20

"Green Growth"?

Introduction

In this chapter, I want to give some examples of a few of the many long-term visions for the future of humanity and its societies that are emerging. I choose not to go into those that could be labeled science fiction, nor is it my aim to present a coherent overview of the literature. I will limit myself to visions that are likely either to have or have had scientific or political impact: the Steady-State Economy movement, the Sustainable Development Goals adopted by the United Nations (UN), Farewell to Growth, a more politicized version of the steady-state argument, and two visions on the long-term impact that information and communications technology (ICT) will have on our societies, one theoretical, the other more practical.

In my opinion no one can make realistic assessments of where our world will be in 2050, let alone 2100. What follows are summaries of some current visions, simply meant to indicate some of the issues involved.

Why choose the label green growth for this chapter? What do I understand by this phrase? It is defined by Wikipedia (https://en.wikipedia.org/wiki/Green_growth, consulted June 5, 2019) as a path of economic growth that uses natural resources in a sustainable manner. It is used globally to provide an alternative concept to typical industrial economic growth. A number of national and international institutions have adopted this approach or a closely similar one (e.g., the United Nations Economic and Social Commission for Asia and the Pacific, the Organisation for Economic Co-operation and Development, the World Bank, and the Global Green Growth Institute). Most of these see green growth as a

way forward with respect to the current sustainability predicament, but within the current socioeconomic free market paradigm.

The reasons for my choices are in part theoretical, in part practical. I am convinced that the climate change debate has from the start been formulated by the scientific community in a way that has precluded general acceptance and consensus – as a threat to our societies, rather than as an opportunity for change. Hence it came to be associated with burden sharing, with limits to growth, and thus with regression; with a way back rather than with a way forward (AtKisson 2010).

The concept of green growth was first introduced under pressure from the business community to make the concept of growth compatible with environmental challenges, as growth is essential for profit in the current capitalist system. It has been adopted more widely as a term that emphasizes transformation rather than regression or danger and accepts that growth is necessary to improve the lot of billions of people in the developing world.

As was the case with its predecessors, sustainability and resilience, the term green growth is ill defined. For me, it implies in effect a profound restructuring of global society that will, in the long run, change the roles and ways of each and every one of us as individuals, as well as the design and functioning of our customs, institutions, and laws, much as earlier structural changes in society (sedentism, urbanization, and the Industrial Revolution) did in the now distant past. As part of that, it is expected to substantively reduce the human use of environmental resources, waste production, and the differences in wealth and wellbeing between north and south, as well as between and within individual countries. But it will, if successful, go beyond that and affect many aspects and sectors of our societies worldwide. Of course, it is impossible to envisage how this will play out – but we need to think seriously about the kinds of dynamics that we should set in motion, why, and how. This is what I would like to consider in this chapter by looking, in the first instance, at some of the futures that others in the sustainability business have (or have had) in mind. In presenting these, I also raise a question about whether growth and its cousin progress have a place in the kind of fundamental change that is required to deal with our sustainability conundrum.

Steady-State Economics

To initiate this topic, I want to go back to a groundbreaking book published many years ago. Herman Daly (1973) is one of the earliest to

envisage a world that goes no further down the path of progress and growth. He was of course not the first to mention that human development may ultimately hit limits. Antecedents of Daly's ideas are found in Smith (1776), Malthus (1798), Ricardo (1817), Mill (1848), and Keynes (1930), to mention but a few. Moreover, Daly's book is part of a cluster of works on the same theme that were published at more or less the same time, including Boulding (1966), Georgescu-Roegen (1971), Meadows et al. (1972), Schumacher (1973), and others. But no one has argued the case of a steady-state economics as convincingly (and untechnically) as Daly.

In evaluating his very strong and in some places emotional plea, the reader is reminded that it was written at a time that information, information processing, and complex systems did not yet figure in our arsenal of intellectual tools. His work is therefore entirely based on energy- and matter-related arguments, and does not in any way consider societies as complex systems. His solution of a steady state still characterizes a linear cause-to-effect kind of thinking.

Yet there are still some interesting lessons for us in his analysis. I present them here in the form of a set of questions meant to promote a critical consideration of the fundamental societal choices that are to be faced in an era in which our global environmental footprint (Wackernagel et al. 1998) far exceeds the sustainable.

Daly's critique of the idea of progress and its role in the world is essentially value-based, in the absence of the ideas that are the foundation of this book, concerning information processing as part of the driving feedback loop that pushes our societies to include ever more people, more technology, more wealth, more power, and better health for (part of) the world population. Thus, he grounds his argument in the western value system, stating: "Once we have replaced the basic premise [*sic*] of 'more is better' with 'enough is best',[1] the social and technical problems of moving to a steady state become solvable, perhaps even trivial" (1973, 2). He thus brings the argument back from economics to political and social philosophy, where it started in the nineteenth century with Malthus, Marx, and many others: "Only by returning to its moral and biophysical foundations and shoring them up, will economic thinking be able to avoid a permanent commitment to misplaced concreteness and crackpot rigor."[2]

For Daly, therefore, "the challenge is to develop a political economics that recognizes both ecological and existential scarcity and develops its propositions at a low to intermediate level of abstraction, understandable by the layman or average citizen. . ." That is indeed the kind of narrative

that needs to be, and in part has been, developed to promote the change in mindset that is necessary to achieve sustainability.

Underpinning all this is a particularly critical vision of the role of science and technology in our societies, which is worth thinking about in view of what is happening in the early twenty-first century. He cites a phrase from the 1933 Chicago World's Fair Guidebook: "Science discovers, industry applies, and man adapts himself to, or is molded by, new things ... Individuals, groups, entire races of men fall into step with Science and Industry" (cited in Dubos 1974–1975, 8). In other words, in how far have we, the scientists, contributed to the spiraling out of control of society's relationship with the environment? Whether we see technology as shaped by the economy or the other way around (Arthur 2009), this is certainly worth thinking about. I raised this issue in a related form in Chapter 3 and in the last section of Chapter 18.

To what extent has the free market ideology, with its "invisible hand" inversion of the relative roles of society and the economy (Polanyi 1944; Chapter 18), and the ensuing systemic acceleration of innovation sucked science and technology into its vortex? If this is indeed the case, can society regain control over the runaway dynamics thus triggered? Daly's kind of steady-state economics would channel technical progress in the socially benign directions of small-scale decentralization, increased durability of products, and increased long-term efficiency in the use of scarce resources. It would thus respond (at least in part) to the issue raised in Chapter 12 – that scientists must better understand invention so that they can focus it on the most important needs of society, rather than let it continue to run rampant in every conceivable direction (as has happened so far).

All this also raises another important issue that has not received enough attention: demographics. In principle, this is the part of the information processing–knowledge acquisition–population growth feedback loop driving our present predicament that we could indeed individually control. Yet in the sustainability debate the issue plays the role of the, often invisible, elephant in the room, being avoided in discussions for two reasons: the western ethic about life being sacrosanct (which does not necessarily apply to the same extent in other cultures), and the ample evidence that in the current system it is impossible to achieve economic growth without population growth.

But the latter may be about to change, as a result of automation. If automation and artificial intelligence (AI), as predicted, cause widespread unemployment, the question of demographic growth is reduced to

an (essentially western) ethical issue: the inviolability of human life and the desire to improve health and lengthen individuals' lives. We need to urgently question whether this value set is compatible with the sustainability of our societies, and if so how we will deal with the resultant increase in the global population, which has thus far in many places been accepted in an almost axiomatic way (except in China and India). Daly states:

> Growth of the human household within a finite physical environment is eventually bound to result in both a food crisis and an energy crisis and in increasingly severe problems of resource depletion and pollution [...] Technological adaptation has been the dominant reaction [...] We need, however, to shift the emphasis toward ecological adaptation, that is to accept the natural limits to the size and dominion of the human household. To concentrate on moral growth and qualitative improvement [...] (Daly 1973, 12)

By implication, we should be "back-casting," working from a future in which those environmental and resource limits apply, toward a roadmap that can achieve the necessary changes, rather than taking the present as a starting point and forecasting from there into the future to create our roadmap.

In this process, as the human mind, as well as the coherence of society, require ever more information processing and acquisition of knowledge, we have to turn to the realm of the mind and the spirit for satisfying that need, rather than to the material and energetic realms. We need to enrich, rather than impoverish, the dimensionality of our value systems by developing the mental, normative, and ethical dimensions that have (in part at least) been jettisoned as part of (one-dimensional, wealth-directed) globalization (see Chapters 14 and 16).

Daly thus initiated a movement toward no growth (steady-state) economics. I want to briefly present and discuss some of the core ideas of this movement as I am not sure it offers a realistic solution to our predicament. A compact treatment of the subject, which places it in its historical context, is found on Wikipedia (https://en.wikipedia.org/wiki/Steady-state_economy, consulted April 28, 2017). First, to avoid a frequent misunderstanding, it is worth pointing out that a steady-state economy (or a degrowth economy) is not the same as a stagnant economy. Whereas the latter is an (undesired) regressive phase in a growth economy, the former is a deliberately politically motivated and implemented economy that is geared to the absence of growth. Critics of the steady-state economy usually object to it by arguing that resource decoupling, technological development, and the unrestrained operation

of market mechanisms are fully capable of overcoming any resource scarcity, any rampant pollution, or any overpopulation ever to be encountered. It will be clear to the reader that I do not agree with that thesis unless it encompasses major societal changes, some of which will be discussed in a later section of this chapter. A core driver toward a steady-state economy should be that invention and innovation are, as far as possible by stimuli, by legal means, and a better understanding of the process of invention and innovation itself, directed toward achieving such a goal, while all efforts should be focused on stopping further digging the hole we are in; i.e., slowing down the feedback loop that is responsible for the current acceleration of information processing and its material and environmental consequences. That in turn requires us to review the role of economy and technology as drivers of society and to consider reinventing that relationship by reengineering societal control over the economy. As I mentioned in Chapter 12, our current predicament is due to 250 years of unbridled and undirected invention and innovation, and as Einstein (n.d.) famously said: "We cannot solve our problems with the same thinking we used when we created them."

Proponents of the steady-state economy, on the other hand, argue that these objections remain insubstantial and mistaken – and that the case for a steady-state economy is gaining leverage every day with the power of new technologies and, in particular, ICT. In my opinion, this is not really a better solution as long as we have large proportions of the global population living in abject poverty and lacking even the basic resources that are available to the developed world. Not only is this ethically unacceptable, but it triggers major societal disruptions both within and between nations, of the kind currently manifest in the Near East.

Sustainable Development Goals

One recent attempt to address the current global inequality, while remaining within a safe planetary operating space from an environmental perspective by adopting limited and directed growth, is the UN effort to promote Sustainable Development Goals (SDGs). These goals are – from a political perspective correctly, if from a scientific point of view maybe too sectorally – formulated in terms of seventeen practical challenges to solve in the near future (Figure 19.1). In this section I will briefly present them, and the way in which a major, global project (The World in 2050) is trying to concretize them.[3] My reason for doing this is that the SDG

FIGURE 20.1 The UN's Sustainable Development Goals (open source by permission of the UN)

movement is the most recent global attempt to move in the opposite direction from the steady-state and degrowth economy movements.

The SDGs are defined in a UN resolution that was adopted in 2015, aiming at, in summary, the following (a more extensive description is found in Wikipedia at https://en.wikipedia.org/wiki/Sustainable_Development_Goals, consulted June 6, 2019):

- To end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfill their potential in dignity and equality and in a healthy environment.
- To protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of present and future generations.
- To ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social, and technological progress occurs in harmony with nature.
- To foster peaceful, just, and inclusive societies that are free from fear and violence. There can be no sustainable development without peace and no peace without sustainable development.
- To mobilize the means required to implement this agenda through a revitalized Global Partnership for Sustainable Development, based on a spirit of strengthened global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders, and all people.

The approach reflects Ban Ki-moon's statement that "We don't have [a] plan B because there is no planet B" (https://news.un.org/en/story/2014/09/477962-feature-no-plan-b-climate-action-there-no-planet-b-says-un-chief, consulted June 6, 2019). Though adopted by all the nations represented in the General Assembly of the UN as "Transforming Our World: The 2030 Agenda for Sustainable Development," the approach represents a very specific perspective on the future of Earth and its societies, which is dominated by the idea of progress – the assumption that things will on the whole always tend to become (or should be made) better (whatever that may mean) (https://en.wikipedia.org/wiki/Idea_of_progress, consulted April 14, 2017).

The approach is heavily goal oriented, and attempts to define 168 specific improvements in the seventeen domains, such as: "By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and [. . .] effective learning outcomes." But most importantly, the SDGs seem to adopt at the global level a more or less linear projection into a future based on current trends, focused on achieving a state of "no one left behind" for the whole of the world's population by attaining a modicum of material comfort for all.[4] As such, it clearly goes against the grain of traditional western liberal capitalism, while adopting the western idea of progress.

As it concerns goals for a possibly foreseeable – but certainly not predictable – future, achieving them could easily be derailed, because of the fundamental uncertainties inherent in the long-term projections of the multidimensional dynamics involved, or because of newly emerging scientific, economic, or political issues.

Moreover, we are all aware of the difficulties and limitations of current social science and humanities research on the topic of global change. While there is considerable scientific knowledge concerning the physical dynamics of the Earth's system, there is much less knowledge of the societal dynamics involved, and little insight into the second order dynamics involved in socioenvironmental coevolution. A major effort in this domain is essential, especially if one views the sustainability challenge as a socioenvironmental rather than an environmental one.

Another question is whether, or to what extent, the linear progress approach is one that all communities involved can subscribe to. Clearly, the SDGs have been negotiated between national representatives principally belonging to their countries' elites, who have, to a certain extent, been brought up with the western ideas involved. It is not clear to what degree the populations of the world would ultimately subscribe to these

ideas or be prepared for the effort needed to implement them. Here, again, Polanyi's, Graeber's, and Munck's warnings (Chapter 18) seem relevant; i.e., that the more forcefully one attempts to make large, culturally different, populations converge, the greater the risk that such a trend gives rise to identity challenges and defensive tensions in the societies concerned. Current developments in Europe and the USA seem to point in that direction, not to mention trends in the world of Islam.

I would therefore argue that the top-down approach developed by the UN is an important step forward as it gives researchers, politicians, and others a mandate to search for various paths forward; but that it is also risky. From the complex systems perspective, it would be wiser to develop a wider plurality of futures and trajectories rather than just progress-based ones, taking different contextual developments and different worldviews into account,[5] in different locations, experienced by different societies that think fundamentally differently, have different cultures, different values, and live in different environmental circumstances.

Alongside the very important efforts currently under way to use advanced modeling techniques to try and define a number of trajectories to attain a sustainable SDG future, such as is being undertaken by the World in 2050 project,[6] there are therefore very good reasons to study a much wider set of potential scenarios for our various futures by adopting a complex systems approach and engaging different societies in discussions about which kind of environment and what kind of society they might want to strive for. It would more realistically represent the true nature of the challenge ahead, something that is not fully done justice to in the UN's linear, compromise-driven, approach.

Such an effort could begin by collecting a wide array of narratives about the future of the Earth from different perspectives and different parts of the world. It would improve our understanding of global and regional socioenvironmental dynamics, would yield a number of alternative pathways for the future, including those that will help us achieve the SDGs and others that might offer different futures for our planet and our societies, and would allow a wider global participation in the discussions about the future of our societies; one that is more representative of the cultural diversity of our planet's population.[7]

In summary, contrasting the SDG goals with the arguments of the steady-state and degrowth movements highlights the fact that we are on the one hand urged (top-down) to live within our environmental means, and on the other hand see the need to generate novel kinds of resource use and economic development across the world so that all of the world's

populations may share in basic human comforts. That kind of innovation is inevitably to a large extent local and bottom-up.

The question we are faced with is therefore how we can sail between Scylla and Charybdis, between unsustainable resource use and continued imbalances in development, and at the same time between top-down steering of world development and bottom-up encouragement and development of networks of local communities. In Chapter 19, I mentioned various movements and experiments striving to do just that, which have emerged in recent years. But much more remains to be done.

Toward a Mindset Change

As an example of the more recent degrowth version of Daly's general argument, I will take the work of Serge Latouche. In his book Farewell to Growth (2007), in language that is no less emotional than Daly's but much more political, he emphasizes and treats in more detail what it takes to abandon the unidimensional growth and progress ideology that drives the current world system, and focuses on the mindset change that this requires. His goal is to: "build a society in which we can live better lives whilst working less and consuming less. That is an essential proposition if we are to open up a space for the inventiveness and creativity of the imagination, which has been blocked by economistic, developmentalist and progressive totalitarianism." (2007, 9)

In striving for that goal, Latouche delves deeply into the political economy that is responsible for the current situation. Thus, he clearly distances himself from sustainability and sustainable development:

> Sustainable development has now found the perfect way to square the circle: "clean development mechanisms" [*sic*].[8] The expression refers to technologies that save energy or carbon and that are described as being eco-efficient. This is more verbal diplomacy. The undeniable and desirable advances that have been made in technology do nothing to challenge the suicidal logic of development. This is another way of patching things up so as to avoid having to change them. (2007, 11)

Instead, he builds on the tradition of the social sciences that is exemplified by such scholars as Emile Durkheim, Marcel Mauss, Karl Polanyi, Marshall Sahlins, Erich Fromm, and Gregory Bateson, who maintain that the economy is to serve society instead of the other way around (Chapter 16). As pointed out by Georgescu-Roegen (1971[2014]), in adopting a Newtonian paradigm that ignores the second law of thermodynamics and the

inevitability of entropy, neoclassical economics creates a formally elegant, closed system model that has little relation to a real world economy that is embedded in an open physical, chemical, and biological as well as social world. It can therefore only be realistically dealt with in a complex flow structure approach, as applied here.

The main aim of Latouche's book is thus to exchange the current extraction-to-waste economy for a (novel) economy of opportunity creation, in which innovation is necessity-driven (Chapter 13; van der Leeuw & Zhang 2014).

In the context of the earlier discussion about demography, it is interesting to see that for Latouche a reduction in the population is a lazy solution that is not realistic. It would not in itself transform the dynamic driving our economies, and would thus at best cause a temporary slowdown. In his vision only a profound dematerialization of our hypergrowth-driven developed and developing societies will have the desired effect, and the main issue is then how the reduced quantities of resources are to be spread across the world. He tends here toward the kind of distribution economy also proffered by Arthur (Chapter 18).

The desired restructuring of our societies, Latouche argues (2007, 33), can be synthesized into a virtuous circle of eight Rs: reevaluate, reconceptualize, restructure, redistribute, relocalize, reduce, reuse, and recycle. These eight interdependent goals, he argues, can together trigger a process of degrowth that will be serene, convivial, and sustainable. It is of necessity a local, bottom-up process that aims for a renewed focus on community, equity, sobriety, taking less and giving more, and using local resources:

> The pleasure of leisure and the ethos of play should replace the obsession with work. The importance of social life should take precedence over endless consumerism, the local over the global, autonomy over heteronomy, an appreciation of good craftsmanship over productivist efficiency, the rational over the material, and so on. A concern for truth, a sense of justice, responsibility, respect for democracy, the celebration of differences, the duty of solidarity and the life of the mind: these are the values we must win back at all cost, as it is those values that will allow us to flourish and to safeguard our future. (Latouche 2007, 34)

In invoking the need to move in this direction, he clearly converges with many moral philosophers (such as John Dewey, see Stanford Encyclopedia of Philosophy (https://plato.stanford.edu/entries/dewey-political/, consulted July 27, 2017), environmentalists such as Gilles Clément (Clément et al. 2007; Clément 2015), and a very large number of Christian

ecologists for whom the eleventh commandment is "Respect nature because it is God's creation."

I do not have the space here to go into the eight processes that Latouche argues for in detail. Among them, he sees a strategic role for reevaluation, reduction, and relocalization. The process to achieve these is a bottom-up one, in which local ecological democracies are created that satisfy needs for identity and control over everyday life. Though he does not cite her, his ideas are in this respect very close to Ostrom's (1990). One of the interesting things in his work is that he refers to many ongoing local initiatives that are effectively moving in this direction, striving for environmental and economic autonomy (including but not limited to renewable energy, locally valid vouchers instead of national currencies, and organic, small-scale agriculture), focusing on the management of local and regional common-pool resources that, importantly, involve active citizen participation in the governance process.

A detailed discussion of the way this approach might play out in the global south is included, and here Latouche emphasizes that local communities should not be forced or seduced to adopt northern ideas, but helped (or left alone) to define their own futures and develop ways to attain them.

For me, an important contribution here is that this would enlarge our global value space and thereby open new ways for harmonious and appreciative interaction between multidimensional communities. The Development Research Centre (DRC – of the State Council of the People's Republic of China) project in ShiShou in China in which ASU is participating (Chapter 18) is an interesting example, where a local community is being given support to develop from a preindustrial agricultural community to a postindustrial one without transitioning through an industrial stage, and along lines the community itself defines. As part of the project, the community is revived and begins attracting back some of the inhabitants who earlier went to the city.

In contrasting this approach with the SDG initiative discussed in the last section, the difference is not so much in the ultimate goal, a better life and a better local or regional balance between resources and consumption, but in the other dimension of our trip between Scylla and Charybdis – top-down versus bottom-up. The bottom-up choice represented here allows for many more, and very different, ways forward. It enhances the dimensionality of our human experience and favors diversity. And after all, isn't it from the bottom up that humanity has created all forms of durable societal organization, including hierarchies?

Pluri-Polarity

In this context Elinor Ostrom (1990) tackles the problem of finding the most appropriate form of governance to achieve long-term stability. Having undertaken numerous case studies, both in the USA and in many parts of the developing world (Asia and Africa) with a very wide network of excellent scholars, Ostrom comes to the conclusion (1990) that (1) relatively small communities are demonstrably able to find effective long-term solutions to managing their complex environments, and in particular what she calls their "common pool resources"(1990, xiii) such as water, vegetation, herds of animals, but also knowledge and other such resources as are essentially the basis for the maintenance of society; and that (2) above a certain size of community, governance becomes less effective, more subject to various kinds of endogenous vulnerabilities, and in general less stable. She therefore makes the case for a multipolar world in which relatively small-scale societies govern themselves and their environments, in interaction with each other.

From the perspective that has been presented in this book, her work has several noteworthy aspects. The first of these is expressed in Chapter 10, where I try to show the interaction between institutions and individuals: at times individuals undermine institutions, while at other times individuals create novel institutions to deal with issues at hand. The difference between Ostrom's work and mine is that I have been able to look at a much longer period, so that both the successes and the failures of small-scale governance that Ostrom mentions might be interpreted as due to a second order dynamic that accounts both for phases of institutional continuity and for variation and change in the system.

Another element in Ostrom's work that resonates with me is the importance of system size in relation to governance. In an era in which much effort is spent on working toward top-down global governance, I believe that this is an unattainable goal that may seriously threaten the effectiveness of governance. Part of my argument is based on the fact that any optimization of resource use necessarily requires intimate knowledge of the detailed spatial and resource structure of the environment. The modern tendency to mechanize and optimally rely on economies of scale, whatever its merits are, is based on a statistical approach to the environment that ignores considerable relevant detail and can thus never achieve optimal results. And in the domain of societal governance, I would argue that governance systems organize themselves to manage a certain number of potentially discordant sources of information, as we saw in Chapter 11.

Instead of top-down global governance, strengthening global bottom-up awareness and cultural commitment to sustainability may therefore be a better means to achieve our goals.

Possible Future Roles for ICT

As the reader of this chapter will be aware, neither the steady-state and degrowth movements nor the SDGs explicitly take into account a number of potentially very important ongoing dynamics that are related to the rapid pace of the ICT revolution. Might ICT be able eventually to help us set a course between Scylla and Charybdis? In the next few pages, I present two visions of the impact of the ICT revolution on our societies that illustrate some of the issues concerned.

One of the many protagonists of the "ICT society" is Helbing. In his publications, he adopts the point of view that the ICT revolution will lead to a society that will largely depend for its information processing on distributed networks of computers. In Helbing (2015), he first renders plausible the assumption that within the next twenty to thirty years AI based on "big data" and sophisticated machine learning will make it technically possible that most of human behavior will be impacted, if not steered, by electronic information processing. In doing so, he echoes the work of many others, such as Kurzweill (2005) and Brynjolfsson & McAfee (2011), as well as the authors of the two reports published by the White House (Executive Office of the President of the United States 2016a, 2016b) on the advances of AI (Chapter 19).

Helbing then poses that this evolution could proceed either toward top-down control of society by computers (the Hobbes model), or bottom-up free-market development (the Smith model) of a self-organizing society that relies on computing for its information processing. The core question to ask is how will the technological capabilities be used. The central issue in responding to this question is that of the coordination capacity of our systems – by increasing central information processing capability (following the Hobbes model) into a Leviathan (a true, huge and unmanageable top-down organization), our social and life support systems may well become hypercoherent, and therefore increasingly unstable, whereas reducing the centrality of information processing (in the sense of the Smith model) we may find that insufficient coordination creates dysfunctionalities such as climate change or tragedies of the commons, and cannot be relied upon either.

With this dilemma in mind, Helbing first discusses the top-down approach, beginning with a well-documented and rather detailed summary of steps that have already been achieved in collecting and using big data centrally by major corporations such as Google, Facebook, the US Central Intelligence Agency and National Security Administration and others such as the World Health Organization, but also a large number of startups that are beginning to crowd this domain. This summary convinced me that, in principle, it is now possible to know so much (5,000+ attributes of every individual in the USA) about every person on Earth that it would – given enough data storage and treatment capacity – be possible to create various ways to monitor, understand, and to some extent predict and influence certain aspects of the behavior of large numbers of individual people. As this trend is accelerating, and the behavioral models involved improve owing to machine learning based on studying very large datasets, certain individuals and institutions are tempted to infer that it will be possible for a central authority (a wise king or benevolent dictator) to know, regulate, and control social life, and thus socioenvironmental dynamics, globally, creating what Helbing has called the Leviathan approach of top-down regulation.

Helbing then proceeds to argue very effectively why this might be advantageous; for example, if it were possible to avoid major events such as the financial crisis, or improve the efficiency of a wide range of processes. But societal predictions – the basis for such management – would immediately lead to social reactions once they became known. Such reflexivity would make judiciously acting on them extremely difficult, and could all too easily lead to a form of totalitarian technocracy (a Big Brother society) in which the predictive policing that is currently being used in combating crime would be extended. In the process, the fundamental assumption that people are innocent until proven guilty would be abandoned in favor of the opposite.

Alternatively, systematic use could be made of nudging our decisions in certain directions, as is currently done through inserting appropriate advertisements into our cellphones or computers, or even through subliminal messaging. The current worries about foreign interference in elections in Europe and the USA reflect this train of thought. As discussed in Chapter 19, this process is enabled by the blurring of the boundary between noise and signal that is inherent in the ICT revolution, and the resulting fuzziness makes it very difficult to come to clear decisions.

But Helbing concludes – for a number of theoretical as well as practical reasons – that this approach can never achieve its intended goal.

A fundamental barrier to "managing" society is the difficulty of distinguishing good and bad solutions. As we saw in Chapter 10, all solutions ultimately lead to unanticipated problems, and thus to ontological uncertainty. Another challenge is the margin of error in the statistical analyses that leads to decisions.[9] The same challenge would be faced by the use of inappropriate models to separate positive from negative courses of action, which would distort the actual risks involved in certain decisions.

A final and convincing limitation is in my opinion the fact that complex systems such as the ones we are dealing with cannot, as Helbing says, "be driven like a bus" (Helbing & Lämmer 2008, 7). One can never expect to have all the information needed to make the correct decision. As the past to an extent determines both the present and the future, in order to make the right decision, one would need to know the past in detail – an impossibility that seriously limits our decision-making in systems that are subject to the butterfly effect or to some Rayleigh-Bénard effect that structures subsets of society in unpredictable ways.

But over and beyond that, the variability inherent in the behavior of social systems is so great, and their algorithmic complexity so huge, that

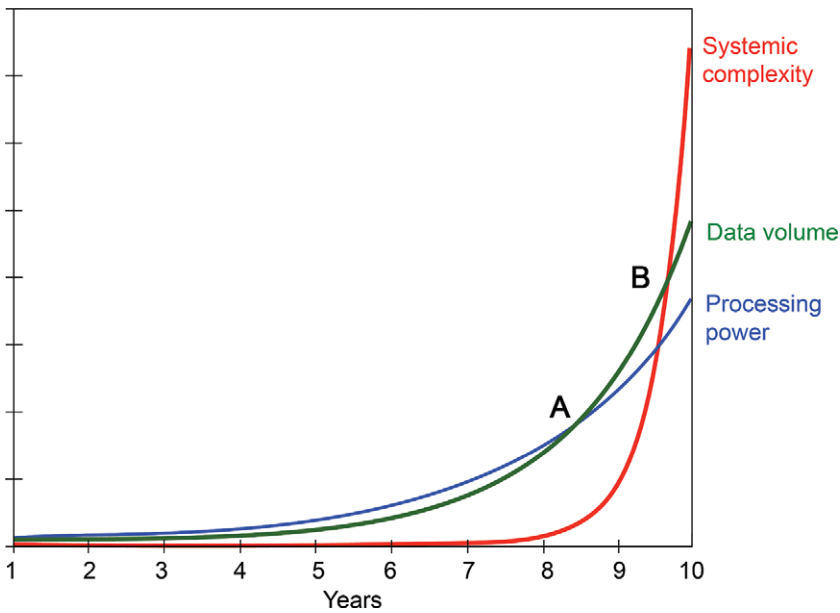

FIGURE 20.2 Relationship between the increase in processing power, data volume, and systemic complexity. (Source: Helbing et al. 2017, Permission Springer)

the computing power needed to deal with the behavior of social systems will always be insufficient.

The reason is that both the data volume generated by our societies and the (combined) system complexity (owing to human intervention in the system, see Chapter 15) are increasing at rates far in excess of the increase in processing power that follows Moore's law (Figure 19.2). Even with the increase in information processing that it predicts, unintended, unknowable consequences would therefore still overwhelm the system.

Helbing therefore argues that instead of a top-down, centrally managed society, a bottom-up, self-organizing society can be developed based on a combination of big data, the Internet of Things, and AI, which will transform the economy, and through it, society.[10]

How would that work? A fundamental change in approach is a necessary part of this process, from a focus on entities and system components to a focus on relations and interactions.[11] Another difference is that rather than force or nudge a system in an a priori determined direction, it would use the fact that forces within a system structure it very efficiently (but in ways not predictable a priori). The resultant dynamic structures tend to be more stable, he argues, than structures shaped from the outside. Our research would thus have to focus primarily on identifying the forces operating dynamically in a system, and on how change is driven by the system itself. And rather than adapt the system to desirable outcomes, we would have to shape desirability around the outcomes of the inherent dynamics. Helbing's core thesis in this respect is that one can, however, let different outcomes emerge by slightly changing the interactions between components (in what he calls "assisted self-organization"). Contrary to the Hobbes approach, these interventions would be local and minimal (involving distributed control). In these circumstances, Helbing argues, such systems would not be totally unpredictable, as they would tend toward a limited number of dynamic attractors, and in many instances would return to them after a disruption. Though formulated in the context of a future under the impact of the ICT revolution, these characteristics are of course inherent in any bottom-up structuring of our future societies.

What is the role of ICT in this context? One would have to be able to identify composite patterns made up of elementary entities by not focusing on improving the condition of individual entities as we commonly do, but on obtaining system-wide benefits. And that would, in Helbing's world, be enabled by the Internet of Things, direct communication between the objects that determine such an important part of our human

behavior, allowing them to make their own decisions unimpeded by human beings and to take many dimensions into account that humans cannot at any time relate interactively because of the limitations of their short-term working memory (Chapter 8).

A very interesting conclusion of his dynamic (traffic) modeling studies is that optimization of local collective benefits does not seem to lead to large-scale coordination when the interactions between the system's components are strong. This restates the thesis of Granovetter (1973) that weak ties are more important in structuring a system than strong ones. And that conclusion in turn reinforces the multicentric approach to societal regulation proposed by Ostrom and her students that I discussed in the last section (Ostrom 1990; Ostrom et al. 1994), while at the same time pointing to the instability of hypercoherent systems, and reinforcing the arguments of Polanyi and others (Chapter 18) that reducing the dimensionality of community values too strongly generates strong social instabilities.

This general approach raises the very interesting, and hotly debated, question of humans' tendency to often collectively balance the advantages of the individual and those of the group in favor of the latter. I do not want to enter that debate, but I do want to point out a couple of interesting things about it.

First, it turns out in the simulations that Helbing presents that random interactions in an open space or network, between (1) people favoring cooperation, (2) people avoiding cooperation ("free riders"), (3) people sanctioning the avoiders, and (4) people not sanctioning the avoiders, results rather easily in a tragedy of the commons (individual behavior undermining the collective good), but within a confined space or cluster in a social network, the opposite happens and the common good prevails.

Another interesting result is that when it is possible for individuals to move around between different networks, this leads to cooperative clusters that emerge during the spatial organization of the population, because the behavior of individuals is determined by the behavior in the individuals' surroundings. Thus, when people can move around freely, this promotes cooperation when the individuals can be integrated effectively in groups.

Clearly, these are results of a number of modeling exercises, and as such have yet to be scrutinized and should for the moment be taken as hypotheses. But it is interesting to associate these results with those mentioned in Chapter 11 concerning the emergence of social networks as a function of percolation theory. Together, they seem to indicate that

there are limits to the extent of cooperation that can be achieved as a network grows in size.

Based on these results, as well as those of Elinor Ostrom about the management of common pool resources (Ostrom et al. 1994), Helbing comes to the conclusion that bottom-up coordination of self-organizing societies is indeed possible, and (in his eyes) preferable to top-down controlling of such societies, but that when the groups become too large, and interact with too many random participants, there comes a tipping point where cooperation in the group decreases.

In the remainder of his book, Helbing outlines a number of properties and developments that would enhance the stability and scope of such bottom-up cooperative systems. I mentioned those that are in my opinion the most relevant in Chapter 18, based on my own vision rather than Helbing's. Here, these concern me less than the general conclusion that bottom-up-based self-organizing systems can more realistically integrate ICT-based tools than top-down-based control systems. For our purposes, this means – I cannot repeat this enough – that to achieve some kind of resilient future for our societies we must actively promote bottom-up approaches to gain a more balanced development than is currently under way top-down, driven by the large ICT companies.

The New World: How Might the ICT Revolution Impact on Society?

In 2016 the director of MIT's Media Lab (Ito) and one of his colleagues (Howe) published what is to my knowledge the first inside story, written for non-technical people like myself, of the fundamental cognitive, intellectual, societal, and practical changes the ICT revolution is currently driving and imposing (Ito & Howe 2016). Clearly, this is done from a perspective that the ICT revolution is unstoppable and that its progress will transform the world. I have argued in Chapter 19 that that is an assumption that in theory need not be either true or positive for our societies. But for the moment their assumption is certainly interesting, and I have therefore decided to end this part of the book with a critical examination of their perspective, following the nine different fields of tension that they expose.

Emergence and Authority

I argued in Chapter 6 that we need to complement an a posteriori, linear perspective on the past and the origins of the present with an a priori one

that is focused on the emergence of the present in a multidimensional space. Ito and Howe take this as a starting point of their argument, but add an important element to it: the fact that the linear perspective is anchored in a hierarchical worldview that is, in turn, deeply anchored in our Judeo-Christian tradition: we are supposed to lead a life that is designed and prescribed by a religious authority or, in its modern form, anchored in ethics ultimately derived from that authority. The newly developing approach they are writing about, anchored in – or at least strongly favored by – the ICT revolution, will enable the opinions of the many to complement, and possibly overcome, those of the few that have until now set the ways in which our societies were evolving. From a world driven by the information processing of the few, we are crossing a tipping point and moving into a world of collective information processing that will be able to deal with much larger information loads than our societies have managed thus far. By implication, the transition that is currently going on is seen as a consequence of the fact that our means of collective information processing are inadequate for the rapid rise in the global population of the last half-century. If this development continues, Ito and Howe argue, one can expect humanity to develop into one (or several?) meta-organism(s), which represents a further step in the percolation approach I described in Chapter 11.

Ito and Howe (2016, 37) call this new form of collective information processing "emergent democracy," and expect that it will ultimately replace what we currently call our (representative) democracies. In Chapter 18 I signaled the beginnings of this process: the traditional role of political parties (and representation) is no longer needed in the context of politicians reaching out directly to their electorates. It is based on the fact that no individual or small group has ever been able to fully impose a particular kind of behavior or decision-making by controlling the information that is available to others in a society. In the current information-processing regime this is even less true than it has ever been before. Rather, in such an "emergent democracy" (or maybe better a "democracy of emergence") the behavior of the collective emerges from the interactions of all its members.

Individuals' "power over" is replaced by the collective "power to" of the society as a whole (see Foucault 1983). Such emergent systems presume that every individual within a group possesses unique intelligence that would benefit the group.

In the process of bundling that collective intelligence, a much wider value space and innovation space are opened up. Ito and Howe present

the contrast between the *Encyclopedia Britannica* and Wikipedia as a good example of this kind of transition, which is also widely documented in many biological systems. Such information-processing tools as Wikipedia are enabled by the huge reduction in the cost of innovation processing achieved by (almost completely) separating information from its energetic and material substrates.

Pull and Push

Part of our hierarchical (authoritarian) approach to governance and (more widely) instantiation of ideas is the fact that ideas are "pushed down" from the top of a hierarchy to the level where they hit the real world. In Whiplash (2016, chapter 2, 61–81), the authors argue for the importance of "pull"; that is, allowing ideas to emerge from the bottom to the top. On this theme, they substantially draw on the work of John Seely Brown et al. (2012), but give the example of the way in which a worldwide network of people with different skills responded to the Fukushima earthquake much faster and more efficiently than either the business world (in the form of TEPCO, the company responsible for much of the disaster) or the Japanese government.

The essence of this idea derives directly from the last one: the wider world has more ideas than any organization, and mobilizing these ideas is therefore a more effective way of reacting to events than the traditional, hierarchical approach or any other organized one. It is more flexible, demands less investment, can respond to a much wider range of events, and, above all, is not limited to anticipated events and responses, but adapts to the real needs of the moment. It mobilizes resources just in time, only for the time necessary, and relinquishes them as they are no longer needed. I argued (in Chapter 16) that under the impact of the Industrial Revolution and its reduction in the cost of energy our current society has hugely accelerated invention and innovation, and, in the process, also increased the speed with which markets are able to create and meet the need for any innovation. The complex dynamic driving these developments has created our current resource-to-waste societies and the sustainability conundrum. Returning, as Ito and Howe argue, to need-based innovation would in my opinion be a major step forward toward global sustainability.

Another aspect of this change in approach concerns motivation. Although our current western system strongly attaches motivation to financial reward, this is certainly not the only motivation that counts for

many people. Much of what has happened in the Internet-based Open Source movement, including Wikipedia, Twitter, and Bitcoin, as well as in the non-governmental organization movement, is based on the fact that people are in search of a personal identity that is satisfied by performance, or in a wider sense making a contribution to a collective goal. In that context, bundling the efforts of many people into a collective achievement, as proposed by "pull over push," is a very strong driver of innovation. This is also demonstrated by the recent emergence of both crowd-funding and crowd-sourcing as major movements strengthening what is happening in cyberspace in terms of innovation. The authors of *Whiplash* conclude:

> As the cost of innovation continues to fall, entire communities that have been sidelined by those in power will be able to organize themselves and become active participants in society and government. The culture of emergent innovation will allow everyone to feel a sense of both ownership and responsibility to each other and to the rest of the world, which will empower them to create more lasting change than the authorities who write policy and the law. (Ito & Howe 2016,71)

And in that process, as Granovetter (1973) mentioned, one's acquaintances often end up playing a more important role than one's friends. But to enable that to happen, one needs to combine creating a network with many such weak ties, and a vision that is reactive to the kinds of occasions that can put such a network to good use.

Compasses and Maps

Innovation is fundamentally open ended and ontologically uncertain. One never knows what the result will be of the emergence of the new, as that engages in a dynamic with novel attractors and new dimensions of perception and action. Hence, Ito and Howe argue that a precise roadmap is less valuable than a compass that shows one the direction in which one can move, but does not fix the path or the endpoint of an innovative trajectory. In their terms:

> A map implies a detailed knowledge of the terrain, and the existence of a [known] optimum route; the compass is a far more flexible tool and requires the user to employ creativity and autonomy in discovering his or her own path. The decision to forfeit the map in favor of the compass recognizes that in an increasingly unpredictable world moving ever more quickly, a detailed map may lead you deep into the woods at unnecessarily high cost. (Ito & Howe 2016, 89)

In business, as in academia, this distinction is commonly discussed as that between a vision and a plan. A vision is a long-term general idea of where

one would like one's effort to lead, whereas a plan is a fixed way of achieving a particular goal. Both have their uses, but when the goal is emergence of novelty and the means is bundling the ideas of many to deal with an uncertain future, the vision is more useful in guiding the effort than the plan because it directly reflects values, which provide a better, more profound, and more flexible compass than the plan.

One can also express this as the distinction between exploration and exploitation. It is essential that a system or a group of people has both capabilities. But at present, in our society, the core is essentially focused on exploitation (even as, in the oil industry, this includes major exploratory efforts that are directed toward creating the possibility to continue exploiting the same resource). Academia, government, and business are essentially (and increasingly) focused on finding new ways to exploit known resources, techniques, values, and knowledge. This is one of the implications of the "closure of our value space," which I mentioned extensively in Chapter 16. It is only in the margins of our societies that true exploration takes place, such as occurs at the Media Lab of MIT, in corporations such as Google for example, and increasingly in many, many small startups. In that context, it is relevant to look at the arts as a major domain of experiment and innovation.

We saw in Chapter 6 that to think about the future we must enhance the number of dimensions we consider. Rather than start reasoning from a fixed end-point (ex post), we should start reasoning ex ante, with the arrow of time and focused on the emergence of novelty.

To imagine the simultaneous interaction between several dimensions is difficult in an oral or written (linear) mode but is much easier by means of images or other forms of art. Therefore, I think art is essential to help scientists develop this kind of emergence perspective.

Moreover, as scientists we have been notoriously bad at communicating our ideas to the nonscientific world. Sustainability science has for thirty years been predicting doomsday, but little collective action has been taken. I think that this is in part because we did not engage the wider public. As scientists we were talking at people, rather than interacting with people. It is now urgent to promote a change of general mindset that can avert disaster. To do so, we need to have a message that is easy to understand. In some cases, this can be a narrative that appeals to underlying values, but in other cases, this is better done with art.

As a consequence of "freeing the animal spirits" (Keynes 1936, 161–162) in the way Ito and Howe propose, our societies would greatly enhance the dimensionality of their value space and thereby enable

themselves to change direction in a constructive, environment-conscious way. Without such an increase in dimensionality, that seems impossible because the path dependency of our current system has created a situation of hypercoherence that makes it very difficult to conceive of changing its current direction.

And this brings me back to a point that I raise a number of times in this book: the need to drastically change our education systems by emphasizing learning over teaching. For professional educators, that also includes learning to listen rather than to talk, respecting the opinions of students (and the wider population), rather than imposing their own ideas, etc. To begin with, it also means allowing, or even creating, diversity of opinions in class, and reinforcing the idea that there are always alternatives and different ways to achieve a vision.

One of the core ideas Ito and Howe develop is that computers allow humans to deal with much more complicated ideas and models than the human mind can, whether individually or collectively. That capability further enhances the dimensionality of our societies' value spaces and the range of tools for thought and action that our societies can develop. Rather than functioning as tools that execute human instructions according to a map, computers can become interactive partners with humans in developing new ways forward with the help of a compass. In that light, one can see the (huge) impact of a program such as Scratch, "which, rather than teaching young children to code, leads them to code in order to learn" (Siegel 2016, quoted in Ito & Howe 2016, 106).

Risk and Safety

I argued in Chapter 12 that our current societies have a tendency to assume stability and study or bring about change. Rather than adopt this approach as the only perspective (following Aristotle), I argue that we should complement it with the Heraclitan approach that change is omnipresent in nature, and stability is (temporarily) imposed by human beings. In effect, both approaches are necessary to understand the complex regulatory dynamics that are responsible for all socioenvironmental interaction, as such interactions generally follow a punctuated equilibrium dynamic.

Risk and risk perception play a crucial role in such a shift. Following Atlan (1992), I have attributed the risk-adverse tendency in our societies to limitations of our human cognitive system, which biases human information processing toward underdetermination of ideas by observations

and their overdetermination by past experience. Ito and Howe argue that the ICT revolution is changing that. They argue (2016, 116) that different risk calculations are at the root of favoring a perception assuming stability or one assuming change, and that the ICT revolution has changed the risk calculus in our society. Their argument runs like this. With a high cost to bring a novel product to market, for example because a large integrated company has to be geared to making the product, it makes sense to favor safety over risk and thus move more cautiously. But with the huge decrease in the cost of innovation that is triggered by the ICT revolution, it makes more sense not to do so, but to outsource the production by quickly assembling an effective supply chain, and thus beat the competition on speed. Hence the ICT revolution favors rapid change, taking risks, and using or developing very light and often temporary organizations.

Clearly, any risk is dependent on the material and social investment made, as well as on the uncertainty involved, so if the investment is small the risk is too. The greater the investment in a cognitive, social, and/or material structure, the greater the risk taken, and the stronger the tendency toward conservatism. If, on the other hand, the investment is small, so is the risk, and it is easy to favor risk-taking and change. An important implication is that rather than see change as a challenge, we are inverting our perception, accepting change as the norm. Indeed, we are living in a period characterized by rapidly increasing volumes of available information and unbridled, accelerating change. This favors creating an intellectual and organizational climate that allows people to overcome the inertia involved in a relationship between information and knowledge that is underdetermined by observation and overdetermined by routines that were successful in the past. That climate is the most important asset of the Media Lab of MIT.

I accept Ito and Howe's argument about the risk calculus, but I still maintain that for the moment at least – pending huge steps forward in dealing with the big data revolution – Atlan's argument is valid for human societies at large, and that there is thus a long-term bias toward continuing on existing trajectories. That raises a question about whether our societies will at some point need to slow down again, as argued by Daly and others. If so, we would have to deal with stability rather than change as the challenge, finding ways to favor it and to slow down the current, ICT-driven acceleration. In today's neoliberal capitalist system that seems far-fetched, but then the historian in me says "We've seen more drastic changes in history."

Disobedience and Compliance

Ito and Howe begin chapter 5 of their book (2016) with a reference to Kuhn's *Structure of Scientific Revolutions* (1962), and argue with him that fundamental changes in approach (so-called paradigm changes) are due to people not following the rules of their community, whether these are scientific, civil, cultural, or legal. They illustrate this extensively with examples from their domains: business, industry, and research. The ICT revolution has currently indeed put an emphasis on innovation and disruption, and on creating a climate of not following the rules. But interestingly, fifteen years later Kuhn published a volume called *The Essential Tension* (1977), in which, in the form of several essays, he emphasized the complementarity of disobedience and compliance. Neither can exist without the other. There are times when disobedience is fundamental for a society and others when compliance is. The Resilience Alliance's lemniscate (Chapter 5) symbolizes this by pointing to the fact that as the information and energy flows reach a point where they cannot further expand in a socioenvironmental structure, a phase occurs in which the system falls apart into component, much smaller, elements that begin experimenting with different organizational forms. Elsewhere I have linked the transition between an expansive and a fragmenting phase in the resilience cycle to the explosion of unintended consequences that is the result of the system's earlier decisions (Chapter 15). But whichever explanation one favors, over time socioenvironmental systems tend to (re)structure after a phase of exploration and fragmentation and, for a while at least, tend toward stability (see Monod 1971). I presented the history of the Western Netherlands in this light in Chapter 10. Thus, while I agree with Ito and Howe that we currently experience a transition in which disobedience is particularly valued, from the long-term perspective that is mine as an archaeologist and historian, unless the ICT revolution fundamentally changes that pattern I would expect that over time our societies will again find ways to deal with the overwhelming amount of new data and new ways to process information that they are currently encountering, and thus shape a new information-processing structure that is stable for some time. What that will look like is anyone's guess, but it will probably involve a closer integration between human and electronic information processing.

That being said, I agree that at this point in our trajectories, to free up the "animal spirits" is fundamental. Our current education systems in developed as well as many developing countries – apart from exceptions

such as Dalton or Montessori that favor learning over teaching – are probably the most important institutional barrier to doing so. In the domain of education, from start to finish – that is from kindergarten to, and including, adult education – we need to make better use of the many other ways of learning that abound in the world. A massive effort is needed to bring human information processing in tune with its electronic counterpart. From their earliest years, our children are brought together in groups with two purposes that are at right angles to each other: socialization and development of learning. Teachers mostly vector these two goals by socializing the children around a set of externally derived values ("truths") that reduce the natural diversity of their thought, favoring conformity above creativity. Once children enter primary schools, tests and exams continue that process of alignment, which is suitable when one lives in a period of relative stability but which is not adapted to the contemporary ICT revolution. Later in life, career structures in most places in developed countries effectively maintain the pressure to conform.

To transform this situation, one should emphasize that in any situation there are always alternatives, and to stimulate learners to explore and compare those before making decisions. Informal learning as it occurs everywhere in the world is a major asset to achieve this, and this is insufficiently recognized by formal educational institutions.[12] A much closer link between formal and informal learning would quickly enrich the experience of millions all over the world, both among those who are now subject to mainly formal education and for those who have had no such training, but have educated themselves in real life. The current KLASICA project (https://klasica.org/about-us/) is an important effort in that direction.

Practice and Theory

Chapter 6 of Ito and Howe (2016) is essentially an argument in favor of learning by doing, rather than learning through theory, by reading or otherwise. "Putting practice over theory means recognizing that in a faster future, in which change has become a new constant, there is often a higher cost to waiting and planning than there is to doing and then improvising" (Ito & Howe 2016,158). Of course, that enhances the chance of failures, but rather than consider them as such one tends nowadays to see failures as learning opportunities, removing the opprobrium that failing used to have and replacing it by learning or experimenting, which both have positive connotations.

This chapter of Ito and Howe (2016) echoes a number of the assumptions I have outlined elsewhere in this book. Referring to Chapter 12, it implies an emphasis on the high-dimensional polyinterpretability of phenomena and things against the reduced dimensionality of theories.

Even at best, learning in theory only relates the mind to a subset of the dimensions of reality, and is thus less effective in gaining insight into the complex patterns of relationships that make up reality.

Their chapter also relates to the section in Chapter 17 that deals with the progressive distancing from the real world that is driven by our media and computer games and, finally, it relates to the core of the cognitive dynamic that drives socioenvironmental coevolution in which reality and practice never completely project onto knowledge, so that knowledge is enhanced by its interaction with practice (Chapter 9).

One very important aspect of learning by doing that I have not emphasized before is that it trains the mind to see relational patterns that place the subject one is learning about in a wider context. Rather than create clarity by excluding all but a small number of observed dimensions of phenomena as "noise" – as happens often in the development of scientific theories – learning by doing trains us to first of all observe the multidimensional patterns of relationships among phenomena as they are manifest in the real world, and then to proceed to build our understanding upon those observations instead of isolating entities in our observations and our thinking as we do in our western scientific approaches. Training the capability to see things as complex relational patterns is precious in the context of the dynamics needed to cope with the ICT revolution. It is that relational perspective that naturally leads us to develop the multidimensional "pull over push" attitude that Ito and Howe emphasize, as well as the emphases on diversity over ability, resilience over strength, and systems over objects that are the subjects of the next paragraphs.

Diversity and Ability

Much of our social structure in science, business, and other domains is currently based on an assessment of people's ability. We give Nobel (and other) prizes to people because they innovated, but we attach to those prizes the label that these people are the most intelligent, the best performers, people able to deal successfully with the most difficult topics, etc. Remuneration is based on ability, and so is social recognition. Hence, the role of individuals is emphasized in many domains in our society – whether in business or in the arts or in academia.

In their chapter 7, Ito and Howe (2016) propose a very different approach. They argue that whatever a person's ideas or capabilities are, in large measure they are determined by the network in which he or she functions.

The difficulty of maintaining secrecy in the Internet society has prompted a debate on the validity of assigning intellectual property rights to individuals or teams without taking into account that the interactions of those people or teams with others, over long periods of time, have contributed to their achievements. According to Ito and Howe, once one adopts a relational perspective, emphasizing teamwork and the contribution of everyone's actions and ideas in the network in which people are functioning, as well as spreading information for collective benefit rather than hoarding information for private benefit, the diversity of the participants in an effort becomes more important than the ability of individuals. This is a direct implication of the fact that the network approach inherently emphasizes a highly multidimensional approach to thinking and acting, which is essential for communities to function well. The basis of this approach is that every individual develops his or her own distinctive ways of thinking, and that bringing these together (bottom-up) is a more effective way to guarantee success than relying on a small number of selected individuals, even if they are considered to have particular abilities. In the ICT community, this approach has led to the successful implementation of crowd-sourcing, for example in scientific domains such as microbiology (see the FoldIt experiment to request participation of the gaming community in solving a challenge that was escaping the scientists and their computers), and in crowd-funding, where many startups now prefer to gather their first funds by soliciting small contributions from numerous participants, rather than depending on venture capitalists and becoming beholden to one or a few individuals or companies.

The ICT revolution has opened the possibility that many individuals can contribute to, and also share in, the results of, collective efforts based on their individual capabilities and wishes. It has proven itself to be a powerful tool to harness ideas, but also to spread wealth rather than allow it to accumulate in the possession of a few individuals. In my opinion this is therefore a very interesting potential antidote to the reduction of our value space to a single lowest common denominator (wealth), which we have identified as the corollary of globalization. It rewards people's identity, stimulates their interest and creativity, and thus adds very different rewards to participation than mere wealth, while maintaining people's independence. It would in all probability also reduce the

wealth gap that is hanging over our global societies. It is an excellent example of Granovetter's (1973) theory about the importance of weak ties. As a result, "the best way to match talent to tasks [. . .] is not to assign the fanciest degrees to the toughest jobs, but rather to observe the behavior of thousands of people and identify those who show the greatest aptitude for the cognitive skills that the task requires" (Ito & How 2016, 179).

Resilience and Strength

Chapter 8 of Ito and Howe (2016) argues that opening up the value space of communities is exactly what contributes to their coherence and resilience – the higher the dimensionality of the value space, the wider the range of potential ways to absorb any negative impact on a society and then rebound. Building strong organizations was a very effective way to ensure survival in a relatively stable system, but in the current very rapidly changing system flexibility is a more effective survival strategy. That has been facilitated, argue Ito and Howe, by the important reduction in the outlay required for change that is the result of the ICT revolution, so that rapid changes, even if they entail a loss, can be overcome rather than sinking the enterprise.

This argument clearly resonates closely with the one they present in their chapter 4, risk over safety, but it allows me to draw attention to another aspect of the shift in attitudes that is triggered by the ICT revolution: a shift from building on an a posteriori perspective in dealing with the future of a company, thus striving toward continuity, toward developing a number of potential a priori perspectives by generating multiple future projects (of which a substantive number are sure to fail, but some might succeed). In the process, feedforward (anticipation) and out-of-the-box thinking are given more important roles alongside the omnipresent idea of feedback, and as a result the way is open for change. I placed the importance of this shift in perspective in Chapter 6.

Systems and Objects

Under this heading, Ito and Howe (2016, chapter 9, 214–231) return from a different angle to the distinction between the focused, subject- and entity-directed perspective versus the context- and relation-based perspective that was one of their earlier topics, stressing the importance of gaining from the outset a high-dimensional grasp of complex real life

patterns, rather than (as the western empirical tradition does) decomposing that complexity into simpler subsets, and then hoping that the understanding thus gained provides an insight into the overall complex phenomenon.

Here it is not the perspective itself that is discussed, but its consequences. The authors draw attention to some of the issues involved in trying to solve what they call intractable problems – which others have called hairy or wicked problems – where it seems necessary to discover all the building blocks in a complex system (Chapter 2). Very important "is the subtle but incredibly important distinction between inter-disciplinary and anti-disciplinary approaches [. . .] that requires the reconstruction of the sciences entirely, the creation of new disciplines or pioneering an approach that eschews disciplines altogether" (Ito & Howe 2016, 219). The fundamental trait of such an approach is that it does away with objects of study – that it studies phenomena *in vivo*, focuses on processes rather than products, uses a high-dimensional conceptualization that goes against the reductionist trend of western science, and focuses on the systems studied as part of larger systems.

Ito and Howe illustrate this with the example of designing appropriate street lighting in Detroit, emphasizing that any innovation is bound to change the system in which it is embedded (Ito & Howe 2016, 225), and that therefore we should shift from design to codesign to ensure that any innovation is compatible with the socioenvironmental system of which it is to be part.

Conclusion

In this chapter, selecting specific works of earlier scholars, I have tried to make the argument for the need of a different approach to our common future and to outline various authors' ideas about how to achieve that. The main purpose of the first part of the chapter was to raise the kinds of questions we have to take into account in making decisions about the way forward. My main personal conclusions are that:

a. It is not realistic to expect that we could achieve a zero-growth or degrowth dynamic in the short term. The only way to come to that point would be to slowly but surely redirect our present (and thus our longer-term future) toward green growth – growth of a completely different kind: dematerialized and based on a fundamental change in the structure of our value space.

b. It seems that efforts to further globalize the scale of our economies and/or our governance structure (for example by using ICT) will increasingly butt up against identity and other issues that are related to the difficulty of maintaining for large groups the combination of high-dimensional value systems and the frequency of communication that is necessary for the creation and maintenance of flourishing, highly resilient communities. A tendency toward polycentrism is the result. The top of our governance levels are likely to lose control over many dimensions in favor of lower levels. In the European Union this has been going on under the label of subsidiarity. It is also likely to occur in the USA, with a shift away from federal to state authority, while China will continue to operate a semi-decentralized structure with high autonomy for its regions. This devolution of power might ultimately make (large) cities the most cohesive governance units.
c. Nobody can predict with any certainty how the coevolution of ICT and our societies will evolve and will affect their sustainability. Major transformations in both are a certainty. But one thing becomes clear: there is an important potential for the ICT revolution to help us deal with some of the major issues involved, but that will minimally require (1) gaining more insight in the societal dynamics involved, (2) exercising political and technical control over the ICT development, (3) improving the integration between human and electronic information processing, and (4) undertaking the complete restructuring of our education systems and their curricula, including universities and research organizations, to promote undisciplinarity. That is where some of these developments must, and can, begin.
d. Last but not least, it is the responsibility of the current crop of sustainability scientists to finally acknowledge that our sustainability conundrum is not an environmental one, but a societal one (see Dyer 2009). Social scientists should take the lead in this, and reconceptualize the current approach to sustainability issues accordingly, looking not only at greenhouse gases, but taking the whole of the socio-environmental system dynamics and their coevolution into account.

NOTES

1 Alan AtKisson drew my attention to the fact that, interestingly, Swedish society's values in the industrial era were partly built around this concept: the phrase "lagom är bäst," which can be roughly translated as "sufficient is best." The concept of lagom is relatively unique to Swedish society, and

means "the optimal amount," a balance point between too much and too little.

2 Crackpot rigor exemplified by: "The behavior of a peasant selling a cow was analyzed in terms of the calculus of variations and Lagrangian multipliers" (Daly 1973, 3).

3 The World in 2050 is a project currently undertaken by an important part of the scientific modeling community involved in GEC research, coordinated by the International Institute for Applied Systems Analysis near Vienna in Austria, the Stockholm Resilience Center, and the Earth Institute of Columbia University. For an up-to-date perspective on its efforts see Sachs et al. (2018).

4 Hence the ire of conservatives in the USA, that "sustainability" is an attempt by the UN to uniformize life across the globe. This, however, is an incorrect interpretation, as the implementation of the SDG program leaves ample leeway for different societies to realize their goals in their own way.

5 I can see the logic of focusing on one single future from a political point of view – mobilizing all forces to achieve that. But to my mind the risks of failure owing to societal dynamics are so important that trying to identify different trajectories toward similar goals, which can be implemented depending on different social, cultural, historical, or local circumstances is preferable.

6 See www.iiasa.ac.at/web/home/research/twi/TWI2050_Report_web-071718.pdf. For transparency's sake, I am part of the team, placing its effort in a wider context in chapter 2 of the report, for which I was coordinating author.

7 Such exercises were done in the run-up to Rio+20 in 2012, at a relatively large scale globally. As an anthropologist, I cannot help but wonder whether these have actually been able to reach down below the practical into the fundamental thought patterns of the populations concerned.

8 Latouche here generalizes a term that was originally a strictly technical one related to UN-mediated purchasing of carbon offsets under the Kyoto protocol.

9 Helbing here refers to decisions of "type I and type II." Type I concerns false alarms, and type II the absence of an alarm when one would have been needed. Even very small errors (0.0001 percent) would have major effects with the large numbers of people involved. There is a dilemma here. The populations are too large to be supported by current resources and technology, but innovation is leading to lethal unintended consequences. I don't see how a reduction in population is escapable.

10 In this, Helbing follows the line of argument that places the economy in control of society, contrary to the position adopted in this book, which holds that society should control the economy.

11 Interestingly enough, although he does not seem to be aware of this, this is moving us closer to the Oriental approach to cognition that focuses on cognizing patterns, rather than entities, as is dominant in the West.

12 One of my early teachers, Jan Kalsbeek, a professional potter at the University of Leiden in the Netherlands, essentially saw formal schooling as an attempt to make children unlearn things they naturally and intuitively knew and practiced. I think there is indeed some truth in that.