THE SELF-ORGANIZING SOCIETY[1] (Version 0.4) –

Taking the future in our hands

by Dirk Helbing

I conclude that Big Data, while potentially powerful and useful, is not a universal solution. I also explain why the concept of super-governments ruling their citizens or of companies steering their customers in a top down way will not work on the long run. To master the growing complexity as we network our world, as cultural evolution progresses, and as economic markets differentiate, we need a more decentralized approach. The "Internet of Things" will empower self-organizing systems that create socio-economic order and functionalities of many kinds in a bottom-up way. This approach can solve the problem of over-regulation, benefit from diversity, and promote innovation, collective intelligence, societal resilience, and individual happiness.

The world is changing at an ever-increasing pace. This has called for new approaches to support decision-making. In the past, whenever a problem had to be solved, the best thing was to ask some experts. These would go to the library, collect up-to-date knowledge, and supervise PhD students helping to

[1] Dear Reader,

thank you for your interest in this chapter, which is thought to stimulate debate.

What you are seeing here is work in progress, a chapter of a book on the emerging Digital Society I am currently writing. My plan was to elaborate and polish this further, before I share this with anybody else. However, I often feel that it is more important to share my thoughts with the public now than trying to perfect the book first while keeping my analysis and insights for myself in times requiring new ideas.

So, please apologize if this does not look 100% ready. Updates will follow. Your critical thoughts and constructive feedback are very welcome. You can reach me via dhelbing@ethz.ch or @dirkhelbing at twitter.

I hope these materials can serve as a stepping stone towards mastering the challenges ahead of us and towards developing an open and participatory information infrastructure for the Digital Society of the 21st century that would enable everyone to take better informed decisions and more effective actions.

I believe that our society is heading towards a tipping point, and that this creates the opportunity for a better future. But it will take many of us to work it out. Let's do this together!

Thank you very much, I wish you an enjoyable reading,

Dirk Helbing

PS: Special thanks go to the FuturICT community.

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fill existing knowledge gaps. But this is a slow process. In the meantime, whenever people have a question, they ask *Google* or consult *Wikipedia*, for example. This might not always give the correct or best answer in the world, but it delivers quick answers when we are interested in them, and on average the so resulting decisions might be better than the decision we took in the past. It is, therefore, no wonder that politics and business are increasingly excited about the Big Data approach. This has even fueled the dream that, finally, there will be a universal approach to answer all the questions one might have and to take the best possible decisions for the world. Why should one, then, still ask experts or the citizens, if there are intelligent machines that can figure things out and are more comfortable to handle? One would just have to collect as much data as possible and evaluate them with powerful machine learning algorithms. In fact, if things were as simple as this, I would perhaps consider to agree with a "wise king" ruling the world, using a Big Data approach, but I have some serious reservations about this approach.[2]

Top-down control will fail

Of course, I recognize that there are many hierarchically (top-down) organized systems in our world, and therefore I don't question that they can be useful at times, depending on the respective circumstances. For example, elementary particles form atoms, atoms form chemical compounds, these form solid bodies, and together they may form a planet, which is part of a planetary system, and a galaxy.

Biological cells create organs, and together they may form a human body. Humans again may organize themselves in groups, cities or organizations, and nations. However, the stability of such hierarchies is based on two important principles: the forces are strongest on the bottom, and the changes

[2] I would perhaps start to believe in this approach, if the Silicon Valley, and the area 100 kilometers around it, was a perfect world for all the people living there, but it's far from this. There is a lot of light, but a lot of shadow, too.

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are slowest on the top. But this is not anymore true in today's societies, where laws are probably made more quickly than companies and people can adapt. On the long run, this is likely to cause a systemic instability. While it is known that delayed adaptation can destabilize a system, we are also trying to push many of our problems into the future (e.g. public debts, implications of demographic change, nuclear waste, climate change). This creates a concrete danger for our society to get out of control, and therefore we need a new approach – one that generates a resilient, more crisis-proof society.

Wouldn't new information systems allow one to rule the world more successfully? Yes, to various extents, depending on the approach. In order to run a country or company well over a long time, close-to-optimal decision-making is needed. The question is, how to take such decisions: top down, bottom up, or by combining both? In previous chapters I have shown that, for a number of reasons, a supercomputer to optimize the world in real-time, a Crystal Ball to predict the future, and a Magic Wand to manipulate it will not work perfectly enough. Trying to create such technologies is dangerous. An information and communication system aiming to collect all data in the world may certainly produce a powerful tool. Nevertheless, we should better not build it, as we don't know how to use it well, and it's unlikely we ever will.

Big Data analytics comes with a number of problems such as over-fitting, spurious correlations, and classification errors. But as a powerful information system will have large-scale systemic impacts, a single mistake can be highly destructive or even endanger humanity. Just imagine the power of such information and communication systems to get into the hands of a misguided group of individuals or a criminal organization. This could easily turn our societies into evil regimes. Hence, wise and caring political leaders as well as companies should better abstain from trying to build an all-knowing and almighty information system. The more powerful information systems are the more safety measures are needed to protect companies and people from potentially resulting harm. This calls for a suitable combination of encryption,

decentralization, transparency, participation, reputation systems, community moderation mechanisms, and legal protection.

Surprisingly, however, not even a decision-maker with the very best intentions and all the data and technology in the world could take optimal decisions. Although computational power grows exponentially in time, the complexity of our world is growing even faster. Therefore, no single person, company or institution will ever be able to optimize our quickly changing world in real-time.

Supercomputers cannot even perfectly optimize the traffic lights of a big city in real time. This is because the required computational effort explodes with the size and complexity of the system. Possibilities for optimal real-time top-down control will even decrease, as man-made systems become increasingly complex, such that the relative lack of computational power grows with time. Despite this, we have so far attempted to "control complexity" in a top-down way by thousands of laws and enforcement institutions. While this approach has served us well for a long time, it is eventually coming to its limits. The top-down approach has produced over-regulation and high debts, while many problems haven't been solved. In fact, we seem to have more problems than ever.

Time for a new approach

Due to many instances of misuse, attempts to collect huge masses of data have undermined the trust of people in a conventional Big Data approach. But the digital revolution does not mean that we must loose human rights, free decisions, dignity, and democracy. There are better ways to create social order and socio-economic well-being with future information systems than by massive data collection of sensitive personal data and surveillance of all kinds, from speed control to Internet control and, one day, perhaps even thought

control.[3] As I have pointed out, diversity and independent decision-making are important preconditions for collective intelligence, which is needed to turn the complexity of the world into our advantage. The consideration of multiple perspectives is key to master our future in an increasingly complex society.

We should, therefore, build our society on a trustful, symbiotic relationship with the citizens, customers, and users. The goal should be a society of well-educated and responsible people that is based on the principles of respect, "live and let live," and participatory social, economic, and political opportunities for everyone.

Locality as success principle of the universe

As Albert Einstein (1879-1955) pointed out, "we cannot solve our problems with the same kind of thinking that created them." Fortunately, an alternative, superior approach exists. A distributed, information-based management of complex dynamical systems is more efficient than classical top-down control. It is based local real-time interactions (where "locality" is not necessarily restricted to "real space").

In our universe, locality is an important success principle. Most physical forces are extremely short-range. Locality is also a crucial principle underlying many self-organization processes in socio-economic systems. It is, for example, a precondition for niches that support diversity and innovation. As we have seen in a previous chapter, local interactions promote the evolution of cooperation and social preferences, too. One might even say that the most interesting socio-economic phenomena are based on co-evolutionary processes that happen on the meso-level (i.e. on an intermediate scale between the individual system component and the entire system).

[3] "Brain hacking" has recently become a scientific field.

So, we should better use the success principle of locality for us. But what implications does it have for the future management of our complex world? We need to pursue an approach based on distributed control and self-organization. Self-organization may be seen as another word for the “invisible hand” phenomenon. But it doesn't automatically produce good outcomes. Phenomena such as phantom traffic jams, crowd disasters, financial crashes, or "tragedies of the commons" show this well. However, these phenomena are now well understood – there are mathematical models or computer simulations reproducing them. And these tell us that it’s often possible to avoid negative outcomes of self-organization: by changing the institutional settings or interaction mechanisms, or just by operating the system in a different parameter regime (e.g. at lower density).

How societies will be "ruled" in the future

Unfortunately, in the past, humans have been pretty bad at specifying suitable interaction rules, and they haven’t even found good ways to formalize them. This problem has so far been standing in the way of self-organization and decentralized approaches. However, the main point to be considered is that every actor, be it a company or an individual or another entity, should have to pay a fair compensation for the externalities produced (be they harmful emissions, toxic waste, noise, or other things that affect others or the environment in a negative way). Social Information Technologies can help to do this. Even where the invisible hand used to fail in the past, we can often make it work in the future, by considering the externalities. Three hundred years after the inception of the "invisible hand," the enabling technologies for this are just becoming available!

In fact, the sensor networks establishing the "Internet of Things," will for the first time in human history enable us to realize Adam Smith's (1723-1790)

brilliant vision of self-organizing systems. This creates an entirely new opportunity to make our increasingly complex world manageable again in a way that is compatible with the complexity of our world. But we need a paradigm shift in the way we think about our world and the way we govern it!

Using the sensor networks of the "Internet of Things," we will soon be able to perform real-time measurements of the data we need, and it is often not necessary to store them. The collection of as much data as possible, which is at the core of today's Big Data approach, is therefore replaced by a tailored measurement approach. Such real-time measurements (without long-term data storage) are sufficient to enable the real-time feedback required for self-organizing systems. As I have underlined before, one can anyway not process all the data currently stored and storing more data does not necessarily mean better results, so why should we keep such data in the first place?

However, to fully unleash the power of information for self-organizing systems, we will have to go beyond the brute-force machine learning approach currently applied to Big Data. Namely, we must learn to combine knowledge from the computer, complexity and social sciences. So far, this combination of knowledge and skill sets has often been lacking. The Silicon Valley is too technology-driven, while the social sciences tend to underutilize technology. Finally, the potential of complexity science for real-world applications is just being discovered...

Waking up from the Big Data dream

It is surprising to hear that decentralized approaches should be able to outcompete centralized ones. How is this possible? Couldn't we emulate a decentralized system, i.e. operate a centralized system like a decentralized one? This seems plausible, but it would certainly be more expensive. Moreover, it's not obvious what kinds of data are relevant, and which ones

obfuscate the truth. In contrast to what the Big Data thinking often suggests, less data can sometimes be better. For example, I discussed earlier that it is possible to predict epidemic spreading with a model-based empirical approach better than *Google Flu Trends* can do it with Big Data. This is, because too much data produces problems like "over-fitting" or "spurious correlations." In other words, one might get results that are not relevant (such as random patterns). These would be misleading, producing bad decisions.

Furthermore, a centralized approach often ignores local knowledge, because it's usually not possible to centrally process all local information. Processing power and data transmission rates are still limiting factors, and they will always be. Such local knowledge, however, allows decentralized "bottom-up" approaches to perform well.

In other words, the Big Data dream, which promises governments and some companies knowledge of everything and power by knowledge, turns out to be a dangerous illusion. Big Data is far from being a universal tool to fix the world. The Big Data approach was not even able to fix the problems of the Silicon Valley. It is, therefore, also time to wake up from this dream and to say goodbye to the flawed Big Data approach of mass surveillance, too. The terrible terror attacks in Boston and Paris have shown that surveillance can't guarantee 100 percent security. It is also known that extremism and crime are often results of lacking socio-economic participation, integration, and respect.[4]

Therefore, control is not a good substitute for trust – "trusting" is "not knowing." Whoever has power must pay attention to avoid anything that could violate widely accepted moral, cultural or legal values, as this can seriously undermine legitimacy and trust. In fact, mass surveillance has considerably undermined people's trust already. For example, two thirds of Germans are afraid that their personal data are misused by companies and public authorities.[5] More than fifty percent of all Germans even feel threatened by the Internet. On the long run, this can substantially weaken the credibility of

[4] Social networks and cultural norms can be very effective in creating social order and resilience.
[5] see http://www.spiegel.de/netzwelt/web/umfrage-deutsche-misstrauen-dem-staat-beim-online-datenschutz-a-973522.html

companies and governments. This might even produce a legitimacy crisis and a loss of power.

Note that the power reached by weapons and other coercive means tends to be destructive and often counter-productive: it undermines the self-organized social order that is based on the local norms and cultures. Therefore, power based on force tends to cause trouble and is usually not stable for long. Constructive power, in contrast, requires the willingness of people to follow their leaders. It is based on a trustful, symbiotic relationship, in which all involved parties, including the citizens, benefit. We, therefore, need suitable institutions that help us to find and maintain a proper balance between different stakeholder interests and support the self-organization of our society and economy (see Information Box 1).

The secrets of self-organization

At times, self-organization seems to be almost magic. So, how does it work? It's mainly based on mutual adaptation processes. These might be imagined similarly to the way the universe works as a result of physical forces. However, it's hidden socio-economic forces that govern the structure, dynamics, and function of our society (and these may change over time as a result of innovations). These forces relate to the interaction rules in the system, and further mechanisms serve to reach a compliance with these rules. For example, social norms – the rules behind our everyday lives – are maintained by "peer punishment" of those who deviate from them.

Complementary, money is an important reward mechanism, but not the only one (social reward mechanisms can be even more effective). The weakness of today's money is that it is one-dimensional, while it takes several control parameters and, therefore, a multi-dimensional reward or exchange system to

manage complex systems in the future. I have shown that nature, in fact, has created humans in a way that makes us responsive to many different rewards. Interestingly, the virtual world now offers new possibilities to create incentive mechanisms: ratings, reputation systems, and gaming scores are good examples.

Finally, for self-organization to work well, one must find and apply suitable sets of rules. But how to determine these rules? Top down or bottom up? Over time, top-down regulation has produced the problem of over-regulation, and it also promotes inequality.[6] The approach of self-organization, in contrast, doesn't have this problem, and it has the further advantage that it creates options rather than compromises (see Information Box 2). It enables local rule sets in favor of socio-economic diversity, innovation, happiness, and systemic resilience. The approach is similar to niches in nature. However, favorable self-organization requires the ability to find and implement suitable sets of rules, which is not trivial at all.

Fortunately, there are recently some new tools, which can help us to identify suitable institutional settings and interaction rules that support the self-organization of desired functionality. For example, we can do experiments more easily. In fact, we may vary and test new rule sets in advance – either with computer simulations or in interactive multi-player online worlds, or both. Compared to today's policy-making, this implies several important differences: 1. computer simulations and Interactive Virtual Worlds can be used as a "policy wind tunnel" to explore the implications of rule sets in advance; 2. no new rules should be implemented without prior testing; 3. alternative sets of rules can be continuously generated and tested.

Moreover, considering the importance of diversity for innovation, societal resilience, economic well-being, and the happiness of people, one should not implement a single rule set homogeneously all over the world. The self-

[6] The issue is that each new rule implies adaptation costs, but these are very diverse. Some have lower-than-average adaptation costs, and these are the beneficiaries of the new rule. In case of many rules, there are only a few players that happen to benefit most of the time, while others have relative disadvantages. As a consequence, introducing many rules implies a large degree of inequality.

organizing society should be rather imagined as a set of co-existing, but interacting self-organizing systems governed by their own rule sets. Social Information Technologies would then help us to master this diversity and benefit from it – by making different rule sets understandable and mutually compatible. Altogether, this can create a rich "socio-economic ecosystem," allowing for new ideas and niche markets. I expect that the underlying principle to “live and let live” would also be able to reduce conflict and extremism, which result when minorities are not provided with enough opportunities to personally and culturally unfold and express themselves.

Where may the digital revolution take us?

It's important to understand that the digital revolution requires us to see the world with different eyes, as entirely new principles will apply. The future world is not well characterized by political categories such as "left" or "right." It will have its own logic, and moving "forward" is the best way of describing it. Even though the digital era will be different and it hasn't been here before, one can already see it coming. One can analyze the new trends underlying the digital revolution, and draw conclusions by studying the transformative "forces" at work.

It is entirely possible that we will go through a phase based on a super-government approach driven by Big Data. However, my conclusion is that future societies will eventually build on advanced self-organization approaches, enabled by "Internet of Things" technologies operated in a decentralized way. This will happen, because such systems are potentially more effective and efficient, promoting innovation, flexibility, adaptiveness, and resilience, in short: they are superior. Self-organization is enabled by real-time information and feedbacks, and it unleashes the potential of local

expertise and collective intelligence, based on coordinated bottom-up engagement.

The best of all worlds

One might say that self-organization as described before combines the best elements of democracies and market systems, and establishes a synergy between economic and social needs. The approach is well compatible with human rights and constitutional principles, and it has nothing to do with anarchism. I absolutely recognize the importance of socio-economic order for prosperity and well-being. Self-organization in the sense I am using it does not mean that we can just choose the rules that please us. We must rather find suitable rules that serve a certain functionality or purpose. Such rules typically require us to consider the externalities of our decisions and actions, and to compensate others for negative externalities.

The self-organization approach is also very different from communism or socialism. First, it implies as little top-down planning and control as possible. And second, it builds primarily on enabling individuals to help themselves and to cooperate more successfully rather than on attempts to reach equality by redistributing wealth. The self-organization approach is based on self-determined decisions, but within an information-based framework that promotes collective intelligence and better decisions by everyone. It builds on awareness to promote responsible, other-regarding behavior.

Suitable reputation and merit-based mechanisms are powerful principles to support cooperation, responsibility, and better socio-economic outcomes in a globalized world. If properly implemented, the future self-organizing world will be more effective and efficient than our current system. Today, top-down regulation still struggles with bottom-up self-organization, thereby causing frictional losses, conflicts, and high costs. In fact, I believe we will not much longer be able to come up for the expensive institutions needed for our current,

over-regulated system. Most industrialized countries have reached historical heights in public debt levels in the order of 100 or 200 percent of their annual productivity, or more. Nobody knows how we should ever be able to pay for this – and for even more regulation.

Understanding and following the principles described in this book allows us to unleash the innovative potential of our society, to exploit the new opportunities of the digital age to come, and to better manage the 21st century challenges ahead of us, such as global financial and economic crises, global epidemic spreading, global conflict, globally organized crime, or global environmental and climate change. The Economy 4.0 will come with more creative work, personalized products, a spirit of sharing, and a collaborative information ecosystem that will overcome some scarcities of the past. Who could afford not to pursue this approach?

In the next decades, I expect the emergence of a Digital Society superior to what we currently have in most places of the world. In the previous chapter, I have given examples showing that a Participatory Market Society is already on its way (the "sharing economy" and the quickly growing "makers community," for example, reflect this well). The Participatory Market Society will build on the new opportunities that information and communication systems provide to us. To get a better idea of how this society might approximately look like, it is useful to discuss the Swiss system, which comes closest to my imagination of how the Participatory Market Society might work.

As we know, the Swiss system works pretty well. Some of the remarkable particularities and success principles of Switzerland are: it is federally organized; it is built on great science and good education; it is based on basic democracy, where people can vote on substantial matters (including not to increase holidays or not to reduce taxes, as the voters have surprisingly decided!); it's a society that allows several languages and cultures to coexist; it is based on a consensus-oriented and, therefore, other-regarding decision-making tradition; it has a rotating presidency to avoid accumulation of too

much power in the hands of one person or party; it has a well-maintained public infrastructure and a fantastic public transportation system; and it has a low debt level compared to other industrialized countries. In a sense, I expect that this system will be further improved, by generalizing it to economic activities, by using new opportunities offered by information and communication systems, and by exploring even better mechanisms to create collective intelligence.

Finally, note that the self-organization approach is conservative in the sense that it builds on proven and tested success principles of our societies and on core cultural and ethical values (see also Information Box 3). By promoting other-regarding behaviors through the consideration of externalities, it helps us to create more sustainable systems, to preserve our environment, and to make our society more resilient. This is reached by enabling our society to better adapt to our changing reality, i.e. to technological change, environmental change, demographic change, etc. But what if we prefer our society to stay as it is? Can we preserve our current society, or get back to how it was before? I wish we could: many of us had a good time in the past! But this is a very romantic dream, and a very dangerous one, because we can't stop our economy and our societies from progressing. And we couldn't really want to stop its progress, because we would miss out the new opportunities that some other countries would surely use to gain competitive advantages. Why would we want to fall back behind others, if we could be leading this development?

Cities as agents of change

Developing the above thoughts further, what does it mean for the governance of our increasingly complex world that we need to engage more into distributed, bottom-up approaches? It suggests that, besides trying to find

global solutions through institutions like the United Nations, we would have to build complementary institutions based on local entities, namely cities and regions. In fact, for many years, we haven't been able to negotiate binding global agreements to reduce climate change, and it has also been impossible to solve a number of other problems. Maybe, a bottom-up approach could be more effective at times?

In fact, more than 50 percent of all people in the world are now living in cities, and the fraction is steadily growing. Cities are the places were the problems occur, and where the solutions are created. They are the places where pollution and crime happens, and where innovations and goods are produced. Cities are also the places that are most threatened by disasters. Thus, our efforts to increase societal resilience need to focus on them.

It is, therefore, worth listening to what the previous chief city planner of New York City, Alex Andros Washburn, has to say in his book on the Nature of Urban Design. Interestingly, there is no master plan for New York City, the leading metropolis of the 20th century. Instead, there is a steady little-by-little adaptation to the needs of the respective neighborhoods. Washburn underlines how important it was that he was able to influence everything, while he controlled nothing. In the first place, urban change requires listening, he says, and he adds that public space is where you build public trust, by bringing all sorts of people together. To make the city more resilient and simultaneously meet quantitative, qualitative, and natural needs, top-down and bottom-up processes must intimately play together, pretty much as I have discussed it in the previous chapter. The same can be said about the "virtual cities" in the Internet, i.e. the communities that have formed in the digital world. To create trust, transparency is important there, too.

City Olympics to improve the world

Going a step further, I believe that digital communities and cities can be important agents of global change. It will be the competition and collaboration among cities, which can bring us forward in our attempts to solve the 21st century challenges. If we manage to find ways to make our cities smarter, this will make our planet smarter. In this way, acting locally will cause a global change to the better. For example, I have recently proposed that we might come up with something like “City Olympics” to address global problems such as climate change (see https://www.youtube.com/watch?v=TaRghSuzBYM).

Calls to counter climate change are often seen by companies and citizens as opposing our preferred ways of life, and that is why they find so little support. However, doing something for our climate could be fun and rewarding, if we would run climate-oriented City Olympics every few years. These would be events with a sportive spirit, where cities all over the world engage in a friendly competition for the best science, technology, and architecture to counter climate change. They would also compete for the greatest citizen engagement (in terms of environmental-friendly mobility, investments into renewable energy technology, better thermal insulation, and more). These events could be presented by the public media in pretty exciting ways. Furthermore, after each Climate Olympics, there would be a cooperative phase, where the best ideas, technologies and urban governance concepts would be exchanged among the participating cities, thereby allowing them to make faster progress. Which city, which country will have reached its climate goals first? Let's be ambitious! While we may dislike regulations that tell us what to do, we love competitions, and we love winners!

In a similar way could we address other global challenges. This would just change the kinds of disciplines in which cities would compete. It also seems natural that cities form global networks with other cities struggling with similar problems. Exchanging knowledge, ideas, technology and experts, or supporting each other when disasters strike will reward such global networks of cities that are glued together by similar challenges and interests. Why

shouldn't we have an alliance of cities that takes the lead in supporting better, climate-friendly technologies? Just suppose cities next to raising ocean lines, such as New York City, Singapore, London, Hamburg, Sydney, and a few others would start this together. Wouldn't that create first mover advantages, which would soon let others follow?

Just a thought: regions rather than nations?

Note that the principle "think global, act local" can be implemented not only by creating global collaboration networks of cities. It might also be good to have governance structures building on regions. In many cases, global negotiations between nation states don't lead to agreements within a reasonable amount of time. This is often because they are acting selfishly on their own behalf, sometimes equipped with veto powers. So, what if, besides top-down political decision-making institutions we would build bottom-up decision-making institutions such as a council of regions? This might often find solutions that are better adjusted to local needs and would provide more space for local cultures and diversity. We might even have top-down and bottom-up approaches working towards the same goals in parallel, finally implementing the first or best solution found. Such competition would be good!

To have a strong legitimacy, regional representatives should be elected directly by the people in each region, and to avoid political casts, every grown-up citizen should be an electable candidate, independently of whether he or she belongs to a political party or not. Moreover, it would promote integration if every citizen above a minimum age living in a region would have the right to vote there, no matter whether born in that region or an immigrant. Remember that lack of participation is one of the most important factors causing conflicts.

To solve problems that have trans-regional relevance, the corresponding

regional parliaments could send representatives for a limited time into trans-regional and global councils established to address specific problems. After all, these representatives would know best how to serve the needs of the people they are representing. To ensure flexibility and avoid accumulation of power and corruption, the global representatives of the regional parliaments could rotate every few months, or have a mandate for certain subjects only, or both.

How to master our future: some actionable proposals

In the past years, I have been talking to a lot of people, and many of them expect that there are major changes ahead of us. There are many signs of a destabilization of our world, and global conflict or war might be the result, because the powers that have dominated the 20th century are struggling to keep their influence. But if we want to manage a smooth transition into a better future, we must innovate not only what we are doing, but also how we are doing it, and how we think about the world. In particular, we need to learn an interaction- and system-oriented thinking.

People expect that governments act on their behalf, but this doesn't mean that governments should increasingly interfere with their lives and try to micro-manage them. In fact, citizens are calling for more opportunities to take decisions that concern themselves. New opportunities for this are just emerging: information and communication systems increasingly allow for a participatory decision-making and coordination of activities.

Now, given that we will probably face a major change in the way our economy and society are organized, how can we get there smoothly, from where we are today? Below, I will make some actionable proposals to start with.

1. **Improve systemic resilience.** Most global or large-scale networks – and networks of networks even more – are prone to highly damaging cascade effects. To protect ourselves from the vulnerability of our

critical infrastructures and their essential functionalities, modular design principles, as they are established in management science, are very important. To get there, we must do at least two things: First, we need to make sure to build in "shock absorbers" or "engineered breaking points," which can effectively stop cascades by decoupling different parts of the network. Note, however, that the specific design of shock absorbers and engineered breaking points strongly depends on the particular kind of system. Therefore, an interdisciplinary solution approach is needed. Whenever diverse perspectives on a problem exist, the collaboration between different stakeholders is needed, typically involving independent representatives from politics, business, science, and the citizens. It would, therefore, be useful if, besides professional politicians, independent qualified citizens would be represented in the respective decision-making bodies as well (usually for a specific task and for a short time period).

2. **Reduce laws and regulations such that it supports diversity and its many positive side effects.** I have shown that diversity is the basis of societal resilience, collective intelligence, cultural evolution, and the happiness of people. Diversity is also the motor of innovation and economic well-being. Thus, the complaints of companies about over-regulation and of citizens about the prevailing attempts to standardize and homogenize their cultures, lives, and cities, must be taken seriously, otherwise great projects such as the European Union may fail on the long run. We should try to combine the strengths of different cultures rather than making them all the same. Copying the leading economic system is not the best solution. (Remember the section on the Netflix challenge.) Therefore, the way to go is as follows: Give each law, apart from the constitutional principles, a limited term of validity. Avoid over-standardization and create opportunities. Allow different systems of self-organization to coexist and compete with each other. Importantly, when trying to reach high social or environmental standards or similar goals, don't fix a single best practice solution, but

offer a choice of 2 or 3 best practice solutions (in the very best sense of pluralism), such that countries, cities, and companies have options to choose from, in favor of a locally and culturally fitting implementation. This will increase diversity and resilience, as there will be not just one solution, but several. It will also increase the support for these laws.[7] Finally, in many cases, compulsory regulations can be replaced by guidelines, thereby, helping everyone to improve established practices.

3. **Build a reputation system to promote awareness, quality and responsible action.** If we reduce the number of laws and regulations, we need to replace them by something else. More freedoms can be given, if decision-makers behave in more responsible ways. Suitable merit-based and reputation systems can promote awareness, quality and responsible action. They are able to support cooperation and social order in an efficient and effective way. In fact, we see the quick spreading of reputation systems in the Internet for a good reason: they are extremely useful. They help to promote better services to customers, and allow providers of services and products to sell better quality at a higher price. However, reputation systems should be improved such that they have the following features: manipulation attempts and information pollution should be sanctioned; facts, advertisements, and opinions should be distinguished; anonymous, pseudonymous and personal ratings should be possible, but given different weights; reputation and recommender systems should be community-specific, pluralistic, and based on multiple criteria rather than trying to make everyone apply identical quality criteria; users should be able to choose, configure, create and share information filters and recommendation algorithms.
4. **Rebalance top-down and bottom-up decision-making according to the principle of subsidiarity.** We should build information systems enabling everyone to take better-informed decisions and more effective actions. This will empower people to contribute to the management of

[7] A broader support of laws can be often reached by increasing the number of options allowed.

our systems in a bottom up way, thereby enabling solutions that are better fitted to local and diverse needs, using local competence and knowledge. Altogether, we will increasingly see the principle "You should do this!" replaced by "I can do something that needs to be done!" We should also create information platforms that support the coordination of such activities as well as the self-regulation of communities, where many conflicts of interests are resolved through a self-organized system of community moderators, considering the externalities of decisions and actions. Those community moderators will serve to judge and support the compliance with local rules, while staying within the framework of our constitutional principles. The temporary role of community moderators in the judgment hierarchy should depend on their previous merits, assessed both in a top-down and bottom-up way in terms of respecting fundamental principles and local rules well.

5. **Establish a new data format based on the data cord principle to enable informational self-determination and micro-payments.** I have pointed out that some of the problems with the Internet as we have it today are related not only with issues of security and cybercrime. They mainly result from a lack of user control over their personal data, from a lack of accountability, and from difficulties to reward companies and people easily and properly for the data, ideas and cultural goods they have produced. I think that all of these problems could be solved by a combination of a Personal Data Store (i.e. a personal mailbox for data) with special encryption techniques and a new kind of data format based on the concept of a "data cord," which connects contents with the respective producer or owner and allows them to control the access to their data.[8] In case of personal data, the related person should be considered the owner, and he or she should be able to control the rights of use of third parties. Furthermore, a Micro-Payment System should enable related multi-

[8] see Big data, privacy, and trusted web: What needs to be done, see http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2322082

dimensional value exchange. Then, the more often data are copied or used, the more (material or immaterial) profits will be produced and automatically shared between the different instances of the value-generating chain. Such a Micro-Payment System would be superior to current intellectual property right (IPR) approaches such as software patents. Current IPR approaches stand in the way of an efficient co-evolution of ideas, which has been the underlying success principle of human culture.[9]

6. **Create a multi-dimensional complementary and backup money system to make our financial system more functional and resilient.** We have seen our financial system to be more fragile than we thought, and we cannot exclude it will collapse one day. It is therefore essential to establish a backup money systems, which can step in and keep up economic exchange in case our current system fails. I, therefore, plea for a multi-dimensional exchange system. This would create a welcome competition with our current financial system, which would help it to improve. In fact, we currently see peer-to-peer payment and lending systems coming up. If they meet certain quality standards and serve public interests (such as providing loans to companies for the sake of investments), governments could support the development of such systems, for example, by a special tax status and less regulations (given there is no "too big to fail problem"). The current payment systems (including *BitCoin*) are not perfect, but allowing for more competition will let our financial system improve.[10] I have also pointed out that a one-dimensional reward system does not allow our complex socio-economic systems to self-organize well. For this reason, a multi-dimensional reward system is needed. Multi-dimensional money could provide such a system. It could be imagined like having several bank accounts for different kinds of use.

[9] Just suppose we would all own a few words and would have to negotiate about their use with others. This would obstruct and limit our language and culture immensely!

[10] maybe jointly with some insurance system to cover damage from small-scale accidents that will probably occur, if we want innovations to happen

7. **Engage in information infrastructures and measurement methods to determine and charge externalities.** For self-organization to work well, it is further important to quantify externalities of decisions and actions, and to charge negative ones to the person or company producing them. If everyone has to pay for damage created, this will largely help to reduce the frequency and size of damage in the future. For the sake of symmetry and fairness, one may also reward people and companies for positive externalities. An important step is therefore to build an infrastructure that is able to measure and quantify damage to our physical and biological environment, but also to our socio-economic system (such as "social capital"). This can now be done with the sensor networks underlying the emerging "Internet of Things," and it will be important to increase awareness and responsible behavior.
8. **Tax systemic risks and provide rewards for transparency, responsibility, data access, informational self-determination, and open innovation.** Besides charging actually incurred damage, it would also make sense to charge *likely* socio-economic damage ("systemic risks"), as insurance companies would do it with risks caused by individuals. In the past, we have often had business models that lead to "tragedies of the commons" or that undermine privacy, pollute the web with spam, or advertise products and services in ways that are barely distinguishable from user ratings and facts. For the time being, until we have figured out better ways, taxation might help us in a relatively simple and straight-forward way to improve our techno-socio-economic systems. Rather than taxing labor more than profits that are made by monetary investments or robotic production, one might consider to tax excessive numbers of interactions, wherever too many interactions might have undesirable systemic impacts. This would encourage to simplify or decouple complex systems, to increase their resilience, and to collect Smart rather than Big Data (i.e. to discourage the collection of huge quantities of data that are of limited use and often quite problematic in many ways). So, it might be worth considering to

progressively tax the number of network links, but also a lack of openness, transparency, participatory opportunities, or informational self-determination. Such taxation could reward local interactions and the provision of high-quality data, but encourage a forgetting of old and irrelevant data. Moreover, one should further promote the generation of participatory information systems that can benefit everyone. Concretely, one should use the money created in the before mentioned way to pay for public information infrastructures and institutions for the digital era to come – in order to quickly build an Information Ecosystem that can benefit everyone. In other words, suitable kinds of taxation could reward desirable and responsible innovations and private activities contributing to them. Let me, finally, stress that such taxation should not stand in the way of an Open Data and Open Innovation approach, and that it should not be based on a surveillance kind of system. Free and open data of high quality should be tax exempt. In this context, it is important to remember that the additional economic value, which can be created by Open Data, has been estimated by McKinsey to be of the order of 3,000 to 5,000 billion dollars per year in the world. It would be great if everyone could get a share of this cake!

9. **Build the infrastructures and institutions for the Digital Society.** I believe that, so far, no country in the world is well prepared for the digital era to come and the new principles governing it. Therefore, it would make sense to engage in an Apollo-like program, and the equivalent of a Space Agency for Information and Communication Technology (ICT): an *Innovation Alliance* with a mission to develop institutions and information infrastructures for the emerging digital society. This is crucial to master the challenges of the 21st century in a smart way and to release the full potential of information for our society. It is instructive to recall the factors that enabled the success of the automobile age: the invention of cars and of systems of mass production; the construction of public roads, gas stations, and parking lots; the creation of driving schools and driver licenses; the

establishment of traffic rules, traffic signs, speed controls, and traffic police; and the invention of safety-enhancing technologies such as guardrails, anti-blockage systems (ABS), and airbags. All of this required many billions of investments each year. We invest a lot of resources into the agricultural sector, the industrial sector, and the service sector. But are we investing enough in the emerging digital sector? While the digital revolution certainly creates new challenges to our societies, it also opens up many promising opportunities to master our future. What do we need to make the digital age a great success? First of all, we need to engage in building *trustworthy, transparent, open, and participatory ICT systems, which are compatible with our values.* For example, it would make sense to establish the emergent "Internet of Things" as a *Citizen Web*. This would enable self-organizing systems through real-time measurements and a public information platform that I call the "Planetary Nervous System." It would also facilitate a new kind of search engine. To protect privacy, all data collected about individuals should be saved in a *Personal Data Store* and, given the agreement of the corresponding users, processed in a decentralized way by third-party Trustable Information Brokers, allowing everyone to control the use of their sensitive data. A *Micro-Payment System* would allow data providers, intellectual property right holders, and innovators to get rewards for their services. It would also encourage the exploration of new and timely intellectual property right paradigms. A pluralistic, *User-centric Reputation System* would promote responsible behavior in the virtual (and real) world. It would even enable the establishment of a new, multi-dimensional value exchange system, which would overcome weaknesses of the current financial system by providing additional adaptability. A *Global Participatory Platform* would empower everyone to contribute data, computer algorithms and related ratings, and to benefit from the contributions of others (either for free or for a fee). It would also enable the measurement, protection and production of *Social Capital* such as

trust and cooperativeness, using next-generation *User-Controlled Social Media*. A *Job and Project Platform* would support crowdsourcing, collaboration, and socio-economic co-creation. Altogether, this would build a quickly growing *Information and Innovation Ecosystem*, unleashing the potential of data for everyone: business, politics, science, and citizens alike. We could also create a *Digital Mirror World* to assess the likely risks and opportunities of prospective decisions by means of sophisticated computers simulations. This would help us to identify suitable institutional settings and interaction rules for self-organizing systems. Finally, *Interactive Virtual Worlds* would allow us to unleash the full potential of creativity and self-organization within different socio-economic settings and *Intellectual Property Right* approaches. Finally, *Social Information Technologies* would help us to cope with the diversity resulting from this and to benefit from it.

10. **Build a new educational system that prepares people for the digital age to come and for creative work.** It becomes increasingly clear that most of our current institutions and jobs will fundamentally change. Much of the work, which has been performed by people in the past, will be done by computers, algorithms, or robots in the future. This applies particularly to procedural and rule-based work. Hence, many people will instead have to find work in the information- and knowledge-creating sector, including the area of cultural production. Rather than a standardized education, we will need a more personalized education and training in creativity. I imagine that the fundamental skills would encompass language skills, mathematical skills, and programming skills; the ability to find and critically judge information, to curate it and to use it for knowledge production; the skill to share knowledge, collaborate with others, and to co-create services and products, considering their externalities; the ability to concentrate on tasks, but also to flexibly adapt to new opportunities; last but not least, the skill to analyze and understand complex systems and to apply an interaction- and systems-oriented thinking. Digital literacy and

> good education will be more important than ever. But with the emerging "Internet of Things" and participatory information platforms, we can unleash the power of information and turn the digital society into an opportunity for everyone. It just takes our will to establish the institutions required to make the digital age a great success. Are we ready for this?

Let's get started!

Of course, governments could bring this on the way, and they should! The spending on wars in the past 10 years exceeded 1 trillion dollars. Instead, we could have used this money to build a basis for the Digital Society of the future. Why not aid people by good information, thereby allowing them to take better decisions? For this, providing information of high quality is key, and that requires openness and transparency. Additionally, participatory opportunities can create new value and trust. Citizens have become part of our global information system. They should now be able to contribute to the collective intelligence needed to solve the ever more complex problems of our world. A new deal on data should treat citizens as first-class partners in exploring the opportunities of the future and mastering our challenges.

However, independently of whether politicians will support self-organization approaches or not, companies will learn to create more efficient systems and make money with them. That's just the logic of automation implied by the digital revolution. As self-organizing systems spread, this will sooner or later also change the way we govern the world. Advances in information and communication technologies will drive this process. But the citizens can drive it, too.

Given that *Instagram* was built by 13 people and *WhatsApp* by around 50, it becomes clear that a few people can now have global-scale impact. Moreover,

note that *Wikipedia* has a lot of contributors, and *OpenStreetMap* is now supported by 1.5 million volunteers. Thus, citizens don't have to wait. They can take action themselves. With future information and communication technologies, we can change the world to the better! We can build a Citizen Web, a user-controlled Internet of Things, ourselves. We can measure externalities. We can create an OpenCulture Wiki, collecting information about the rule sets that make diverse cultures succeed. We can build Social Information Technologies to understand each other better and interact more successfully. We can run information platforms, where data, algorithms, and information filters are shared. And we can create a global maker community, producing our own products.

Thanks to the digital revolution, almost everything seems possible, now. It's not utopia or science fiction anymore. We are just limited by our own imagination, and our will to co-create our future. Do you want to be part of it? Then, follow the FuturICT blog and social media, join the nervousnet community (nervousnet@ethz.ch), and contribute to a trust- and respectful, participatory society, using the power of information!

INFORMATION BOX 1: From a Big Data society to a self-organizing society

A participatory and resilient society needs a sufficiently distributed management of complex systems, based on bottom-up self-organization. In many cases, the self-organization approach can be nicely embedded in the institutional frameworks that we have today, as novel information and communication technologies add new opportunities. For example, a self-organized community management may complement our court system. In other cases, we will find inefficient institutions to be increasingly replaced by better institutional settings.

For self-organization to work well, information must be locally available and manageable. This requires informational self-determination and can be realized with the concept of a Personal Data Store. Note that informed consent to collect personal data is not enough. To exercise our constitutional freedoms, we must be able to determine who can access and use what personal data for what purpose. This does not necessarily mean that we can have data deleted or changed as we like (if the data is not factually wrong), but we could make certain categories of data not viewable to others (e.g. health data, and this would also mean that it wouldn't be allowed to infer health-relevant personal information from other data). Public authorities might, of course, have additional access rights, but solely on the basis of transparent laws and procedures.

In all uses of Big Data, high ethical standards have to be applied. Complementary, one needs efficient technical, cultural, and legal protection from misuse of data and discrimination. For this, it is important to contrast unfavorable perspectives with favorable ones (e.g. "in dubio pro reo"). This applies not only to legally relevant uses of Big Data, but also to business cases. Good quality control mechanisms must make sure that the scientific state-of-the art is applied. For instance, only statistically significant results should be taken as basis of favorable or unfavorable personal treatments (e.g. the classification as a "bad risk"). Furthermore, to avoid massive discrimination, the fraction of people considered "bad risks" should be very limited.

One of the best means to reach all this would be to ensure a sufficient transparency of data-related procedures. Furthermore, the anonymization, encryption and decentralized storage of personal data is strongly recommended to minimize misuse and unintended use. Much of the above still needs to be put in place. So far, we are still lacking proper institutional settings for the digital era to come.

INFORMATION BOX 2: Future governance: options rather than compromises

It would certainly raise satisfaction to have a governance approach where decisions are taken by those who will be affected by the decision, no matter whether this is on a local, regional, national, supranational, global, company, or community level. In principle, we could enable such decision-making by means of electronic participatory voting platforms. Individual points of views could be integrated by an argument map such as *debate graph* into a reasonable number of options (perspectives). If decisions are not taken in a basic-democratic way (which can be done only for a limited number of key questions), these different options should be all properly represented in the decision committee. The relative number of votes should depend on the respective externalities. Moreover, I would like to suggest that, the more diverse a community is, the larger should the committee be. This applies particularly to a committee that is supposed to resolve global issues. Let's assume we have various options or communities i. Then, each of it could be represented by $a^* ln\ W_i$ people, rounded down to integer numbers, where ln denotes the natural logarithm, and W_i stands for the contribution made to the common good to be created, e.g. the taxes to be paid or the externalities suffered from the respective decisions. Finally, a is a constant that determines the overall size of the committee. I also think that, to establish a new regulation that would apply to all, one should require a high level of support (ideally of the order of two thirds of all votes). Usually, this could only be reached by not just setting a single, homogeneous standard everywhere, but by providing a few best practice options, among which the companies or regions could decide. This would make the desire to have some standardization compatible with the desire to have options and opportunities that are locally and culturally fitting. In other words: self-organization means to create options rather than compromises for everyone. This can embrace the

innovative power of diversity and also the collective intelligence that will be the basis of successful Digital Societies in the 21st century.

INFORMATION BOX 3: A framework of fundamental principles to guide our (inter)actions

In this book, I have argued that we need to allow for diverse sets of rules in order to enable a large variety of functionalities, but also to allow companies and people to experiment and find better rule sets. Nevertheless, it would be favorable to share a number of fundamental principles with each other in the world – a guiding rule set small enough that everyone can remember it, and from which many things, including peaceful co-existence, would follow.

As I have demonstrated before, in a strongly connected world, maximizing the own payoff does not produce the best results. To avoid undesirable systemic instabilities and tragedies of the commons, superior principles than self-regarding optimization are needed. The following set of fundamental rules is the result of extensive discussions I have had with many people. The similarity with principles promoted by philosophers and world religions are not by chance. It is clear that these ethical principles have been the fundament, on which the success of societies has been based for thousands of years. As I pointed out before, these cultural principles are more persistent than steel and more powerful than wars. They also create Social Capital, which is a basis of economic well-being, too. The rules below particularly consider the problems implied by complex interdependencies, strong interactions, and the increasing importance of information, which are characteristic of today's world.

1. **Respect:** Treat all forms of life respectfully; protect and promote their (mental, psychic and physical) well-being.
2. **Diversity and non-discrimination:** Support socio-economic diversity

(including diversity-preserving uses of Information and Communication Technologies). Engage against discrimination or repression and against a punitive society; give priority to rewards.

3. **Freedom:** Support the principle of informational self-determination; respect creative freedom (opportunities for individual development) and the freedom of non-intimidating expression; abstain from mass surveillance.
4. **Participatory opportunities:** Enable self-determined decisions and offer participatory opportunities and good options to choose from. Engage in properly balancing the interests of all relevant (affected) stakeholders, particularly political, business and citizen interests.
5. **Self-organization:** Create a framework supporting flexible, decentralized, self-organized adaptation, e.g. by means of suitable reputation systems.
6. **Responsibility:** Commit yourself to timely, responsible and forward-looking actions (and non-actions), considering their externalities.
7. **Quality and awareness:** Commit yourself to honest, high-quality information and good practices and standards; support transparency and awareness.
8. **Fairness:** Avoid negative externalities that are directly or indirectly caused by own decisions and actions, or fully compensate the disadvantaged parties for them (in other words: "pay your bill"); reward others for positive externalities.
9. **Protection:** Engage in the protection from harm, damage, and exploitation; stay away from aggressive or war-like activities (including cybercrime, cyberwar, and misuse of information).
10. **Resilience:** Reduce the vulnerability of systems and increase their resilience.
11. **Sustainability:** Promote sustainable systems and long-term societal benefits; commit yourself to systemic benefits.
12. **Compliance:** Engage actively into the protection of these ethical principles and in the compliance with them.

To summarize the above even shorter, the most important rule is: **Be other-regarding and pay the fair price for your externalities.** This fundamental principle takes care of the implications of our interactions, and it's probably enough to create a better world that will benefit everyone! Mastering our future isn't that complicated, after all!