics in the name of religion, can inflame the world.)

It is surprising how little we yet know about "culture" as a factor in world society. Research focuses predominantly on cooperation in small groups wanting to achieve shared objectives, a common utility (*utilitatis communio*) and a common cultural background being the main assumptions. Where, unexpectedly, cooperation does not come about, what remains — culture — is taken into account, initially to explain the failure and then, possibly, to overcome or avert it. How cooperation works in larger groups, in large international organisations or even between societies that differ culturally in some way or other (which, as has been said, is the norm) remains a mystery.

As concerned scholars as well as citizens, our aim is to get to grips with what is, by its nature, a transdisciplinary question and to do so empirically and by reference to basic theory. How, for example, do such intercultural teams as aircrews, disaster relief workers, hospital staff, police forces and civic centres operate as they and their clients become increasingly varied linguistically and culturally? Is the UN General Assembly a diplomatic stage for culturally blind power politics or, in a figurative sense, a theatre of the world's cultures? Is there such a thing as Asian values (and do they conflict with Western Christian values, whatever they may be)? In other words, are unfamiliar cultures a source of enrichment, or do they encounter each other like cats and dogs? Furthermore, who wants to see it this way — and who assumes precisely the opposite, a humane inclination to empathy? Does it help to have travelled in foreign regions, or does that tend to feed the prejudices? How do altruistic assistance and global solidarity work in the event of epidemics, famine and philanthropic deeds? In our multicultural everyday lives, we all make certain observations, but the ambivalence of the cultural factor is certainly inestimable.

Rather than becoming set on its remedial or ruinous effect from the start, we should therefore consider the culture of cooperation itself. Cooperative relations are, after all, based not only or principally on matching interests, tit for tat, shared expectations of benefits and mutual obligations of *homo oeconomicus*. Cooperation is also and especially a mark of the "pointless" play of children; a musical ensemble improvises not (only) because they want to sell a disc; the dancers in a *corps de ballet* work together for the sheer joy of it; and a choir sings largely for the sake of singing together. Or look at a festival with its rich presentations and performances where the organizational infrastructure is always topped by an immense playfulness of actors and players in the strictest sense.

These small examples demonstrate the *intrinsic* value of cooperation as such, a value that is based on empathy and emerges from itself. The exchange of gifts, which engenders mutual obligations but may also include "irrational" profligacy, is a concept that has migrated from ethnology to cultural studies and that needs to be examined under the conditions of global interaction. What matters more than ever in global cooperation, then, is that these cultural elements are analysed and applied with extreme caution to large negotiating arenas and causes of confrontation.
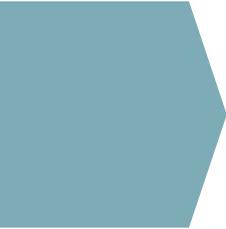
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THE EUROPEAN CONUNDRUM

Let us now change the perspective and have a closer look at Europe and the miserable state of the European Union. For the essential reform of the European Union, two major building blocks are missing: transformative policy and democratic legitimacy. The "growth package" adopted in Rome in June 2012 is far from being a master plan for the southern European countries on the model of the European Recovery Program, or Marshall Plan, for the Europe that was left in ruins after 1945. The venture still lacks any kind of spark and, moreover, any genuine new money, since all that has been done, for the time being at least, is to re-label some poorly used and distributed EU structural aid and to polish up some investments by the European Investment Bank that had already been planned. This is not the way to create a more ecological or socially fairer Europe.

More serious is the evident failure of the elites of the European executives to attach any particular importance to the legitimacy of their plans. If the radical change to the European institutional system outlined by the EU leaders was prescribed and implemented from the top down, it would probably be the EU's final crisis — the accumulated legitimacy deficit would almost certainly mark the end of the Union, and the national populists could fight over the remains like vultures. "No taxation without representation" is the basic rule of representative democracy — those who pay taxes also want to govern themselves. It was the president of the EU parliament, Martin Schulz, who reminded the "makers" of this elementary rule of democracy.

Any acceleration towards a European economic and financial government must be approved and controlled by a European *demos*. (Let us here assume them as the "actors and players" on

Dionisio González, *Gardella Restated: The House of the Zattere. 1953-2011,* 2011

stage). Although the Gang of Four consisting of EU Commission President José Manuel Durão Barroso, Euro Group President Jean-Claude Junker, European Council President Herman van Rompuy and the head of the European Central Bank, Mario Draghi, called for a "stronger democratic basis," they did not go into the specifics. Democratic legitimacy and control are, however, essential if there is to be "more Europe." The general public will withdraw their support from any enlargement agreed in the shadows, and in June 2012 the guardians of the German Constitution in Karlsruhe promptly intervened, because they found the process not to have sufficient democratic legitimacy from the German viewpoint. On the other hand, they ruled that the ratification of the permanent European rescue fund, the ESM, and of the European fiscal pact, was constitutional.

Thus the German Constitutional Court has ruled that Parliament must have knowledge of and be involved in the resolution of the European sovereign debt crisis and the rescue of the euro. But, even in normal times and on far less spectacular occasions, the balance of power and division of labour between legislative and executive has been shifting away from Parliament.

Everywhere the subject matter is allegedly too complex (as in the case of health policy), too technical (energy policy), or too legal (every policy). Speed is objectively of the essence because the many and varied crises in industrial society are limiting the state's ability to exercise control, forcing it into permanent crisis intervention. The restriction of parliamentary rights is one aspect of the collateral damage caused by the privatisation of politics — whose only function now is to act as a fire brigade — and it is bound to fail when an active state and regulative policy are urgently needed.

In the past, Europeanisation too has often meant, in the absence of a fully fledged EU Parliament, deparliamentarisation and less democracy. Even in earlier rulings, such as its judgment in June 2009 on the Lisbon Treaty, the Federal German Constitutional Court set itself up as the protector of nationally constituted democracy and of the sovereign state in the shape of the *Bundestag*, the German Parliament, and specifically as the guardian of Article 23 of the Basic Law, which requires the *Bundestag* to be informed comprehensively and at the earliest possible time. Karlsruhe will intervene whenever German democracy is eroded by EU rules imposed by

Berlin and Brussels. But the national perspective underestimates the real shift of political power to the supranational level at which — in far more striking fashion than the EU — such clubs as the G8, the G20 and the WTO operate. Here — in an informal and content-related way — democratic control and countervailing power create at best NGOs that are influential and receive media exposure, act as champions of local opposition or global commons and tend to merge into the transnational decision-making system as experts for one side of the argument or the other.

Karlsruhe will apply the brakes whenever the end result of fiscal union and economic government is likely to be the United States of Europe, with Strasbourg, of course, upgraded to a real Parliament. To that end, not only must the Basic Law be amended, but Germany will eventually (or perhaps even quite soon) have to adopt a new Constitution, and Europe must at last be given one. EU Commission President Durão Barroso's proposals for the further development of the EU into a "federation of nation states" point in precisely this direction. The German Constitutional Court can no longer fend off this dynamic, because the European dimension of the principle of democracy adopted for the Basic Law is undeniable.
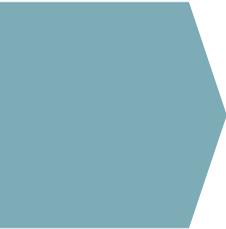
> **European identity has always been ex-centric, since much that is "European" hails from Asia (Minor), and always ex-territorial, since Europe exported its achievements to the rest of the world in both peaceful and aggressive-colonial ways. The instability of the borders to the south (and to the east) becomes almost physically tangible in the Mediterranean space**

The drawback with the extensive, though not sufficiently extensive, proposals put forward by Wolfgang Schäuble and the Gang of Four is that they are still tailored to a core or residual Europe and would widen the gap between the euro countries and the non-members of the Monetary Union, specifically the UK and the Czech Republic — in other words, they would accelerate dissociation tendencies that have already grown not only in London and Prague, but also in The Hague and Helsinki.

However, it would be wrong to think that a core Europe would be stronger than the EU 27 or a greater Euro-Mediterranean region: only as a large power can Europe counterbalance the *political* competitive advantages of the United States or China. And at this point democratic legitimacy and transformative policy come together again: a Euro-Mediterranean Union (by analogy with a Baltic Sea Union, an Alps-Adriatic Union, etc.) will not only provide the working basis for a real development pact: it may also offer a federal perspective for the sustainable democratisation of the region.

A Europe of the Regions has so far been envisaged and arranged on far too small a scale, as a provincial prop for a large quasi state ruled from Brussels and legitimised from the

capitals. Regional associations on the basis of a common cultural heritage and multicultural encounters may revive the good old principle of European federalism — they rise above the nations that often operate today as blockading powers, but they are also still near enough to the cultural characteristics and networks of the people of Europe.

NEW MÉDITERRANÉE?

Since antiquity, the harbours of the Mediterranean have exerted a fascination over travellers and cultural researchers. Visiting them today, however, one is presented with no more than a shadow — part run down, part picturesque — of their former grandeur and importance. These ports once lay at the heart of the first trans-Mediterranean phase of globalization, the central axis of which shifted to the Atlantic in the sixteenth century. Nowadays, the turnovers of even the larger Mediterranean harbours, such as Istanbul or Marseilles, are easily outstripped by the container terminals in East Asia and the Gulf.

Harbour cities as places of movement, immigration and emigration, as places of inclusion and exclusion, develop distinct modes of being that not only reflect different cultural traditions and political and social self-conceptions, but also contain economic potential and communicate how they see themselves as part of the larger structure that is "Europe."

The Mediterranean serves as a passageway for around one third of all global transports of crude oil and natural gas. Its harbours are largely the destinations of cruise liners and ferries, just as its airports are the starting and end-points for beach holidays and city breaks. Fishing, another an icon of southern Europe, has also changed in character. The photograph in the pizzeria of a fisherman mending his net promotes the *Méditérranée* brand but bears little connection to the reality of the heartlands of mass tourism.

Due to the expansion of EU fleets and the invasion of Asian fishing boats, overfishing endangers species such as tuna and swordfish; in many cases, the maximum sustainable yield can no longer be reached and overall fishing quotas have decreased substantially. The current United Conventions Law of the Sea grants each state an exclusive sovereign right over a coastal zone, extending up to 200 nautical miles into the sea, for the exploration and exploitation of resources. This is in addition to the continental shelf, the (notional) extension of the continent underneath the surface of the sea. In the "small" Mediterranean, this gives rise to much overlap, which could well become a point of conflict in the future — especially when it comes to gas fields and offshore drilling rights.

However, the sea incurs most damage from its interaction with land use — industrialized agriculture, fierce urbanization and holiday paradises, with their high levels of consumption and waste, are what puts the most strain on the Mediterranean. Tourism and industry enter into

competition, but they are also directly related. Salinization, eutrophication (caused by effluents) and algal growth pose a further danger to the Mediterranean ecosystem that is warming as a result of climate change.

The Rhône and Po rivers, in particular, carry copious masses of heavy metals and chemical substances into the Mediterranean; nitrates and phosphates, which enter the rivers through permanent over-fertilization, cause algal bloom to proliferate on coasts where water exchange is restricted. Freshwater inflow is decreasing constantly, compounding disadvantages connected to the slow rate of salt water renewal in the Mediterranean (every 80 years). According to estimates, the Mediterranean annually absorbs 500 million tonnes of slurry, 600 000 tonnes of nitrate fertilizer, 200 000 tonnes of phosphorus fertilizer and many further thousands of tonnes of heavy metals and radioactive waste, primarily from French nuclear power stations. Coastal dwellers, seafowl, crustaceans and fish are severely affected by these toxic inflows. The coasts of northeast Spain, the French Riviera and the Adriatic are particularly contaminated.

Shipping, oil harbours and refineries pollute the Mediterranean with toxins; a constant convoy of tankers moves between the Suez Canal and Gibraltar. A tanker collision causing an oil spill would be devastating for the entire Mediterranean ecosystem, as was demonstrated by the heavy pollution of the Lebanese coast in 2009. An estimated 800 000 tonnes of oil flow into the Mediterranean annually, making it among the most polluted seas in this respect too. The waste generated by cruise liners, in particular, equals that of small cities and is not always disposed of according to regulations; the high carbon emissions these popular fleets emit are another matter.

The harbour cities of the Mediterranean are still located at the intersections of global networks, but they no longer possess a sense of self or vitality. The impression given today by cities like Genoa, Almería, Palermo or Piraeus corresponds all too closely to the image of the PIGS. This porcine acronym — regardless which stockbroker, Eurocrat or clown thought it up — stands for a crisis that concerns the entire European Union. Many in the north would be happy to cut loose of the quartet at the earliest opportunity, while the dominant mood in the south is one of "let's break the yoke of Brussels." Together, they evoke the image of a nation-state yet more incapable of regulation or effective action than the increasingly challenged supranational community of the EU.

The southern periphery of Europe, extending from Portugal to Greece via the North African states, is nowadays regarded as a zone of threat, almost like the Eastern Bloc during the Cold War. The South — formerly a political compass point generally evoking positive and carefree associations in the popular imagination and in political culture — has been designated by politicians and the popular opinion as the source of the greatest security risks: Islamist terrorism, "contagious" euro-collapse and waves of refugees from the global South.

HISTORY, TERRITORY, EMPIRE

A supranational construct of Europe that imposes boundaries but also makes them negotiable has contradiction built into its genetic code. Looking at maps of Europe at various times since antiquity, this hardly seems new — Europe's external borders as well as its internal ones have shifted infinitely often. However, the era of nationalism and the nation-state — with its illusion of the coincidence of territory, language, history and collective identity — has encouraged a certainty of definition more incompatible than ever with a porous external border. The European Union, as a "supranational partnership of convenience that is, as a matter of principle, open to expansion," has borders that are inherently fluid; they are regulated by European law and notoriously contested in border regions.

In the Mediterranean space — the "middle sea" between Europe, Africa and Asia — these fluid borders are all the more problematic, since they cannot be symbolized by a fence or equivalent territorial demarcation. Instead, borders literally disappear into the shimmering horizon and can only be maintained through the occasional patrol. Here, the experience of globalization contemplated by Georg Simmel over a century ago becomes social fact: borders are cultural regulations that (can) take form spatially. The European Union is thus best understood through its borders.

But its borders are also where its sovereignty is most strongly under attack. Ultimately, this is an expression of the perennial problem of European identity. It is an identity that has always been ex-centric, since much that is "European" hails from Asia (Minor), and always ex-territorial, since Europe exported its achievements to the rest of the world in both peaceful and aggressive-colonial ways. The instability of the borders to the south (and to the east) becomes almost physically tangible in the Mediterranean space: in water, boundary lines become fluid and ambiguous and their validity is contested. The weather, the conditions of the ships, and patrols add to the uncertainty.

Until recently, the Mediterranean was a hotbed of instability, not to say a combat zone. This is something forcefully evoked in Mathias Énard's extraordinary novel *Zone*, whose protagonist, like some furious Achilles, harkens to the echo of past battles and retraces more recent massacres — from Homer's Trojans to Jean Genet's Palestinians, from the Spanish Civil War to the Algerian War, from the crimes of the German occupying force in Greece and the deportation of the Jews from Thessaloniki to the murderous collapse of former Yugoslavia or as another review put it, from the Battle of Thermopylae to Napoleon's Montenotte Campaign, Gavrilo Princip's pistol-shot, the deportation of the Greek Jews, the slaughter of the Palestinians in the camps at Sabra and Shatila, the disembowelment of a Serbian grandmother with her crucifix. In Serbia, the Mediterranean is occasionally called the "blue cemetery."

Dionisio González, *Hotel Bauer,* 2011

If Mediterranean politics are to be realistic, they must be aware of this history of violence so as not to have to experience it anew. The process of becoming history can also, however, teach us about the ways in which the Mediterranean space, with its harbour cities and its islands, was peacefully interwoven and politically, economically and culturally connected. The concept of the *polis* was famously developed and put to the test in the Mediterranean by one of the world's first naval powers — the city-states of the Delian League — in the fifth century BC. Their

symbol was the Acropolis in Athens, whose construction was ordered by Pericles and which has now become the tumbledown icon of the Mediterranean "pigsty" in the evening news.

Without wanting to idealize this league of *poleis* (*hoi Athenaíoi kai hoi sýmmachoi*) and render it excessively topical, it nonetheless contained a political core relevant to how we might think of contemporary transnational cooperation: a horizontal association, unusual for its time, of small cities granting democratic involvement to their full citizens, emerging as political power in place

of an oriental land power, the despotic Persians. Symmachy allied city-states on the Greek mainland, in western Asia Minor, in Thrace and on the Aegean Islands; their meeting-place was first the Cycladic isle of Delos, then Athens, while the League's financial resources, amassed through members' tributes, were kept in the temples of Apollo or Athena.

Founded as a defensive front against the Persians, whom it defeated at the Battle of Salamis, the League became an instrument of Athenian hegemony. Colonization went hand-in-hand with the export of democracy, until the League came primarily to serve the interests of domination and exploitation — then, as now, democracies waged wars of aggression. Athens' brutal attack on the insubordinate inhabitants of the small island of Melos is evidence of this, as is the environmental crisis that took place in the fourth century BC, attested by archaeological finds, caused by slag heaps from lead mines and radical deforestation for the purpose of acquiring firewood to fuel furnaces.

Whereas older empires (with the exception of the Vikings) were land-bound, in modern times the sea forms the natural and systemic environment of the international state order. The crystallization of modern statehood and economy was substantially advanced during the "age of discovery," a process of trans-Atlantic, globalizing colonialism that took place first under the aegis of Portugal and Spain, then the Netherlands and Britain; international relations, international law and free global trade to a great extent developed on this basis. Here, the Mediterranean was no more than the starting point from which the Florentine Amerigo Vespucci and the Genoese Christopher Columbus crossed the Atlantic, leaving from Lisbon and Cadiz.

Maritime expansion differed considerably from terrestrial expansion in that it was neither guided nor constrained by borders. This *de facto* universalism, or spontaneous cosmopolitanism, left a lasting mark on maritime law and relations of trade and traffic that span the world today; however, it also increasingly became a function of terrestrial development, based upon the composition, concentration and cooperation of nation-state systems. From the sixteenth century onwards, the Mediterranean was relegated to the periphery.

CULTURE, TRADE, MIGRATION

Scholars like Swiss-Slovenian historian Desanka Schwara have described the Mediterranean region as a nested structure of diaspora communities. In imperial spaces, migrant milieus were founded on the basis of sea long before modern nation-states were shaped and consolidated. The most important representatives of these communities were merchants, mariners and pirates; people who were highly mobile, who placed great importance on their freedom of movement and who — in the interests of profit and booty — were bound not by the loyalties of

nations but those of religion and the extended family. The Mediterranean lay before them as an expanse for the acquisition of goods, passengers and ideas; they turned it into a dense communication zone of different worldviews and rivalling beliefs, which became manifest in a chequered calendar of religious holidays. At the same time, the boundaries between sanctioned trade and criminal and clandestine privateering, between theological dispute and missionary zeal, were fluid.

The Mediterranean as zone of diaspora, in which "routes" counted more than "roots": this view must not lead to the romanticization of mobility and deracination, for in earlier epochs, too, migration was often violently induced. In and of itself, diaspora — literally "dispersal" — is not the breeding-ground of innovation and cosmopolitanism; it only becomes this under favourable circumstances of urban tolerance. The more neutral term "networks" thus seems more apt. Be that as it may, the physical interactions and imagined bonds in the Mediterranean region established neither a clear common identity nor a territorial unity; rather, they created "margins" (see Natalie Zemon Davis), interstitial worlds. These hark back to Europe's cultural origins in Mesopotamia and radiate into the north and south Atlantic regions, the colonized areas of Africa and Asia, and the many Mediterranean diaspora communities worldwide. In this sense, *Méditerranée* can be found with the Sopranos in New Jersey, the Papakonstantinous in Melbourne, and the Mandelbaums in Los Angeles and Shanghai.
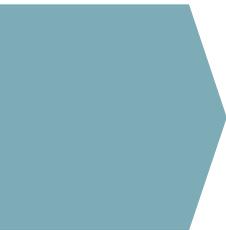
> The powers that long ago characterized the Méditerrannée ought not to be held up as a contemporary ideal. Certainly, the downfall of the Mediterranean world is a history of loss. Yet it is legitimate to search in that history for a structure for contemporary Europe, elevating the network of city-states to the status of model and hub of Euro-Mediterranean unification

Since the time of the Phoenicians and the Etruscans, networks between city-states have been especially important for Mediterranean worlds; their exchanges, as Fernand Braudel and others demonstrated, endowed the Mediterranean area with factual unity. As long as this network functioned, it was possible for the Mediterranean region to lie at the centre of the world and to be the arena of the first stage of globalization. Its influence and formative power waned as globalization expanded along the Atlantic axis and as international relations came to be informed by the Westphalian sovereignty of denominationally homogeneous nation-states and the race for imperial spheres of influence.

For this reason, it is necessary to recall the historical urban systems whose vitality derived from the existence of a public space frequented and shared by all (male) communities. In this

Dionisio González, *San Giustinian Lolin,* 2011

space, the palette of professions, nations and denominations unfolded; it was able to integrate a high degree of heterogeneity and afforded considerable latitude to minorities and outsiders, opening up possibilities for social ascent and political careers. In it there developed a wealth of male-dominated systems of patronage and clientele, business connections and networks of friendship — unique in world history; the public space was where people met in taverns, coffee houses and ballrooms, where charity was practised, amidst banks and pawn shops.

One fact merits at least a brief note: this "Christian Occident" was strongly influenced and informed by Jewish and Muslim minorities and elites, while the Arabs only reached their own high level of development as a result of expansion to the south of Europe via Mesopotamia, Syria and Egypt. In the late Middle Ages and the early modern era, cities like Damascus, Cairo, Kairouan, Fes, Palermo, Córdoba and other places in al-Andalus were the centres of the religious and scientific world. Theology, philosophy, jurisprudence, mathematics, astronomy and

other subjects blossomed, as did literature, architecture and medicine. It was at the Toledo School, in particular, where the leap from antique culture to modern Europe was made; Arabic was the lingua franca in which important works of world literature were composed, including those of the Golden Age of Jewish literature.

The Reconquista, the expulsion of Islam and of Jews from the western Mediterranean area, dealt a major blow to intellectual development in Catholic Europe, just as it did in the Arab world. However, without al-Andalus's achievements in translation and transfer, neither Spain's ascent to become a world power nor the later global dominance of western Europe would have been conceivable. Those who dismiss such reminiscences as "multiculturalist" romanticism are wrong. No one is denying the political and theological competition between the monotheistic denominations, or the conflicts that on numerous occasions were settled through violence. But no one should misjudge the achievements of this epoch and hence its function as model for a Mediterranean union of a new type, which it has increasingly come to be since 2001, for reasons of political expediency.

The powers that long ago characterized the *Méditerrannée*, and that are now probably lost beyond retrieval, ought not to be held up as a contemporary ideal. Certainly, the downfall of the Mediterranean world since the sixteenth century, with all its diversity, represents a history of loss. However it is a history that must be observed soberly. At the same time, it is legitimate in the current crisis to search in that history for the basis for a polymorphic structure of contemporary Europe — a structure that, while devoid of any pressure to imitate, elevates the network of city-states to the status of model and hub of Euro-Mediterranean unification. The *Mare nostrum* would thus be decolonized for good and its national, ethnic and religious antagonisms mitigated.

In the coastal regions and island zones of the Mediterranean, city-states with a high awareness of their autonomy first emerged as antipodes to territorial states and later functioned as lively and self-confident enclaves. It is therefore no coincidence that much Mediterranean scholarship, including fiction and essays, refers to these urban agglomerations more than to the provincial and agrarian hinterland formerly considered by many anthropologists and travellers as the Mediterranean world's centre of calm and guarantor of stability. There are now an infinite number of centres on the map of the Mediterranean: the towns established by the Phoenicians and Etruscans, Athens, Carthage and Rome in classical antiquity; the residences of the Carolingians and the Hohenstaufens; the large and small metropolises such as Byzantium and Granada, Venice and Ragusa — the list goes on. It was in the Mediterranean region that the modern city as type, with its clear pattern of urbanity and urbanization, developed *par excellence*, its model character lasting up until the American (suburban) city emerged and became dominant in the nineteenth century. Even today, most residents of the region live on the coastal strips and on deltas (most densely in the merging

metropolitan region of Cairo/Alexandria, in megacities such as Istanbul, and in agglomerations around Athens, Algiers, Rome, Marseilles and Barcelona). Viewed by night, the urban centres of light trace a line along the coastline like a string of fairy lights.

FROM PIGS TO PARTNERS: DEVELOPMENTAL PROSPECTS

Reasons for why nearly all the Mediterranean countries have, in social and economic terms, lagged behind in recent decades are now much discussed (and ethnicized). Overreliance on revenue from commodity and agrarian exports, tourism and money transfers from migrant workers meant that their economies failed to keep up with capitalist globalization in the 1970s. Another reason is that, since the 1980s, parts of these same economies have adapted rapidly to global casino and kamikaze capitalism, investing revenues in speculative real estate and financial transactions, while leaving intact essentially anachronistic state apparatuses and social structures. The consequences of this are manifest today. Mental and institutional path dependency is difficult to overcome, yet nothing less than a radical change of direction is demanded of these crisis-ridden societies. This cannot succeed through external "advice" or pressure, but only in the framework of a pan-European sustainability offensive that desists from the unfavourable mix of austerity and blind growth.
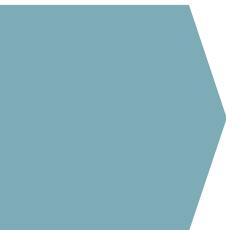
> The transformation of the European consciousness must be accompanied by ongoing cultural and scientific cooperation, oriented towards the needs of the younger generation, within the framework of existing EU programmes (Erasmus, Leonardo da Vinci, Jean Monnet)

A new type of Mediterranean union requires a more ambitious and far-reaching framework, in which the loose and disparate elements of Mediterranean policy to date are better adjusted to each other and made more sustainable. A convergence of this kind would complete the process of decolonization and confer an important role on the southern European EU member-states. The young people of the Mediterranean need a perspective beyond stagnation and emigration, pauperization and precariousness, authoritarianism and violence. A number of key political fields come to the fore: energy supply, tourism, external trade, environmental conservation and the knowledge economy.

To date, energy supply and export patterns on the southern periphery barely reflect the potential of this sun-drenched and wind-swept zone for generating renewable energy. Renewable

energy from the south must not only be incorporated into northern European electricity networks but also, and above all, used to promote sustainable development in the countries themselves, as well as in sub-Saharan Africa. This will enable a break with the vicious cycle of oil dependence, climate-damaging economic activity and debt.

The Mediterranean region still claims approximately one third of global tourism and this has had a deep influence on its infrastructure and mentality. At the same time, decades of mass tourism has caused severe ecological and economic damage. Instead of being a mass influx from the North to the service centres of the South, tourism needs to be transformed into a respectful and creative encounter between the two cultures.

Despite industrial development and the growth of a service sector, the Mediterranean countries have remained caught in an asymmetric division of labour with the rich EU countries. This has kept them in constant dependency and, until the 1980s and again now, caused unqualified and qualified workers to emigrate. An agrarian economy that is ecologically sensitive and much better adapted to local needs and markets needs to be negotiated, as does a more balanced trading system with the North and a sensible migration regime.

The vulnerable ecological basis of the sea must be protected by promoting sustainable fishing, preventative coastal preservation and appropriate offshore energy services. The *Méditerranée* must once again become "our sea" in the European consciousness.

The Mediterranean area lacks a sustainable, locally coloured knowledge economy that transcends cultural and religious boundaries and is oriented toward the histories of the various cultures. Connections to the past may have been broken, but there is truly no shortage of role models.

This programme of transformation must be accompanied by ongoing cultural and scientific cooperation, oriented towards the needs of the younger generation, within the framework of existing EU programmes (Erasmus, Leonardo da Vinci, Jean Monnet) and the relevant sections in the association agreements.

EU "rescue funds" and "structural assistance" only make sense in the mid to long term if they are directed at alternative energies, sustainable tourism, fair trade and maritime development (among other things). Only then can vague and *ad hoc* restructuring lead to sustainable development and the political tutelage of the North turn into cooperation between equals. Of course, these opportunities for development have only been broadly outlined above (and, given the crisis management thus far, are counterfactual). The key point is that decision-makers and the public debate need to provide the EU Growth Pact with perspectives for the future, perspectives that include the institutional reform of the EU and the Mediterranean union.

POSTSCRIPT: COOPERATION AND HUMAN NATURE[1]

Let me conclude with the challenge of supraregional, global cooperation. Could globalisation be asking too much of international organisations, governments and of us as human beings? Despite the worldwide consensus on the dangers of climate change and the shrinking limits of the earth system, climate negotiations have been marking time for years and the expectations of the earth summit to be held in Rio de Janeiro in June 2012 are steadily declining. As political scientist Dirk Messner puts it: "The international system that emerged after the World War II no longer appears to match the demands of the twenty-first century. Rather than global cooperation, global policy is increasingly beset by national egoisms, distribution conflicts and struggles for power. Machiavelli and Thomas Hobbes seem to be winning out against Kant, who coined the term cosmopolitan society (*Weltbürgergesellschaft*) as long ago as 1784. Is globalisation again bringing to light what economic theory has long preached: human beings are egoistic creatures preoccupied with optimising their own interests? The realistic school of international relations, too, might feel vindicated. It sees states as actors seeking to maximise their national interests in the anarchic world of the international system. Are human beings being thwarted by their own nature?"

In a column in the *New York Times* David Brooks wrote in 2007: "From the content of our genes, the nature of our neurons and the lessons of evolutionary biology, it has become clear that nature is filled with competition and conflicts of interest." The successful Russian-American writer Ayn Rand sends the same message in her novels. For moral obligations and cooperation between human beings she has only scorn and derision. Egoism, she claims, is what drives human beings, the only obligation anyone has is to him- or herself. This view of the world is not new. In the nineteenth century, the British philosopher Herbert Spencer was already describing the life of men and states as a never-ending struggle which is a matter of the "survival of the fittest." Yet one may be very surprised to see social-Darwinism of the kind to be endorsed by Paul Ryan, Mitt Romney's running mate in 2012 and a Vice-Presidential candidate of the United States of America.

Against these popular and dangerous assumptions Frans de Waal, a biologist, ethnologist and evolution researcher, has shown that, since *Homo sapiens* emerged some 200 000 years ago, human beings have been heavily dependent on each other for survival. In the course of their lifecycle everyone, whether young, old or sick, needs the support of others. The unique cooperative abilities evolved by our ancestors allowed them to reach into previously unexplored areas in search of food and resources and, crucially, to coordinate the hunt for large animals.

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1. The following section owes much to cooperation with my colleague and co-director of the Center für Global Cooperation Research in Duisburg/Germany.

Cooperation for mutual benefit, or reciprocity, is a basic building block of human existence. In de Waal's view, humans are therefore primarily gregarious animals and social beings. They can be described either as highly cooperative creatures at pains to keep egoistic urges under control, or as beings which, though extremely competitive, nonetheless have to strike a balance between competition and cooperation in order to survive as a species.

Michael Tomasello, Director of the Max Planck Institute for Evolutionary Anthropology in Leipzig, reaches similar conclusions. He ascribes the unique characteristics of human beings that set them apart from other animals to their ability to cooperate. Shared goals, knowledge and beliefs, as well as the ability to think in terms of a joint "we," are the foundations of humankind's cultural success story. Cooperation, in other words, became evolutionarily advantageous. If human cooperation fails on a significant scale, the result is a rupture in civilisation, war, crisis. The basis of cooperation is not least the capacity for empathy, to which Theodor Lipps in the late nineteenth century had already referred. When we watch a high-wire artist, we instinctively hold our breath, we share his experience. Seen from any of these angles, the image of humans as self-interested utility-maximisers is a rather poor caricature of the evolution of humankind.

The ability of human beings to cooperate is also confirmed by the social sciences. In numerous studies on successful and unsuccessful attempts to protect such commons as forests, fisheries and water resources, Elinor Ostrom, winner of the Nobel Prize for Economics, has identified some essential requirements for cooperation: communication, trust, reputation, reciprocal behaviour, jointly developed sets of rules, evolving we-identities and means of punishing opportunistic behaviour. These are the foundations of successful cooperation. The "natural state" of human beings is not, then, ruthless competition and conflict. Cooperation is possible, but it can also fail without the backing of suitable institutions.

So why are the institutions necessary to cope with the global systemic risks not emerging at the beginning of the twenty-first century? The theories of evolution based on the natural and behavioural sciences might provide an answer to this question. Issues such as globalisation, climate change, tipping points in the earth system, and challenges to humankind have been discussed only in recent decades. The realisation by human beings that they are not only dependent on each other at a local level and in their national societies, but in fact constitute a global risk community is fairly new in the history of humankind. A theory of world society is thus still in its infancy. Cooperation was essential to the success of *Homo sapiens* as a species early in its evolutionary history. The hard question of our times is: Will humans learn to raise their evolutionary success programme as gregarious animals and beings capable of cooperating to the level of global society before serious global systemic crises arise? And how might this learning process be accelerated? Can "we-intentionalities" be scaled up to global level? Can human beings develop empathy in a global society context? Can the new communication technologies help in this respect?

The theories of cooperation similarly provide useful pointers to the reasons for the current dysfunction of international cooperation. Owing to the major power shifts in the world, some of the main conditions for successful cooperation are under considerable pressure or have yet to be created. A glance at the G20 formation quickly reveals how it differs from the western clubs — from the G7 to NATO — with their declining clout: trust, dense communication patterns, reputation, "we-identities," common sets of rules and joint learning processes have yet to be developed between the old and new powers. Whether this investment in the cornerstones of global cooperation will be effected quickly enough for serious globalisation crises to be avoided and what form institutions capable of managing global problems should take are not trivial questions.

The world, now multipolar and host to new powers, is essentially in agreement on general objectives such as green growth and fair trade, limiting climate change and the extinction of species, reforming the financial markets and eradicating poverty and hunger. Yet despite all the normative and ideological convergence, the instruments, institutions and actors needed to turn the consensus into reality are lacking. This essay debates problems of cooperation within the European Union and proposes new areas and axes of multilateral cooperation in the Mediterranean basin. The author discusses in detail the prospects for green growth, soft tourism and knowledge society in this area. These would encourage civil society in the new Arab democracies and give a perspective to the unemployed youngsters of the region. Impulses from the South may then support a new federalism and macro-regionalism in Europe.

BIOGRAPHY

Claus Leggewie

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Since 2007, Claus Leggewie has been director and chairman of the board at the Institute for Advanced Study in the Humanities, Essen. In 2008, he joined the German Advisory Council on Global Change, where he is director of the project *Climate and Culture*. In 2012, he became co-director of the Käte Hamburger Collegium "Political Cultures of World Society" at University of Duisburg, Essen.

Professor Leggewie is founding director of the Center for Media and Interactivity of Justus-Liebig University, Giessen. Since 2007, he has been deputy-managing director of the same university, where he is also a member of the board of the post-graduate programme "Transnational Media Events" funded by the German Research Foundation, and of the Graduate Center for the Study of Culture.

In 1989, he became Professor of Political Science at Justus-Liebig University. From 1986 to 1989, he held a chair at Georg-August University in Göttingen. He received an honorary doctorate from the University of Rostock in 2008.

Between 1995 and 1997, Professor Leggewie held the Max Weber Chair at New York University. He has been a faculty fellow at the Remarque Institute of New York University and fellow at the Wissenschaftskolleg zu Berlin. He has also been a visiting professor at both Université Paris-Nanterre and Institut für die Wissenschaften vom Menschen in Vienna.

Professor Leggewie has recently published *Zukunft im Süden. Wie die Mittelmeerunion Europa wiedebeleben kann.* Hamburg: Körber-Stiftung 2012.
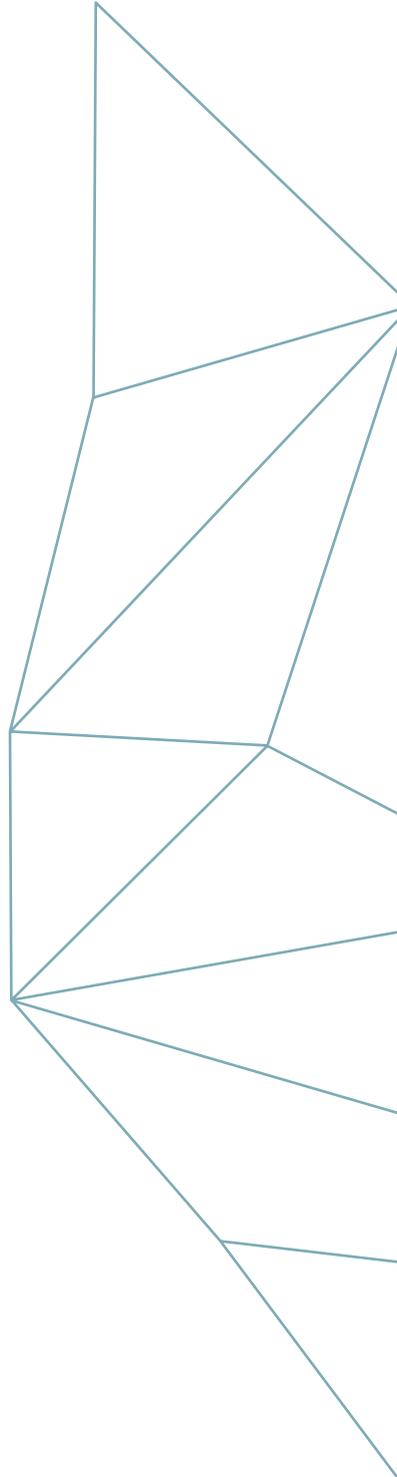
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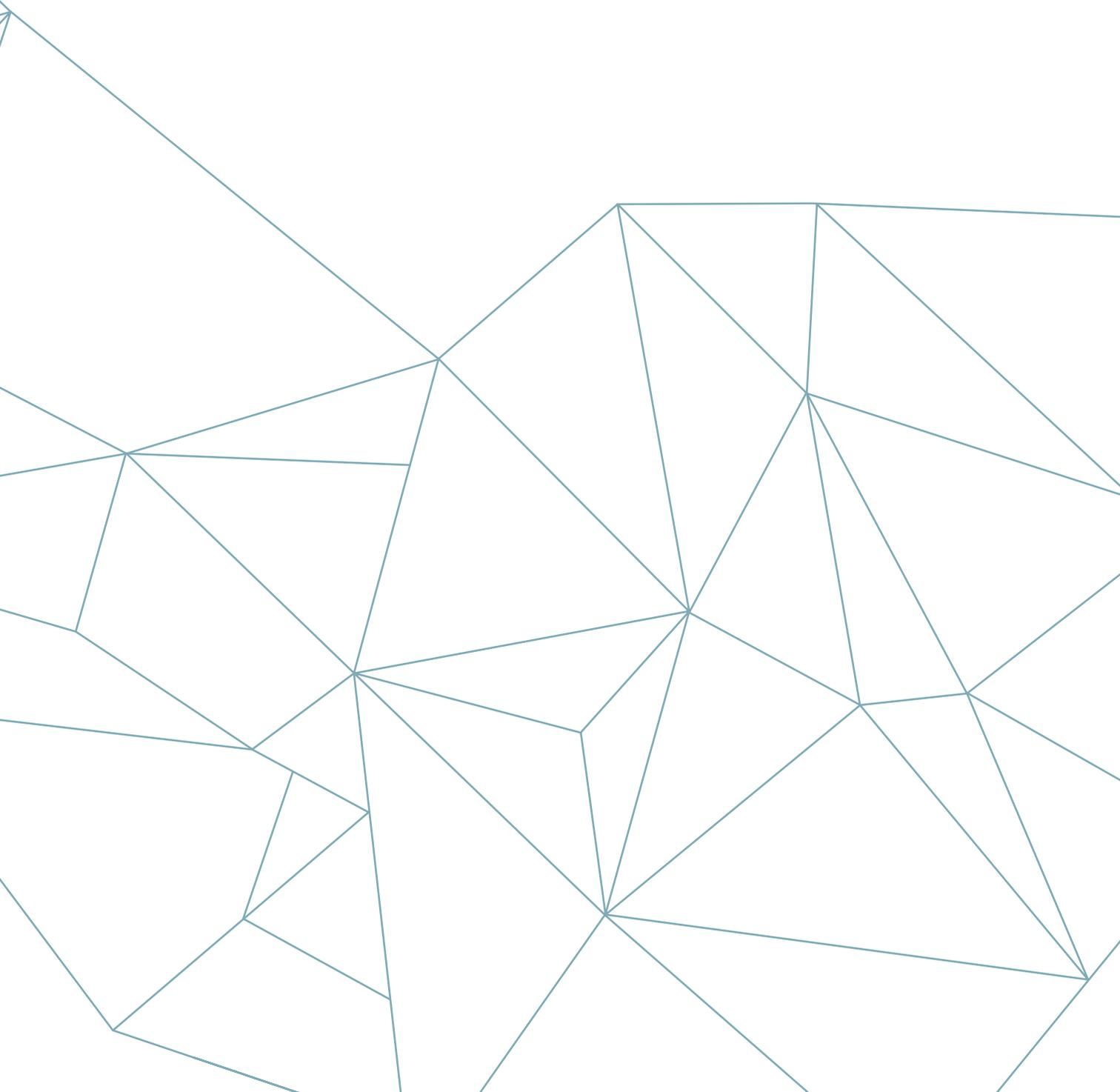
The Good Life: An International Perspective

Amitai Etzioni

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Towards the end of 2012, the economic growth rates of China and India are falling sharply; the growth of the United States and Japan is anemic; the EU is on the edge of a recession. While the Arab Awakening is considered mainly a call for democratization, most citizens of the nations involved are keen to command higher standards of living, which may not be forthcoming. The IMF has warned that the global economy is headed toward its lowest growth rates since 2009 (Rushe and Inman 2012). Governments seem unable to find the economic tools that would restore the economy of their nations, and indirectly that of the world, to the levels enjoyed in previous decades. Historically, domestic upheavals and conflicts among nations occur not when they are most poor and oppressed, but when growth is lost and expectations are dashed. Indeed, one sees in many nations an increase in nationalism, xenophobia, racism, religious fanaticism, and extreme politics. The fact that inequality is rising very sharply in all the nations involved, adds further fuel to the sociologically combustible transnational condition.

If the people of the world cannot return to what is being called the "old normal" (paid for by strongly growing economies), what will the "new normal" look like? Will it simply be a frustrating and alienating scaled-back version of the old normal? Or will the people develop new concepts of what makes a good life, as they did in earlier historical periods? If successful, a recharacterization of the good life will allow people to make — to use a rather archaic turn of phrase — a silk purse out of a sow's ear; in plain English, to turn their misery into an opportunity.

Blanca Muñoz, *Archipiélago* (detail), 2008

GOOD LIFE IN A HISTORICAL AND TRANSNATIONAL PERSPECTIVE

People immersed in the consumerist culture that now prevails in large parts of the world's civilizations find it difficult to imagine a good life that is based on profoundly different values than those they live by. However, throughout history, different conceptions of what makes a good life have arisen. For instance, for centuries the literati of imperial China came to prominence not through acquisition of wealth, but through the pursuit of knowledge and cultivation of the arts. This group of scholar-bureaucrats dedicated their early lives to rigorous study, in preparation for the exams required for government service. They spent years memorizing the Confucian classics.

The literati, having passed the imperial exams, were qualified for government service, but instead elected to dedicate their lives to the arts, or retired early in order to follow artistic pursuits. They played music and composed poetry, learned calligraphy, and gathered with like-minded friends to share ideas and discuss great works of the past.

Sociologist Reinhard Bendix writes that in keeping with Confucian teachings, "the educated man must stay away from the pursuit of wealth … because acquisitiveness is a source of social and personal unrest. To be sure, this would not be the case if the success of economic pursuits was guaranteed, but in the absence of such a guarantee the poise and harmony of the soul are jeopardized by the risks involved … The cultured man strives for the perfection of the self, whereas all occupations that involve the pursuit of riches require a one-sided specialization that acts against the universality of the gentleman"(Bendix 1966).

During the Middle Ages, knights were expected to adhere to an exacting code of chivalry. The tenets they were expected to live by are well captured in Song of Roland, an 11th century poem. Throughout the poem, the worthy knight is shown to gladly and faithfully serve his liege lord, to protect the weak and the defenseless, to show proper reverence for God, to respect and honor women, to be truthful and steadfast, and to view financial reward with revulsion and disdain. In traditional Jewish communities, studying the Torah was considered the preferred way of life.

Even in recent Western history, there have been significant changes in what is viewed as the good life. One such major change occurred after the end of World War II. At the time, economists held that human beings had fixed needs and that once these were satisfied, people would consume no more. Moreover, economists noted that during World War II, the American productive capacity greatly expanded. They feared that with the end of the war, the idling of the assembly lines that produced thousands of tanks, planes, and many war-related materials would lead to massive unemployment — because there was nothing that the assembly lines could produce that people needed, given that their fixed needs were sated.

In this context, John Kenneth Galbraith came up with a solution. In his book *The Affluent Society*, he concedes that private needs were satisfied, but points out that the public sector
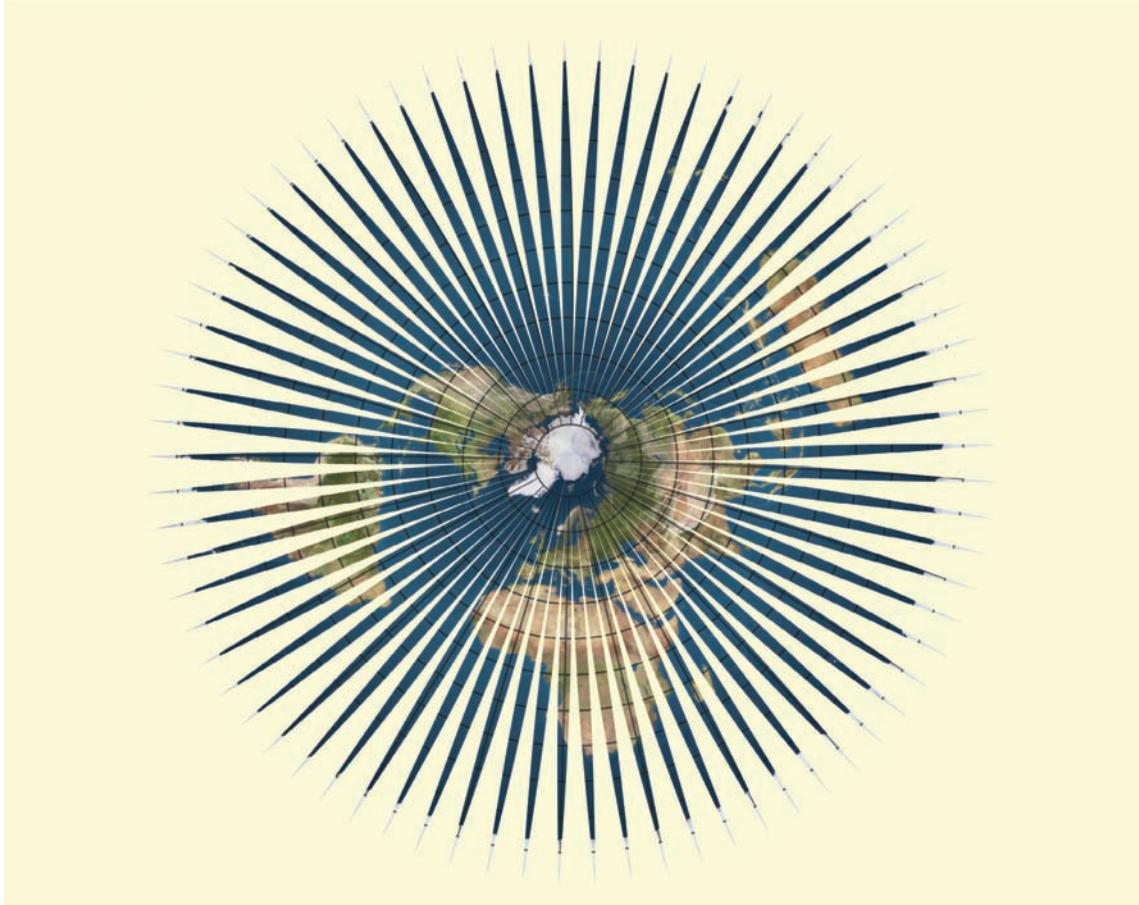
Jack van Wijk, *Azimuthal*

could absorb the "excess" capacity. It could be invested in public schools, parks, museums, and such.

Sociologist David Riesman published an influential essay, "Affluence for what?," in which he suggested that the "surplus" be used for projects such as paying the people of New Orleans to continue to maintain their 1955 lifestyle so future generations of children could come and visit this sociological Disneyland to see what life was like in earlier ages, as they do in Williamsburg.

Instead, in the years that followed WWII, industrial corporations discovered that they could produce needs for the products they were marketing. For instance, first women and then men were taught that they smelled poor and needed to purchase deodorants. Men, who used to wear white shirts and grey flannel suits like a uniform, learned that they "had to" purchase a variety of shirts and suits, and that last year's wear was not proper in the year that followed. The same was done for cars, ties, handbags, towels and sheets, sunglasses, watches, and

numerous other products. Vance Packard lays all of this out in his best-selling book, *The Hidden Persuaders*.

More generally, the good life was defined as having a high and rising level of consumption, in the sense that a person could never consume enough. There was always a new smartphone, flat-screen TV, or this year's fashionable towels and sheets that the person "needed."

Less often noted, probably because it is so self evident, is that paying for the high level of consumption requires hard work. Initially, mainly the husbands worked to provide for the family, leaving little time and energy for other pursuits, including being with their family, a lifestyle depicted in Arthur Miller's *Death of a Salesman*. In later decades, as more and more women joined the labor force, the incomes from husband and wife combined went to paying for the high-consumption lifestyle. More and more people began to take their work home with them, even on holidays, courtesy of Blackberries and their equivalents.

In short, there is nothing natural or unavoidable about what is considered the affluent life: it entails the kind of lifestyle that was considered worthy of contempt by previous societies and in early historical periods of the West.

REPLACING VERSUS CAPPING

Criticisms of consumerism, materialism, and hedonism are at least as old as capitalism and found in the West and not just in the East. Numerous social movements and communities have pursued other forms of the good life within capitalist societies. The Shakers, who left Manchester for America in the 1770s, founded religious communities characterized by a simple ascetic lifestyle.[1] Other such communities (some secular, some religious) include the Brook Farm Institute, the Harmony Society, the Amana Colonies, and the Amish. In Britain, John Ruskin founded the Guild of St. George in the 1870s, which he intended to guide the formation of agrarian communities that would lead a simple and modest life. Jewish refugees who emigrated to Palestine starting early in the 20th century established *kibbutzim*, in which the austere life was considered virtuous, consumption was held down, communal life promoted, and advancing a socialist and Zionist agenda was a primary goal of life. Numerous religious orders also started with an ascetic life.

In the 1960s, a counterculture (hippie) movement rose on both sides of the Atlantic Ocean. Its core values were anti-consumerism, communal living, equality, environmentalism, free love,

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1. "The Shakers," *National Park Service,* http://www.nps.gov/nr/travel/shaker/shakers.htm

and pacifism. Timothy Leary encapsulated the hippie ethos when he advised a crowd to "turn on, tune in, and drop out."[2] The British iteration of the hippie movement manifested itself in London's underground culture, a "community of like-minded anti-establishment, anti-war, pro-rock'n'roll individuals, most of whom had a common interest in recreational drugs," and many of whom opted out of mainstream consumerist culture.[3]

Many of these movements and communities sought to buy out of both the consumption and work system of capitalism and to form an alternative universe committed to ascetic life, while dedicating themselves to transcendental activities, including spiritual, religious, political, or social elements. They sought to replace capitalism rather than to cap it and graft onto it a different society.

Most important: practically all of these movements and communities failed to lay a foundation for a new contemporary society, let alone civilization, and practically all of them either disintegrated, shriveled, or lost their main alternative features. It seems that there is something in ascetic life that most people cannot abide for the longer run. It hence seems that if the current environment calls for a new attempt to form a society less centered around consumption, the endeavor will have to graft the new conception of a good life onto the old one. That is, not seek to replace consumption but to cap it and channel the resources and energy thus freed into other pursuits.

Once one approaches the subject at hand through this lens, one finds millions of people who have already moved in this direction, although they are hardly following a vision of a new good society nor do they come together to promote it. These millions include a large number of senior citizens who retired before they had to, to allow more time for alternative pursuits. These seniors typically lead what might be called a comfortable life from a materialistic viewpoint, but they spend more of their time socializing and engaged in politically active, spiritual, and cultural pursuits, rather than continuing to be employed and consume full throttle. (Note: by definition those who retire early earn less than those who continue to work, and hence they either consume less or leave less of a bequest, which limits the consumption of their families.) The same holds for the millions of women who decide not to return to work after they have children, at least until they reach school age, and many for much longer, even though this means that they will have to consume less.

As these two large groups (as well as those who drop out of high-earning pursuits to follow a more "meaningful" life — say, as teachers for those less privileged) illustrate, one need not lead a life of sack cloth and ashes, of deprivation and sacrifice. One can work enough to ensure one's basic creature comforts but dedicate the rest of one's resources, energy, and aspirations

2. http://www.pbs.org/wgbh/amex/love/filmmore/pt.html
3. http://www.guardian.co.uk/culture/2011/jan/30/underground-arts-60s-rebel-counterculture

to goods other than consuming more, and one can find more satisfaction in alternative pursuits to working long and hard to pay for consumption above and beyond what is needed for a comfortable life. The fact that millions have long persisted in capping their consumption and finding other sources of contentment suggests that such capping is much more sustainable than the ascetic life of the social movements and communities that sought to replace capitalism altogether.
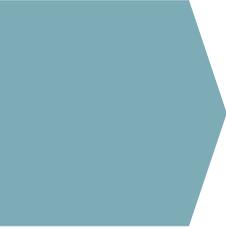
> Working fewer hours and hence consuming less can be viewed — at a relatively high level of income — as an opening for reexamining one's lifestyle and the beginning of a quest for alternative sources of contentment

THE MAIN ALTERNATIVES

Consumerism has long been shown not to provide contentment (or happiness). The data, as most social science data, are complex. Not all the correlations yield the same results (Veenhoven and Hagerty 2006; Stevenson and Wolfers 2008). However, overviews of the data have repeatedly concluded that after income rises above a given level, additional income buys little happiness. Japan is an often-cited example. Between 1962 and 1987, Japan's economy more than tripled its GNP per capita. Yet Japan's overall happiness remained constant over that period (Easterlin 2005). In 1970, Americans' average income could buy over 60 percent more than it could in the 1940s, yet the average happiness had not increased (Easterlin 1973).

At high income and consumption levels, additional consumption (and the work required to afford it) leads people to deny themselves alternative pursuits. It seems a form of fixation. It has been referred to as a hedonic treadmill.

These data ought now to be reexamined, as many middle and working class people face not so much giving up additional income (and obsessive consumption) in order to free up time and resources for alternative pursuits — but they are forced to give up the dream of an affluent life based on high and rising levels of consumption. Can they come to see such capping not as a source of frustration but as an opportunity to reexamine their priorities? The analogue is to a worker who finds that he is furloughed one day each week and hence works only four days, but who finds that the extra day offers a welcome opportunity to spend more time with the kids or to go fishing — as opposed to someone who loses his job.
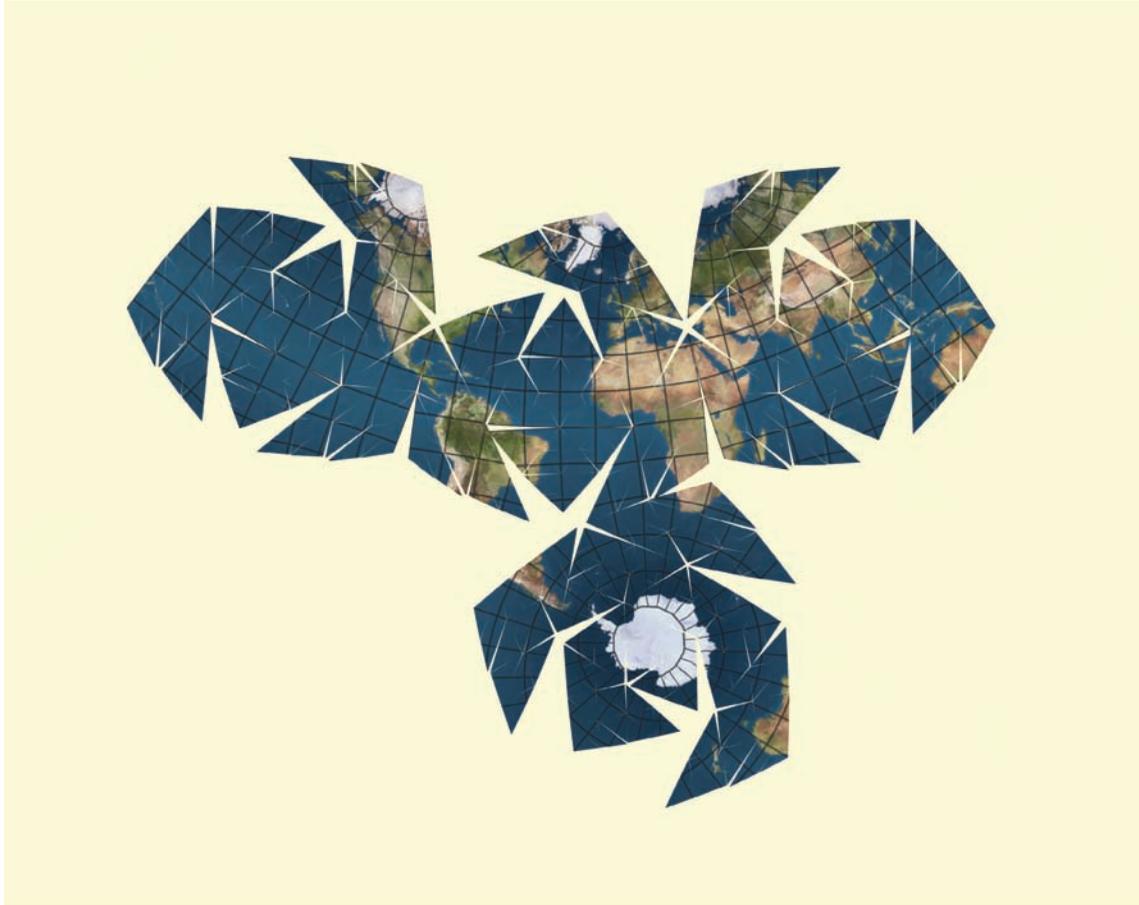
Jack van Wijk, *Tetrahedral*

NOT STATUS ACCEPTANCE

I must digress to stress that the thesis that people will be better off if they cap their consumption and dedicate the freed energy and resources to alternative pursuits should not be interpreted as suggesting that people should engage in what sociologists call status acceptance. Status acceptance is the argument that whatever your position in society is, you should accept it as your place in life and not seek upward mobility. Such precepts find their roots in the philosopher who dealt most explicitly with the subject at hand, what makes a good life, and gave us the felicitous term "flourishing" — Aristotle. He did not mean by it, as modern thought might, that people live up to their fullest human potential; but rather that people will find their basic contentment if they labor to carry out best whatever social role they find has been cast their way. The servant serves well, the lord leads well, and so on. (Aristotelian

philosophy is much more nuanced and complex than the preceding lines suggest, but this need not detain us here.) The Catholic Church made this precept one of its central tenants during the Middle Ages. And status acceptance is built into the Indian caste system.

The precept here advanced is that those whose basic needs are not well sated are indeed fully entitled to higher levels of consumption. Capping is called for only once these needs are satisfied. To highlight the point, it is useful to draw on Abraham Maslow's hierarchy of human needs. At the bottom of this hierarchy are basic creature comforts; once these are sated, more satisfaction is drawn from affection, self-esteem, and beyond that, from self-actualization. When the acquisition of goods and services is used to satisfy the higher needs, consumption turns into consumerism — a social disease. The transition is empirically indicated by the level at which additional income generates little or no additional contentment. In short, the thesis outlined here is not a suggestion that unemployment or low wages are legitimate, but that working fewer hours and hence consuming less can be viewed — at relatively high level of income — as an opening for reexamining one's lifestyle and the beginning of a quest for alternative sources of contentment.
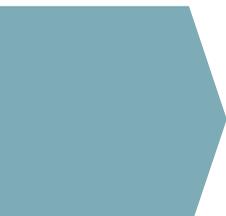
> Capped consumption combined with greater involvement in one alternative pursuit or another (or a combination of several) leads to more contentment than consumerism. The challenge we face is to share these findings and their implications for those dragged into an age of austerity

THE ALTERNATIVES

The main alternative pursuits that generate much more contentment than consumerism are very familiar and hence visited next very briefly.

Social activities: Individuals who spend more time with their families, friends, in social clubs, and in communal activities — those who do not bowl alone — are more content than those less socially active. An analysis of nearly 150 studies found that individuals with stronger social relationships exhibited a 50-percent increased likelihood of survival (Hold-Lunstad, Smith and Bradley Layton 2010). Robert E. Lane (1993) writes, "Most studies agree that a satisfying family life is the most important contributor to well-being … The joys of friendship often rank second." Robert Putnam presents a mountain of data to the same effect.

Spiritual and religious activities: Individuals who spend more time living up to the commands of their religion (attending church, praying, fasting, making pilgrimages, and doing

charity work), studying for studying's sake rather than as a vocation, or engaged in cultural activities such as painting or making music, not to serve a market but for the intrinsic enjoyment, are more content than those less so engaged. For example, studies have demonstrated that people with a deep religious faith are healthier, live longer, and have lower rates of divorce, crime, and suicide (Bok 2010). To cite but one study, Robert Putnam and David Campbell (2010) found that the difference in happiness between an American who goes to church once a week and someone who does not attend church was "slightly larger than the difference between someone who earns $10 000 a year and his demographic twin who earns $100 000 a year."

Community involvement: Researchers who examined the effect of community involvement found a strong correlation with happiness. One study, which evaluated survey data from 49 countries, found that membership in (non-church) organizations has a significant positive correlation with happiness (Helliwell 2003). Derek Bok (2010: 20) notes, "Some researchers have found that merely attending monthly club meetings or volunteering once a month is associated with a change in well-being equivalent to a doubling of income." Other studies have found that individuals who devote substantial amounts of time to volunteer work have greater life satisfaction (Ibid.: 22).

There is no need for more documentation here as these studies are familiar and readily accessible. They suggest that capped consumption combined with greater involvement in one alternative pursuit or another (or a combination of several) leads to more contentment than consumerism. The challenge we face is to share these findings and their implications for those dragged into an age of austerity.

TWO BONUSES

A society in which capping consumption is the norm and majorities find much of their contentment in transcendental pursuits will gain two bonuses of much import. One is obvious, and one much less so.

Obviously, a good life that combines a cap on consumption and work with dedication to transcendental pursuits is much less taxing on the environment than consumerism and the level of work that paying for it requires. This is the case because transcendental activities require relatively few scarce resources, fossil fuels, or other sources of physical energy. Social activities (such as spending more time with one's children) require time and personal energy but not large material or financial outlays. (Often those who spend large amounts of money on their kids' toys or entertainment bond less with them than those whose relations are much less mediated by objects.) The same holds for cultural and spiritual activities such as prayer,
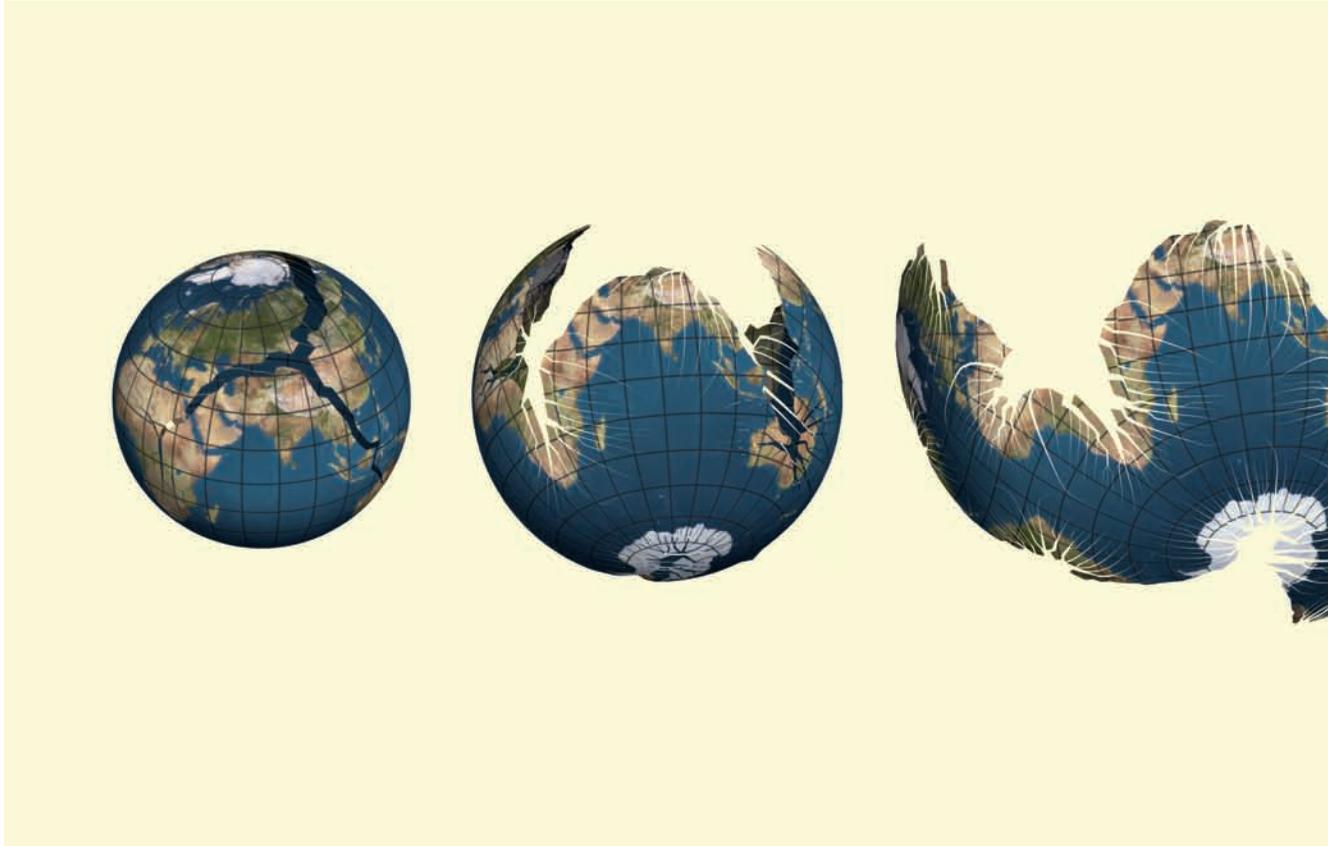
Jack van Wijk, *Unfolding the Earth to the Coastline of the Earth*

meditation, enjoying and making music, art, sports, and adult education. True, consumerism has turned many of these pursuits into expensive endeavors. However, one can break out of this mentality and find that it is possible to engage in most transcendental activities quite profoundly using a moderate amount of goods and services. One does not need designer clothes to enjoy the sunset or shoes with fancy labels to benefit from a hike. Chess played with plastic pieces is the same game as the one played with carved mahogany or marble pieces. And the Lord does not listen better to prayers read from a leather-bound Bible than those read from a plain one, printed on recycled paper. In short, the transcendental society is much more sustainable than consumeristic capitalism.

Much less obvious are the ways the transcendental society serves social justice. Social justice entails transferring wealth from those disproportionally endowed to those who are underprivileged. A major reason such reallocation of wealth has been surprisingly limited in free societies is that those who command the "extra" assets tend also to be those who are
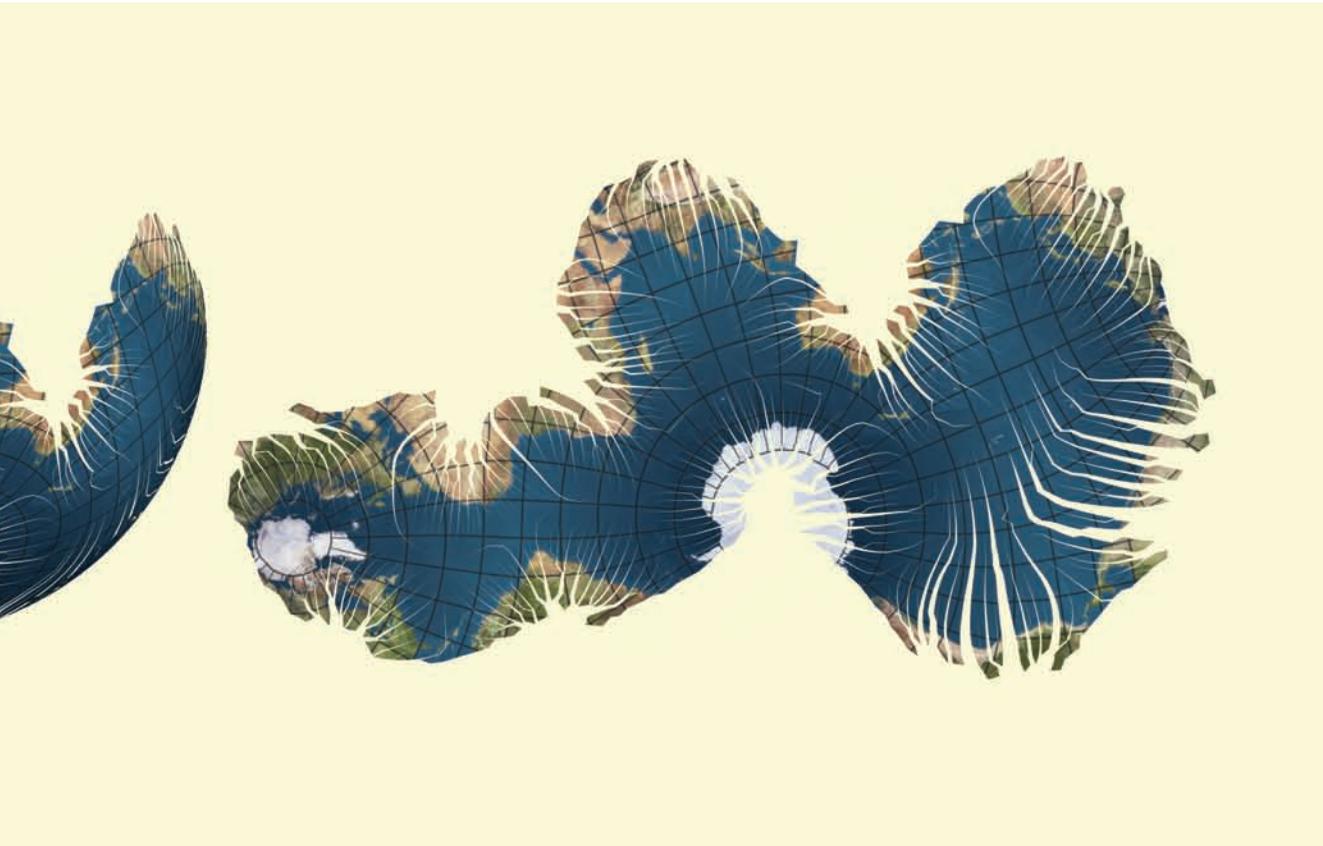
politically powerful. Promoting social justice by organizing those with less and forcing those in power to yield has had limited success in democratic countries and led to massive bloodshed in others. Hence the question: Are there ways to reduce the resistance of the elites to the reallocation of wealth?

Recharacterization of the good life along the lines here indicated helps, because it leads those with high income to derive a major source of contentment not from acquiring additional goods and services but from transcendental activities, activities that are neither labor- nor capital-intensive and, hence, do not require great amounts of assets. There are numerous accounts of rich people who have given substantial parts of their wealth to what they consider good causes. More generally, those who have strong religious beliefs (note that all major religions make giving to the poor a major commandment) and those who subscribe to social liberalism or democratic socialist ideals of social justice and opposition to inequality tend to share willingly with those less endowed. Hence, the more transcendental ideals are accepted,

the greater the number of affluent and powerful people who will have less reason to oppose reallocation of wealth, and the more who may even find some source of contentment in supporting it.

One can surely envision other characterizations of a good life. However, the dialogue about what such a society will look like and what its norms and projects can be should not be delayed. The world would benefit greatly: if it faced prolonged sluggish economic growth, this would not be viewed as frustrating and alienating but as an opportunity to reexamine life's priorities, and to determine whether we can make progress without attempting to deny that we all seek and are entitled to secure basic creature comforts. Such a recharacterization of the good life will not only spare the world major social and political upheavals and international conflicts, but it will also turn it into world in which all people can flourish.

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THE WORLD ECONOMY IS SLOWING DOWN, AND GOVERNMENTS ARE STRUGGLING TO FIND THE TOOLS TO RESTORE THEIR ECONOMIES TO THE LEVELS THEY ENJOYED IN THE PAST. INEQUALITY IS RISING SHARPLY IN MANY NATIONS, WHICH ARE WITNESSING INCREASED NATIONALISM, XENOPHOBIA, RACISM, RELIGIOUS FANATICISM, AND EXTREME POLITICS. WHAT IF IT IS SIMPLY NOT POSSIBLE TO RETURN TO THE "OLD NORMAL", TO GO BACK TO LIFESTYLES DEPENDENT ON STRONGLY GROWING ECONOMIES? WHAT WILL THE "NEW NORMAL" LOOK LIKE? WILL WE MANAGE TO CREATE A NEW CONCEPT OF THE GOOD LIFE THAT WILL ALLOW PEOPLE TO TURN THEIR MISERY INTO OPPORTUNITY? THIS ESSAY TRACES CHARACTERIZATIONS OF THE GOOD LIFE THROUGHOUT HISTORY, ENCOURAGING US TO RE-EXAMINE OUR PRIORITIES AND EXPLORE THE POSSIBILITIES FOR CREATING FUTURE SOCIETIES WHEREIN ALL PEOPLE CAN FLOURISH.

BIOGRAPHY

Amitai Etzioni

George Washington University

After receiving his PhD in Sociology from the University of California, Berkeley in 1958, Amitai Etzioni served as Professor of Sociology at Columbia University for 20 years. He was a guest scholar at the Brookings Institution in 1978 before serving as a Senior Advisor to the White House on domestic affairs from 1979 to 1980. In 1980, Etzioni was named the first University Professor at The George Washington University, where he is currently Director of the Institute for Communitarian Policy Studies.

Etzioni is the author of 24 books, including *The Monochrome Society* (Princeton: Princeton University Press, 2001), *The Limits of Privacy* (New York: Basic Books, 1999), and *The New Golden Rule* (New York: Basic Books, 1996), which received the Simon Wiesenthal Center's 1997 Tolerance Book Award. His most recent books are *My Brother's Keeper: A Memoir and a Message* (Lanham, MD: Rowman & Littlefield, 2003), *From Empire to Community: A New Approach to International Relations* (New York: Palgrave Macmillan, 2004), and *Security First: For A Muscular, Moral Foreign Policy* (Yale University Press, 2007).

In 2001, Etzioni was awarded the John P. McGovern Award in Behavioral Sciences as well as the Officer's Cross of the Order of Merit of the Federal Republic of Germany. He has also received the Seventh James Wilbur Award for Extraordinary Contributions to the Appreciation and Advancement of Human Values by the Conference on Value Inquiry, as well as the Sociological Practice Association's Outstanding Contribution Award.

Futures of Education for Rapid Global-Societal Change

Jennifer M. Gidley

INTRODUCTION

Education today in most of the world is more suited to the nineteenth-century industrial era than it is to the twenty-first century. There are three key aspects to this insight.

Firstly, knowledge is evolving. The fragmentation of knowledge through specialization is widely regarded as being unsuited to the complexity of the twenty-first century by scholars and thinkers from many fields (including complexity science, ecology, futures studies, integral studies, philosophy and psychology). Yet education is still largely a piecemeal affair.

Secondly, consciousness is evolving, and education needs to evolve with it. Research on the evolution of consciousness — pioneered by Rudolf Steiner in the early twentieth century (Steiner [1926] 1966) — has gathered impetus throughout the twentieth century. These theories are still marginalised by narrow Darwinian notions of biological evolution. However, evidence to support the evolution of consciousness comes from three main sources: from integral theorists (Donald 2001; Elgin 1997; Gangadean 2006; Hart 2001; László 2008; Russell 2000; Swimme 1992; Thompson 1998; Wade 1996); from adult developmental psychology research on postformal reasoning (Bassett 2005; Commons et al. 1990; Commons and Richards 2002; Cowan and Todorovic 2005; Kohlberg 1990; Labouvie-Vief 1992; Sinnott 1998, 2005; Torbert 2004); and from the literature on planetary consciousness (Benedikter 2007; Earley 1997; Elgin 1997; Gangadean 2006; László 2006; Montuori

1999; Morin and Kern 1999; Nicolescu 2002; Russell 2000; Swimme and Tucker 2006). My own research over the last decade on the evolution of consciousness confirms my view that education urgently needs to evolve (Gidley 2007a, 2007b, 2009, 2010a, 2010b).

Thirdly, education belongs in the realm of culture, not economics. Educational bureaucrats produce concepts such as the "knowledge economy" which appropriate education for the purpose of profit. While schooling was taken over during the Industrial Revolution to provide fodder for the factories, education is fundamentally a socio-cultural practice. In the post-industrial twenty-first century education needs to be primarily concerned with developing the minds, hearts and souls of young people, to live in an increasingly complex and uncertain world.

What do today's educators know about, and think about, these challenges? What is the role of educational futures in these major developments? How can education transform itself to incorporate these new insights?

WHAT HAPPENED TO KNOWLEDGE IN THE TWENTIETH CENTURY?

Throughout the twentieth century, and increasingly in the last forty years, significant developments can be mapped in most, if not all, of the major academic disciplines. New ways of thinking have emerged within the disciplines of science, philosophy, psychology and education. There is also an emerging movement to integrate knowledge, to move beyond the fragmentation of knowledge associated with disciplinary specialisation via inter-, multi-, and trans-disciplinary approaches. These developments can be regarded as *enactments* of new ways of thinking and new knowledge patterns, respectively — and are arguably facets of the evolution of consciousness. An environmental scan of the major fields of knowledge identifies the following disciplinary developments as well as post-disciplinary developments:

- The scientific turn from classical physics to quantum physics followed by the shift from the closed systems of classical physics to the open systems of post-classical biology (Bertalanffy [1969] 1976), chaos and complexity sciences and emergentism (Combs 2002; Einstein [1920] 2000; Maturana and Varela [1980] 1991);
- The parallel — though more marginalised — philosophical turn from static mechanistic metaphors to organic, living, process metaphors of thinking (Bergson [1911] 1944; Deleuze and Guattari 1994; Steiner [1894] 1964; Whitehead [1929] 1985);
- The development of psychology beyond empirical and behaviourist approaches to approaches that include humanistic and person-centred, transpersonal and postformal perspectives.

In spite of these strengthening developments within and across many disciplines and knowledge fields, the institution of mass education, appropriated by the industrial era, has been pretty static since the onset of the Industrial Revolution.

If we are to cope with the complexity of global-societal change to be expected over the next 20–50–100 years, we must move beyond disciplinary and ideological siloism and develop new forms of knowledge coherence. Education can best be re-designed through deeply embracing the new thinking and knowledge patterns, and by replacing profit-driven metaphors such as "knowledge economy" with more culturally appropriate metaphors.

Throughout the twentieth century, significant developments can be mapped in most, if not all, of the major academic disciplines. New ways of thinking have emerged within science, philosophy, psychology and education. There is also an emerging movement to integrate knowledge, to move beyond the fragmentation of knowledge associated with disciplinary specialisation via inter-, multi-, and trans-disciplinary approaches

NEW THINKING, NEW KNOWLEDGE PATTERNS AND GLOBAL KNOWLEDGE FUTURES

"Imagination is more important than knowledge. For while knowledge defines all we currently know and understand, imagination points to all we might yet discover and create." Albert Einstein

It is not enough for educational futures to be primarily focused on external "trends" such as globalisation, economic and environmental crises, and so on, thus overlooking the major paradigm shifts rocking the foundations of knowledge for the last century. The "megatrends of the mind" are as important for higher education futures as the megatrends in the external world (Gidley 2010b).

Identifying New Thinking — Disciplinary Developments

A broad-based global scan of the developments both within and across disciplines provides considerable evidence that leading thinkers have begun to enact new ways of thinking to such a degree that most academic disciplines have undergone a major paradigm shift throughout the twentieth century.

Major shifts have occurred within scientific, philosophical and other disciplines since the beginning of the twentieth century.

Shifting Foundations of Science since Einstein

The modernist, formal, scientific worldview, based on Cartesian dualism and Newtonian classical physics — with its static notions of a mechanical, "building block" universe of atoms — is gradually being replaced by postmodern, postformal worldviews. Important scientific shifts of the twentieth century include:

- The shift from classical physics to quantum physics;
- The shift from the closed systems of classical physics to the open systems of post-classical biology (Bertalanffy [1969] 1976);
- The new sciences of chaos and complexity (Einstein [1920] 2000; Maturana and Varela [1980] 1991);
- The transition from classical biology, including Darwin's theories of evolution, to the new biology-based theories of self-organisation and emergence (Deacon 2003; Goodenough and Deacon 2006; László 2007; Russell 2000).

Philosophical Shifts in the World of Ideas

A similar transition can also be observed in Western philosophical thought throughout the twentieth century from modernism to postmodernism and poststructuralism. The singular notion of "philosophy" — implying British analytic philosophy — has been increasingly accompanied by a greater "philosophical pluralism"(Mandt 1986). Significant twentieth-century philosophical shifts include:

- The shift from static mechanistic metaphors to organic, living, process metaphors of thinking (Bergson [1911] 1944; Deleuze and Guattari 1994; Steiner [1894] 1964; Whitehead [1929] 1985);
- The *linguistic turn* — the linguistic reflexivity of the French post-structuralists (Derrida 2001; Kristeva 1986);
- The awareness of continuity and historicity of European hermeneutics (Gadamer [1960] 2005; Habermas 1986; Heidegger [1927] 1962; Ricoeur 1985, 1988);
- The *religious turn* in continental philosophy (Habermas 2008; Manoussakis 2006) and the *spiritual turn* in the late works of the French postmodern philosophers (Benedikter 2005; Caputo 1997).

Postformal Psychology

Since the 1960s there were also major changes taking place in the way that scientific research per se was conceived and practiced. The emergence of the very broad approach to research, often referred to as postpositivism, seeded a plethora of research methodologies and concepts better suited to social science research than the reductionist forms of empirical research then dominating. Social scientists developed and worked with a diverse range of qualitative methods

Julian Germain, *Classroom Portraits, 2004-2012. Escola Estadual Nossa Senhora do Belo Ramo, Belo Horizonte, Minas Gerais, Brazil. Series 6, Mathematics. November 17th*, 2005

that were increasingly sensitive to the social construction of reality, subjectivities, cultural differences and the presence in researchers themselves of taken for granted values and other forms of tacit knowledge (Berger and Luckman 1966). This sowed seeds for major shifts in the discipline of psychology:

- From behaviourist to humanist, even transpersonal, psychology;
- From clinical models to positive psychology notions of human potential;
- From developmental notions of formal reasoning as the highest stage of thinking to several higher stages of postformal reasoning (Cook-Greuter 2000; Kegan 1994; Kohlberg 1990; Sinnott 1998).

Beyond Disciplinary Boundaries to New Knowledge Patterns

In parallel with these disciplinary developments, disciplinary specialisation itself is being transcended. Several approaches to knowledge have emerged in the second half of the twentieth century that seek to counterbalance the excesses of fragmentation, specialisation and reductionism in the dominant worldview. They attempt to create new systems of knowledge not bound by disciplinary constraints. As knowledge breaks the disciplinary boundaries it also moves beyond old conceptions of time and space, through:

- *Post-disciplinarity:* new attempts to create *knowledge-bridges* between disciplines, through interdisciplinary and transdisciplinary research (Grigg, Johnston and Milson 2003; Klein 2004; Nicolescu 2002; Ricoeur 1997; van den Besselaar and Heimeriks 2001);
- *Integration:* the emergence of systemic, holistic and integral thinking in various fields including philosophy (Gangadean 1998; Gidley 2006; Hampson 2007; László 2007; Wilber 2000);
- *Expanding notions of space:* the movement in political science from the centrality of nation-states to the concept of global, and hybrid concepts of global/local, glocal and even "glonacal" (Marginson 2004);
- *Expanding notions of time:* the transition from studying the past to an awareness of the value of foresight and futures thinking, in parallel, with the deconstruction of the modernist, linear narrative of time.

The Frontiers of Global Knowledge Futures

When taken together, these developments in thinking and systems of knowledge could be said to mark a paradigm shift from industrial worldviews associated with positivism, modernism, specialisation and formal reasoning, to postindustrial worldviews associated with post-positivism, postconventional, integral and postformal reasoning — arguably more suitable for "postnormal times".

A deep analysis of the above-mentioned knowledge trends led to the discovery of several discourses that identify and/or enact new paradigms of thinking. Over the last few decades there have been various attempts to cohere these rapid changes and to theorise about them. The most significant discourses that either identify and/or enact new paradigm thinking are: postformal studies, integral studies and global/planetary studies (Gidley 2007b, 2010c).

Postformal Studies

Postformal is the most widely used psychological term to denote higher developmental stages beyond Piaget's *formal operations*. Adult developmental psychologists have been undertaking research into postformal thinking for several decades, particularly in the USA. They identify

numerous features of postformal reasoning — including complexity, contextualisation, creativity, dialectics, dialogue, holism, imagination, paradox, pluralism, reflexivity, spirituality, values and wisdom (Cook-Greuter 2000; Kegan 1994; Kohlberg 1990; Sinnott 1998). Michael Commons et al. have identified up to four postformal stages of psychological development: systemic, meta-systemic, paradigmatic and cross-paradigmatic (Commons and Richards 2002). *Postformal studies* also includes the work of educational researchers who use the hyphenated form of *post-formal* in relation to critical and postmodern approaches to education (Kincheloe, Steinberg and Hinchey 1999). Educational researcher Joe Kincheloe referred to post-formality as "the socio-cognitive expression of postmodernism" (Kincheloe and Steinberg 1993, 309).
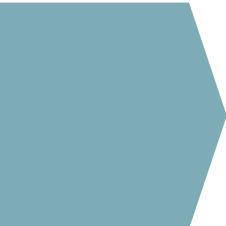
If we are to cope with the complexity of global-societal change to be expected over the next 20–50–100 years, we must move beyond disciplinary and ideological siloism and develop new forms of knowledge coherence

Integral Studies

Integral is a widely used term by several different schools of thought. The use of the term *integral* or *integrative* has become increasingly common in leading edge approaches to many disciplines. Some significant twentieth-century and contemporary writers working from a substantially integral perspective include Rudolf Steiner, Michael Polanyi, Jean Gebser, Sri Aurobindo Ghose, Ervin László, Ashok Gangadean, William Irwin Thompson and Ken Wilber. An important basis of the idea in its varied forms is that the complexity of the present times requires higher-order forms of thinking that go beyond the narrow specialisations of reductionist rationality. Integral approaches include multiples ways of knowing, being and acting in the world. By *integral studies* I include the various discourses that explicitly refer to their theoretical approaches as integral (such as Gebser, László, Sri Aurobindo and Wilber) and also those that can be regarded as integral according to the integrality of their approaches (such as Morin, Nicolescu and Steiner).

Planetary/Global Studies

The term *planetary* has been increasing in usage within the evolution of consciousness and futures discourses. The pluralism of its contemporary usage provides a counterbalance to the term, *globalisation* — which has often been limited to politico-economic discourse and

processes. Many researchers who use *planetary* have been inspired by Teilhard de Chardin's notion of the *planetization of mankind* (Teilhard de Chardin [1959] 2004). The term *planetary* — which primarily denotes an anthropo-socio-cultural and ecological framing — is a term to characterize important features of the new consciousness, particularly for those theorists who have a critical sensibility in the light of our complex current planetary situation. In addition to its popular use by environmental activists it is used in academic contexts by a range of philosophers, scientists, educators and sociologists. This critical use of *planetary* has been emphasised in the writings of French philosopher, Edgar Morin, who refers to the present times as the *Planetary Era*, which he claims began around five hundred years ago (Morin 2001; Morin and Kern 1999). By *global/planetary studies* I refer to the emerging discourses that use the term *planetary* in the following contexts: critical environmental, transcultural, philosophical and spiritual interests. I also include the political science and international relations literature that points to the shift from nationalistic to transnational and planetary/global worldviews.

A MACROHISTORICAL VIEW OF EDUCATION

In terms of *historical* perspectives on education, I have identified three broad phases: i) *"informal education"* via family/tribal enculturation, elite tutoring, and private religious schooling, prior to the beginnings of mass public education approximately two hundred years ago; ii) *"formal school education"*, from late eighteenth to twentieth centuries in Europe, USA and increasingly in other parts of the world last century; and iii) a diversity of postformal pedagogies, beginning in the late twentieth century and — one would hope — flourishing throughout the twenty-first century and beyond (See Table 1). This table refers primarily to the situation in the so-called developed world. The situation is far more diverse and complex in traditional and non-Western-European-based cultures.

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Table 1. Socio-Cultural, Political and Educational Phases

	Prehistory to 18th Century	*18th to 20th Century*	*20th to 21st Century and Beyond*
Socio-Cultural Phases	Pre-modern	Modern	Post-modern
Political Phases	City-states	Nation-states	Global-planetary
Educational Phases	*Informal* family/ tribal enculturation, or elite tutoring	*Formal* schooling, mass education, factory-model	Pluralism of *post*formal pedagogies, integral, planetary sensibility

Julian Germain, *Classroom Portraits, 2004-2012. Omar Bin Al-Khattab Educational Complex, Boys' Science Secondary School, Doha, Qatar. Grade 10, Religion. March 13th*, 2007

From Informal to Formal to Postformal Education

Prior to the Industrial Revolution, which embedded modernist ideas into the socio-cultural fabric of Western society, education for children was not such a formal process, even in the Western world. Children were enculturated by their extended families and cultures and only the children of the wealthy — who could afford private tutors — or those who wished to become clerics had any formal education. Earlier integrally-inspired educational reform had been initiated in the seventeenth century by Moravian educational theorist Johann Ámos Komensk? (more frequently called by his Latin name, Comenius) who wrote the influential *Didactica Magna*, which proposed a three-tier universal schooling system for all children (Dahlin 2006). Subsequently in Germany, the notion of the evolution of consciousness, which was a major contribution of German idealists and romantics such as Goethe, Hegel, Schelling and Novalis, contributed to the initial impulse for mass public school education, which began in Germany in the late eighteenth century. This was carried forward particularly through Schiller's aesthetic educational principles

(Schiller [1954] 1977), Herbart's integrative pedagogical system (Klein 2006) and Humboldt's implementation of public education (Holborn 1964). However, after the deaths of these leading German philosophers, by the middle of the nineteenth century the idealist-romantic educational project was largely hijacked in western Europe by the gradual influence of the British Industrial Revolution, so that schools increasingly became training grounds to provide fodder for the factories. This factory model of school education was picked up in the USA around 150 years ago (Dator 2000).

I have begun to use the phrase "evolutionary pedagogies" as an alternative to "educational reform" or even "educational transformation". This is because I want to highlight the scope of the transition we, as humans in a planetary age, are undergoing. The notion of "educational reform" very often only tinkers at the surface of appearances — a bit like rearranging the deckchairs on the Titanic. While the notion of "educational transformation" potentially goes further than "reform", it can be limited by the philosophical perspective, ideology — or even paradigm — that it subscribes to. The meaning that I ascribe to my notion of evolutionary pedagogies is one that connects education more consciously with the evolution of new patterns of thinking.

I have scanned the Anglophone educational literature for signs of emerging pedagogies that are reflecting one or more of the features of postformal, integral or planetary consciousness. There is a lot of encouraging material being written about new educational approaches in the last decade. There is also a very powerful neo-fundamentalist backlash in the Anglo countries from government-backed educrats who seek to dominate the educational agenda with scientism, economism and technicism — through the "audit culture" (MacLure 2006). On the other hand, there are also several educational theorists and researchers who are attempting to expose and counter this reactionary neo-conservatism (Abbs 2003; Coryn, Schröter and Scriven 2005; Denzin 2005; MacLure 2006).

The Evolutionary Waves in Twentieth to Twenty-first Century Education

There have been three waves of educational impulses since the beginning of the twentieth century that contribute to the evolution of education.

First Wave: Weak Signals from the Early Twentieth Century

Although much of European and Anglo education did lose its initial idealist/romantic impulse during the nineteenth century, and succumbed to the weight of industrialism, secularism, and materialism, new threads began to emerge in various parts of the world in the early twentieth century. There were Maria Montessori and Rudolf Steiner in continental Europe, Alfred North Whitehead in the UK, John Dewey in the USA and Sri Aurobindo in India, all pioneeering more integral, organic educational approaches that provided a counter-weight to the dominant factory

model. They emphasised imagination, aesthetics, organic thinking, practical engagement, creativity, spirituality, and other features that reflect the emergent integral consciousness. These educational pioneers were also futures-oriented in that they all subscribed in some way to evolutionary notions of consciousness, culture and even cosmos. However, these approaches have mostly remained marginalised, or in the case of Dewey's initiative, been appropriated in a reduced form by the mainstream system as so called "progressive education".

> **The commodification of knowledge abounds as a socio-cultural by-product of globalization. Borrowing heavily from industrial-era metaphors, education is now marketed as the "product" in a globally competitive "knowledge industry"**

Second Wave: "Alternative" Education, a 1970s Trend

What I call the *second wave* was sparked by the dramatic consciousness changes that erupted in 1968 with the student protests in Paris, followed rapidly by the 1969 Woodstock Peace Festival in the USA, which laid foundations for a youth peace movement against the Vietnam War. These events also paralleled the arrival of futures studies on the academic scene with the journal *Futures* being founded in 1968 along with significant global meetings such as *Mankind 2000* that led to the forming of the *World Futures Studies Federation* (WFSF) in Paris in 1973. These events coincided with the beginning of various "new age" movements, including participatory politics, new forms of music, east-west spiritual-philosophical dialogues, new gender relations, post-nuclear family lifestyles and recreational use of "designer" drugs. These movements were taken up quite strongly in the Anglo countries, particularly in pockets of the USA and, at least indirectly, they began to shift ideas about formal education. The 1970s to 1990s saw a broadening of alternative educational modes, including home-schooling (Holt 1970), holistic education (J. P. Miller 2000; R. Miller 1990, 1999), critical pedagogy (Freire 1970; Illich 1975), futures education (Fien 1998; Gough 1989; Hicks 1998; Rogers 1998; Slaughter 1989), and a raft of educational reforms within mainstream settings. All were critical of the formal, modernist "factory-model" of mass education. Most sought to broaden education beyond the simple information-processing model based on a mechanistic view of the human being to a more holistic, creative, multifaceted, embodied and participatory approach. Yet not all honour the spiritual needs or the multi-layered nature of the developing child, as part of a consciously evolving human species. Furthermore, these approaches are still minor threads and unfortunately most approaches are also isolationist in relation to each other.

Julian Germain, *Classroom Portraits, 2004-2012. Guard House Primary School, Keighley, West Yorkshire, UK. Year 6, History. October 19th*, 2005

Third Wave: Postformal Pedagogies

The late twentieth and early twenty-first centuries mark an important transition from formal, factory-model school and university education. We are currently experiencing a *third wave* of impulses to evolve education. I refer broadly to these third wave approaches to evolving education as "*post*formal pedagogies". I have identified over a dozen emerging pedagogical approaches that reflect new ways of thinking, which facilitate the evolution of consciousness (for references to the literature in relation to these approaches see: Gidley 2009). These include:

- Aesthetic and artistic education;
- Complexity in education;
- Critical and postcolonial pedagogies;
- Environmental/ecological education;

- Futures education;
- Holistic education;
- Imagination and creativity in education;
- Integral education;
- Planetary/global education;
- Postformality in education;
- Postmodern and poststructuralist pedagogies;
- Transformative, spiritual and contemplative education;
- Wisdom in education.

Lest this list give the appearance that education globally in the twenty-first century is alive and well, creative and innovative, it is worth noting that all of these are relatively small counter-streams to the dominant hegemonic factory model of education. One of my interests is to foster dialogue between these postformal pedagogies to strengthen their awareness of each other and to increase knowledge transfer among them. Such an integration of third wave educational approaches could lead to a deep shift from an economics-driven concept of *global knowledge economy* to more human-centred *global knowledge futures*.

FROM GLOBAL KNOWLEDGE ECONOMY TO GLOBAL KNOWLEDGE FUTURES

"Where is the wisdom we have lost in knowledge?
Where is the knowledge we have lost in information?"
T. S. Eliot, 1934, *The Rock*
"One of the greatest problems we face today is how to adjust our way of thinking to meet the challenge of an increasingly complex, rapidly changing, unpredictable world. We must rethink our way of organising knowledge."
(Morin 2001, 5)

The two quotes opening this section speak of knowledge. The first is from American-British poet, T. S. Eliot, and the second is from French philosopher, Edgar Morin. Eliot bemoans the loss of wisdom while Morin hints at its reawakening. Perhaps it takes the eye of an artist, a poet, to perceive the loss of wisdom in the stripped-down, prosaic pragmatism of the *Information Era*. Yet it is a philosopher — a lover of wisdom — who actively thinks towards more complex ways of organizing knowledge in the *Planetary Era*.

As Eliot indicates, the modern era of hyper-rationality and hyper-specialization has been a reductive process in which the pre-modern unitive worldview of inherited, or revealed, "wisdom"

has been superseded by bits — and, more recently, bytes — of information. In this context, the term "new knowledge" is often used to mean new technologies.

In addition to this fragmentation, commodification of knowledge abounds as a socio-cultural by-product of globalization. Borrowing heavily from industrial era metaphors, education is now marketed as the "product" in a globally competitive "knowledge industry".

At the close of the first decade of the twenty-first century, some of the most creative, innovative, and dynamic knowledge around the globe is being produced and disseminated *outside* mainstream universities. Academic researchers and research council bureaucrats need to take heed. Now that "knowledge production", "knowledge transfer", and "knowledge dissemination" have become core commodities of the increasingly competitive global knowledge market economy, how will universities and their research centres keep up?

While the juggernaut of old-paradigm thinking keeps its hold on educational institutions, the burgeoning of new knowledge "paradigms" is breaking through from the periphery. A plethora of private providers, social movements, niche research institutes, open source resources, edutainment and, of course, the ubiquitous information kaleidoscope of the worldwide web, make it increasingly difficult for the former bastions of knowledge production and dissemination — formal educational institutions to compete for "market-share". But is competition the best way forward? Could it be that the leadership of universities and research councils need to listen more deeply to the periphery — to the new, unorthodox developments in the creation and dissemination of knowledge?
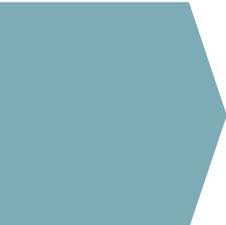
More complex, self-reflective, organic ways of thinking will be vital in re-shaping education so young people are better equipped for the complexity, paradox and unpredictability of life in the twenty-first century

We also hear the term *information era* as if it were a complete encapsulation of the present phase of cultural evolution. The proponents of the information era generally fail to attend to the evolutionary move beyond mere 'information' to new ways of knowing, new knowledge patterns and the emergence of knowledge integration.

The insinuation of neoliberal economic theory into all walks of life — including education — has led to the reframing of education as a subset of the new "knowledge economy". In this new knowledge economy, we can witness nations and regions scrambling to grab market-share through creating "science parks", "education cities" and "knowledge hubs". The most disturbing aspect of this "globalization of knowledge" is that it frequently reflects

homogenization. This McDonaldization of education transplants outmoded models and approaches as if they were fast-food franchises with little regard to the quality of the learning experience for students or the cultural context in which the model is implanted. In the rush to the top of the globally competitive league tables, there appears to be a blind disregard for epistemological and cultural diversity, through alternative ways of knowing. With their embeddedness in the global economy such approaches to global knowledge are also locked into short-termism, stasis and homogenization (see Figure 1).

Figure 1. Global Knowledge Economy – Ideological Stasis and Homogenisation

While proponents of neoliberal capitalism argue for the new "knowledge economy", this economics-driven thinking perpetuates fragmentation, commodification and instrumentalism. This economistic framing fails to attend to the richness and diversity of knowledge creation being enacted on a planetary scale. By contrast, pluralistic ways of knowing grounded in human creativity innovation and relationship are less dependent on economic and material resources and thus intrinsically more sustainable for a fragile planet (see Figure 2).

In contrast to the reductive and economistic ideologies underlying the notion of the "global knowledge economy", my term *global knowledge futures* is intended to unsettle those who use the term knowledge reductively and/or prescriptively. *Global knowledge futures* includes research that eschews the mechanistic, instrumental, reduced versions of knowledge. It seeks to go beyond, to go deeper, to imagine longer time-scales and planetary spaces, to develop and enact more coherent futures of knowledge integration.

My notion of global knowledge futures is framed within the understanding that human consciousness is evolving and for the first time in history we can consciously participate in co-creating our futures through conscious evolution.

Building on the evolution of consciousness literature, my phrase *global knowledge futures* can be teased out semiotically to clearly distinguish it from the hyper-modernist *global knowledge economy*. The cultural pluralism implied in my notion of global, and the ideological diversity in my notion of futures, fold back into the term knowledge, enriching it and opening it up to insights from the frontier discourses discussed above that are central to global knowledge futures (see Figure 2).

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Figure 2. Global Knowledge Futures — Dynamic Unity in Dialogue with Diversity

Global	Pluralism and multiplicity	Planetary
		Culturally Diverse
		Transnational
Knowledge	Multiple epistemologies / Multiple perspectives	Integral A-perspectival
		Disciplinary/Transdisciplinary
		Formal and Postformal
Futures	Anticipating alternatives / Foresighting innovations	Possible
		Preferred
		Participatory
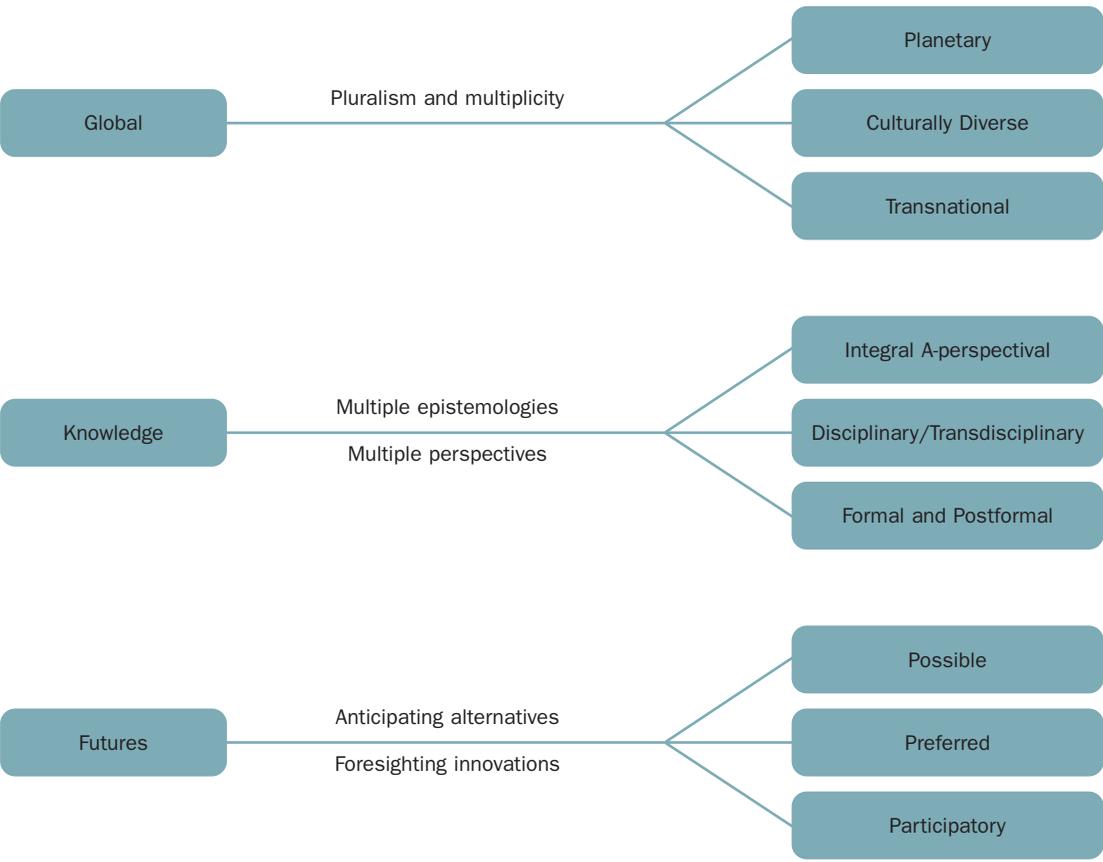
VISIONARY FUTURES OF EDUCATION FOR RAPID GLOBAL SOCIETAL CHANGE

If we are to seriously move beyond the business-as-usual stance of the guardians of old paradigm thinking, we need to embrace new ways of thinking and patterns of knowledge,

Julian Germain, *Classroom Portraits, 2004-2012. Al Tadhamon Boys' School, Malah, Rada', Yemen. Year 1 Intermediate, Mathematics. May 13th*, 2007

consciously co-create our own evolving consciousness, and wrest education back from the economists and auditors so that it reclaims its place as a vital component of cultural development. In these ways, the nineteenth-century factory model of formal education will have been *postformalised* to suit it for the twenty-first century.

To these ends educators would begin by integrating the following twentieth-century knowledge developments into their thinking about education:

- Post-classical sciences including quantum physics, chaos and complexity, emergentism, open systems;
- Postmodern, poststructuralist and comparative philosophies;
- Postformal reasoning, including complexity, creativity, paradox, reflexivity;
- Inter- and transdisciplinarity;
- Systemic, holistic and integral theories;
- Global and planetary perspectives;
- Foresight and long-term futures thinking.

Secondly, as the implications of the evolution of consciousness begin to be fully appreciated by educators, the skills-based, reductionist, fragmented, profit-driven factory model of education from the past will gradually be recognized as the anachronism it is. There will be a diverse flourishing of postformal educational centres, offering much greater creativity, reflexivity, imagination, dialogue, paradox and the many other features of postformal reasoning that are emerging in high-functioning adults today who are open to them.

Thirdly, in due course education will de-link from economics and reclaim its place in the cultural domain. From that time teachers will no longer be primarily childminders, researchers will not expect to be primarily fundraisers, and university courses will be oriented more towards the whole development of the students, rather than pointing them towards jobs that will no longer exist. Once the profit motive has been removed from education and replaced by cultural higher purpose the following issues may also attract serious futures thinking and attention from education experts:

- Environmental degradation now includes more dramatic climate conditions;
- After the GFC the limits to growth discourse is even more pertinent;
- Social and global justice are far from commonplace;
- Cultural pluralism and the needs of the global south require sustained focus.

In summary, the systemic knowledge shifts of the last century are facets of complex processes that are as yet little understood in terms of their significance for the future of ideas and the culture of education. These diverse, independent, yet interconnected movements pave the way for the emergence of more living and pluralistic approaches to education and knowledge futures. Education researchers, practitioners and policymakers need to take serious account of these dramatic shifts in ideas and ways of organising knowledge. More complex, self-reflective, organic ways of thinking will be vital in re-shaping education so young people are better equipped for the complexity, paradox and unpredictability of life in the twenty-first century.

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EDUCATION TODAY HAS MORE IN COMMON WITH THE NINETEENTH-CENTURY INDUSTRIAL AGE THAN WITH THE TWENTY-FIRST CENTURY. IT IS FRAGMENTED AND COMPARTMENTALIZED, CLINGING TO A FACTORY APPROACH TO LEARNING. WE NEED TO MOVE AWAY FROM MASS EDUCATION TOWARDS PLURALISM AND PLANETARY SENSIBILITY. KNOWLEDGE IS EVOLVING, CONSCIOUSNESS IS EVOLVING, AND EDUCATION NO LONGER SITS COMFORTABLY IN THE REALM OF ECONOMICS: IT IS AN INTEGRAL PART OF CULTURE AND SHOULD BE TREATED AS SUCH. THIS ESSAY CONSIDERS WHAT TODAY'S EDUCATORS THINK ABOUT THESE CHALLENGES. WHAT ROLE SHOULD EDUCATION PLAY? HOW CAN EDUCATION TRANSFORM ITSELF TO REFLECT THE INCREASING COMPLEX WORLD AROUND IT? THE AUTHOR PROPOSES THE NOTION OF *GLOBAL KNOWLEDGE FUTURES*, A SHIFT AWAY FROM THE REDUCTIONISM OF THE CONCEPT *GLOBAL KNOWLEDGE ECONOMY*. SHE ARGUES FOR LIVING, PLURALISTIC APPROACHES TO EDUCATION THAT ARE FOUNDED ON MORE COMPLEX, SELF-REFLECTIVE AND ORGANIC WAYS OF THINKING. THIS SHIFT IN PARADIGM WILL BE VITAL TO HELP YOUNG PEOPLE PREPARE FOR LIFE IN THE TWENTY-FIRST CENTURY.

BIOGRAPHY

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Dr. Jennifer Gidley is a Research Fellow in the Global Cities Research Institute. She is a psychologist, educator and internationally recognised researcher in the futures studies field, with a transdisciplinary understanding of global shifts in culture and consciousness. Her career includes experience as a school and community psychologist, teaching principal, academic teacher and researcher, and consultant, spanning three decades and all educational levels and sectors.

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Based in Melbourne, Australia, Dr. Gidley travels widely for research collaboration, which has led to speaking invitations in Australia, Europe (Czech Republic, France, Germany, Luxembourg, Romania, Spain, Sweden), North and South America, Africa (Egypt) and Asia (Malaysia, Shanghai, Taiwan). Her research interests include educational futures, knowledge futures and the evolution of consciousness, global psycho-socio-cultural change and planetary/global futures.

Imagining the Future

Leading the Way in a Changing World. Consumer Trends for The Future

Anne Lise Kjaer

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In my line of work it is well known that the future is not just somewhere you go: you create it. This means that governments, companies and individuals play an active part in determining the direction of society, through their actions and choices. Yet there is no doubt that today we face a particularly tough set of challenges. As the quantity of information at our fingertips increases, keeping up with analysis, pattern spotting and extracting useful information becomes even more crucial. With data overload everywhere in our daily lives, we need a system that talks back to us and enables us to make informed decisions — a sense-making platform that integrates data and insights to provide both information and inspiration. Over the past 20 years, I have developed tools and approaches for trends management that help companies and organisations determine the way ahead. The Trend Atlas is our trends filter, containing the building blocks for future mapping. It reveals the multiple layers — the scientific, social, emotional and spiritual dimensions that impact our everyday life — and we use it to decode the cultural contexts of society. While traditional P-E-S-T-E-L analysis only looks at part of the equation, this model documents the whole picture, giving a panoramic view of the future. In short, a Trend Atlas is a GPS for navigating complexity.

THE EVOLUTION OF CONSUMPTION AND "ENOUGHISM"

Reading today's Trend Atlas, it is clear that our century-long "love affair" with economic growth hasn't delivered more happiness. This is why

Blanca Muñoz, *Centrípeta II* (detail), 2007

people are looking elsewhere for new models and asking: How can I get more out of life? When we look back on human history and see how societies have evolved and developed, it has not been a nice even curve of constant progress, but rather, a bumpy journey of lessons to be learned. Keynes predicted that by 2030 economic growth in the developed world would, in effect, have stopped, because people would "have enough" to lead the Good Life. But the question is: Who sets the measure of what is enough? Our reality is that media constantly bombards us with contradictory messages. One day: "Small is Beautiful" and the next: "Big is Better." And when we hear the call to: "spend, spend, spend", it becomes all too easy to confuse the Good Life with a Goods Life.

There is a global consensus that one of the main challenges is that of over-consumption. In the Western world, "to consume or not to consume" has become today's big ethical dilemma — one that seems to unite us but at the same time divide the haves and have-nots.

Since the Industrial Revolution, we have been urbanising at an exponential rate. Only 150 years ago, we consumed 26 times less than we do today. We have now reached a negative tipping point, where unsustainable lifestyle patterns are impacting and affecting us in both a global and local context. In *The Economics of Enough: How to Run the Economy as if the Future Matters*, Diane Coyle says: "Many would argue that our relentless pursuit of higher economic growth, indicated through GDP statistics, is at the heart of our current dire circumstances."

New Models are Needed

So how can we mend the imbalance created by over-consumption and deliver a positive future legacy? Business models that embrace a system based on consumption alone are obsolete. It is crucial to evolve from a production-focused MEconomy to a WEconomy, founded on shared responsibility. This means engaging the State, companies, communities and citizens and — with calls for a more inclusive society — we must face up to the fact that just owning more is not a sustainable route to a better future. When politicians say that it is our "duty" to go shopping to keep the economy going, we are justified in asking ourselves: Is consumption our sole reason for existence? As Joseph E. Stiglitz and Amartya Sen observed in their report, *Measurement of Economic Performance and Social Progress*: "Those attempting to guide the economy and our societies are like pilots trying to steer a course without a reliable compass."

Thankfully, we are starting to see a subtle shift in culture, a move towards a more transparent, sustainable and, most importantly, meaningful model where people actively consider how to achieve the Good Life. It is, therefore, hardly surprising that people now call for companies to demonstrate that they really do care and demand these attributes in everything from government policies to products and services.

According to the Meaningful Brands Index survey of 50 000 consumers globally, only 20 percent of brands are perceived to have a notable positive impact on our sense of well-being and quality of life and — what is more — people would not care if 70 percent of today's brands ceased to exist. This clearly indicates that it is time to rethink business models in order to match people's real expectations and their lifestyle universe.

Introducing a "4 P" Bottom Line

I believe that, in order to develop a more sustainable future, a 4 P bottom line, where People, Planet, Pleasure and then Profit are guiding principles, must underpin twenty-first-century business models. Most people can agree with this principle and aim to lead more sustainable lives, but our "Always On" society encourages a culture of constant consumption.
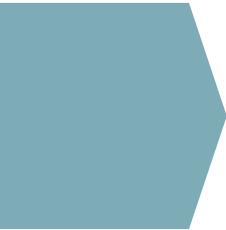
The future is not just somewhere you go: you create it. This means that governments, companies and individuals play an active part in determining the direction of society, through their actions and choices

Contrasts will always co-exist, and this presents additional challenges for organisations. Consumers and citizens demand, on the one hand, transparency and ethics, and on the other, more choice and discounts. To balance these contrasting demands requires "whole brain" thinking. A left-brain outlook of analysis and detail paired with a right-brain ability to imagine and see the bigger picture are vital dynamics that must come together to enable organisations to think from the outside in.

What is more, a growing, so-called hyper-connected, middle class globally is aspiring to more and better, demanding instant access and gratification. This creates a tough set of choices for all of us as consumers: Disposable versus Sustainable, Fast versus Slow. And yes, it is rather complicated to work out how to strike a happy balance, but one thing is certain — you can't solve a problem with the same mindset that created it.

The real opportunity for companies is to become trusted exponents of Good Life choices, delivering them to people in a straightforward package and enabling them make the right decisions without even thinking about it. The ideal solution must be easy and sustainable at no extra cost. A global P&G consumer survey bears this out, showing that currently, 70 percent of people want to live a greener life but they don't want to be penalised. However, people's priorities and values are set to shift dramatically in years to come. So investing in a 4 P scenario now is not only crucial for the planet and to attract talent, but it also makes good

business sense. Governments and companies pioneering this approach are seeing huge benefits and this is already influencing how we do business, as well as shaping policy in fresh ways. Put simply, profit has to be calculated in an inclusive manner to ensure positive outcomes and rebuild people's trust in business and government.

TOMORROW'S KEY SOCIETY DRIVERS

When we look ahead, success will depend on empathic leadership, where governments, institutions and brands all act as facilitators, enabling people to achieve a more fulfilling life through open dialogues about sound ethics and meaningful lifestyle choices. According to a White Paper from The Luxury Institute, building a caring company culture will enhance your own life experience and transform you from just another business executive into a happy and thriving human with a far greater purpose than the pursuit of money. Ironically, sales and profits will follow. By taking this approach, leaders demonstrate that they are heading an empowerment organisation that practises rather than just preaches values.

This requires vision, but also an understanding of both key society drivers and the mindsets of the people organisations want to invite into their universe. The first stage of this process is to step outside the corporate or government box to understand people's culture and how they see you. Only then can you effect positive changes and innovation. It is therefore meaningful to explore some of the Key Society Drivers and disruptive forces impacting today's lifestyle choices, as well as to link them to people's value sets. Not only do they provide us with a profound insight into tomorrow's consumer mindsets, but they also identify both business challenges and opportunities. In the section that follows, I have mapped out the key drivers from the Trend Atlas that will affect society, brands and people now and in decades to come — think of them as Future Sound Bites. While we often tend to talk about trends individually, it is important to understand that they are, in reality, all interconnected.

Total Transparency & Trust
Society & Business: In future, organisations will have to work harder to be noticed and trusted, earning this continuously through openness, consistent performance and total transparency. Research has also shown that the more transparent you are, the more people are willing to forgive if mistakes should happen. With growing online exposure, there is a strong call for credible interactive platforms for mutual stakeholder exchange. Social media is already causing a global paradigm shift, influencing people's habits and behaviour. This will be a core ingredient in building rewarding, trusting relationships and it requires deep consumer engagement in order to build reputation. An authentic organisation ensures that brand promise and consumer

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experience are totally aligned with performance. In fact, brands' very future depends on their accountability and requires a personable and sincere approach, demonstrating respect for and fair use of personal data. One live model of transparency can be seen in Scandinavia, which is — perhaps not coincidentally — also among the top-ranking regions when measuring life satisfaction. Here, e-government is serving citizens and the public sector alike by making a vast amount of information available in a national spatial data infrastructure (NSDI) when needed, while preserving the privacy of the individual.

People: According to Datamonitor, levels of trust in business are low and discerning consumers have proved to be highly ambivalent, questioning business praxis across all sectors. Globally, just 37 percent trust consumer packaged goods companies to tell them the truth. This distrust, paired with people's increased skill in decoding cultural messages, means that traditional marketing is often met with scepticism. Worse still, trust in brand morals is so precarious that 65 percent of

consumers would like to see stricter regulations across the board — from product safety to traceability and retailer pricing. Social networks and platforms allow people to increasingly bypass traditional routes of trade, so brands not delivering on trust issues will face becoming obsolete. Organisations must shape up to meet consumers' and society's demands for radical transparency. Adapting to an open and approachable model now — disclosing the good as well as the bad of the organisation's "value ecosystem" — will earn trust from people and consumers in the future.

Smart Tech & The Internet of Things

Society & Business: Smart Technology and hyper connectivity means we can control all aspects of our lives like never before and this is fundamentally reshaping the way society is operating. Already, technology routinely facilitates our work, shopping and socialising, also informing and enabling efficient control and planning of finances, energy consumption, health and even lifestyle transitions. Within the foreseeable future, more smart devices than traditional computers will be used to access the Internet and this will call for brands to move from being device- and channel-centred to adopting people- and consumer-centred approaches, adapting their messages to multiple devices. Technology insiders have long predicted "true convergence" — this is only the beginning — but it also raises expectations of personalised information and rapid services. Many technology experts, engineers and scientists are more than willing to tell us what technology will be able to do, but this does not tell us what tomorrow will bring. A key issue we face as a society is in acknowledging that what is technologically possible is not necessarily morally acceptable or, indeed, economically viable. Ultimately, the route to maximising the success — and positive benefits — of smart technology and the Internet of Things must be in letting people and society shape their future direction.

People: As physical and virtual borders dissolve, seamless transitions and self-defined boundaries in all areas of life will be the norm. The physical retail store is no longer the core customer universe, with brands expanding onto several platforms. We will see this even more in the future and businesses need to evolve to be where people are. A new generation, raised on the freedom created by technology, social media and sharing, expects convenience alongside lower-cost products and services. Consumers already expect exchange and interaction, with the power balance tipping towards the needs and wants of people, regardless of demography and cultural context. Without doubt, we will see continuing rapid growth of social commerce and other technology-enabled industries. The mobile apps and content sector alone is, according to Gartner, set to grow from $18 billion in 2012 to $61 billion by 2016, while spending on e-books, online news, magazines and information services will rise from $5 billion in 2012 to $16 billion by 2016. This obviously challenges the media sector, while presenting ample opportunities to innovate and create new businesses. Across the board, we will see calls to rethink current industries and distribution models.

Cloud Culture & Open Dialogue

Society & Business: The *cloud* is one of the biggest game-changers in a world where big data and Master Data Management (MDM) will redefine how we interact. Moving services, applications and storage to clouds fosters agility for both businesses and individuals by putting immense computing power — with vast quantities of information — in easily accessible formats at relatively low cost. However, we risk moving from being digitally enabled to digitally disabled if we do not navigate this space with great care. The online data footprint we all leave behind represents an obvious opportunity for marketers, but it also raises issues of data protection. It is imperative to respect boundaries because mutual exchange of information is the key to maintaining crucial relationships. Organisations will only prosper if they are transparent about how they hold and use data because, for consumers to willingly share information, they need to know the benefits to them. Businesses must deliver immediacy and responsiveness and recognise that we live in a flatter, more democratised world, where access allows individuals to become self-styled experts. As we move away from traditional top-down distribution of knowledge, communication of brand messages is being transformed from one-way storytelling into a dynamic narrative.

People: We are becoming people of the cloud and, with the cloud responding to our pattern of behaviour, this is a world where digital and virtual truly begin to blend. According to McKinsey, 39 percent of companies already use social media as their primary channel to reach customers. With this set to rise to 47 percent over the next four years, people want organisations to engage with them on their terms, developing propositions that enrich their lives. The desire to share and access content on multiple devices will motivate consumers to start storing more than a third of their digital content in the cloud by 2016, according to Gartner. The cloud will then become a virtual extension of people, sparking a culture where anyone can be positioned as a brand. Skills and learning will increasingly be developed through networks and communities, sparking a new kind of entrepreneurship that puts The Good Idea at its core. Amidst all the promises and potential of a digitally enabled future, it is important to realise that people are essentially analogue. While cloud culture allows highly personalised digital products and services at incredible speed, it will still be analogue human touch-points and genuine service that win the loyalty of tomorrow's consumers and cultivate fertile relationships.

Global Citizens & Cultural Mobility

Society & Business: It is estimated that, by 2050, 70 percent of people will live in cities. But what we are seeing right now is the beginning of a global movement of cultural enrichment, one where mobility reaches new levels. Eighty percent of Millennials and Gen-Y, the main proponents of Global Citizen ideals, have stated in a recent survey that they would like to live abroad, as

working internationally is essential to their career plans. Meanwhile, the 50+ segments — the "grey" version — are likely to work longer and to seek new opportunities by engaging in learning, travelling or bridging their career. With their culturally open mindset, Global Citizens are hugely influential and also vital to companies' future success. They demand new standards in virtually all areas of society and the constant flow of different points of view, passions, and interests they generate are already informing the value sets of tomorrow's so-called digital natives. Global Citizens are fostering a global collaborative "WE" mindset, as well as being the cohesive factor for tomorrow's flourishing social networks. Companies must forge new bonds within both the working and social environments that Global Citizens operate in so seamlessly because this group will lead society in exciting new directions.

People: Global Citizens use new technologies as a means of establishing personal interest groups and exploring fresh ideas. They are driven by the desire for opportunities and, rather than being concerned with immediate locality, they view the world as their global network device. Flexible, open-minded and naturally attracted to diversity, they seek enhanced interaction and multi-layered experiences, with technology as the key enabler of cultural exchange, social networks and brand engagement. Future migration is not only influenced by traditional pull factors, such as job opportunities and wage levels, but also by the desire for personal development and improved cultural and political conditions alongside the provision of a "higher level of service", according to the Copenhagen Institute of Future Studies. This highly mobile citizen is shaping an entirely new future consuming culture. This is a reality where the emphasis will be on access over ownership, as they prefer facilitation over "more stuff". Younger Global Citizens are particularly attuned to sustainability issues and expect goods to be produced and delivered responsibly.

Rising Economies & A New Middle Class

Society & Business: Rising Economies are altering economic and geopolitical global balance. As well as shifting manufacturing centres, they bring a fast-growing middle class and, according to McKinsey, by 2025 as many as 50 percent of the world's population will have joined the so-called consuming classes and annual consumption in rising economies may hit $30 trillion. Information and communication technology (ICT) is playing a central role in economic development and the telecom industry in emergent markets could reach $200 billion by 2013. The great challenge for businesses is to adapt to local contexts because cultural capital and regional heritage are essential components in a flourishing economy of the future. Business must invest in local skills to gain an edge over global competition and resonate with local cultural values. Signs are that this is already happening because, in a recent survey of 100 global corporations conducted by Worldwide ERC, 95 percent of senior executives who responded reported that national cultures play an important or very important role in the

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success of their business mission. Brilliant business models are never anonymous — they reach out to local communities and enable people to connect across borders — so winners of the future will be the organisations that are agile enough to adapt to *Glocalisation*.

People: In a recent report called *Macroeconomic Foresights*, The Futures Company said that: "In developed markets, consumers feel threatened by the loss of status in declining economies. In emerging markets, consumers feel threatened by a relentless push into an unknown future because of rapidly growing economies. In both cases, consumers want reassurance, guidance and encouragement." Provenance and heritage give brands an edge and people a sense of belonging. Local craft, storytelling and specialties will grow in value as a commodity, in tangent with an emerging need to reconnect to narratives rooted in locality.

People will seek out a guide, a familiar anchor, in an increasingly fragmented, mobile and globalised world. New communities or "tribes" will be formed based on shared values and lifestyle sets and there will be a growing emphasis on balancing the need for self-expression and individuality against the WE mindset of the future. By employing global connectivity and social media applications, people can communicate globally, absorbing new regional flavours, sharing knowledge and creating authentic narratives with the potential to change concepts of belonging.

Female Factor & Social Capital

Society & Business: The Female Factor is influencing fresh approaches to collaborating and creating value, at the same time as business is recognising the twenty-first-century imperative to observe a social capital focus. As the World Bank noted: "Social Capital is not just the sum of the institutions which underpin a society — it is the glue that holds them together." The inclusive mindset of women is more oriented toward the greater good of society, rather than individual gain. This "whole brain" approach goes hand in hand with the idea of a collaborative leadership model where our cultural environment is increasingly made up of dynamic social live networks. This collective value is now being recognised as a measure of companies' worth as investment vehicles — but there is also increasing evidence that the Female Factor may be the vital catalyst to deliver both economic prosperity and social cohesion. With many organisations looking hard for capable talent to tackle the big challenges ahead, it is worth being reminded that Harvard research has shown that female leaders score highly on delivering better bottom lines. More importantly, their approach also strongly correlates to other key measures of organisational performance, including increased transparency, innovation, well-being and community engagement.
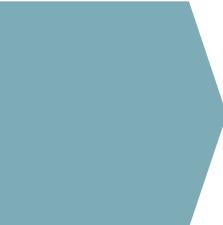
> **Brilliant business models are never anonymous — they reach out to local communities and enable people to connect across borders — so the winners of the future will be the organisations that are agile enough to adapt to *Glocalisation***

People: Not only are women increasingly willing and able to play a major leadership role, but there are now more female graduates than male in Europe. According to Goldman Sachs, "closing the gender gap can drive long-term economic growth — pushing income per capita 14 percent higher than baseline projections by 2020, and as much as 20 percent higher by 2030". Nurturing a balanced gender culture to inspire the best in people in terms of

contribution, innovation and loyalty — while ensuring optimal conditions for their individual happiness — is vital to the future success of our society. The growth in participatory culture, as seen in crowd-sourcing, sharing, volunteering and affinity networks, is the positive measure of people's desire for meaning and their aspiration to give back and "be better together". Brands that understand how to leverage the Female Factor to connect and collaborate will thrive. This will be an altogether more human-centred approach based on real relationships, where bricks and mortar retail may well become a vehicle to bring people and communities together in positive experiences — with online retail doing the actual sale.

A Better World & Global Sustainers

Society & Business: Although many economists and politicians still view continuous and rapid growth as the only model going forward, in a Better World scenario, clean tech and conscious consumption sit alongside transparency as a core business strategy for long-term growth. It is believed that business and not government must be the primary driver behind this ecologically intelligent future. In his book, *People, Planet, Profit,* Peter Fisk argues that business leaders need to rethink fundamental strategic questions like: "why we exist, where to focus, how we are different, and why people will choose our products or services, want to work for us, and invest in our business." This resonates with the *Goodpurpose Study* 2012 by Edelman, which shows that 87 percent of global consumers want businesses to place at least equal weight on society's interests as on business' interests. In this same survey, less than a third believe current business is addressing societal issues, making this a key differentiator for successful businesses of the future. It seems clear that people and organisations will have to work in synergy to create a positive, equitable future. The CEO of Carrefour Group, Lars Olofsson, has expressed this challenge very well: "We must make the aspirational attainable, the attainable sustainable, and the sustainable affordable."

People: To consume is fundamental to being human and it provides cultural and social expression. However, as we now consume at a scale that is not sustainable, we need a rethink of this fundamental drive. Notions of status are changing, as we focus more on human connections and experiences and less on consumption and ownership. In this context, we are seeing a trend towards people conducting more or less public experiments in living with less, also challenging others to follow their example. The Share Economy, or collaborative consumption, is a manifestation of this — and this movement is already creating a global economy of its own. It favours access to goods and services over ownership — addressing the growing rejection of consumption through "unconsumption". However, while frugality may suddenly be a new cool trend, as consumers we are realistic in our Better World aspirations. The *Goodpurpose Study* by Edelman found that 76 percent of consumers worldwide think it acceptable for brands to support good causes and make money, up from 33 percent in 2008.
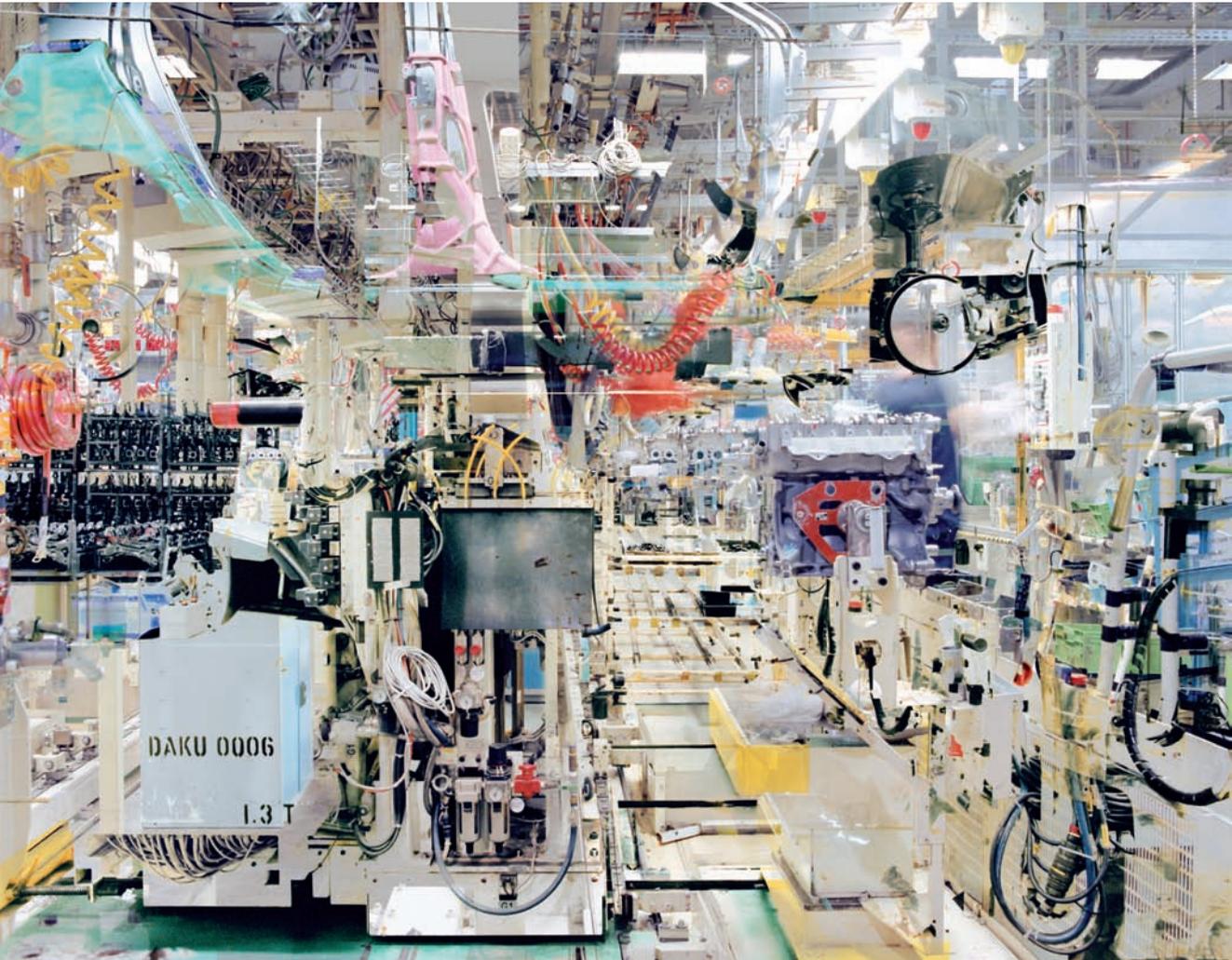
Stéphane Couturier, *Melt. Toyota 15*

This suggests that improving our society by practising the Good Life can go hand in hand with delivering on the bottom line.

The Good Life & Happinomics

Society & Business: Economic growth does not necessarily indicate more life satisfaction — or, at the very least, it is not the only thing we should be measuring. *Happinomics* is flourishing, as many corporations have realised that they can achieve success and change behaviours by encouraging employees to adopt a mindful approach to work and life in general. Besides holding seminars on life satisfaction, the UK Cabinet Office published a paper in 2011 pointing to new

policies that could improve the happiness of the nation. With global challenges for traditional growth, plans to measure GDP alongside Gross Domestic Well-being (GDW) have been suggested. A sense of well-being can inspire and enhance "plenty" in many areas — productivity, social connectivity and improved public health — but until we start looking beyond balance sheets, we won't get an accurate measure of how well society is delivering the Good Life ideals. Perhaps we can learn from the fact that Harvard Business School's course on positive psychology as the catalyst for change is now oversubscribed and is informing a new generation of business leaders. It seems inevitable that future economic models will be balanced with data measuring happiness levels.

People: As the Dalai Lama has pointed out: "happiness is not something ready made, it comes from our own actions". Experiences that contribute to the greater good of humanity, the planet and our community are key to people's search for engaging narratives. Personal well-being is high on the agenda, reflected in both increasing health concerns over diet and lifestyle, and in the boom in life-coaching and personal pampering. While personal well-being and meaning remain key motivators, Happinomics is something much broader. From politics and business to work and lifestyle choices, this is a big-hearted approach and a pivot for innovation of products, services and new disruptive business models. A wide range of influences determine our happiness levels, but recent scientific theory asserts that our genetic make-up is matched 50:50 by other factors. However it comes about, we know happy people live longer and have more productive lives. New business concepts, such as financial coaching and "energy makeovers", are just the tip of the iceberg when it comes to delivering Good Life propositions and experiences that engage people in self-improvement and in building the future society they want to see.

NEW DIRECTIONS

Living with the growth imperative, encouraged by government and economists, we have lived by the mantra, *I consume, therefore I am,* for far too long. Increasingly, and especially in the light of a new global financial reality, we are starting to question the logic and values behind our raison d'être.

As we start to challenge the belief that personal happiness is dependent on the consumption of stuff, we look to other models for inspiration on how to restructure a society based on different values. Whichever way we look at the current landscape, it is clear that the Good Life is the overriding driver for the future agenda and the social glue that interlinks all the trends, in one way or another. This presents an obvious challenge for businesses and organisations to rethink their current models and, indeed, their values.

Scenarios for 2030: Creating Opportunity from Crises Through Real Value

In 1962 — the year I was born — Thomas Kuhn's book *Structure of Scientific Revolutions* was published. It describes how a crisis often leads to paradigm shifts. Are we witnessing just such a Kuhnian paradigm shift? With prolonged financial turmoil in the West, an impending environmental crisis and a technology revolution that has empowered people in ways previously unimaginable — not to mention the profound changes taking place in the geopolitical arena — there is more than enough to trigger just such a seismic change.

Trend management is a powerful strategic tool because the recognition of patterns provides a framework for future projection, planning and ideation, and combining several drivers can create scenarios for any given sector or answer specific questions about the future. Narrating potential futures requires detailed analysis, paired with the ability to ask the right questions.

Scenario development is the trend analysis' framework, providing a storytelling platform for narrating meaningful content. Good scenarios have the potential to open minds, changing the perception of both people and businesses in a profound way. You get rid of prejudice and old patterns of thinking by opening and exploring possible future developments; the results are often surprising, enabling you to view the world in an entirely different way. To add life and structure to our scenarios, we link the trends to value sets, creating a Consumer Mindset Map to understand people's likely behaviour. This tool provides a simple yet holistic understanding of consumers and their lifestyle preferences. All the typologies are relevant as we are not "clean-cut types" but, rather, dynamic individuals switching mode depending on our needs or situation.

Consumer Mindset Maps

So how do the trends affect tomorrow's people and consumer mindsets? Well, we live in a diverse and polarised society made up of patchwork tribes where people share common lifestyles, preferences and value sets across conventional geographic and demographic borders. This moves us away from traditional consumer analysis and metrics into a more profound and holistic understanding of individuals and groups. In general, society is made up of two contrasting mindsets: ME People — who put themselves at the centre of everything; and WE People — who consider the world and togetherness first.

On a rational level, people demand ease of access, mobility and connectivity to drive their quest for personal empowerment. Facilitation, access and openness are central to connecting with consumers, with interaction happening through technology-driven platforms. The mindset typologies in the rational dimensions are the High Achievers and Happy Bohemes. Their key motivational value drivers are openness and flexibility — and connectivity through honest dialogue.

On an emotional level, people expect sound ethics and social and environmental responsibility within a transparent corporate community. People-centric offerings built around integrity and trust are essential in order for organisations to develop genuine and lasting

consumer relationships. The Cultural Explorers and Karma Hunters are the emotional mindset typologies, with a marked preference for real engagement and collaborative communities based on meaning.

Tomorrow's successful organisations target ME and WE People equally, also ensuring they have strategies for both rational and emotional value chains. This is the way to win both the minds and the hearts of tomorrow's consumers. To highlight what will matter to people over the next decades, we've illustrated four mindset profiles.
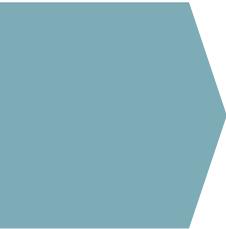
> **Business leaders need to rethink fundamental strategic questions like: "Why do we exist? Where should we focus? How are we different? Why will people choose our products or services, want to work for us, and invest in our business?"**

High Achievers

The Rising Economies are paving the way for enormous growth of a new middle class. These High Achievers are ambitious ME People; individuals with a rational and progressive mindset, truly depending on the power of Cloud Culture as a connective global force. For them, the cloud presents an infinite source of new possibilities. They thrive on and expect "real-time" dialogue and a sense of partnership, building value through mutual exchange of knowledge. Inspire them by offering unique and intelligent experiences with a human touch-point and a sense of personal control and ownership.

Happy Bohemes

Tomorrow's curious and open-minded Happy Bohemes focus on human relationships. Smart Technology is perceived to be a key enabler and the central management tool, assisting them in all aspects of life. As Global Citizens, they are informed about the world and naturally seek out opportunity in a global context. This often young and very mobile group needs flexible solutions that balance their desire to be recognised as individuals with their fundamental WE-centred mindset. This group want experiences that enable them to focus on social awareness as well as nurturing their sense of digital connectivity.

Global Sustainers

Global Sustainers are proactive and informed, enjoying community participation — real and virtual — and connecting through ideas and new concepts of sharing and authentic togetherness. These emphatic WE People have embraced an inclusive leadership style and the

Female Factor as a key driver of a sustainable long view. As would-be influencers, they are attracted to businesses based on ethical principles. Offers that breathe a culture of collaboration — and take a lead in building communities to facilitate a Better World for all — will be inviting and inspiring for this mindset.

Karma Hunters

Karma Hunters are early adopters in redefining concepts of the Good Life and are attracted by brand narratives delivering on the promise of being active in the happiness agenda. To this end, trust is fundamental for a thriving relationship, making Total Transparency central to all communication and strategy. Karma Hunters are intuitive and mindful ME People, constantly reassessing what constitutes a better life. These important shapers of the future are true early proponents of the 4 P business model and engagement through meaningful and value-based experiences will make them vital brand ambassadors.

CONCLUSION

Relying on traditional measures of growth is not only unsustainable in environmental terms but also in terms of human well-being. So to succeed in the future, it will make sound business sense to start with a strategy of maximising social value and optimising conditions for human happiness within the planet's capacity, also considering our consumption and production patterns. There is growing evidence that businesses and welfare can thrive on different models, and they must certainly explore options beyond the current unsustainable trajectory.
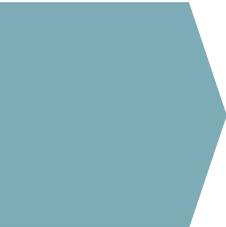
> As we start to challenge the belief that personal happiness is dependent on the consumption of stuff, we look to other models for inspiration on how to restructure a society based on different values. Whichever way we look at the current landscape, it is clear that the Good Life is the overriding driver for the future agenda and the social glue that interlinks all the trends

There are already the first signs of a shift, with new models of consumption being introduced based around concepts of sharing — including leasing goods, services and access and rewarding people for consuming less or behaving more sustainably. One thing is certain, new collaborative consumption models will be more accessible to all, more convenient, affordable and personalised. This is exciting and allows us to develop new and more positive scenarios for the future.
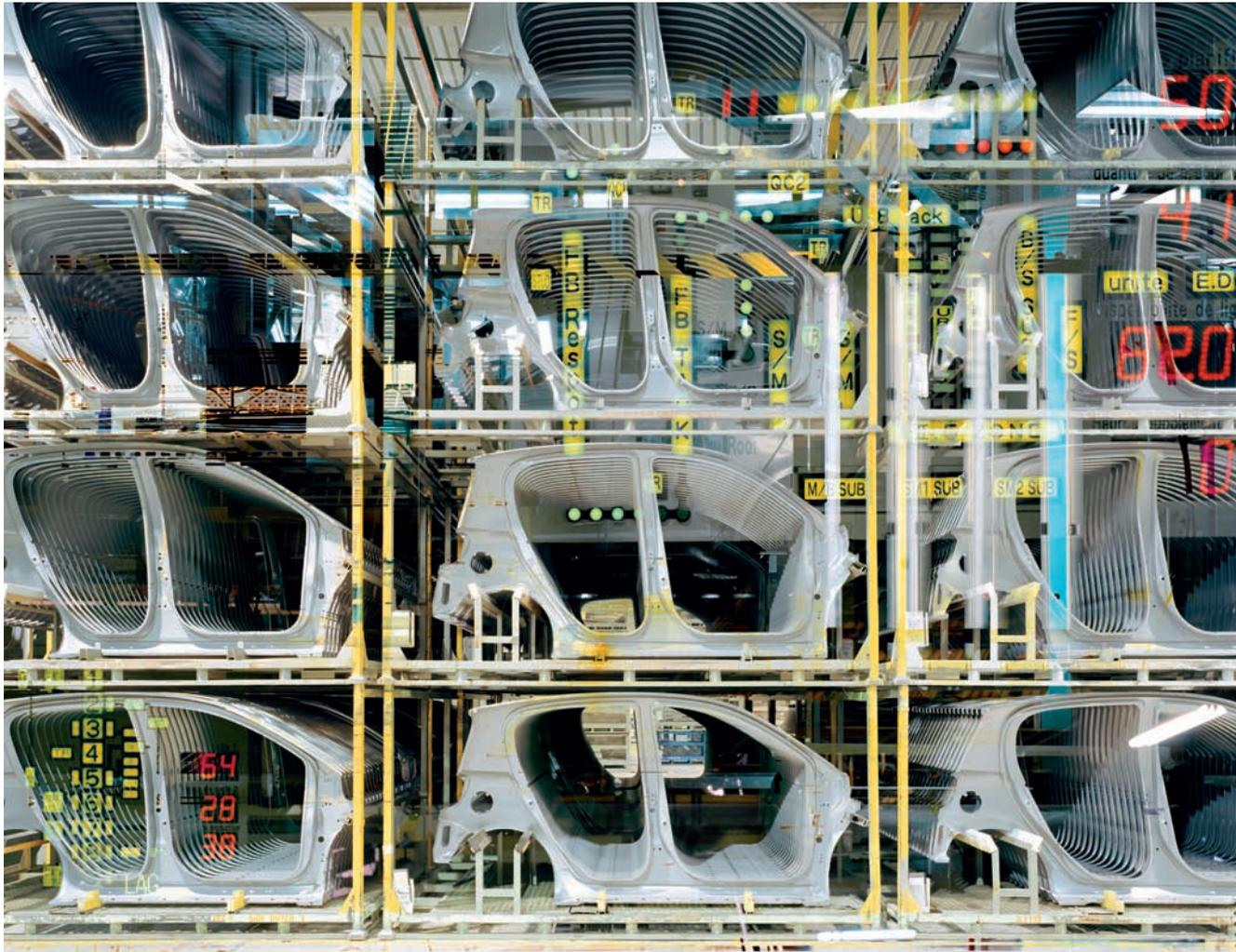
Stéphane Couturier, *Melt. Toyota 20*

As our mindsets demonstrate, we are experiencing a paradigm shift where life priorities are already changing for many, with the rest following in the future. Increasingly, people are saying: Don't tell me, show me! Connecting with others requires empathy and, for businesses, it is about the ability to inspire, empower and facilitate the Good Life. Understand too that people — whether they work for you, use your services or buy your products — have higher standards and more complex decision-making processes than ever before. To deliver on meaningful consumption requires a holistic brand architecture that can deliver authentic goods, services and experiences in all areas of people's lives.

The measure of a twenty-first-century brand's true worth and potential is how it engages with the world as a whole. To be a winner, you must implement a 4 P strategy and bottom line. We have talked about People and Planet and how to balance these with the essential P for Pleasure: the meaning and foundations of the Good Life. Focus on balancing the first three and the final P for Profit will follow. The 4 P is not just a communications and marketing strategy, but also a whole new opportunity for thriving as a business through real value and meaning.
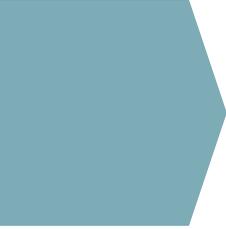
To succeed in the future, it will make sound business sense to start with a strategy of maximising social value and optimising conditions for human happiness within the planet's capacity, also considering our consumption and production patterns

We are all participants in shaping the future, whether we passively accept the old and unsustainable business-as-usual route or embrace change by implementing new models that deliver brighter futures for society, business, people and the culture in which they operate. I firmly believe that current signs indicate more of us are choosing the latter path. We face huge challenges but, with a positive and open mindset, we can shape a future that brings us much closer to the Good Life ideal.

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WE ARE ALL PARTICIPANTS IN SHAPING THE FUTURE, BUT TODAY WE FACE A PARTICULARLY TOUGH SET OF CHALLENGES. HOW CAN WE MEND THE IMBALANCE CREATED BY OVER-CONSUMPTION AND DELIVER A POSITIVE FUTURE LEGACY? SIMPLY OWNING MORE IS NOT A SUSTAINABLE ROUTE TO A BETTER FUTURE. WE NEED TO EVOLVE FROM A PRODUCTION-FOCUSED **ME**CONOMY TO A **WE**CONOMY, FOUNDED ON SHARED RESPONSIBILITY. THIS ESSAY EXPLORES HOW COMPANIES CAN REACT TO AND HARNESS THE PARADIGM SHIFT IN LIFE PRIORITIES AS PEOPLE REDEFINE THEIR CONCEPTS OF THE GOOD LIFE. COMPANY BALANCE SHEETS NEED TO REFLECT THE CHANGING WORLD AROUND THEM THROUGH A **4 P** BOTTOM LINE, WHERE PEOPLE, PLANET, PLEASURE AND THE PROFIT ARE THE GUIDING PRINCIPLES. ONLY BY EMBRACING NEW BUSINESS MODELS CAN WE DELIVER BRIGHTER FUTURES FOR SOCIETY, BUSINESS, PEOPLE AND THE CULTURE IN WHICH THEY OPERATE.

BIOGRAPHY

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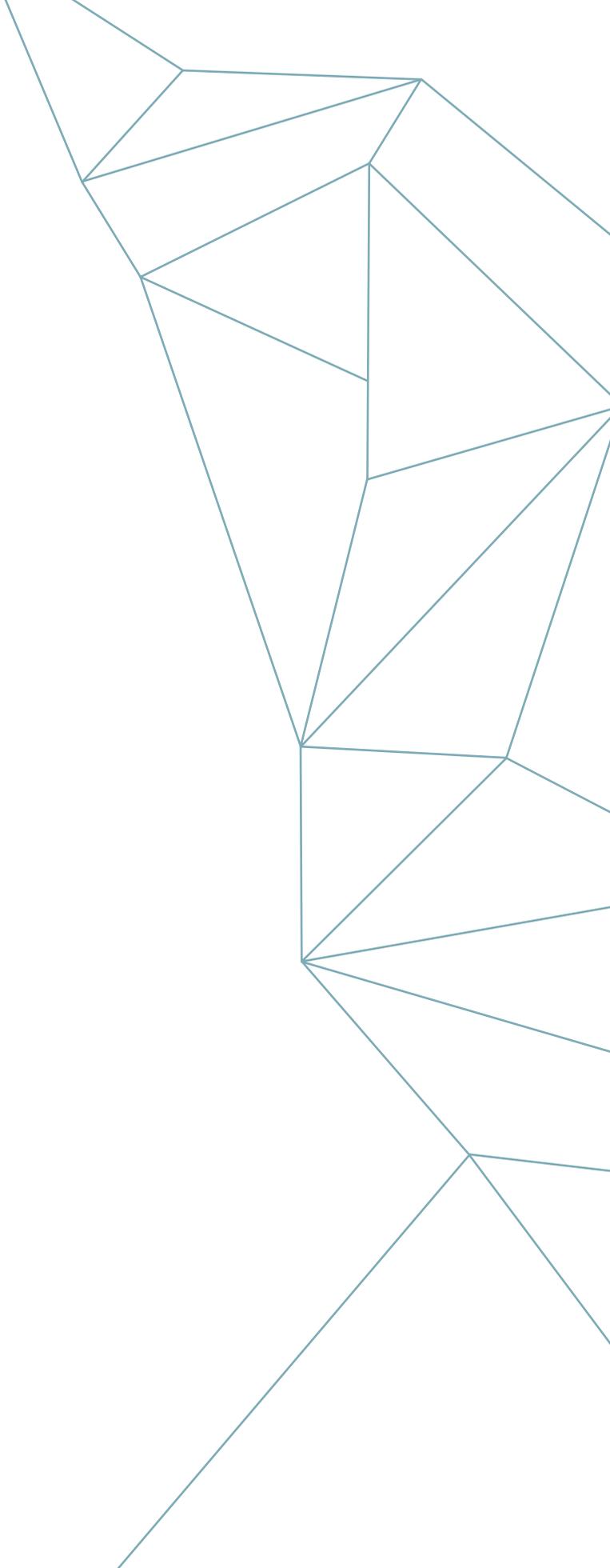
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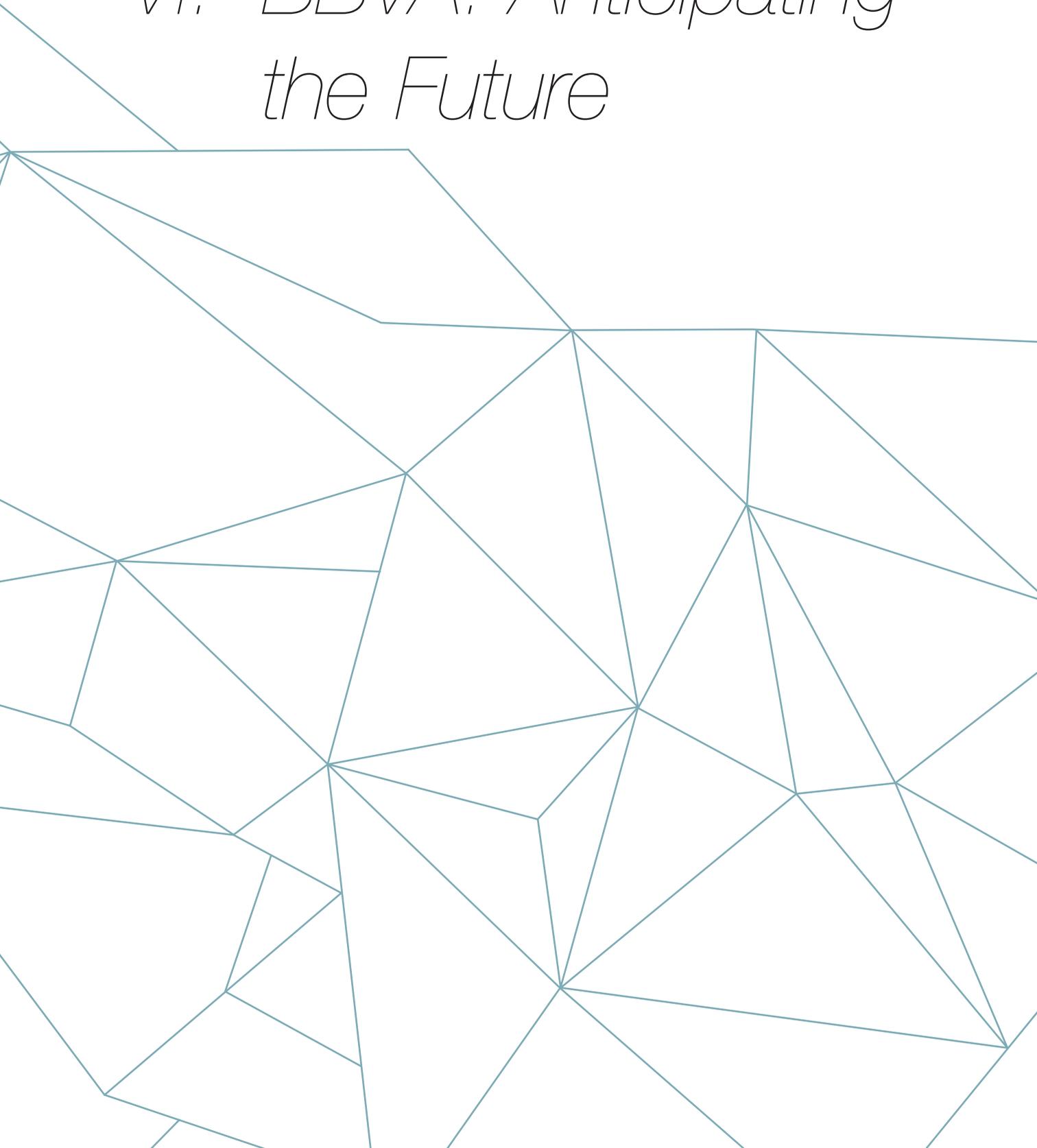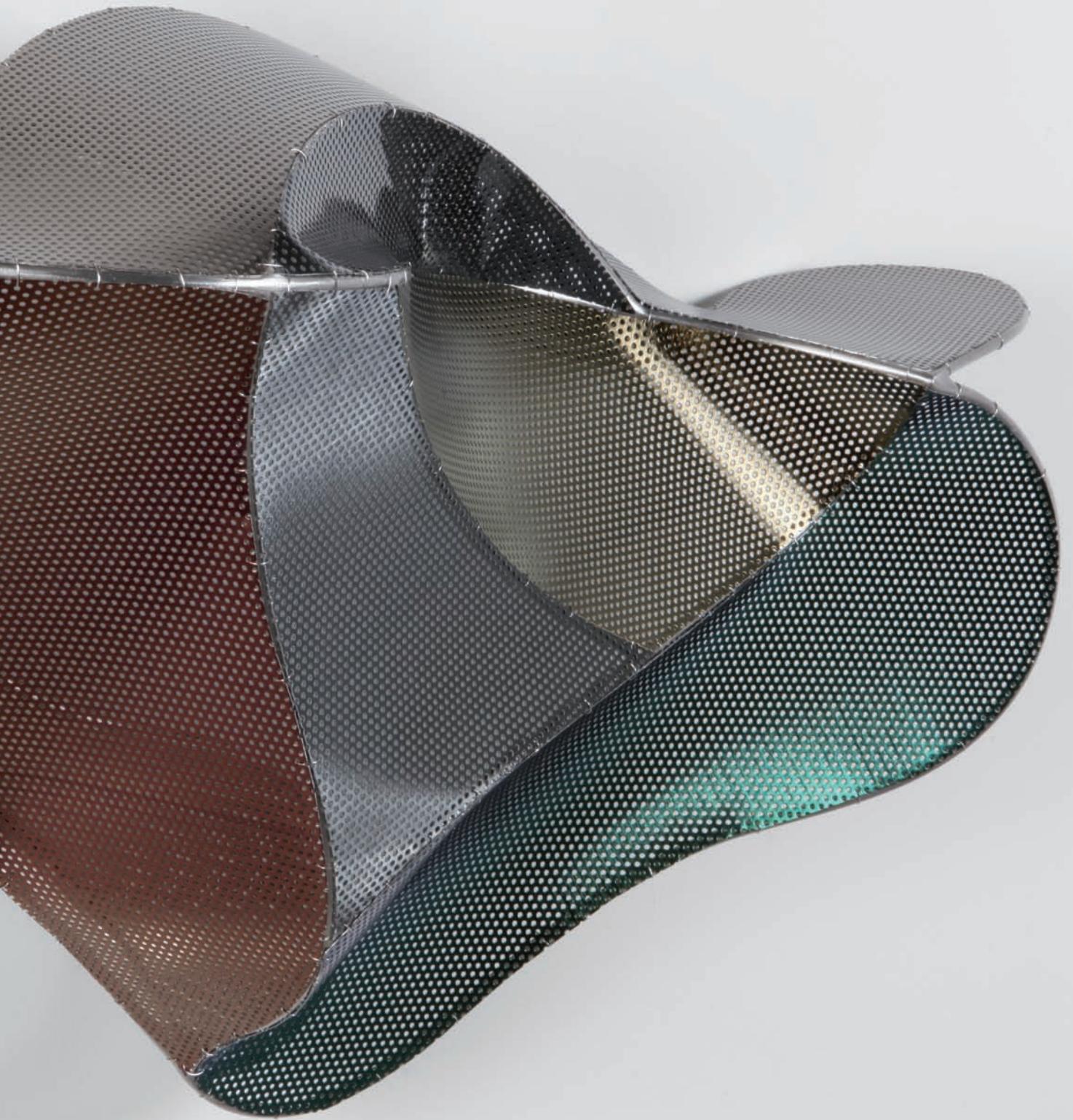
Vision 2020+[1]
A Future to Be Built

Beatriz A. Lara Bartolomé

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THE ORIGIN OF VISION 2020+

Vision 2020+ is a story of restlessness: the restlessness to discover the future possibilities of BBVA and those of the financial industry itself, based on the information we have today.[2]

In our analysis, we have selected a series of indicators that go beyond our operational scope as a bank — indicators that affect us and involve everyone collectively. Above all, they are concerned with people's

1. 2020+ refers to the decade beginning in 2020.
2. "Vision 2020+" is the result of two years of collaborative work between the people of BBVA and an extensive network of experts: an immensely enriching experience. This article, together with the rest of the publication, will be available on OpenMind at www.bbvaopenmind.com and on the BBVA Innovation Centre website: www.centrodeinnovacionbbva.com. Readers can also visit the Madrid Living Lab to experience first hand the new technological applications for banks, delving deep into the future. I would like to thank readers for their interest and I am available for any comments or clarifications on: Facebook (https://www.facebook.com/beatrizlarabartolome), Twitter (@beatrizalara) and LinkedIn (http://www.linkedin.com/in/beatrizlarabartolome/).

   In writing this article, I have been fortunate to be able to count on many of my usual collaborators and friends from the BBVA Innovation Centre, whom I thank for helping compare viewpoints, gain inspiration and find direction in developing the various arguments.

   I also want to pay homage to those people from the BBVA Innovation Unit and some friends from the Innovation Centre who have been more than helpful with their contributions, baptising some of the characters in the families who illustrate the scenario of a "World in Balance." Between us all, we have made this compendium of the BBVA Vision 2020+ possible.

   The BBVA Innovation Network has enabled us to examine technological applications for the latest scientific advances and we have been able to estimate their degree of acceptance thanks to the understanding of the "human factor" from Continuum, Ideo, Gravity and Mormedi, our usual collaborators in the designing of some of the pieces that will form part of the new reality. I would like to make equal mention of the Z Punkt team, who have provided us with methodology and new search tools and analysis to prepare the scenarios, and the Institute for the Future, who have given us the long-term perspective (of 100 years) to evaluate the impact of the trends for the coming decade.

quality of life and with sustainable growth. Some of the indicators are alarming, others hopeful; the way many of them evolve may be corrected or accelerated, depending on the decisions that we take both as institutions and as individuals.

The perspective of over 150 years of history, during which BBVA has done nothing but grow, speaks of our comparative capacity to adjust ourselves to the world around us. BBVA has survived and prospered through military conflicts, changes in government models, political tensions, energy and economic crises, etc.

This is partly because we have always concerned ourselves with observing trends in order to plan our activities. But nowadays, it is not enough to observe: we need to anticipate. Reactive adaptation is no longer effective enough.

BBVA Innovation Center in Madrid

We need to understand the dynamics of change from the moment it begins and we have to venture possible future scenarios to help decision-making now. That is why we created an innovation unit at BBVA 10 years ago, so that, resolute and free from complacency, we could explore the transformations that globalisation — and especially technological innovation — were going to bring about on multiple levels on the planet: all this to understand how these changes could affect the logic of our relationship with our customers, our business model and the future development of the financial industry.

BBVA Innovation Centre in Madrid, Spain

In 2010, following several years of work, we began putting together the BBVA approach to the Bank of the Future, in which we analysed how information and communication technologies affect and will affect the financial business. That was the first time BBVA announced a line of information and analysis that was not strictly economic. In it, we highlighted the need to transform the financial industry and our commitment to be consistent with that vision.

All of the knowledge accumulated in the last 10 years has crystallised into the current BBVA Vision 2020+ that we are presenting to you today.

The method: beyond the conventional

Strategic planning methods have been applied since the last century to define medium-term goals and the courses of action of an organisation. Using those instruments, we extrapolate the future and, by analysing the strengths, weaknesses, opportunities and threats, we understand how to tackle business and develop the skills of a company.

Going beyond the conventional requires an approach to the future that offers us a longer journey than that of conventional strategic planning. That is why at BBVA we apply a different methodology. We visualise the future from the present situation and we travel along the return path so as to decide what we want our arrival position to be in the medium term.

The future is our starting point: in this way we anticipate uncertainty and we learn to manage it. At the same time, we set a course towards the new skills that will enable us to shape the opportunities that the future always brings.

We start by identifying the factors or conduits for change that are now shaping great evolutionary trends. We then look at the panoramas that these trends sketch out for the decade of 2020 in technological, personnel, demographic and economic matters. This allows us to then analyse the challenges that crop up along the path towards consolidating those trends.

After assessing the possible evolutionary routes of the change factors and the interaction between them, we have found three possible future scenarios for the decade of 2020. We have also identified what we would need to implement now in order to bring ourselves closer to a desirable future. The sum of all of these parts constitutes the BBVA Vision 2020+.

To prepare Vision 2020+, we have based ourselves on open information: substantiated data sources; global field studies to spot undiscovered consumer needs; mathematical tools for analysing trends and the probability of scenarios; as well as idea creation and discussion workshops with specialists from the BBVA international innovation network.

All this has been possible thanks to collaboration from the people who make up BBVA, together with a set of consumers, observers, thinkers and specific experts in the task.

Given that this Vision 2020+ is not a closed or self-conclusive thesis about how the future will be, but rather a systematic approach to its potentiality, I invite readers to participate in it.

You can contribute with your knowledge and viewpoint on the design and construction of the better future that we all desire on OpenMind, *CentrodeInnovaciónBBVA*, or any other BBVA social network (see footnote 2).

Science and Technology, catalysts of human evolution

Over the last two centuries, science and technology have been the great catalysts of change in the history of humanity. The world population did not rise above 500 million inhabitants before the invention of the steam engine that got the planet moving. The telegraph distanced the message from the messenger, making it possible to have the first real-time expansion of knowledge. Electric light added hours to the day, and delivery periods shortened. Penicillin lengthened life expectancy and so on, successively, until the transistor opened up the gates of the digital world and the Internet for us, the information society.
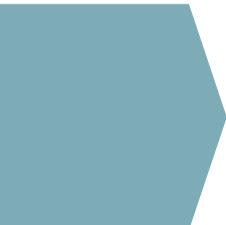
> The extrapolation of modern trends only enables us to sketch out a panorama for 2020, not to accurately predict the reality of that future life. What we do from now until then is what will determine our "final scenario" — the reality we will inhabit in 2020+

In a little over 20 years, more than 5 billion people have gained access to a GSM network. Just the basic service, the possibility of making a simple call, has meant an extraordinary improvement in the quality of life all over the world. For example, in Africa, millions of people have to travel for kilometres to reach a water well. Now, in times of drought, they can ask if a well still has water and, if not, they can head for one that is still working.

Science and innovations generate huge benefits, but they also entail an effort to adapt on the part of individuals. People who are over 80 can testify to this. As children, they saw the first light bulb being switched on in their house; they witnessed the first television set and the first mobile telephone. They have lived through the birth of commercial aviation and its evolution into a low-cost service. They were surprised with the arrival of a man on the moon and it now seems natural to them to look at "human flying saucers" on Mars.

But our lives have changed in an even dizzier way over the last ten years. That which did not exist a decade ago is now essential to us. In August 2002, Nokia presented the first telephone with a camera and Blackberry introduced electronic mail into mobiles. In December of the same year, Apple launched its iPod with iTunes, joining the applications era that was initiated by NTT DoCoMo and was consolidated with the i-Mode. All of these devices enabled the Internet to expand. New businesses sprang up in the digital world and the value chains of many traditional businesses were transformed.

The concept of a particular audience for radio and television evolved with the appearance of new participatory services between users such as Wikipedia, YouTube, Facebook and Twitter. Without realising it, we have gone from asking, "What are they showing on telly?" to participating actively through Twitter in conversations and discussions, and choosing the video we want to watch on YouTube.

Exponential growth

We continue to harness new technological progress. In the field of technology, every new phase is built on the resources, knowledge and methods that we have obtained in earlier phases so that, in finance, interest is added to capital for the next cycle.

Compound interest means that our assets are growing at a rate that is proportional to their value; this is known as exponential growth. We can see this type of growth in a country's economy that grows at 3 percent per year, or in the world population that is increasing at an annual rate of 1.5 percent.

Understanding exponential behaviour is not straightforward, but it is fundamental for extrapolating the future. Few are worried by the population growing by one or two percentage points per day, yet the consequences of this surprise us: every person is born into a world with four times fewer inhabitants than the planet on which he or she will die.

The speed of the Internet is an even more extreme example: its speed doubles every year meaning that, in 2032, downloading the 200 million videos that exist on YouTube today will take… two minutes. Of course, by then YouTube will also have grown exponentially.

Human beings are protagonists in and subject to changes. The technology that they produce changes them and they project it to a new evolutionary state in an exponential process.

Network externality effect

Technology makes our lives easier, whilst at the same time increasing the complexity of systems. It connects everyone to everyone else, generating the "network externality" effect. This effect is easily observed in social networks. The first members of a network seldom find readers who share their opinions, which is why the network is of limited use. Therefore, its existence is most endangered in its first months of operation. Then, the more people who join in, the easier it is for each of the members to put forward an opinion because of the visibility it attains. Its usefulness grows exponentially as the acceptance of it grows, in a virtuous spiral. Simultaneously, the relationships between the people in the network grow more and more complex.

When something is complicated, human intelligence has learnt to moderate it by dividing the problem into elemental parts and looking for relationships that explain the behaviour observed. However, even though we have applied technology to improving and automating the parts that

make up modern ecosystems, we have not been very effective when it comes to understanding and improving the relationships between the parts.

In an interconnected world, the output of each element supplies another one that in turn re-supplies the first one. Modern reality, as well as changing exponentially, is complex. However, our advantage is that the technology that creates this complexity is also our best ally in managing it.

The future does not happen suddenly

The future is starting to be created right now. Our decisions and actions are shaping it and they are leading us towards the future along a path of infinite alternatives. When it comes to giving shape to our Vision 2020+, we have taken scientific thought as a guide to structure our approaches to possible future realities.

According to Einstein's special theory of relativity, space-time is a place where all of the physical events of the universe occur, which means that our reality is a space-time continuum, from which we cannot escape. Each of us is observing a reality and every step that we take towards the future leads us to a new point in that space-time, where multiple opportunities are put to us again.

Defined in this way, the future is being built on a concatenation of events. Our influence on the reality that we are building means a huge responsibility for the decisions we make and the actions we perform.

A better future means something different to each of us. It is directly related to our current situation and our aspirations. Present well-being, individual or collective, depends on our state of mind, our living conditions and our culture. Aspirations are intrinsic to our nature, to our capacity to imagine. How do we get it right in a labyrinth of decisions? What actions are the most effective for achieving this? And, even more difficult, how do we get the multiplicity of personal alternatives to come together in a better quality of life?

Faced with the multiplicity of states of matter, Heisenberg proposed accepting vagueness as a consubstantial principle of the universe at sub-atomic levels. Rather than following the evolution of physical systems from start to finish, he analysed the initial and end states that he observed, within an applied margin of uncertainty, without concerning himself too much with what happened in the middle. The development of this principle has made it possible to make great scientific progress. The immediate application of this was the drafting of new laws for mechanics for the sub-atomic world, where it was concluded that we cannot know exactly the starting point and the quantity of movement of a particle.

We use these two scientific approaches by analogy to understand the paradox of the future. We cannot accurately predict it, but we can analyse its possibilities. The extrapolation of modern trends only enables us to sketch out a panorama for 2020, not to accurately predict

the reality of that. What we do from now until then is what will determine our "final scenario" the reality we will inhabit in 2020+.

2020 TRENDS

In order to find our place in the future, which we will be able to influence through our decisions and actions, at BBVA we have deconstructed current reality in search of the factors that are driving the change. We start defining a trend by identifying a fact that is significant to us, something that attracts our attention because it stands out within the context observed. After noting it down, the fact is monitored and alerts are established to observe its evolution. Sometimes it is an isolated fact that does not set a trend and so it is discounted as a change factor. With others, however, we see multiple connections beginning to form around them. In these cases, we have a relevant fact that has an influence on the environment: a factor or driver of change.

A data analysis is then made in search of evidence to track its possible line of progression. The trend that is thus established is complemented by an estimation and analysis of its possible catalysts and inhibitors.

In drawing up these future trends, we have based ourselves on publications in different fields of knowledge. We have used knowledge management tools to scan modern life in its different facts and search engines to monitor patents. Similarly, in the process of defining how change factors profile trends, we have used software tools for the logical analysis of decision-making in complex environments.

Trends that profile our lives

Formulating trends is essential in order to share and contrast the sense and magnitude of the changes with others in a more intelligible way than by using abstract mathematical probabilities. Once again, the scientific method has inspired our work in preparing this substantive part of our Vision 2020+.

In 1851, Jean-Bernard Léon Foucault, a French physicist, hung a spherical pendulum from the dome of the Pantheon of Paris and demonstrated the rotation of the Earth, in a simple and comprehensible way. Foucault's achievement did not consist so much in persuading his fellow citizens of the rotation of the planet, a fact that few doubted in the mid-nineteenth century, but rather in making that reality evident, tangible, comprehensible and incontestable.

Thus, we have identified 14 trends of change that map out a panorama of feasible opportunities for the year 2020 in technological, individual, social and economic matters.

Figure 1. shows a simplification of those 14 trends.

Figure 1. Simplified map of 2020 trends

The 2020 technological panorama profiles well-known trends in information technologies and telecommunications, along with their application to scientific research in other disciplines so as to bring about greater progress. As we have seen, technology is capable of inducing new habits and customs in people. In 2020, the trends towards hedonism, the improved quality of life, the capacity to choose and collective thought will set the profiles for the characteristics of the individual.

The 2020 social panorama is marked by polarising trends in the demographic profiles, by migration to cities, by diversity and security threats.

In the 2020 economic panorama, the growth of emerging countries will be greater than that of developed countries; there will be a scarcity of key professionals for development; we will see the appearance of new business ecosystems and of new models of industrial relations; and we will witness the appearance of the knowledge economy as a fourth sector.

Our everyday technology

Tomorrow's devices will be considered to be key for accessing an infinite number of services. We will see the proliferation of sensors in packets, rubbish bins, traffic signals, domestic appliances, even in our clothing and in soft drink tins. The information gathered from these will

be used for real-time decision-making based on evidence and applied to new logistics systems, to urban waste management, as well as to assist drivers, surveillance, remote control or population reduction.

The "man-machine" interface will be invisible to us. Goodbye to the mouse and to CTRL + ALT + F1. Machines will have a "man-machine" interface: they will talk to us, listen to us and they will be touch-sensitive.

The underlying idea of Moore's law will still be valid: the price of devices will drop at the same time as their provisions grow and today's Smartphone will become "tomorrow's PC." There will be devices for all pockets that will assist billions of us with our transactions between the physical and the virtual worlds. The progress of three-dimensional printers will enable us to print off everything, even food. Because of their cost and complexity, these printers were only used in large industries until a short while ago, but they have evolved in accuracy, simplicity and price and they are starting spread across the entire production sector. In the decade of 2020, we will have them at home, converting every house into a potential manufacturing centre. They will lead to a revolution in the logistics and distribution of product manufacture, because they will make it possible to produce articles whenever and wherever they are needed. In short, the digitalisation of objects will have an impact on the manufacturing value chain, just as the digitalisation of content has had on music and movies.

Living in the clouds

The device revolution will feed back into the evolution of networks. Given the growing demand, telecommunications companies will offer reasonably priced broadband services. In the next ten years, everything will be connected to everything: people to people, people to things and things to other things.

Interoperability standards will have been defined and computer networks will talk to each other as telecommunications ones do today. Applications will write on open interfaces with an entire community of developers and they will have the capacity to move from one network to another, just as happens with telephone calls today.

As a result, the Internet will become increasingly smart — the environment where objects come to life. Computers will have a sufficient level of understanding of what is happening on the Internet to generate new types of information. The cloud of contextualised contents will understand what we want to say and it will go from being a tool to becoming our advisor. Furthermore, augmented reality will form part of our day-to-day living: We will deliver information to our environment and it will return to us enriched.

The Software as a Service (SaaS) trend will end up imposing itself in order to automate tasks and optimise processes, with a consequent improvement in the competitiveness of many medium-sized companies and the appearance of new business models.

At the same time, different scientific and technological fields will begin to converge into "super-disciplines," extending and surpassing the line currently known as "NBIC convergence": the result of merging research and development into Nanotechnology, Biotechnology, Information Technology and Cognitive science (NBIC).

These four disciplines not only complement each other, they also come together in many fields of application in order to achieve a qualitative leap forward in research or developments that would otherwise not be possible. One example: the advances in understanding the human genome have come about thanks to the confluence of an increase in calculation capacities, the miniaturisation of sensors and progress in biology and medicine.
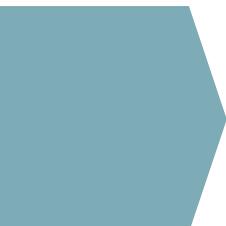
> **Tomorrow's devices will be considered to be key for accessing an infinite number of services. The information gathered from these will be used for real-time decision-making. There will be devices for all pockets that will assist billions of us with our transactions between the physical and the virtual worlds**

Similarly, the NBIC convergence will make it possible to make progress in epigenetics, the science that studies how external factors act on the development of an organism. It has already been demonstrated that a temperature change activates "sleeping" genes in the DNA of flies and plants, and that this alteration is passed on to the next generation. In 2020, we will have more information about how our lifestyle affects our cell development and how it has an impact on ageing and the development of illnesses. Medicine is the great field of application of this young science.

The trend towards NBIC convergence will become consolidated as a reality in the decade of 2020, thanks to the short-term benefits that this means for many research centres in sharing their R+D costs.

New possibilities: nanotechnology and graphene

Although nanotechnology will still be immature in 2020, we have already seen its first results in new materials such as graphene, a bi-dimensional carbon atomic layer. The 2010 Nobel Prize for Physics was awarded to two Russian researchers from the University of Manchester, Geim and Novoselov, for characterising this material and discovering its extraordinary properties.

Graphene generates electricity when light reaches it at almost any frequency. It is 200 times more resistant than steel, almost as resistant as diamonds, as transparent and elastic as plastic, as well as being as light as carbon fibre, but much more flexible. It has high levels of thermal and electrical conductivity, it is wholly impermeable to all gases and liquids — apart from water — and it is not affected by ionizing radiation.

Its capacity for chemical reaction with other substances can produce compounds of different properties and this endows it with great developmental potential in covering surfaces, armour-plating, waterproofing, energy generation, interactive protective screens, etc.

With graphene, we can create a sensor superimposed on living cells that allows us to see the communications going on between them with no need for a microscope. In the field of medicine, there are already very promising laboratory prototypes. In the coming years, we will be able to see the first devices with graphene screens that are transparent and resistant and that can be folded up like a sheet of paper.

In spite of the many applications of graphene, there are still great developmental challenges in realising its potential. Right now, it can only be asserted that this new material — and more generally — nanotechnology will have an impact on our lives even greater than electricity had on the lives of our grandparents.

The power of the individual over the group

The technological panorama described will open up new possibilities for individuals and it will induce gradual changes in their habits and customs. The trends that we observe in this area are contradictory. On the one hand, we see growing trends towards "I" and, on the other, the development of strong links between individuals who do not personally know each other. Both trends pivot around the unlimited access to information that the Internet offers us. We will be able to choose to extend our social circles beyond their physical environment and be part of a greater whole, or to cut ourselves off as we differentiate ourselves from the whole or, of course, do both, depending on the circumstances and our state of mind.

The individual focused on self

Hedonism has been a constant feature of humans. But in the coming years, individuals will increasingly focus on themselves, on differentiating themselves from others and seeking to improve the quality of their lives with minimal effort.

In biological terms, older people will be younger and adolescence will be even more prolonged than it is now. Lifestyles will share an obsession for health and physical well-being, and "life coaching" — advice on planning your life — will enjoy great popularity.

The generation of digital natives will have set guidelines for managing online relations; we will be consumers and highly flexible employees, without loyalty to brands or employers. We will make choices all the time, considering the best for ourselves. Given similar options, we will choose the easiest or the most entertaining one.

The life of an individual will be governed by his or her own life plans, with preferences for institutions such as the family, a partner and the community where he or she lives. Personal realisation will be sought at work, and reaching this will be a sign of achievement. Personal

relations will be more distant and we will consider consumption to be a way of feeling ourselves to be loved and of acquiring greater social status.

Collective mind

In spite of this trend in continuous growth that associates individualism with happiness, we will — in some respects — be more sociable than ever before. The mobility of information will create a heightened awareness that we are a human collective with similar motivations and necessities, regardless of our origin or situation. Every part of the world will coexist in one single virtual world and we will have created connections independent of time or place.

We will have a common awareness, a collective intelligence; we will reinvest in how we get on with each other and how we make decisions because we will all participate in what happens on the planet.

For the first time in human history, we will see the effectiveness of individual power over the group; an idea could go around the world in a few hours.

We will produce and consume differently, giving rise to multiple models of individual and collective provisioning. Crowd-sourcing for talent, crowd-funding for financing and "peer-to-peer" for the exchange of goods and services will be commonplace.

The power of influencing

Thanks to technology and its capacity to break down space–time barriers, one single click will awaken the individual's awareness of possessing a certain "gift of ubiquity". Each of us will also be aware of the potential power in our individual capacity to express ourselves on the Internet. We will participate in defining and preparing company visions, products and services by criticizing, recommending and giving opinions that brands and institutions will not be able to ignore because they will be public. Furthermore, each of us will have enough information to decide whom to trust, influenced by the community of the digital world. A brand's reputation will be that observed by the community, not that which the brand communicates.

New ways of organising and understanding life will lead to bespoke educational itineraries designed in line with personal talents and aspirations, and freelance opinion will prevail over fixed professional careers. We will see new political parties, new models of organisation, a new paradigm in decisions about consumption and the rise of participatory democracy for certain local government decisions.

Older, city-dwelling and tolerant

In the geo-demographic aspect, the panorama is marked by a dual pattern. Populations of developed countries will age even more, to reach an average age of 42 and life expectancy of 79, while developing countries will have younger populations and a much higher number of

inhabitants: 6.4 billion as compared to the 1.2 billion who will inhabit the OECD countries. At the same time, the average age in emerging countries will also rise from 27 to 29 years old, as a consequence of increased life expectancy.

Dual world

These demographic profiles face different problems: some of them will fight to maintain their living standards while others will strive to meet their basic needs. Demographic changes indicate a trend towards stagnation and deceleration in developed economies, which means that workers will have to work more hours and postpone their retirement. In the meantime, the emerging countries, with a relatively young workforce, will enjoy much more dynamic economies, and they will be responsible for a large part of the global economic growth.

The fall in competitiveness in developed countries will prompt the most qualified workers to move to emerging economies, in search of more promising and stimulating careers. Similarly, the most skilled emigrants who travelled to developed countries in the past will return home to see if there are better prospects for the future in their countries of origin. As a result, the growth of the global middle class will be concentrated in emerging countries and, in general, their inhabitants will enjoy considerable improvements in their quality of life.

Homo "urbanus"

Today, the urban population of the planet exceeds the rural one and it will keep on growing. Human beings continue to appreciate the economic and social benefits of the city as a living environment and it is expected that over 1 billion people will migrate to urban areas in the next ten years. We have never faced such high migration rates before: it is as if almost the entire population of China decided to move their place of residence in just one decade.

In 2020, it is very likely that more than half of the world's major cities (in terms of population and contribution to GDP) will be located in emerging countries. The number of cities with over a million inhabitants will triple in a decade, and there will be twice as many megacities with over 10 million inhabitants. Many of these cities will be connected to each other, thus consolidating the concept of cross-border economic macro-regions.

The development of urban nuclei and the concentration of people in them will require new city models, large investments in infrastructures, a greater diversion of basic resources to urban centres, and special attention to and control over CO_2 emissions. Nor can we rule out the appearance of new cities due to the mass displacement of people caused by natural disasters or significant socio-economic instabilities. Refugee camps will grow in number and population, and settlements initially considered temporary could become cities of hundreds of thousands of inhabitants with dire nutritional needs and urgent infrastructure requirements.

Immigration will cause people from multiple cultures and origins to live together; the virtual world will bring together people of any age, origin or life experience in work or leisure environments.

Measures for promoting the presence of women in economic and social decision-making positions will improve the representative balance of men and women in many other social spheres. The frontier between gender roles will become blurred.

Mixing and exchange will produce more open, dynamic and creative societies, with systems of mixed values, more detached from the concept of a nation. Although discriminatory behaviour will not disappear everywhere, we will be on the way towards a more tolerant society.

Individual behavioural trends, along with demographic ones, will lead to a substantive change in the concept of the family unit. The traditional family of "a young mother and father with children" will be just one option amongst many. There will be more partners of divorced people who bring children to the new family nucleus, more couples who are together but live separately, more single parent duos, etc. Living alone will be more widespread and those who decide to get married and have children will do so later than is common now, in both developed countries and emerging ones.
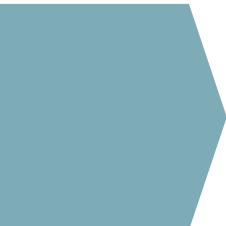
> **A transition of power in other spheres will also take place, hand in hand with economic power: the geo-political landscape will change significantly as the countries that are most advanced today become less influential, and emerging ones, especially in Asia, become more powerful**

Disparate growth in an environment of scarcity

In this dual world with two-speed growth, the concerns and interests of countries will also be divergent. If the mature economies are chiefly concerned with the re-balancing of the commercial equilibrium and the persistent unemployment rate, emerging countries will focus their attention on price increases and economic overheating.

A transition of power in other spheres will also take place in a manner that goes hand in hand with economic power: the geo-political landscape will change significantly as the countries that are most advanced today become less influential, and emerging ones, especially in Asia, more powerful. Their influence on multilateral institutions will increase. The pre-eminence of the developed economies in global governance will be eroded by the emerging economies, which are seeking a multi-polar global power structure.

The economic "EAGLEs"

At BBVA, we believe that the future economic panorama will be marked by countries we have named "EAGLEs".

The EAGLEs are Brazil, China, Korea, India, Indonesia, Mexico, Russia, Taiwan and Turkey, countries that will be responsible for over half of world growth in the next ten years.

China and India are the most prominent EAGLEs. China's contribution to world economic growth in the next ten years will be 34 percent and that of India, 11.9 percent, as compared to the 9.6 percent contribution from the US.

Potential EAGLEs make up the "nest" nations, a group of countries that contribute more to world economic growth than the lowest contributing member of the G6 nations: Italy. The nest nations currently number 15: Egypt, the Ukraine, Chile, Argentina, Bangladesh, Colombia, the Philippines, Malaysia, Nigeria, Pakistan, Peru, Poland, South Africa, Thailand and Vietnam. Over the next ten years, the EAGLEs will be responsible for around 60 percent of global GDP growth, while the nest countries will contribute 9 percent. All G7 countries together will contribute 16 percent.

China, Africa and Latin America establish close ties

China is Africa's leading trading partner with 150 billion dollars in exchanges during 2011. It is one of the main investors in sectors related to natural resources and in the infrastructure of countries such as Zambia, Angola, Sudan and Côte d'Ivoire.

At the same time, economic relations between Asia and Latin America have also been strengthened: trade movements between both regions have increased nine-fold over the past 20 years. The main opportunities come from China, which has become the partner of choice in trade and investment in the region. Everything indicates these trade and investment relations will grow even stronger in the coming years.

Growing demand, limited resources

The intensive consumption of energy, water and food linked to economic and demographic growth maps out a complex panorama. In 2020, natural resources will play a crucial role in global prosperity. Countries that produce raw materials will have currencies that are ever more valuable in acquiring international influence. The current map of producer countries will change because, in a world with limited resources, it is foreseeable that prices will rise and the considerable reserves of minerals thus far unexploited will start becoming profitable. This, in turn, will lead to further environmental erosion.

For the individual, this scarcity of resources will be translated into higher prices for end products, widening the gap between rich and poor. The scarcity will also hit expert human resources, including health and teaching professionals needed to deal with the growing populations of developing countries.

New business ecosystems

Outsourcing and offshoring models will be common, enabling companies to concentrate on their business, while insourcing will be done so as not to lose basic skills or to incorporate others deemed necessary.

The large global companies we know today will have lived through a process of transformation. In order to cut costs and maintain competitiveness, they will harness the collective talent of the digital community and introduce new models of relationships with their suppliers. All this will bring about new business ecosystems that will establish themselves as conglomerates of activity, based around a common goal. Temporary alliances and partnership networks will proliferate and competitiveness will spring from talent and innovation.

Future business environments will be characterised by flexibility, personalised services and the decentralisation of the focal points generating value. Small and medium-sized businesses will become even more important.

New working world

In this space, the key driver of growth will be knowledge-related jobs. Workers will have better training and they will be able to carry out their work in more open structures. The world of industrial relations as we know it will not fit in to a world in which the knowledge gap between emerging countries and developed ones will — albeit slowly — become narrower.

An entrepreneurial culture, self-employment and the creation of new forms of relations between professionals will certainly be patterns in the future world of work, one that is already starting to emerge.

The abundance of information will shift market conditions in favour of experts who can extract maximum value from that information. In this context, the poet T. S. Eliot's observation, "Where is the wisdom we have lost in knowledge? Where is the knowledge we have lost in information?," becomes particularly relevant.

The "war for talent" between companies, the mobility of workers and the decentralisation of corporate structures will enrich the professional ecosystem, spawning new types of work and more flexible ways of understanding employment contracts.

THE NEW CHALLENGES

The future is the result of the interaction of multiple elements and trends. Companies, organisations and individuals take directions that jointly determine their development routes. When the various paths cross and interlink, and a series of challenges emerges in parallel, we need to move ahead to achieve a desirable future.

We have distinguished five large categories of global challenges that will condition the quality of our lives in the coming years: these categories are new technologies, demographics, natural resources, new economic and work paradigms, and individuals.

The challenges of technology

In recent years, mobile telephones and the expansion of the Internet have contributed towards communicating with and connecting most of the inhabitants of the planet. Aside from these advantages and opportunities, there are already big differences between those who have access to superior technology and those who do not.

As we have seen in the 2020 technological panorama, savings stemming from sharing R+D costs is one of the key factors in the trend of NBIC convergence and the advances associated with this. However, maintaining international cooperation in technological development is not easy when the discoveries represent a clear competitive advantage. It may not profitable in the long term for some of the biggest leaders to share these benefits. This would lead to delays in obtaining results and greater inequalities in the overall quality of life.

As NBIC research matures, new ethical issues will emerge. For example, experts in the field of genomics are working on increasing brain capacities, curing and preventing illnesses, and extending longevity, aspects that could pave the way for a group of "ge-nobles," privileged people who have access to this type of treatment.

According to the modern Hippocratic Oath, health professionals must ensure they "apply all the necessary measures for the benefit of the patient"; and they must "not permit considerations of religion, nationality, race, party politics or social standing to intervene," according to the Geneva Convention. Can the consensus that exists in medicine, to always act for the benefit of human beings, be extended to all "advanced technologies"? One ethical issue arising from this would concern access to advanced technology, depending on whether the users could afford this or not.

Given that the characteristics of the 2020 socio-demographic panorama suggest a dual world, the challenge is to stop a new type of technological gap appearing that is directly related to health and the quality of life.

In the field of telecommunications, this same issue provokes a debate on how to define the "universal service" of access to communications in different countries. Regardless of whether fewer or more people gain access to new technologies in the future, we can assert that the number of Internet users will grow in percentage terms. In the coming years, the Internet will be present in all corners of the planet, in one form or another; all of us will be in the cloud. In this context, we will have to find effective ways to transfer basic rights from the physical world to the virtual one.

In the physical world, attempted robberies or identity thefts trigger a set of protection mechanisms (complaints at police stations, international communication of stolen documents,

etc.), but these are not clearly defined in the virtual world. The great challenge will be to define, protect and guarantee our future digital identity, articulated in the same way as any other civil right.

Violation of our privacy is a crime in the physical world. It is necessary to have a court order to search our homes or obtain our bank details. In the logic of the Internet, all our information will reside in the cloud. The Internet will collect all our movements, tastes and even opinions, blurring the line between offering personalised value-added services and intruding on our privacy.

Since the Internet is a global environment, the regulations concerning privacy and security must also be drafted in global terms.

Another challenge is constituted by the risks of a type of freedom of expression that, in its digital form, does not have ethical codes. The Internet was created by the scientific community with the aspiration of creating a "service for everyone," in which everyone is entitled to share the information that they want in any way they choose, as long as they do not commit an offence. We all feel that we have something to say; we all want to be heard. But not all of us are trained, for instance, to carry out a medical check-up. For many people, it is very difficult to determine the quality of the source consulted when there is no digital identity which guarantees that the author is an accredited individual. Therefore, health authorities can only provide adequate information with the hope that their opinions will prevail, amongst countless incorrect sources.

Guaranteeing the quality of Internet services is another key area. We have grown used to using free services that exempt the supplier from liabilities in the event of improper functioning and release them from indemnifying damages. Tighter limits must be set to ensure the relationship between consumer and supplier is always resolved to their mutual benefit, with all of the necessary guarantees.

Furthermore, the smart drivers of the cloud will not cease to be applications generated by a community of developers. Here, we have no alternative but to trust the ethics of these experts when it comes to designing and applying any automatism, given that there are not yet any mechanisms to find out, *a priori*, whether they are guiding us properly.

Advances in artificial intelligence will make it increasingly difficult to determine whether we are interacting with a machine or a person. We will have to develop mechanisms of trust when we perceive the loss of human control over a world that is excessively technologized.

Cyber-terrorism, a separate section

One large technological challenge of the coming years will be the new areas of insecurity in the virtual world. It will be increasingly difficult, if not impossible, to define the thin line that currently separates the secure and reliable "interior" of our corporate networks from the insecure and ungovernable "exterior" of the Internet.

The Internet is based upon open standards and platforms on which highly useful services and applications are developed. Many of these services store data of a personal nature. Organised criminal gangs represent a clear threat, because they try to find vulnerabilities in order to access personal data with malicious intent. In addition, it is foreseeable that we will see a rise in cyber-crime and cyber-terrorism activities, carried out by criminal organisations capable of generating malware in the form of Advanced Persistent Threats (APTs). This type of malicious software is especially dangerous because it can conceal itself for long periods of time, and it attacks business or political targets.

Cities, infrastructures, homes and individuals are vulnerable to digital attacks, just as in the physical world. However, there are three important differences in the digital world. Firstly, attacks may originate from any point in the Internet: geographic proximity is not necessary. Secondly, the anonymity granted by the Internet makes it much more complicated to pursue those responsible. Finally, the intrinsic capability of propagation generates a multiplying effect as attacks appear simultaneously and unexpectedly at a multitude of sites.

Challenges for the individual

In the last ten years, the individual has been able to adapt to technological advances, but each of us now faces many more simultaneous changes occurring on many fronts.

The individual has gone from having a single identity in the physical world to being capable of creating different personalities in the virtual one. We need to take precautions to avoid having our privacy invaded or exposing ourselves to security risks.

In the world of work, people will have to accept that every temporary job they take will require certain skills and different ways of doing things. It is even possible that daily work will arrive in batches from a crowdsourcing environment that allocates our tasks through algorithms and that may also assess the quality of our work (the "boss").

The borders between personal and working life began to blur at the end of the last century. They will be very hazy in 2020. Distance working means working from home, while for those who have emigrated, family and friends are located in the virtual world. With these premises, the individual will have to find a way to reconstruct his or her personal lifestyle in these new physical spaces, while at the same time incorporating his or her virtual identity. All this must be achieved without losing the connection to reality and without becoming an entity that is split into parts.

Furthermore, being part of the "collective intelligence" will entail actively participating in social networks and discussion forums or those of common interest. It is safe to assume that time spent connected will reduce contact time with the "real" physical world. It is highly likely that behavioural disorders related to the intensive use of the Internet will spread.

Social cohesion

Cohesion enables societies to be efficient, keeping the peace and facilitating the inclusion of all of its elements. Societies strive to ensure that this cohesion is not lost or degraded, even seeking to reinforce it. New challenges are presented by the living conditions within each country and also between societies across the length and breadth of the planet, together with population ageing and the growing diversity of the value systems.

In the OECD nations, the level of economic resources of the richest 10 percent of the population is on average nine times greater than that of the poorest 10 percent. Inequality has also been rising in recent decades. In the UK, the gap widened from a proportion of 8 to 1 in 1985, to 12 to 1 today. Even in those countries that are traditionally considered to be more egalitarian such as Sweden, Denmark and Germany, the gap between the income of the rich and the poor is also widening: from a proportion of 5 to 1 in 1980, to the current one of 6 to 1. In the leading emerging economies, the disproportion in the possession of wealth is 50 to 1.

But income is not the only dimension of inequality. We will see a significant disparity in the social opportunities of people who migrate to cities and those who stay in rural areas, in terms of both access to health services and job offers that enable them to improve their lifestyles. The growth of the city will be concentrated on the outskirts. Some of the new suburbs will be marginal neighbourhoods and their inhabitants will not find it easy to gain access to the education necessary to escape their social exclusion.

Gender inequality represents another great challenge. Significant progress has been made in this field; women today represent 40 percent of the planet's workforce and they account for over half of the university places. Yet even if these advances continue, the gender gap will persist. Girls will still be less likely to receive education than boys in developing countries, especially in sub-Saharan Africa and in some parts of south Asia. Women will also remain less involved in the political arena and less present in the upper levels of institutions, whether these are companies, political parties or scientific environments.

In the developed world, the proportion of retired people will grow, with the consequent pressure on pensions and health systems.

If measures are not taken to combat the effects of the different sources of social inequalities, we could see the development of two parallel cultures, with different scales of values and attitudes, in every town or city.

Tackling the challenges of global demography and integrating the needs of all individuals to guarantee social cohesion is therefore an imperative that cannot be postponed.

Natural resources and infrastructure

Natural resources and ecosystems, infrastructure and the mechanisms of government are the basic systems that ensure the survival of humanity. These systems are and will remain exposed

to a variety of pressures. How we handle these pressures is going to determine how we will live in the future.

The technological deployment since the Industrial Revolution has brought about a huge growth in population and improvements in living conditions. But, it has also sparked an unsustainable increase in the consumption of natural resources. The demand for energy, food, water and raw materials is going to keep on growing, with the consequent impact on the mechanisms of the biosphere, especially as far as the climate is concerned.

A variety of indicators demonstrates climate change is underway: the worldwide increase in temperatures, the thawing of the polar ice caps of the Arctic, the disintegration of Alpine glaciers and the rise in sea levels.

Three quarters of greenhouse gas emissions — responsible for heating the planet — can be attributed to the energy cycle, both in terms of production and consumption. Although gas emissions per capita in the developed world are still much higher than those of emerging countries, they are rising much more quickly in the latter.

Stabilising the levels of greenhouse gases in the atmosphere is acknowledged as a necessary condition for first limiting the rise in global temperatures, and then stabilising it. This requires drastic cutbacks in the emission of gases in a global economy with a growing "hunger" for natural resources.

It is generally thought that we are still in time to avoid a catastrophe, but that optimistic assessment is useless if we do not act now. The coming decade will be decisive for determining the direction the climate will take and the living conditions of humanity.

There is undoubtedly concern about energy sufficiency and whether many natural resources will be able to meet human needs. But it is water that constitutes the biggest challenge. The data are not optimistic: climate change will have very significant adverse effects on the availability of water. At the same time, the demographic growth has tripled water consumption in the last 50 years and if the population continues to grow at its current rate, the demand for water will increase by 64 000 cubic metres a year.

Pressure on water supplies is also closely associated with food production, thereby establishing a vicious circle that is very hard to break. Agriculture is by far the biggest consumer of water, accounting for 70 percent of total demand. Economies dependent on agriculture are therefore very vulnerable and at serious risk of food crises.

The scarcity of resources goes beyond the natural ones. Manmade infrastructure also faces very serious challenges. Infrastructure is the backbone of social and economic development: it shapes all aspects of daily life, as well as trade and manufacturing. We only notice it exists when it fails, revealing just how dependent we are on it. From electricity outages, trains that do not arrive on time, and servers that go down, all these events send our daily lives into collapse.

Infrastructure challenges present themselves in different ways, depending on the region. The focus in the developed world lies in improving the existing capacity, while in emerging economies more importance is placed on the capacity for deployment to meet the emerging demand. In the most disadvantaged countries, infrastructure needs to be built: its absence severely hinders their economic and social progress.

Developing infrastructure requires plenty of time and money, and maintaining it is costly. Infrastructure is designed to keep working for a long time; therefore, inherited infrastructure tends to engender a particular form of "protectionism" that makes it very hard to change it.

Adapting the global energy system to meet growing demand whilst taking care of the environment is one of the biggest challenges humanity is facing. First, we have to assume that the existing structure is not as efficient as technology allows for, so we should completely rethink the way energy is produced and distributed to the end consumer, identifying new renewable sources and new distribution plans.

Transport is another area of infrastructure that presents a very significant challenge, fundamentally because it is one of the economic sectors that makes the most intensive use of energy resources. Globally, lifestyles are trending towards the generalised adoption of western models: everyone wants their own car and they aspire to travel by plane with the consequent energy consumption and gas emissions.

Infrastructure related to water actually worsens water availability. Developed countries have antiquated installations, with no recycled water circuits. These need renovation, which requires massive public investment. Meanwhile, in emerging countries, 15 percent of the population does not yet have direct access to drinking water. These countries have to tackle the lack of health infrastructure and waste collection, both essential for the public health of 2.6 billion people worldwide.

It is clearer to all of us every day that prompt and energetic measures are needed to tackle all of these challenges. Perhaps the biggest advance to date is the consensus around the global nature of these challenges. But that is just the first step towards resolving them.

New paradigms for work and businesses

Asian economies are no longer just assembling products for western consumers; the competitive framework has changed. Thus, companies in emerging economies will become the competitors of western corporations. Western multinationals hope to find 70 percent of their opportunities for future growth in emerging markets. India and China would represent 40 percent of that growth. But operating in these environments requires profound changes in the business models that are dominant at present.

Many of tomorrow's new multinationals will probably have their headquarters in emerging countries. These corporations will adapt, developing practices to enable them to make a profit

in this new environment. They will turn themselves into the seeds of innovation and rise up as a great challenge to their western competitors.

The new global landscape sketched out for the business world means companies need to revolutionise not only their business models, but also the ways in which they innovate. It is increasingly clear that integrating clients and suppliers as a decisive part of the innovation process leads to more satisfactory results. The challenge is how to transcend the limits of a particular corporate culture in order to commit to co-creation models, to open up innovation processes to social networks, to invest in third-party activities, and to gestate companies with a view to ultimately granting them their own existence.

This new way of thinking and operating will eventually materialise as companies see that the old business methods limit their ability to harness the potential growth that the new business models offer. The challenge is to manage the transition and to make use of the right resources to achieve this.

Both production workers and those who work with knowledge will find themselves forced to compete in a global market. People could potentially find work anywhere in the world because the knowledge-based economy knows no borders; it identifies talent and it seeks it out wherever it may be located.

Workers who cannot or do not know how to adapt to the knowledge economy will face job insecurity. Flexible contracting and temporary employment will be common practices in the near future and workers will have to acquire skills quickly in order to adapt to demand.
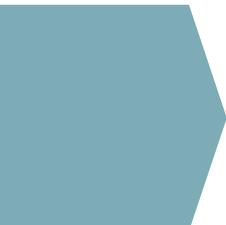
Stabilising the levels of greenhouse gases in the atmosphere is acknowledged as a necessary condition for first limiting the rise in global temperatures, and then stabilising it. The coming decade will be decisive for determining the direction the climate will take and the living conditions of humanity

2020+ SCENARIOS

Constructing future scenarios requires a lot more than correctly identifying relevant trends. In reality, each of the fourteen trends defined has an impact on all of the others; at the same time they all place conditions on each other. The diagram below shows all the possible interactions between the trends described. From this, we can see how difficult it will be to distil, determine and explain the influence of each trend in the future. In turn, the trends relate to more profound change factors, which are also interrelated in a complex and often random way.

Figure 2. Illustration of the interaction between trends
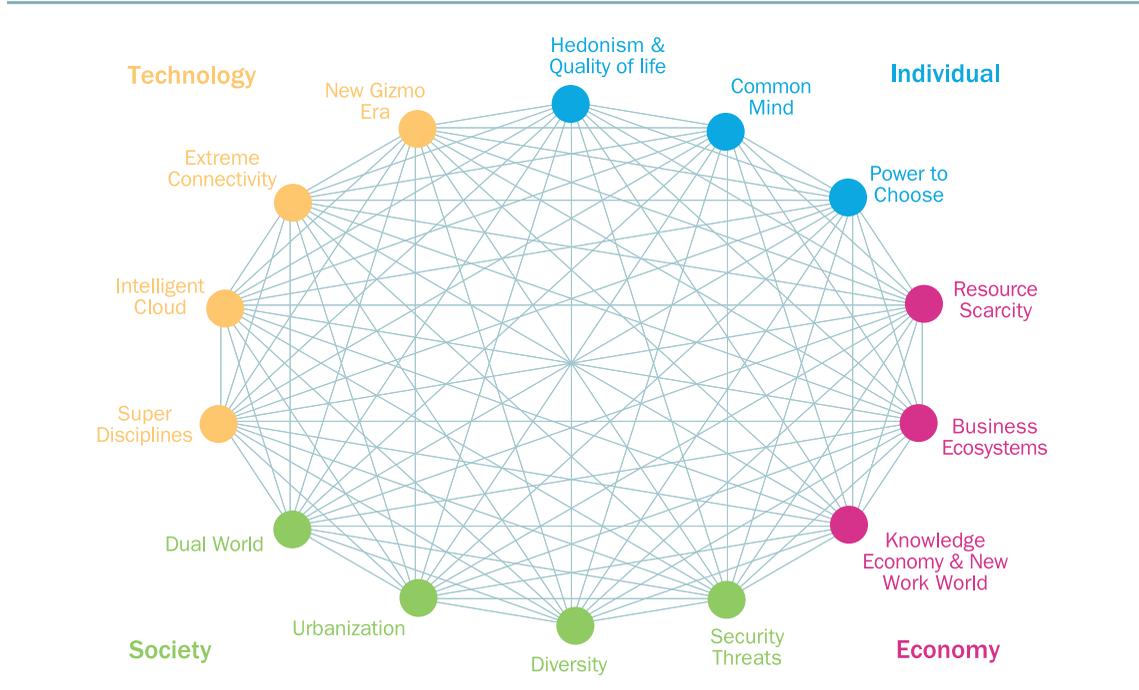
This is why, when it comes to shaping our Vision 2020+, we have used mathematical tools to analyse complex decisions and probabilities, and to calculate the impact certain change factors will have on others. Thanks to the software used, we have been able to "visit" many futures, programming the tool for different intensities of the impact of every change factor.

For example, security issues have a strong bearing on the occurrence of new opportunities. Factors relating to security are seen on three fronts: risks generated by human beings themselves (wars, criminality, terrorism of any type, hacking, etc.); the inevitable natural disasters, which are largely unpredictable; and the technological faults that threaten the continuity of a planet that is highly technical (nuclear leaks, Internet blackouts, etc.).

In preparing the scenarios we have taken into account the argument that tensions stemming from the scarcity of resources or social inequalities may unleash specific and localised violent events. This change factor has not been aggravated to the point at which military conflicts can be scaled up to global level. Similarly, the initial premises have not considered a pandemic or a natural cataclysm that would massively affect the global population. Technological threats have been taken into account in order to weigh up the evolution of the Internet and its impact on the reality through which we are living.

Three possible scenarios

After running through the number of combinations of results of the different change factors, depending on logic of occurrence based upon comparative data, we have found three possible scenarios that we may live through in the decade of 2020. We have called these scenarios: Fluctuating World, World in Crisis and World in Balance.

The diagram below shows how the change factors — the creators of the 2020 trends — evolve in each of the three scenarios.

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Figure 3. Change factors in the preparation of scenarios

To best highlight the differences between these scenarios, we have shown them in a graph with two separate axes. The vertical axis, from a greater to a lesser extent, shows the soundness of the economy and the associated level of quality of life, both closely related to making the best use of opportunities. In the horizontal axis, we move from lesser to greater global coherence in the actions of the countries. That is to say, on the left we see the lowest level of coherence, where some countries are trying to resolve their problems in an isolated way and others work together in order to achieve this. On the right, the action of the countries is homogeneous, they all act in the same way: they all compete or they all work together.

Figure 4. Possible scenarios

Figure 4. Possible scenarios

As we have seen, the new challenges arising today are of a systematic and long-lasting nature and they cannot be resolved in a straightforward manner. The strategies to tackle them must be global and continuous over time.

What we are doing from today onwards will lead us to live in one of these three possible scenarios.

The Fluctuating World is characterised by the unequal development of the economy and quality of life, depending on the region or the country. This scenario will materialise if we continue to tackle decisive challenges such as the growing energy demand or climate deterioration with partial solutions and without joint measures.

In turn, the World in Crisis demonstrates a generalised loss of the quality of life in every country, a situation that we will come to if we cannot resolve the fundamental challenges facing us.

Lastly, if we can work together and define a sustainable growth framework for everyone that translates into a better quality of life, we can move towards or even achieve a World in Balance.

A Fluctuating World

In a Fluctuating World, the energy demand will continue to grow due to the proliferation of technology and to population growth. Energy will therefore constitute one of its biggest

challenges and needs. Resources will be increasingly scarce, and there will be a growing tension between countries that make intensive use of resources.

At the same time, the environmental situation will deteriorate as a direct consequence of the increase in consumption of the middle classes in emerging countries, which will add to the already high consumption levels of developed countries.

Similarly, the Fluctuating World will be a highly complex, highly connected scenario, where any local conflict or solution could spread to global levels with exponential speed.

Technology will perform a significant role in the digitalisation and automation of tasks, but it will not be possible to make use of its full potential to manage complexity and anticipate solutions, because the data and information necessary to do this will be incomplete.

In the face of scarce resources, the only thing that will grow in an unlimited way will be information. However, resources will not be linked so as to make them manageable, because infrastructure will be inadequate. Consumption and leaks will not be efficiently measured, and demand will not be tracked to identify possible solutions.

In addition, we will see some highly protectionist and competitive countries and institutions refusing to share their information. It will therefore not be possible to understand the full movement of the consumption of resources from their sources of origin to their destination, something necessary to design coordinated measures that guarantee supply.

Therefore, the prevailing tone of a Fluctuating World will be reactivity and improvisation when it comes to dealing with new challenges, mostly because long-term global solutions for managing the complexity will not be found.

In this scenario, many countries in the world will have chronic budgetary difficulties, unable to correct the imbalances generated during the financial crisis. The population-ageing phenomenon will also contribute to a long-term imbalance of the fiscal balance and high unemployment rates would similarly translate into a fall in the contributions obtained from raising taxes.

In the economic field, new blocks will take shape based on differential economic growth. Heading towards 2020, many countries that we today describe as emerging will have stopped being so. They will move on to the frontline, and those that we today call "developed" will have started on the path towards decline.

Inequality in access to education and social services will be another characteristic of this Fluctuating World.

Basic educational centres may become insufficient and education could go from being a public to a private asset. It is also likely that emerging countries will face a lack of services as health or education. There will not be enough teachers or health care staff to meet the needs of a population that is constantly growing.

In this scenario, serious safety threats could arise from an environment of collective hysteria or fear, which have never been the best allies in the search for solutions to meet new needs. The costs of the measures for coping with these threats would be huge, and what is worse, their human implications would lead to restrictions on daily life and would restrict already scarce resources.

In other words, the Fluctuating World is essentially an extrapolation of the current one: the world we live in today will, with a very high degree of probability, lead us to a Fluctuating World. A Fluctuating World has to be understood as an unstable world, with a growing risk of heading towards an even worse scenario.

A World in Crisis

Let us now imagine that we have not been able to make the most of the opportunities the 2020 initial panorama offered. We have not taken the necessary measures to correct the course of reality. We know that attitudes have to change imminently, so inaction would lead to disaster. We would therefore find ourselves in the scenario of a World in Crisis.

This is not a catastrophic scenario based on pessimistic reflection. Instead, it is an entirely possible framework that has arisen from a close analysis of the evolution of change factors.

The World in Crisis will be more disruptive than our current situation, because it means that after the centuries of evolutionary learning that have brought us thus far, humanity has been overtaken by the challenges it faces. In such a discouraging scenario, political and economic systems will be subject to huge pressures that could end in violent demonstrations.

In the World in Crisis, global stability will be threatened by a growing, tension-fuelled duality. The global economy will have failed to get out of the recession that began in 2008 and that has presented western countries with massive problems concerning public debt and currency stability.

Countries, both emerging and developing, will not be able to invest in infrastructure, health, education and environmental protection. The much-needed advances will not only not have happened, they will not even have been discussed and no feasible solutions will be seen on the horizon.

At supra-national level, a new type of nationalism and protectionism will become the prevailing tone in the political environment of this World in Crisis. Military conflicts between industrialised and emerging countries could not be ruled out — evidence of the inability to define a path towards a solution given the tough economic times.

In this scenario, many will defend autocracy as a suitable form of government in order to overcome an economic crisis whose effects are excessively prolonged. Public opinion will favour the governing elite closely guarding their powers, associating efficiency, capacity and stability

with autocratic political systems. Most will flee from the complexities of the democratic process, whose decisions will be seen as slow and not very effective.

In developed countries, the wealth gap that seemed unbearably wide during the recession after 2008 will reach discouragingly record levels in 2020. While being poor will not under any circumstances mean losing the right to vote, it will raise issues of fair representation in a political system that defines itself as democratic and in which the capacity to influence is a key part of the process.

Democracy in a World in Crisis will also be impoverished, moving away from its ideals and losing traction as the needs of the individual cannot be met.

The coexistence of the "first" and "third" worlds within developed countries will aggravate the social situation: inequalities within industrialised countries will not only increase, the richest will also start to be affected.

Cutbacks in basic social services such as education will end up seriously affecting the quality of training and its human resources. There will therefore be a severe shortage of trained people able to apply mechanisms of creative thinking to unblock a situation of deep crisis. The scarcity of human resources will affect fundamental aspects of existence such as health and education. In emerging countries, there will not be enough teachers or doctors to attend to and train their inhabitants, and the lack of international cooperation will hinder the development of distance services and distance education.

The business community will also resent that lack of skilled human resources. In fact, they will respond to the crisis by placing the focus on a policy of cost-efficiency rather than applying the levers of innovation. In this context, a growing global supply of cheap manpower will make it possible to manufacture and distribute low-quality products for the segments of clients with less income.

The economies with the best chance of subsisting would be those directly associated with the production of essential goods, because the long and intense period of mass consumption would have placed excessive pressure on the availability of natural resources.

Unemployment is another fundamental cause for concern. The continued economic recession will raise unemployment figures to unprecedented rates in some western countries. There will be a generalised fear that employment rates will never return to levels prior to the 2008 crisis.

Emerging countries will not be able to make the leap to knowledge-based economies and they will suffer as their production centres are moved to even cheaper regions. People will then follow the employment trail, generating a migratory movement to the cities where they hope to find more opportunities. As a consequence, cities will grow in an uncontrolled way that will exceed the existing capacity to generate habitable environments. A huge number of megacity citizens will live in marginal neighbourhoods, with limited access to health infrastructure and the

constant threat of criminality. The worst form of poverty will be urban poverty. Social tensions will be heightened, and street protests and unrest will be commonplace.

Most of the population will only meet their most basic needs; personal values and consumption preferences will be things of the past. In fact, in the scenario of a "World in crisis," we will live through the end of the consumer society as we know it today. The power of the individual in the collective will be reduced to the point at which people will be first and foremost resources for their governments rather than citizens.

There will be no demand for new technologies, even those that could generate affordable and significant improvements. This will not just be because they are unaffordable but also because of a generalised distrust regarding matters such as reliability and privacy. The capacity of technology as a catalysing element of change will be nothing more than a theory, cast aside. Only its dark side — the threat it poses to privacy — will remain.
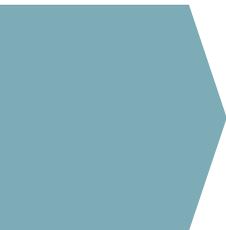
The World in Crisis will be more disruptive than our current situation, because it means that after the centuries of evolutionary learning that have brought us thus far, humanity has been overtaken by the challenges it faces

A World in Balance

This scenario is the result of having satisfactorily coped with most of the challenges on the horizon, consolidating the opportunities present in the 2020 panorama. This in itself would constitute a change in paradigm compared to current reality.

In this scenario, the equilibrium between the US and China will lead to global economic and ecological cooperation, guided by transparency. This will enable us to establish bodies to oversee the interest of the planet as a living element and one that we share as a human collective.

In the scenario of a World in Balance, high energy prices and scarce resources will have forced us to adopt new behavioural patterns, making sustainable consumption a general practice. Growth will be defined in terms of global well-being. Communication technologies will have become ever more affordable.

In this World in Balance, most people will enjoy good living standards in healthy cities endowed with smart structures. Economic and political agents will understand that sustainability is a competitive advantage and that too many regulations reduce economic freedom. In this World in Balance, we may see the rise of business initiatives with a social foundation and a return to the regionalisation of the economy with an increase in the global division of labour, lowering unemployment rates.

In short, environmental efficiency, new types of work, technology at the service of people, smart infrastructures, etc. will have materialised in the World in Balance. Our everyday life could be similar to that of the families that we have imagined in order to visualise this better future for everyone; the reader will find their stories below.

A better future is possible

The World in Balance is a possible scenario based on a thorough analysis and not an idealistic vision born from optimism. It is feasible to achieve this world if we put the right measures into practice now.

Human beings are capable of evolving and re-investing themselves to make their aspirations become a reality. From the outset, they have transformed their reality, creating more favourable environments for their survival and that of their community.

Many events in history and at present are appalling; they horrify us from the perspective of our modern knowledge and values. Many others are admirable and they inspire us to move ahead. Invention and innovation are innate to human nature and life in society; cooperation has been key to the development of humanity.

Today, we are living together in a melting pot of societies and with sophisticated technologies. Our habitat is much more complex than any earlier human habitat and it also offers many more possibilities. In spite of all the existing problems, never before in the history of humanity have we had a starting point for our future like the current one.

Today we have more democracies, fewer military conflicts, greater freedom of expression, better legal guarantees and a higher level of development and quality of life than just a few decades ago.

Politically, we are living in a present with many parliamentary democracies and states where there are broad margins of political rights and civil liberties that have never been seen before. The number of autocracies has fallen since the middle of the 1970s; certain forms of autocratic states allow for growing margins of liberties — such as Singapore and Dubai — and even the Asian giant, China, is moving in a slow but constant way towards greater social conquests.

The end of the Cold War caused a dramatic drop in armed conflict around the world. During the 1990s, the number of wars between states plus internal or civil wars plummeted — down 60 percent from its peak. This downward trend has continued since the start of this century.

Even more importantly, conflicts no longer go unnoticed. Information and telecommunications resources and technologies are improving all the time, and as a consequence, we can access relatively objective and high quality confirmation of peace. The boom in independent news media is occurring in tandem with the global trend towards greater democratization and peace.

Today, the values of life, dignity and human rights are widely shared. The Universal Declaration of Human Rights protects and promotes the rights of all individuals, regardless of

their sex, race, religion, cultural background or other condition. Tolerance, equality and respect help reduce friction in society and create the kind of societies in which we would like to live.

Since 1990, historical breakthroughs have been made to benefit children during the first nine years of their life; the worldwide rate of mortality of children under 5 has fallen. In several regions around the world, the gender distinctions in primary school enrolment have been eliminated, and huge improvements have been made as regards access to primary schooling and childhood vaccinations. We are currently in pursuit of formulas to ensure support given at infancy continues into adolescence; this situation was unimaginable just twenty years ago.

Human development is understood to be the process by which a society improves the living conditions of its citizens through an increase in the assets required to cover their basic and complementary needs, and in the creation of an environment in which the human rights of everyone are respected. The Human Development Index, drawn up by the United Nations Development Programme, has recorded major progress worldwide (41 percent) since records began in 1970, with substantial improvements in health, education and income. Almost all countries are showing signs of progress, although to very different extents. Only the Democratic Republic of Congo, Zambia and Zimbabwe have indicators that are worse now than in 1970.

In July 2011, the General Assembly of the United Nations recognized the pursuit of happiness as "a basic human objective" and invited Member States to promote public policies that include the importance of happiness and well-being in their commitment to development. The resolution (passed unanimously) also recognizes the need to apply a "more inclusive, fair and balanced" approach to economic growth to promote sustainable development, eradicate poverty, and foster the happiness and well-being of all peoples.

Towards the Millennium goals

Moreover, there is also a common project: the Millennium Development Declaration and Goals, passed by the General Assembly of the United Nations in September 2000.

The formulation of the Millennium Goals has set up a series of specific aims (reducing the proportion of people living in poverty or suffering hunger, reducing infant and maternal mortality, achieving universal primary education for all children, increasing the number of people with access to clean drinking water, etc.). This has meant that for the first time, specific objectives have been established for all international policies as a whole.

The Millennium Declaration represents an agreement between the main economic players on the world stage. Poor countries have promised to improve their policies and government management, and to strengthen their accountability to their citizens. Rich countries have promised to provide the resources. Because the commitment to meeting the goals was made at the highest political level, for the first time entire governments are committed to achieving

them. And the main international financial institutions (the World Bank, the IMF, regional development banks, and increasingly, the members of the World Trade Organization) expressly declared they would also monitor the achievement of the goals.

Furthermore, the goals also define specific aims to be reached within set time spans, in most cases by 2015. Here it is very important to underline the fact that compliance with the goals is being monitored.

Although the conclusions or declarations at each summit have not always been signed and ratified by the various states, if we look at the degree to which goals have been met, the fact that there is a binding project with on-going efforts provides hope for a better future. Perhaps no more than 50 billion dollars of additional aid is required to meet the goals. The numbers are clearly huge, but we can put them into perspective when we think of the 900 billion dollars spent on arms every year, or the 300 billion that rich countries spend on agricultural subsidies.

DECISION-MAKING TIME

The trends we have observed involve a transformation in our technology, identity, society and economy. We have set ourselves vital challenges that must be overcome in order to move towards a sustainable future.

It is not a question of "retouching" structures. We have to reformulate institutional models on a very basic level and revolutionise our everyday behavioural criteria. This means a deep-seated cultural transformation.

At BBVA, we believe this context requires us to think in a disruptive way, including relationship and partnership mechanisms so decisions are taken that best foster positive progress for the planet and the people living on it.

On our journey towards a World in Balance, managing the transitions between the current paradigm and the new one — which we have to define — we must observe the highest possible ethical values in terms of integrity, transparency and responsibility.

The decisions we will take over the coming years and the actions we undertake to implement them are crucial. It is time to ask ourselves whether we are "Fortune's fools," as Shakespeare had Romeo describe himself, or whether we can start to influence our future to prevent the current situation from degenerating into a World in Crisis.

Principles for action towards a World in Balance

The notion that the future is not predetermined is key to being able take action and turn the world into a place in which we would like to live. But how should we act? What levers should we pull in order to be truly influential?

Together, we have the knowledge, the resources and the technology required to tackle the transformation and overcome the challenges. However, their size and complexity make it impossible for a single organization or institution to face them alone. Solutions come from contributions made by everyone: governments, institutions and companies, and individuals, articulated around civil society.

The concept of cooperation must be transferred to the logic of all areas (co-creation, co-branding, co-working) in order to make effective use of technology in line with human needs and to generate useful innovation — not only innovating more products and services, but also bringing innovation to the way we innovate.

Partnerships between players are needed to help understand the mosaic of relationships surrounding the challenges we face. Even if we now have access to an increasingly large amount of data, these data are usually property of the institutions holding them, and their interpretation — the information — is biased towards the particular needs of each owner. Only a coordinated effort undertaken between everyone involved will enable us to understand the dynamics of the system and to internalize the undeniable network effects. At this point, innovation must provide new sustainable solutions.

Collaboration between governments, institutions and companies is a basic mechanism required to foster change towards a World in Balance, hand in hand with technology focused on individuals and systemic innovation. We have identified a variety of economic and social domains in the analysis of scenarios, in which the application of these principles is essential to changing the dynamics of the world towards sustainability.

Smart cities

What smart cities have in common is the efficient management of resources and a better quality of life for inhabitants through the use of technologies and information. At the centre of this concept lies a model that views the city as a complex, dynamic and interconnected system. Information generated by the city at any given moment helps us retrieve the knowledge needed to take decisions aimed at optimal management.

The activities of the citizens, the operations of organizations and urban services, communications networks, buildings and infrastructure, environmental sensors and means of transport — everything generates information in the form of digital footprints referenced in space and time. The data and the knowledge involved are the heartbeats of the city and its essence.

All the technology deployed in smart cities would make little improvement in the quality of life of citizens without the collaboration of all the institutions responsible for regulating urban services. Quantitative models based on information are needed to design new services that are the right size. The design process must involve the entities responsible for implementing and

managing the services, and formal innovation processes are needed to provide solutions for the vital needs — whether explicit or not — of the citizens.

Smart infrastructure to combat scarcity

Once again, collaboration, technology focused on people, and innovation are the only viable ways to reduce the overall vulnerability of infrastructure. Over the course of the coming decades, a large-scale change will be necessary to ensure infrastructure meets growing demand. As progress is made towards ecological sustainability, it must continue to act as an engine to activate economic and social development.
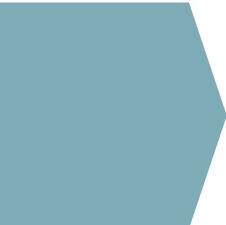
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Our energy model must change to prevent supply from being based solely on fossil fuels. This is where renewable sources come in, the possibilities of which are almost infinite — a clear source of hope. Developments in energy generation will activate the change, but it is also necessary to reduce losses during transport.

Nor is there any limit to the research into this field. Alongside the modernization of cables, there is even the possibility of doing away with them altogether through wireless technology by means of electromagnetic induction or light beams.

Innovation in this field is starting to bear fruit. In pursuit of answers to growing energy demand and a responsible reduction in CO_2 footprints, technology companies are locating their large data centres alongside waterfalls, in mines to take advantage of geothermal energy, or next to the sea to use the tides and waves. These pioneering initiatives are having a simultaneous impact on the generation, distribution and sustainability of electrical energy. They efficiently bring generation close the point of consumption, while at the same time integrating it into the electrical distribution network.

This approach, applied to other infrastructure such as water, transport, recycling or telecommunications, marks the path to follow.

The new concept of the "generation" of basic resources will facilitate decisions, allowing the management of investments to be brought closer to the point of consumption, to citizens and to companies.

In some cases, this transformation involves the selective decentralization of infrastructure for basic services, or the regional relocation — worldwide — of production processes in order to seek out optimal locations. In others, it may be necessary to first centralize and reorganize, in order to then distribute using a different layout. This also necessarily leads us to a new concept in the topology of distribution networks for basic services and the need to endow them with the intelligence to manage multiple sources of generation and consumption.

Furthermore, bringing resource generation closer to consumption would help reduce demand, because consumers would become aware of the importance of savings. For example, the smart metering of electrical consumption in companies and homes has engendered new services related to energy saving. Another example is how introducing gamification in automobile electronics could lead to more efficient and safer driving habits.

On a political level, setting a suitable price for carbon emissions as part of a global climate framework could help people and companies to become more aware of the environmental consequences of their actions. Similarly, there is also huge potential for smart incentives for the efficient use of resources.

This process will also require new financing mechanisms to ensure suitable levels of investment in green infrastructure. Collaboration between public and private organizations could serve as a tool to facilitate investment by sharing costs and bridging economic gaps. In India, for example, the first rapid transit bus system was deployed in 2006 after this approach was taken.

Improvements in education systems

Evolving towards a World in Balance scenario involves profound changes in society. More than ever before, individuals will need to be educated in social skills, creative abilities and trained in technology, able to recognize their own emotions and talent.

The adaptation of education systems is essential. Primary and secondary education must be universal, since they constitute a basic lever for progress. Education should therefore be democratized. In a first instance, this means free access to education. Here, technology plays a vital role: firstly, because of its ability to disseminate academic contents beyond educational centres using the Internet as a basic vehicle; and secondly, because of the economies of scale provided by digital formats over paper and other materials, as well as being much more environmentally friendly.

There are more and more informal activities on the Internet providing education opportunities that are not formally structured. This provides access to education for a large number of people without economic resources, or who do not live close to an education centre, or who are unavoidably busy when traditional centres give their courses. There are good examples of initiatives promoted by universities from all over the world and training platforms

open on the Internet. Nevertheless, strong institutional backing is still required, as is the case with the recent phenomenon of massive open online courses (MOOC) on the Internet.

This technology means any student can access training given by the best educators. And what is more, this makes it possible for everyone to choose what they want to learn and to add their own experience to the body of knowledge.

On another level, democratizing education means guaranteeing a method that allows everyone to learn. We do not currently know how to evaluate or develop all the skills of all individuals — their "multiple intelligences." The Montessori Method demonstrated the existence of educational alternatives focused on personalizing the way in which each individual is educated.

Given the challenges we are faced with, education does not need to be reformed: it needs to be transformed. The key to this transformation does not lie in its standardization, but rather in its personalization, in revealing the individual talents of every child, and developing a passion for learning.

Unfortunately, around the world, with a few exceptions, the reality is still one of curricular contents more focused on deadlines and standardized contents than on ensuring every individual assimilates them correctly and is prepared to employ the knowledge gained appropriately.

Educating in accordance with the natural abilities of the individual, without reducing the demands made, can also lessen the stress on students, thereby preventing failure at school and people leaving the system early. We would have better prepared individuals to face the changes and uncertainty ahead. Education systems must start to design programmes that include workshops to develop social skills and entrepreneurship as well as the current analytical and rational techniques.

The more educated and trained individuals are, the greater the collective intelligence of humanity as a whole, and the faster we will progress.

Individuals in a World in Balance

If you accept that collaboration is one of the keys for finding answers to new problems or problems of an exponentially large scale, then individuals in a World in Balance must be intensively involved in their realities. And they cannot expect problems to solve themselves.

Being properly informed about all the forces at work in the scenario in which we live is the first step towards reflecting on and deciding how to contribute to improving it. Learning to distinguish which elements we can act on most effectively is an aid to constructing the desired reality. The main assets at the disposal of individuals in a World in Balance are their lifestyle, collective power and social entrepreneurship.

Sustainable lifestyles

The consolidation of new lifestyles will help conserve our natural resources and better protect the environment. Since energy consumption is what most damages the environment, any practice that saves energy is an efficient lever for sustainability. Systematic practices for reuse and recycling are also a responsibility that must begin at home, with changes to habits that reduce the quantity of waste each family generates, opting for more environmentally friendly packaging and containers or rationing the use of the family car by using public transport alternatives with a low environmental impact.

In a World in Balance, individuals would change their consumption preferences, placing a premium on products and services created using environmentally friendly processes. This could mean, for example, encouraging the consumption of pulses and vegetables to drastically reduce the consumption of meat because of the environmental consequences of raising livestock for human consumption.
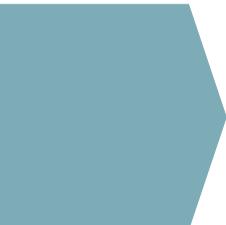
Social entrepreneurship is a key concept combining multiple levers. It is a multiplier that consolidates business excellence practices for the purposes of serving the common good. The organizations that have been set up with this spirit constitute a seed that could flourish into an example of the virtues required by our society at this moment in time

The pursuit of mechanisms and alternatives to facilitate the multiple use of a single asset by various people is another common recourse. Clear examples can be found in the practice of sharing private vehicles for everyday transport in urban areas (carpooling or car-sharing), the return to exchange systems, giving away what is no longer useful to you, and even opting to rent instead of purchasing and owning assets.

Education at home should strive to create a balanced attitude to income. It should promote equal opportunities between genders and establish healthy guides for conduct, thereby reducing health costs and improving quality of life in old age, while encouraging the mixing of generations. These are all guidelines that each individual should follow to make the transformation towards a World in Balance possible.

The power of the people

Individuals have a growing potential to act as agents of transformation by adopting ethical criteria for all of their actions and demanding that those with institutional responsibilities apply them too. This power is backed up by the integration of interest groups in collectives, in order to achieve improvements more quickly and to have a greater impact.

The Internet and social networks are vehicles that have demonstrated the power of the collective, with results both in the virtual world (all kinds of viral campaigns) and in the real world too, acting as a catalyst for transformation processes such as the Arab Spring, among others.

Moreover, the concept and practices of co-working and crowdsourcing are a possible response to the challenge of a flexible labour market in which people can influence each other and join forces even though they do not necessarily work in the same activities or on the same projects.

Social entrepreneurship

Individual good intentions are not enough on their own to move the planet towards sustainable growth. We will require mixed forms of organizational culture, such as a cross between profit-led organizations and traditional assistance networks.

Levers such as social entrepreneurship — a practice which places equal importance on the generation of profits for reinvestment and on sustainable social benefits over time — spur people to act as agents of change for the positive development of society.

The benefits of achieving social entrepreneurship, currently in its infancy and mainly involving individual initiatives in developing countries, could cause the transfer of this approach to the domain of traditional companies, which currently aim exclusively at obtaining profits for shareholder pay-outs. If this occurred it would be highly desirable.

Social entrepreneurship is a key concept combining multiple levers. It is a multiplier that consolidates business excellence practices for the purposes of serving the common good. The organizations that have been set up with this spirit constitute a seed that could flourish into an example of the virtues required by our society at this moment in time. BBVA can be found amongst these, as will be shown below.

Today, the pioneers of change are promoting market solutions to global challenges, on a small scale. They employ financial practices in the developing world, help construct water infrastructure in remote populations, implement new shared vehicle schemes to reduce traffic and pollution, and apply new health service methods in countries with low incomes and ageing populations.

Even though these efforts are minuscule compared with the magnitude of the challenges we are facing, they play a vital role in starting the transformation and they significantly contribute to redirecting our path towards a World in Balance.

Different Lives in a World in Balance

Families, increasingly diverse
Farha and Bettina, happily bringing their family together. Sydney, 8 May 2025

Farha (46) and Bettina (43) live in Sydney with their two children, Daniel and Aashi. Bettina works as an environmental mediator and spends a lot of time travelling. She is currently in Melbourne.

It is six in the morning. Farha loves getting up early. "I must be the only one on the whole planet," she thinks.

But there is Bettina, her image perfectly reflected in the mirror as if she was at her side. They say hi and talk about their plans for the day.

Before breakfast, Farha goes up to the garden they have on the roof. This is her favourite part of preparing breakfast. Each family has its own space on the flat roof of the building and they pick their own avocados, strawberries and peaches.

At the table, Aashi chatters away while Daniel, her older brother, eats breakfast in silence and checks the messages on his phone. After clearing the table, they put the cups and plates in the dishwasher, which will start automatically when the home software determines the solar cells have produced enough energy and there is enough hot water in the tank on the roof.

Farha, Aashi and Daniel check the school timetable. Both children have flexible timetables adapted to their specific interests. Today, for example, Daniel is registered for a virtual visit to the World Expo and he will have to produce a multi-media report. Aashi, on the other hand, has opted to participate in the "Democracy Game." The game gives students real municipal government problems and asks them to suggest possible solutions.

When they leave the apartment, Farha looks at her electronic agenda to check the morning's energy use. Their home has emitted almost 2 percent more CO_2 than normal because Daniel had to heat water using network electricity. "We'll have to compensate for this during the rest of the week," thinks Farha. She sends a message to say she will pick up the evening dress she has ordered from the Spanish store associated with tenestilo.com, rather than paying the delivery costs.

Farha accompanies her kids on the bike ride to school. They are there in less than 15 minutes because the traffic lights have been optimized for bicycles. Very few people use their cars on a daily basis; there are several car-sharing services and Farha is using one today to go and buy her daughter's birthday present, a second-hand piano she found on a website for exchanging hobby items. Over the past 15 years, sustainable consumption has slowly been introduced and today it is completely normal in Sydney.

When she gets home, she starts work. As a life-planning consultant, Farha is contracted by companies who want to ensure their employees have the best possible working environment and they can reconcile their working and family lives in order to optimize their capabilities. Farha uses AIAnalyzing software to look over the profiles of her clients. Depending on how much data the client is willing to share, she reviews training calendars and working timetables, checks posts on social networks, sends messages of encouragement, suggests changes in diet, asks people to get into contact with her, and responds to requests for consultancy. She is especially happy with the progress of Harry, who works as branch manager for a major bank. He is from Hobart, Tasmania, and he has managed to change his lifestyle in order to be able to look after his adopted son.

At lunchtime, Farha takes a look at the network of local stores. She wants to know which products are in season before going shopping. Each food item has a RFID (Radio Frequency Identification) label and is registered automatically in the fridge, so the fridge itself notifies her before anything reaches its expiry date. This has dramatically reduced the amount of food thrown away: in 2012, up to a third of all food produced was wasted.

Before returning to work, she checks on Bettina's day in Melbourne and takes a couple of minutes to analyse the health data of her parents in Bangalore. Everything seems fine on the

other side of the Indian Ocean. Her phone also informs her that Daniel and Aashi will be home in an hour's time.

Aashi is a member of a virtual orchestra made up of kids living on all five continents. There is an open rehearsal scheduled for today and the whole family can watch, even their grandparents. When they arrive at the cultural centre, Aashi goes to the music cubicle, and Daniel and Farha look for a seat in the audience. The connection is made to the platform and they find themselves amidst a large audience, which does not stop them from all having the sensation of being in the front row. Their grandparents are projected alongside them, so they can chat as if they were really sitting together.

Back home, they have dinner together and then the kids go to bed. Farha connects with Bettina again and tells her how well Aashi played the piano during the rehearsal. They talk about their day in the living room, with Bettina's face on the TV, almost as if they were together.

The new environments of the individual
Wei-Lu, happy with his lifestyle. Shanghai, 8 May 2025

Wei-Lu is a 39-year-old engineer specialized in Information Technologies. He is single and he lives in Shanghai, working for SMG (Shanghai Media Group), one of the most important companies in Asia. He has a good job and he enjoys working in the sector of IT security and human relations.

Wei-Lu is very interested in the relationship between art and technology in a city such as Shanghai, the largest in the world in terms of GDP growth and the second largest in terms of the number of homes. When he wakes up, Wei-Lu can still sense the virtual reality he programmed the previous night for his dream, which enabled him to enjoy views of the fishing port and the pagodas of medieval Shanghai. When he gets up, there are just skyscrapers and neon lights.

He has a sweet rice soup as part of his vegan breakfast while getting ready for work, and he connects to his smartphone application on the screen in his living room. His "assistant" — his smartphone — has the same name as his favourite childhood singer: Jay.

Jay suggests a possible timetable, which Wei-Lu changes slightly by delaying a meeting. The smartphones of the others attending the meeting are quick to confirm the change.

Wei-Lu checks the press but Jay does not highlight any particular news, so he takes a look at the information most viewed by his friends on the social networks. He then orders Jay to tell anyone writing to him he will respond personally to messages when the meeting is over. The smartphone screen is flashing: it is Alexander, who is about to go to work. Wei-Lu sends him a request to pass by so they can go together.

Three minutes later, he is closing the apartment automatically and descending from the 88th floor to the hall. The people around him are all in a hurry to get to work and he remembers the

medieval Shanghai of his dream; a few trees would not be amiss. Alexander's ETA is 90 seconds, and he turns up right on time in his brand new German vehicle. The passenger seat is upholstered in leather, but the fuel cell in Wei-Lu's car is much better, as befits someone with his position in the company. Alexander turns on the automatic driving so they can discuss work. Jay directs the vehicle to the closest drive-through ATM, because he knows Wei-Lu needs money to buy vegetables in the traditional market, which is held every Thursday in the neighbourhood.

Half an hour later they arrive at the tower where the meeting is to be held, as recognized by their smartphones. Two hours later, Wei-Lu returns to his post. The meeting has been a success, there were no problems and those in attendance were happy with the improvements made to the conference room: they talked as if everyone participating was actually there. Wei-Lu was responsible for the machine which prepared and handled the connection data and which was charged with evaluating the participants based on analysis of previous meetings.

During the rest of the morning he answers his messages and talks to some co-workers, tasks only interrupted by a break for tea. Jay reminds him it is lunchtime and asks if he wants to visit a new art gallery. Wei-Lu asks him for a 75-minute break and a CO_2 zero-emissions driverless taxi to take him to the Beijing East Road art gallery, with a stop en route to pick up

some fast food. The gallery is specialized in virtual sculptures: objects only visible through glasses which decipher the corresponding software. The gallery staff explains that there are a limited number of pairs of glasses to see the works of art concealed in the city. Jay recommends he buy two pairs and does not allow anyone to bother him for the next half hour.

Before returning to work, Wei-Lu publishes a comment on his social network and checks out what his friends are up to. His smartphone tells him his purchases have been made and the products will be delivered that night to his home. He always works until sundown, and when he gets home the lights of his apartment are already on.

Handel's music is playing. Wei-Lu is happy and his mood is reflected in the menus and applications he consults. When the shopping arrives and everything is organized, he accesses his parents' database to find out what they have done during the day. He is an only son and has to take care of them. They live in a village close to Zhengzhoua just three and a half hours away by train, but they still view it as 1 000 kilometres and feel a long way away. When he left home, the relationship between them became closer. Today his mother has received an unscheduled visit from the doctor so Wei-Lu calls them: it was nothing serious.

His parents are the members of a page that lets them look for relationships for their son, and they have organized a meeting with a girl called SunYue. He should go. Wei-Lu goes out onto the balcony. From there he can see his office. He is thoughtful and decides to have a cup of tea with his Confucian deity. He starts the programme; the projection begins with the programmed movements. Then come the questions on two topics: his parents and society.

The rest of the night goes well. SunYue, the girl he meets, seems interested in art, so they go to the centre of the city in his vehicle. The glasses allow them to see the sculptures interacting with the environment: waves on the asphalt, the passers-by transformed into an army of ants, etc. And they arrange to meet next Saturday so she can show him where she works: one of the first nano-electrical power plants working with photosynthesis in the province of Zhejiang.

To end the day, he reads the news while cleaning his teeth, and once in bed, he accesses the medieval view of Shanghai in his virtual reality. To go with the images, the system reproduces a fragment of the rehearsal of an orchestra of children from all five continents, which is a hit on the social networks. Wei-Lu falls asleep with the feeling of being in a very different Shanghai to the one in which he lives.

The elderly, getting younger and younger
Carmen and Antonio, happy to manage by themselves. Madrid, 8 May 2025

For more than 25 years, 72-year-old Carmen helped her husband in the office with programming and the accounts. Since her retirement, she has run "Hire a Grandmother," an Internet service for helping families with small children. Antonio (76), her husband, teaches carpentry to young people in a local school. Their son, Jorge, works in Jakarta.

During his entire working life, Antonio hated getting up early, but now he has been retired for a decade and can sleep all day long, his internal clock wakes him up at six. There are still 30 minutes to go before he has to take his morning medicine. He gets up without waking Carmen, and in the corridor he says: "Lola, reading glasses." Lola is the name he has chosen for the "smart" system application of his house. It is also the name of the virtual assistant of his bank. The response is immediate: "On the kitchen table." He is happy there are sensors in the house. At first he did not want to bother, but the joint offer from the mobile phone and security company works really well.

At quarter past seven, Carmen joins Antonio in the kitchen. She is accompanied by her small robodog, who also looks after them in her own way. Zita, as she is called, fetches Carmen's pills, and she encourages them to play ball with her if they have not done any exercise. Last year, Carmen fell over when Antonio was away, and Zita called the ambulance and contacted the tele-doctor.

Carmen consults the electronic blackboard in the kitchen and tells her husband his carpentry class is today at three in the afternoon. Around a dozen students are scheduled to take part. As for her, she has to pick up Jaime, one of the kids she looks after as a grandmother. For evening plans, her telephone guru suggests a Galician bagpipe concert, which she thinks is a great plan.

While she is going over the agenda of her "Hire a Grandmother" service for the next week and responding to the mails from new families in need of her help, she receives an on-screen call from Jorge. It is 10:30 am in Madrid, which means he is about to finish his working day in Jakarta. Antonio is happily pottering around in his small workshop, but that does not stop all three of them from enjoying an animated conversation.

On Thursdays their food is brought to them at home. The company, a subsidiary of their medical services supplier, brings individual meals exactly in line with their nutritional needs. If they use the service at least three times a week and allow it access to their personal health data, they get a significant discount on the service.

Carmen loves looking after Jaime. They walk to the nearby park together, where there are just a few children. Aluche has become a neighbourhood full of old people, Carmen thinks, and she entertains him with the images of a children's concert that is about to end.

Antonio always calls a taxi when he goes to the school to give classes. He likes chatting with the drivers. Lola has managed his agenda and taken care of reserving the classroom. Now her voice is telling him he is just five minutes away, and she reminds him not to forget his toolbox and the work samples he promised the kids last class.

The students arrive in high spirits. Apparently the school has been awarded a grant to set up a new virtual reality room. That is good news. But Antonio thinks the kids should learn things based on reality. He starts his class by explaining the tools he has brought with him. Some of them remember the names from the previous week, but others write them down in their digital folders to find out what they are used for.

During dinner, Carmen and Antonio talk about their day's activities. A few minutes later, with the table cleared, Carmen's smartphone guru reminds her of the bagpipe concert. Eight people they know are going to see the band. They reckon they could take advantage of their community points to buy the tickets. After all, Carmen gets points for looking after kids with learning difficulties three times a week during the summer holidays. Another option would be to watch and listen to the concert at home using their virtual reality system.

An hour later, Carmen and Antonio are on their way to the concert hall. The cost of travelling around Madrid is astronomical; it varies according to the CO_2 emissions of the vehicles. So they decide to go by metro. While they are waiting for the train, the advertising board on the platform links up with Carmen's smartphone and they access the list of their latest digital purchases. Then the system starts to suggest brands and products. At the concert hall, Carmen's phone shows them the way to their seats, where their friends are waiting for them.

It is almost midnight when they get home. They are very tired, but they are happy to know their home looks after itself: during the night, the robot vacuum cleaner cleans up the dust and the dishwasher starts automatically when network electricity demand is at its lowest. That is

also when Zita plugs herself in to recharge her batteries. The TV has even recorded from the Internet the rehearsal of the Mawaar virtual orchestra made up of children from all over the world.

More opportunities for children
Julio Edgardo and Ana, happy to get ahead. Mexico City, 8 May 2025

Ana (30) is a freelance designer of handbags and craftwork inspired by Mexican art. She is married to Julio Edgardo (32), a security guard at a large shopping centre. They want their children, Jorge and Luisito, to study so they have better opportunities in life. Julio Edgardo's parents live with them.

Ana wakes up first and does a mental check of her daily tasks. In the days running up to 5 May, a Mexican national holiday, sales have been good, especially because she managed to get some of her work into Fonart stores, which belong to the National Fund for the Development of Arts and Crafts.

Her father-in-law's smartphone, a model designed for older people, is charging in the living room. Ana could use her Internet TV to check her e-trade platform but the solar panels do not produce enough energy at this time in the morning. She does not want to spend too much, so she picks up her father-in-law's phone and consults the sales and the pages visited. It only takes a minute to access the data.

Then Claudio, her father-in-law, gets up. The first thing he does is his lung test using a preventative tele-health application. Then he is off to the community garden.

The city government leased the management of this space to the neighbours, and they pay a small amount in exchange for the services provided. Claudio is responsible for allocating and rotating the small allotments among the families and for the storage and provision of tools. The garden has sensors to monitor the humidity and the pollution of the fruit and vegetables. His grandchildren have installed an easy application for him so there is no waste during watering and natural insecticides are used.

Jorge and Luisito go to the bus stop on their own. For their safety, the school provides waistcoats with integrated RFID chips so in the event of an emergency, the children can warn the authorities or call a helpline.

Luisito knows school is important if he wants to get on in life — his parents are always telling him so — but he cannot help dreaming about football. Nonetheless, he tries hard to concentrate on his lessons. They are talking about how excess CO_2 caused the acidification of the oceans. He knows all about this subject. In actual fact, his grandfather lost his fishing boat because of it. His father is astonished by what the kids are able to understand in 2025. He had to watch an old film by Al Gore twice before he understood what it was about.

In the meantime, Jorge is busy in the school laboratory. He wants to compete in the National Chemistry Olympic Games and in order to classify at the end of July, he has to set up and document a difficult experiment.

At break-time in the shopping centre, Julio Edgardo chats with his colleagues in the staff room. They are recalling how they celebrated the 5 May party and one of them tells a story about an augmented reality projection, which gave him the sensation of being in the middle of a battle.

It is Julio Edgardo's job to control the monitoring station of the shopping centre for the next three hours; metal seagulls fly around the car parks and local streets.

Ana likes working in the sewing workshop. She shows other people how to sew the most difficult pieces, which she designed, or she looks at other people's work in search of inspiration. The government pays a good chunk of the rent, otherwise this space with its 3D printer and fast Internet connection would be too expensive. Today she has received an order for eight personalized handbags from a Spanish green brand and now — having distributed the work among the best weavers on the web, all grandmothers — she is busy drawing the designs.

When Jorge and Luisito come home from school, Ana is already at home, with all the designs finished and submitted to her colleagues. It is hard to motivate the kids to go over their

lessons, but Ana and Julio Edgardo are convinced the only route to a better life is through education.

A large part of the family budget goes towards paying training credits, which can be exchanged for online lessons. Many higher education providers now offer their services on the largest platform in the country, and just choosing the right lessons is an art in itself.

Julio Edgardo has bought a TV with Internet access thanks to a large discount he was given at the shopping centre. For several weeks now, Jorge and Luisito have been attending English classes in the University of Nairobi. They are cheaper than other options and they are very good. Educator training has been a major concern in Kenya for over twenty years.

The conversation over dinner is about the new environmental legislation aimed at reducing pollution and increasing energy efficiency, a measure Julio Edgardo is very critical of. Energy is getting more and more expensive, he says, and they already have problems paying the bills. Ana tries to make him see the positive side: they can always sell excess energy from their panels, or try to save to install more panels, so when the prices rice, they can earn more money.

They see some lovely images of kids yawning on the television, and turn the volume up. The worldwide concert has been a success despite the fact that the young musicians had to get up early in Mexico and stay up late in Sydney to adapt to the timetable of the conductor, a rather elderly man in Israel.

Before going to bed, Ana checks her orders again and her bank tells her she has one more, paid in advance! Tomorrow she will have to send another handbag by mail to San Francisco. May has turned out to be a successful month. She joins her husband and thinks to herself before falling asleep: we are climbing up the ladder in the world.

BBVA COMMITMENT

The Vision 2020+ we have just unfolded, which originated from concerns regarding the fulfilment of our own potential future as an institution, leaves us with one very clear conclusion: the statement that our realities can be improved leads to our commitment to get involved in their transformation. This commitment is nothing less than the reflection of the BBVA vision, which sums up our strategy and our culture:

At BBVA we are working for a better future for people

Our vision requires work to achieve the attributes of a better world: quality of life, respect for the environment, sustainable growth and the development of a partnership society. And it makes two things essential: the first is to take action in accordance with strong ethical principles — honesty, integrity and transparency. And the second is to be optimists: to believe human beings can and must find the way to solve the challenges we currently face. We also believe that a global financial group such as BBVA can make a significant contribution towards achieving this.

The financial industry is vital to development: World Bank data for the Human Development Index show a clear positive correlation between the per capita GDP of countries and the proportion of the population with access to financial services. The greater the degree of access to banking — and the more efficient and higher quality these financial services are — the greater society's capacity to respond to the major challenges of tomorrow and provide well-being to its citizens. That is why the main contribution a bank such as BBVA can made to development is precisely to perfect the way it offers financial products and services: in price, in accessibility and in how it adapts to the needs of each client.

Especially when we take into account the fact that only a fourth of the world population has access to financial services. In other words, there are more than 2.5 billion adults around the world excluded from the banking system, almost 90 percent of whom live in developing countries. Providing populations without access to banking with basic financial services would probably be the greatest impact a bank could have on human development.

In tandem with its daily activities, BBVA also undertakes a major exercise in corporate responsibility, to which it devotes an amount equivalent to 2.5 percent of its attributed profits. This task is focused on those levers we consider to be vital to improving the future of everyone, as described in the pages above: the generation and dissemination of knowledge, education and the fostering of social entrepreneurship.

These are the objectives guiding the range of initiatives undertaken by the Group, which include the BBVA Foundation, set up to promote and disseminate knowledge; and the BBVA Microfinance Foundation, already serving a million clients in Latin America (almost 4 million

beneficiaries). Then there are the programmes of the BBVA Group itself, which include the Financial Education Global Plan; the grants programme "Children Getting Ahead", implemented in Europe, the US and Latin America; and the worldwide "Momentum Project", supporting social entrepreneurs.

Banking — the financial industry in general — needs to bring about a profound transformation in order to adapt to major technological, social and individual changes and to contribute effectively to the great objective of a World in Balance. Changes that must be aimed at getting the most from the possibilities provided by technology in order to provide the best possible services and help achieve a better future for people. BBVA aspires to lead the transformation in the financial industry. To this end, we believe innovation is an essential lever: innovation for people.

People-focused technology

Technology is a key lever for innovation. And innovation is the base of our business project. As a consequence, we have adopted a proactive approach to get ahead of the panorama appearing before us. Our work on prospecting and monitoring technological trends has enabled us to draw up a map of the future of technologies that are going to have an impact on the financial sector over different time scales.

This map has served, in a first instance, as an operational tool to improve our technological platform. That is how we have built a highly automated, consolidated and universal infrastructure to enable us to optimize our services, reduce costs and eliminate risks. This technological platform is the base on which we can set up a user-centred business model.

In addition, the map helps us anticipate technological innovations that continue to change the relationship models with our clients, and to detect business opportunities that will arise in the future as people adopt new technologies. Relationships with clients take on a new dimension when we are able to generate commercial offerings suited to the real needs of clients in real time, while connecting the real world to the virtual world seamlessly. From this point on, we are ready to tackle a disruptive change in order to develop our model, by placing the client at the heart of our business.

Understanding peoples' needs

In order to ensure we can respond to the financial needs of people, we have carried out a major field study with interviews and observations from people with a range of attitudes and in different living situations: with or without access to banking, high/low incomes, experts in technology and banking and over a wide range of ages. Thanks to what people tell us, what they do, think, feel and believe, we are able to reflect on the nature of the bank of the future.

Easy Bank

From the perspective of clients in the financial industry, their functional needs can be summarized in two categories: "undertaking things," in other words, solving transactional questions on a daily basis, and "achieving financial well-being," which is connected to long-term objectives. In addition to these functional needs, clients expect to be recognized by the institution, they want operation dynamics to be safe and comfortable, and they want to feel satisfied what they achieve.

We have discovered there are a range of types of people, and they all have these same emotional needs in regard to their finances, but they value them differently during transactional experiences and when they are planning their financial future. Therefore, as a bank we have to provide an adapted response to build confidence and simplicity in the relationship, giving mutual respect and an adequate proposal.

This is the bank clients want.

Customer-centric bank

In line with these ideas, we have been working on transforming the client relationship model to keep pace with developments in technology, individuals and societies.

The traditional banking model provides clients with a series of services. There is just one offer and clients must adapt to it. This is over. Banks must reinvent themselves and dance to the tune of client needs: we must give them what they need when they need it, so individual expectations are met. In a world in which clients have taken control of the relationship, the banks of the future must become a guide for them to achieve their aims.

BBVA's response is the Customer-centric Bank model, a bank with clients at its heart; one that is ubiquitous, transparent and intelligent, without losing sight of its human side. The new banking model is focused more than ever on clients, and it is geared towards offering a satisfactory user experience, consistent in all points of contact from the branch to the mobile telephone, from interactive ATMs to the Internet and the social networks, and through any kind of device.

In order to meet this objective, the bank must become universal, completely digitalized and integrated, providing global and easy access to its products and services with a robust and seamless experience.

The bank must have a flexible relationship model that facilitates contact with clients. Points of contact or channels offer all the options of access to banking services on a daily basis, so clients can set up the relationship in the way they feel is most suited to each moment, in a more granular way — in real and virtual worlds — and in a highly functional manner.

On the physical side, the concept begins to take shape through the creation of a new bank branch space called the Easy Bank.

Easy Bank

This is a simple way of banking, in which clients make their transactions by themselves.

In this model, new spaces are designed to foster relationship transparency and break down barriers between clients and bank clerks. Interaction between clients and managers is easy and shared through a new partnership desk. The space is for and occupied by the clients. The clerks' workstations are moved to the backroom, which they leave to come and attend to clients.

In addition, new automated "ways of doing" have been set up, paper-free and with digitalized processes, as in the case of signing documents electronically.

Clients choose the channel they want to use to receive services. On many occasions, they do not require help from a clerk and prefer the self-service option. To this end, BBVA has developed a new self-service experience called Abil.

Abil

Automatic teller machines were introduced en masse in the banking sector more than 40 years ago. ATMs met major needs of both the financial industry — service cost reduction and

increase in capillarity — and the clients — speeding up some of the most frequent operations and expanding the availability times of services. However, very few functional changes have been made to this channel since.

That is why, when BBVA decided to bring the financial self-service experience closer to the real needs of twenty-first century clients as part of its Customer-centric Banking strategy, the design of the ATM had to be developed to make it truly adapted to the needs and motivations of clients.

By responding to the aspirations of users in terms of simplicity, flexibility and ergonomics, the new design provides innovative concepts such as the large tactile screen with guided navigation, direct access and privacy; a single slot; 90-degree angle (perpendicular to the wall); and ancillary space so it can be operated comfortably. These operational advances have been recognized by prestigious and heterogeneous institutions such as *The Banker* in the UK and New York's MoMA Museum of Modern Art in the US.

The success of this initiative has led BBVA to improve other similar channels such as the Drive-Thru, self-service for vehicles, with a high degree of expansion and acceptance in certain regions of the US, which has benefited from the Abil experience. This approach has also been turned on the virtual channels, such as remote banking and mobile banking, where users want a better experience.
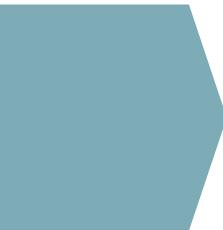
Right now, the Innovation Network — a network of collaborators — is a highly developed and stable ecosystem, which has expanded around the world and is composed of more than 40 000 scientists, investors, entrepreneurs and some of the best known analysts in the science and technology sectors

Lola: Distance banking virtual assistant

At BBVA we have analysed the demands of the users who most use virtual channels and the barriers that put many other clients off using them more. We have learnt that clients expect these unattended channels to provide a simple and individualised experience, and above all, for them to generate the same confidence in operations and decision-making as inspired by a personal clerk at a branch.

That is why at BBVA we have been working on the design and development of Lola (the internal name of the project) for some time now. This is a virtual assistant specifically for financial services, capable of communicating with clients by using natural language and helping them find the information they need, or even making transactions in their name.

The assistant, which understands the bank's commercial offer and the needs of every client, can even give advice on decision-making related to financial situations, and it is able to contract products.

BBVA: Our own innovation model

Innovation is more than just managing creativity and ideas; it requires a method and skills in order to apply a range of disciplines. At BBVA, we first focus on client needs, and then we evaluate the alternatives depending on their attractiveness for the client and their economic sustainability. The entire rational process involved in our innovation initiatives undergoes a series of monitoring points to guarantee only the ones that become increasingly viable during the process make it to the next stage.

BBVA's innovation agenda takes a range of dimensions into account to ensure balance; one concerns the scope of the transformation. For BBVA, one aspect of incremental innovation is the on-going improvement of our service in all the regions in which we operate, and the significant improvement in our skills, which differentiates us in the eyes of our clients. Innovation is disruptive when it allows us to expand the frontiers of the business and creates completely new value for the brand. It is a question of reinventing experiences, and leading the transformation of the financial industry.

The route map we designed has led us to generate numerous significant innovations in our current business model, many of which have become points of reference within our sector of activity.

This is all the result of a decade of work. At the beginning of the millennium, here at BBVA we set up the first innovation organization in order to respond to the opportunities on offer at the birth of the digital world, in anticipation of the impact this would have on the way clients operate with the bank. That is how Uno-e — an online bank, Adquira — the marketplace for online purchasing and negotiation, and Solium — cloud computation services, came into being alongside other initiatives.

While analysing the key factors for the 2020+ outlook, at BBVA we have identified the emergence of new economic frameworks, which in some cases transcend the financial sector. BBVA works to identify the opportunities on offer and to develop solutions covering the needs detected. We also have to analyse them in relation to our key skills and identify which skills have to acquired or improved.

Areas with major opportunities for development for 2020 include universal banking access, health, digital entertainment, smart cities and education.

Universal access to banking services

As we have pointed out above, providing financial services suited to populations without access to banking is essential to building a better future. However, the traditional financial services industry does not offer a complete solution to the basic financial needs of the most

disadvantaged populations. The main reasons are that people do not hold all the necessary documentation (such as a mailing address); they live a long way from bank branches (involving additional costs and loss of income); and they cannot afford the price of traditional banking services.

The field research carried out around the world to better understand the needs and wishes of this population has raised three global questions that must be tackled simultaneously. The first of these is key and consists in promoting the adoption of financial services. Populations with access to banking must be educated to increase their understanding of financial products and services and to help them benefit from them. At the same time, questions concerning accessibility must be resolved. We have to eliminate the long journeys required to visit a branch and simplify contact points, enabling banking without branches and creating easy-to-use machines. Lastly, there is affordability. Most people without access to banking are paid in cash, they spend 80 percent settling bills in the first few days after being paid, and they keep 20 percent for the rest of the month. At BBVA we have been working to implement much more accessible and cheaper models — especially in Latin America — in order to provide financial services in more disadvantaged sectors. At the same time, our efforts in financial education seek to promote the adoption of financial services.

Smart cities

By the end of 2012, 74 percent of economic growth worldwide will be concentrated in cities, together with half the world population. This kind of concentration is already generating tensions in the exploitation of natural resources and infrastructure. It is not therefore an exaggeration to claim that the living conditions of the vast majority of humanity depend on the efficient and sustainable management of cities.

In this context, a large number of metropolises around the world are moving towards the smart city model. What smart cities have in common is the efficient management of resources and the improvement in the quality of life of their inhabitants through the intelligent use of technologies and information. In what is commonly referred to as the "Internet of things," data generated by sensors are doubtless one of the most potentially interesting and rich flows of information for measuring and understanding the rhythm of cities and their inhabitants.

At BBVA we analyse these data for a variety of applications, such as to determine the optimal location for public services, to model the real impact of events, to optimize transport networks and to determine the precise valuation of commercial outlets.

Of particular importance amongst the challenges faced by smart cities is the area of transport and mobility. Tensions inherent to the use of natural resources and the limitations of infrastructure become apparent here. What is more, transport has its own challenges as regards its environmental footprint, its direct impact on everyday well-being, its capacity for

BBVA Innovation Center in Madrid

creating economic growth, its strict requirements for coordination and operability, and lastly, its global nature, which transcends the scale of the cities.

At BBVA we are exploring solutions to some of these transport challenges in order to contribute to the development of more convenient, accessible and sustainable services. An important trend is towards seeking out multi-modal solutions for transport, where the user gains

an improved experience of mobility thanks to the integration of a range of means of transport such as private vehicles, trains, the subway, bicycles and taxis. A vital element guaranteeing the success of these solutions is the transparency of the user experience. And a necessary condition for this transparency is open and multi-modal payment solutions: here is where a financial institution could play a major role within a value chain that continues to offer big opportunities.

Health

The health market is not saturated: the more demand is met, the more it grows because life expectancy is increasing. Nevertheless, the consequences are clear: unlimited demand for a finite service produces an increase in costs and generates tension due to the impossibility of meeting it.

The health care ecosystem is undergoing a profound transformation through a range of health systems in order to guarantee greater access to quality, which is endangering its sustainability over time.

The new paradigm of the healthcare model must be defined to ensure it is more efficient, sustainable and balanced. To this end, a new relational model is required capable of strengthening the patient-doctor union, based on three essential axes: new technological developments, new clinical research, and innovative business models.

BBVA has the opportunity to participate meaningfully in this industry, and by employing its skills, it can provide new solutions to facilitate and promote this new relational model.

Digital entertainment

Technology and social networks have radically changed the way in which people consume content, relate to each other and have fun. "Network leisure" is growing exponentially and it has sparked the appearance of virtual currencies and new payment methods providing backing for the new business models generated by these new consumption habits.

A new trend, which is revolutionising digital marketing, has appeared strongly related to the concept of digital leisure and entertainment we are exploring. "Gamification" takes the mechanics and dynamics of the design and experience of games and applies them in other domains. BBVA is having an impact on these and other aspects in order to apply the new trends to our proposal and relationship model.

Education

As we have discussed above, a World in Balance is only possible if we increase the level of training of the global population. Technology and innovation are key levers for meeting demand and distributing more knowledge to more people without an unsustainable increase in costs. We

at BBVA have spotted major opportunities in this scenario to unify this new offer and manage it properly according to demand, while helping to ensure an increasing number of people can receive training in the areas they require, when and how they want.

An innovation partnership model

We at BBVA understand that only partnership can lead us to a World in Balance. Our corporate responsibility initiatives pursue the creation of partnerships with other institutions such as the UNHCR (the UN Refugee Agency) and the OEI (Organization of Ibero-American States) for primary education initiatives. We work with the World Bank on initiatives for financial inclusion, with the OECD on initiatives for financial education, and with the ONCE Foundation on initiatives for social integration and work for people with disabilities.

This philosophy of partnership lies at the base of our innovation model, a model open to all creative people and institutions with ideas and talent. In fact, we created the BBVA Innovation Centre with the fundamental objective of being close to people and helping them innovate.

BBVA Innovation Centre

The BBVA Innovation Centre is a meeting point and key reference for anyone in the BBVA Group who has ideas and wants to improve things. And of course, its doors are also open to the world outside. It has a wide-ranging agenda of activities and events focused on innovation. Visits by experts, round tables, workshops and meetings add to the chance to get to know first hand some of the group's innovation projects. This is how the centre has become a meeting point to share, listen and learn from others.

The Innovation Centre is a broad concept that is not restricted to a single physical place. We have other spaces in different locations around the world: the US, Mexico and Colombia, where we give local talent access to the knowledge of the expert innovators who work with BBVA. We share our innovation projects and we seek to draw attention to the needs, ideas and talent of the countries where we operate.

The BBVA Innovation Centre is the coordinator behind a large innovation community: experts in innovation and entrepreneurship ecosystems, among others, interact and participate in discussions and activities linked with innovation. Programmes such as BBVA Open Talent and other initiatives supporting entrepreneurship based on technology aim to facilitate the exhibition, visibility and launch of projects, while at the same time keeping BBVA in close contact with ideas and talent.

Other entrepreneurial activities worthy of special mention that receive backing from the BBVA Innovation Centre are the TR 35 awards promoted by the Massachusetts Institute of Technology (MIT) and the EMTECH (Emerging Technologies) event held in countries such as Spain, Colombia, Mexico and Argentina.

Over the years, we have slowly built up a vast worldwide network of innovation, which has enabled us to share information between the best specialist sources of science and technology, experts in different fields and institutes, and companies in different locations around the world.

Right now, the Innovation Network — a network of collaborators — is a highly developed and stable ecosystem, which has expanded around the world and is composed of more than 40 000 scientists, investors, entrepreneurs and some of the best known analysts in the science and technology sectors. The plurality of points of view provided by these experts in different disciplines of knowledge has increased and enriched our capacity to observe different realities.

These areas of knowledge have generated new ideas on how to tackle the following key questions for BBVA from a different perspective: 1) a real, substantive change in the financial industry; 2) a new value proposal for the client; and 3) the identification of new business opportunities beyond conventional models.
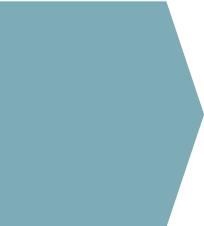
Transforming our client relationship model means making our internal relationship model highly collaborative, based on the sum of each individual's talents. At BBVA we believe in a collective intelligence that emerges when people work together: this is greater than the sum of the individual cognitive skills of each member of the group

Key skills

The 2020 outlook offers us the chance to move beyond the conventional model for our business, acquiring new key skills to transform the business model and to contribute to a scenario of a World in Balance.

We have currently identified disruption areas common to the new economic and social frameworks. Each of these disruption areas requires a group of skills to meet specific needs and to formulate new business models or new sustainable ways of providing people with services.

BBVA aims to lead the transformation of the financial industry — and we are equipping ourselves with the corresponding skills — using the following lines:

• A branch-free banking model, a step along the road towards universal access to banking starting in emerging markets, whilst simultaneously facilitating entry in mature economies with a simple user relationship model and with cost efficiency.

• The development of new value services closer to people, with a single and simple access, using knowledge based on internal and external data sources.

• New payment methods adapted to all social realities, the ubiquity of the digital world and new purchasing styles.

- Banking as a service that allows us to offer part of our value chain to new or existing business models by generating hybrid value models and proposals.

Internal transformation

It is unrealistic to think about changing outwardly if you do not change internally as well: our intention of transforming our client relationship model must involve transforming our internal relationship model into a highly partnership-oriented model, based on the sum of the talents of each individual.

At BBVA we believe in a collective intelligence that emerges when people work together: this is greater than the sum of the individual cognitive skills of each member of the group. We believe the combination of the knowledge held by the group can create a broader and more complete vision than isolated multiple intelligences and skills. That is why we have made a commitment to building a community to share knowledge beyond the traditional methods of teamwork.

The intention behind introducing the partnership environment to the logic of our everyday work is to activate dynamics that transform the administration of knowledge into a route by which it can be shared more effectively: a route that generates commitment, global thought processes, and improvements in skills and experiences from which our clients can benefit.

In addition to facilitating a partnership of internal talent through a new working environment, our focus is necessarily on attracting, training and retaining the best professionals in the Group. In those countries in which BBVA operates, published surveys identify us as one of the best employers. Leadership is not just an aspiration for BBVA; it is a requirement. As a consequence, we invest considerable effort in training leaders who take on board the values we defend and who make a personal commitment to them. Our executive development programmes are the best guarantee of keeping our commitments over the coming years.

CONCLUSIONS

Through drawing up our Vision 2020+, we have learnt a great many things about our world, our potential as an institution, the power of the collective, the need to get involved in change management, as well as the shared challenges humanity faces and how we can tackle them responsibly and ethically. BBVA is an institution with a culture of ethics and solidarity. And the people at BBVA who work for others participate in this culture. Our Vision 2020+ recognizes that we are part of something bigger than ourselves, and our task of working towards a better future for people requires that we make a contribution to walking forwards together towards a World in Balance.

Let's move ahead.

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By analysing the trends and challenges that will shape the future, BBVA's Vision 2020+ identifies three possible futures: a fluctuating world, a world in crisis and a world in balance. We have the knowledge, resources and technology to handle the transformation and if everyone contributes — governments, institutions, companies and civil society — we can overcome the challenges to achieve a world in balance. The article concludes by setting out how BBVA promotes innovation in all areas, and how the bank will take part in building a better future for people.

BIOGRAPHY

Beatriz A. Lara Bartolomé

BBVA

Beatriz Lara is a graduate in physical sciences from the Complutense University of Madrid (1986) and she completed her university studies with management programmes at the IESE (University of Navarre), MIT Sloan and Harvard.

Since she began as a researcher she has acquired skills in the fields of quality, standardisation, development, information technologies, manufacturing industry, deployment of the net, large commercial accounts, business development, marketing, strategy and the creation of new businesses and alliances.

She has created and led multi-disciplinary teams to take on complex international projects. She is considered to be a visionary and entrepreneurial. She has undertaken most of her professional career in a highly innovative and technological sector, performing leadership roles in multinational such as ITT-Nokia, AT&T Network System, Ericsson and Alcatel. She is currently the Corporate Transformation Manager at BBVA. She joined the group in 2006, in the Technology and Operations department, and she held the post of Innovation Manager until September 2012.

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