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Dirk Helbing

Why we need democracy 2.0 and capitalism 2.0 to survive

The world is running into great trouble. The Anthropocene challenges (including climate change, impending resource shortages, demographic change, conflict, financial and economic crises) call for entirely new answers. As a result, we are now seeing the emergence of data-driven societies around the globe. Feudalism 2.0, fascism 2.0, communism 2.0, socialism 2.0, democracy 2.0 and capitalism 2.0 can now be built. What framework should we choose? What would be the implications?

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[Rz 1] In the recent past, we have seen companies and governments around the world collect increasing amounts of personal and other data. This has been justified with better customer experience and with security issues, e.g. the need to fight organized crime and international terrorism. However, statistical investigations do not confirm that mass surveillance is more efficient in identifying and preventing terrorism than conventional means.[1] In fact, all individuals who have recently committed terror attacks in Europe were known before to be potentially dangerous extremists.[2] Nevertheless, the attacks have not been prevented. Therefore, can mass surveillance ever serve the declared purpose? And if not, why is it so energetically pursued?

[Rz 2] Recently, it has become increasingly clear that personal data about everyone of us is not only collected for the sake of personalized advertisements, services and products,[3] but also politically used in various countries. The keyword here is «Big Nudging», i.e. the combination of methods from behavioral economics («nudging») and Big Data to manipulate the attention, opinions, decisions, and behaviors of people.[4] The more data is available about us, the easier it becomes to manipulate us subconsciously, i.e. without our awareness. It is suggested that this method would be used to make us behave in a healthier and environmentally friendly way, but the method has also been applied to manipulate other public opinions and elections.[5] Politics

1 The effectiveness of predictive policing: Lessons from a randomized controlled trial, Journalist's Resource (6 November 2014), http://journalistsresource.org/studies/government/criminal-justice/predictive-policing-randomized-controlled-trial (all internet sources have been last visited on 25 April 2016); Kai Biermann, Predictive Policing – Noch hat niemand bewiesen, dass Data Mining der Polizei hilft, ZEIT Online (29 March 2015), http://www.zeit.de/digital/datenschutz/2015-03/predictive-policing-software-polizei-precobs; Ellen Nakashima, NSA phone record collection does little to prevent terrorist attacks, group says, The Washington Post (12 January 2014), http://www.washingtonpost.com/world/national-security/nsa-phone-recordcollection-does-little-to-prevent-terrorist-attacks-group-says/2014/01/12/8aa860aa-77dd-11e3-8963-b4b654bcc9b2_story.html?hpid=z4; see also http://web.archive.org/web/20150211220452/http://securitydata.newamerica.net/nsa/analysis.

2 Sascha Lobo, Die Mensch-Maschine: Tiefgreifendes, strukturelles, multiples Staatsversagen, Spiegel Online (30 March 2016), http://www.spiegel.de/netzwelt/netzpolitik/sascha-lobo-ueber-is-terror-ueberwachung-ist-die-falsche-antwort-a-1084629.html.

3 Frank Pasquale, The Black Box Society: The Secret Algorithms That Control Money and Information (Harvard University, 2015); Mnih Volodymyr et al., Human-level control through deep reinforcement learning, Nature 518 (2015), pp. 529–533; Kai Schlieter, Die Herrschaftsformel: Wie Künstliche Intelligenz uns berechnet, steuert und unser Leben verändert (Westend, 2015); Thomas R. Köhler, Der programmierte Mensch: Wie uns Internet und Smartphone manipulieren (Frankfurter Allgemeine Buch, 2012).

4 Dirk Helbing et al., Digitale Demokratie statt Datendiktatur, Spektrum der Wissenschaft 1/2016 (17 December 2015), http://www.spektrum.de/news/wie-algorithmen-und-big-data-unsere-zukunft-bestimmen/1375933; see also the podcast of the event «Wie verändert die digitale Revolution unsere Demokratie?», https://www.volkswagenstiftung.de/aktuelles/aktdetnewsl/news/detail/artikel/muendige-wege-durch-den-datendschungel/marginal/4954.html; Dirk Helbing, Societal, economic, ethical and legal challenges of the digital revolution: From big data to deep learning , artificial intelligence, and manipulative technologies, in: Jusletter IT 21 May 2015.

5 Robert Epstein/Ronald E. Robertson, The search engine manipulation effect (SEME) and its possible impact on the outcomes of elections, Proceedings of the National Academy of Sciences of the USA 112 (2015), E4512–E4521;

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has started to notice the danger of this approach, which enables new kinds of propaganda and misinformation, while it also undermines social cohesion by means of the «filter bubble effect».[6] Furthermore, it reduces critical thinking, which makes people vulnerable to populist and extremist opinions.

[Rz 3] Despite its power, Big Nudging is not as effective as hoped in reaching its health- and environment-related goals.[7] Therefore, companies and countries like China have started to introduce Citizen Scores that rate peoples» behaviors, including the links they click in the Internet.[8] These scores will then determine the interest rates of loans offered, health benefits, travel visa, or jobs one might get. In such a way, it is easy to create a «digital nose ring» to make citizens do certain things. As a consequence, the use of Big Nudging and Citizen Scores will increasingly reduce the freedom of decision-making of citizens and with this, the ability to control their own lives. It recently becomes clear that this approach can be highly invasive: We are told to do 10,000 steps every day. The calories and kinds of food we eat become increasingly measured. The accumulated information might be used to decide who is entitled to get certain kinds of health services and who not. Since gene sequencing is cheap and gene editing is possible (e.g. with the Crispr CAS-9 method), experts, furthermore, think about eliminating diseases by «selective breeding».[9] Various countries have also built detainment camps for millions of people,[10] in order to be able to manage pandemics, future disasters, and social uprisings. The refugee camp in Idomeni is a sad example of how such camps may be operated.[11] Taking all of this together, there are currently many signs of an upcoming new totalitarism[12] – a digitally empowered political regime that would be highly privacy-invasive and potentially more dictatorial than any political regime we have seen in the past.

[Rz 4] One reason for this development seems to be related to a serious misunderstanding of what Big Data can accomplish. Since Chris Anderson's claim that «the data deluge makes the

see also Jonathan Watts/David Agren, Hacker claims he helped Enrique Peña Nieto win Mexican presidential election, The Guardian (1 April 2016), http://www.theguardian.com/world/2016/mar/31/mexico-presidential-election-enrique-pena-nieto-hacking; Joachim Laukenmann, Wie digitale Medien Wähler manipulieren, Sonntagszeitung (10 April 2016), http://www.sonntagszeitung.ch/read/sz_10_04_2016/gesellschaft/Wie-digitale-Medien-Waehler-manipulieren-59964; Rafael Schupisser/Schweiz am Sonntag, Roboter würden SP wählen – oder: Warum Twitter eine Gefahr für die Demokratie ist, Watson (21 February 2016), http://www.watson.ch/International/Social%20Media/558554953-Roboter-würden-SP-wählen---oder--Warum-Twitter-eine-Gefahr-für-die-Demokratie-ist.

6 Clio Andris et al., The rise of partisanship and super-cooperators in the U.S. House of Representatives, PLoS ONE 10(4): e0123507 (2015). Rising social polarisation, populism and extremism are concerning phenomena of our time, and they can be interpreted as social cascading effects in a overly connected world (see Dirk Helbing, Globally networked risks and how to respond, Nature 497 (2013), pp. 51–59); taxing links to reduce over-connectivity and resulting systemic risks may help.

7 Jonathan Rowson, Nudge is not enough..., Guardian (19 July 2011), http://www.theguardian.com/commentisfree/2011/jul/19/nudge-is-not-enough-behaviour-change.

8 Jay Stanley, China's nightmarish citizen scores are a warning for Americans (5 October 2015), https://www.aclu.org/blog/free-future/chinas-nightmarish-citizen-scores-are-warning-americans.

9 New CRISPR technology can be used to make designer babies (7 January 2016), http://www.news-medical.net/news/20160107/New-CRISPR-technology-can-be-used-to-make-designer-babies.aspx; see also Kemal Atlay, Gene-editing poses ethical questions, The Saturday Paper (16 April 2016), https://www.thesaturdaypaper.com.au/2016/04/16/gene-editing-poses-ethical-questions/14607288003113.

10 See https://www.youtube.com/watch?v=FfkZ1yri26s and http://info.publicintelligence.net/USArmy-InternmentResettlement.pdf.

11 See https://www.amnesty.org/en/latest/news/2016/04/greece-refugees-detained-in-dire-conditions-amid-rush-to-implement-eu-turkey-deal/ and http://www.amnestyusa.org/news/press-releases/amnesty-international-releases-new-report-on-refugee-crisis-pushes-obama-to-do-more.

12 Frank Schirrmacher (ed.) Technologischer Totalitarismus (Suhrkamp, 2015).

scientific method obsolete», the idea has spread that one could optimize the world and rule it like a benevolent dictator, if one just had enough data.[13] It sounds extremely plausible that «more data is more knowledge, more knowledge is more power, and more power is more success». In the meantime, however, Data Scientists have realized that there are many traps one can fall into.[14] These are not only related to the limitations of Big Data analytics (e.g. the fact that correlations do not mean causality and that more data imply more spurious patterns[15] – the well-known overfitting problem). It is also related to the fact that data volumes grow faster than processing power and systemic complexity grows even faster than data volumes.[16] Therefore, good theories are needed to decide what subset of data should be processed and how. Furthermore, there is no scientific method to determine the right goal function: should it be gross domestic product per capita (GDP) or sustainability, power or peace, happiness or life expectancy, or anything else? In modern complex societies, the common answer to this dilemma has been pluralism. We should not give up on it, because this would make our society more vulnerable: pluralism allows for diversity, which is the basis of high innovation rates, collective intelligence and societal resilience (it hedges risks and can better cope with uncertainty).[17]

[Rz 5] I am writing all this, because democracies worldwide have repeatedly been questioned[18] and come under pressure.[19] In Europe, we have seen this in Hungary, Poland, France, and Turkey, but also elsewhere.[20] In fact, it is now possible to build data-driven versions of well-known historical political systems: fascism 2.0, communism 2.0, feudalism 2.0, capitalism 2.0, and democracy 2.0. Our societies are at a crossroads (or, scientifically speaking, at a tipping point). As a conse-

13 Dirk Helbing, Society is not a machine, https://www.edge.org/response-detail/26795. Note that it is often said that one needs a benevolent dictator, when decisions are time-critical and finding consensus would take too long. However, a benevolent dictator can easily make mistakes, particularly in a complex world. If the benevolent dictator is powerful, such mistakes will be big and affect the existence of millions of people. Therefore, I suggest that different solution approaches should be tried out in various places, as the federal and subsidiarity approaches suggests, and that these experiments should be scientifically evaluated to spread and (co-)evolve the best solutions. In a complex world, such a pluralistic approach is more promising for humanity to master difficult times than applying big solutions to all. By the way, such a pluralistic approach has just been used by the Daimler AG to identify good strategies for the future, see https://www.youtube.com/watch?v=cpuz8x-6BDA.

14 David Lazer et al., The Parable of Google Flu: Traps in Big Data Analysis, Science 343 (2014), 1203–1205; Dirk Helbing, Thinking Ahead – Essays on Big Data, Digital Revolution and Participatory Market Society (Springer, Berlin, 2015).

15 For an entertaining illustration of the problem see the book by military intelligence analyst Tyler Vigen, Spurious Correlations (Hachette, 2015)

16 Dirk Helbing, What the digital revolution means for us, Science Business (12 June 2014), http://www.sciencebusiness.net/news/76591/What-the-digital-revolution-means-for-us.

17 Dirk Helbing/Evangelos Pournaras, Build Digital Democracy, Nature 527 (2015), 33–34, http://www.nature.com/news/society-build-digital-democracy-1.18690.

18 Tony Blair, Is Democracy Dead? The New York Times (4 December 2014), http://www.nytimes.com/2014/12/04/opinion/tony-blair-is-democracy-dead.html; Harald Welzer, Die Demokratie – ein Auslaufmodell, Die Welt (2 August 2008), http://www.welt.de/welt_print/article2332799/Die-Demokratie-ein-Auslaufmodell.html; Jakob Tanner, Demokratie – ein Auslaufmodell?, Tagesanzeiger (19 July 2015), http://www.tagesanzeiger.ch/schweiz/standard/Demokratie-ein-Auslaufmodell/story/20251334; Michael Safi, Have millennials given up on democracy?, The Guardian (18 March 2016), http://www.theguardian.com/world/2016/mar/18/have-millennials-given-up-on-democracy.

19 In his remarks by at the White House Correspondents' Dinner on 30 April 2016, President Obama said: «[…] this is […] a time around the world when some of the fundamental ideals of liberal democracies are under attack, and when notions of objectivity, and of a free press, and of facts, and of evidence are trying to be undermined. Or, in some cases, ignored entirely. And in such a climate, it's not enough just to give people a megaphone. […] that's why your power and your responsibility to dig and to question and to counter distortions and untruths is more important than ever.» See https://www.whitehouse.gov/the-press-office/2016/05/01/remarks-president-white-house-correspondents-dinner. Also see above, footnote 13.

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quence, we should make up our minds and take a conscious decision. We need a public debate to determine the path we want to take. In the following, I will try to sketch some implications of the various data-driven models mentioned above.

[Rz 6] *Fascism 2.0 – the Big Brother and Brave New World Society:* This system is turning majority opinions into social norms, laws, and regulations with little protection of human rights, particularly those of minorities. It leads to a populist governance supported by a propaganda apparatus that is controlled by government and business elites. In the beginning, resources of minorities are redistributed to the majority, which increases the popularity of the government. Eventually, however, the loss of diversity leads to a lack of innovation, which undermines the success of the economy and the functionality of the society. To counteract the resulting destabilization of the socio-economic system and overcome the shortage of resources, fascist societies typically end up in wars. They also tend to value diverse people differently (e.g. to attribute a lower value to certain ethnicities, groups or religions), which can lead to ethnic cleansing and social sorting. A trend towards fascism 2.0 can be seen in several countries today, also in Europe.

[Rz 7] *Communism 2.0 – some are calling it the Big Mother Society:* This system is pursuing a benevolent dictator approach, trying to optimize the state of society. The «caring state»,[21] which engages in Big Nudging, clearly has elements of this. Communism 2.0 imposes values, norms, and forms of life on people. Communism 2.0 engages in a centralized, top-down planning of the use of resources. In this process, the goals are set by the government. In many cases, this includes the re-distribution of resources from certain elites to a broader public. However, communism 2.0 undermines competition, innovation and entrepreneurship, thereby reducing the amount of resources available, ending up in a desolate economic situation that requires the government to ration resources.

[Rz 8] *Feudalism 2.0 – the Big Other Society (called surveillance capitalism by some people):*[22] This system amasses huge amounts of customer data and basically turns citizens into products. The system is based on the accumulation of resources and power in the hands of a small business elite, which is said to be in favor of an efficient use of resources («economies of scale»).However, there are also undesirable side effects such as the misuse of power, relatively low innovation rates, and too-big-to-fail problems (as we have seen them in the financial sector).

[Rz 9] In some economic sectors, the accumulation of resources and power has created quasi-monopolies. Typically, the related monopolists, oligarchs or plutocrats demand the right of breaking the rules[23] (which is often framed as «creative destruction») and to determine the rules

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21 Richard H. Thaler/Cass R. Sunstein, Nudge: Improving Decisions about Health, Wealth, and Happiness (Penguin, 2009).

22 Shoshana Zuboff, Big Other: Surveillance Capitalism and the Prospects of an Information Civilization, Journal of Information Technology 30 (2015), 75–89. It is a well-known problem that even bottom-up organisational approaches tend to turn into feudalistic structures eventually (see the Iron Law of Oligarchy, https://en.wikipedia.org/wiki/Iron_law_of_oligarchy). This has also be found for Wikipedia (see http://www.sciencealert.com/wikipedia-is-basically-just-another-old-fashioned-bureaucracy-study-finds). To counteract this tendency, various measures can be taken, including: decentralization, separation of roles, limited office periods, democratic elections, random elements, multi-dimensionality/diversity/pluralism, mechanisms avoiding too much accumulation of resources and power, division of power/checks and balances, participatory approaches, shared values, accountability, and transparency. Such elements should be built into the system («democracy by design»).

23 I.e. applicable laws or even the constitution

of the future.[24] Some of Silicon Valley's IT giants openly admit that they consider democracy an «outdated technology».[25] It appears that they want to replace it by a new, data-driven, world-spanning operating system[26] to overcome the limitations of nation-based politics.[27]

[Rz 10] All three of the above governance systems (i.e. fascism 2.0, communism 2.0, and feudalism 2.0) are run with Big Data and Artificial Intelligent technologies (smart algorithms). They are all operated in a top-down way and imply severe breaches of basic democratic principles and achievements that many societies have fought for over thousands of years. I will now continue with a discussion of novel, data-driven forms of society that have strong bottom-up components: democracy 2.0 and capitalism 2.0. Here, «big solutions» are replaced by the «glocality» principle: «think global, act local».

[Rz 11] *Democracy 2.0:* This system recognizes the important role of pluralism and diversity for high innovation rates, societal resilience, and collective intelligence. It understands that socio-economic and cultural diversity is just as important as biodiversity, which requires a proper protection of minorities and human rights (including informational self-determination). It is committed to a division/separation of powers as a means of balancing the interests of different stakeholders and ensuring peace. It also offers participatory opportunities for citizens in recognition of the importance of civic engagement for a thriving society. It provides freedoms to citizens

24 To give a simplified picture, a lot of innovation happens in small and medium-sized enterprises (SMEs) and is bought by big businesses, which then scale up promising solutions to cheaply produce for a global market («economies of scale»). While this division of labor makes sense, it is less clear how helpful standardization is in this context. If tailored to the needs of a few big companies, then this creates disadvantages for SMEs and reduces the diversity of solutions. Requiring transparency, openness, and the removal of obstacles to interoperability and innovation seems to make more sense. Another issue is the following: to expand quickly, big businesses focus on products and services generating the highest revenues (say, 20 percent). Other products and services, even if profitable, are often not provided. SMEs, but also non-government organizations and citizen engagement are, therefore, needed, to create and offer products and services, which are desirable, but less profitable or require even an investment. Such products and services are important for a thriving society as well. In other words, big business can efficiently satisfy the basic needs of millions or billions, but this alone will typically not create a high quality of life. For this, a close-knit information, innovation, production and service ecosystem is needed, which is highly differentiated and diverse. SMEs are indispensable.

25 The complete quote is: «Die Demokratie ist eine veraltete Technologie. [...] Sie hat Reichtum, Gesundheit und Glück für Milliarden Menschen auf der ganzen Welt gebracht. Aber jetzt wollen wir etwas Neues ausprobieren.» Another quote from Larry Page is: «Es gibt eine Menge Dinge, die wir gern machen würden, aber leider nicht tun können, weil sie illegal sind. Weil es Gesetze gibt, die sie verbieten. Wir sollten ein paar Orte haben, wo wir sicher sind. Wo wir neue Dinge ausprobieren und herausfinden können, welche Auswirkungen sie auf die Gesellschaft haben.» See https://www.youtube.com/watch?v=NCtBdVpUY08 and Christoph Keese, Silicon Valley: Was aus dem mächtigsten Tal der Welt auf uns zu kommt (Albrecht Knaus, 2014). One such place beyond the rule of national law is CERN. It has built something like a Crystal Ball for society, which uses predictive analytics, but also predictive programming technologies («big nuding»), and machine learning approaches (Artificial Intelligence). See Peter Welchering, Die Software vom Cern spielt Orakel, FAZ (25 April 2016), http://www.faz.net/aktuell/technik-motor/computer-internet/einsatz-der-cern-prognose-software-im-alltaeglichen-bereich-14184322.html; Chris Merriman, CERN: The gulf between machine learning and AI, The INQUIRER (29 July 2015), http://www.theinquirer.net/inquirer/feature/2419669/cern-the-gulf-between-machine-learning-and-artificial-intelligence. It is now important to create a scientific, ethical and governance framework, which is pluralistic, interdisciplinary, transparent, and accountable, to prevent improper use of these technologies.

26 Adrian Lobe, Google will den Staat neu programmieren, FAZ (10 October 2015), http://www.faz.net/aktuell/feuilleton/medien/google-gruendet-in-den-usa-government-innovaton-lab-13852715.html; Katherine Noyes, Forget Trump and Clinton: IBM's Watson is running for president, PC World (8 February 2016), http://www.pcworld.com/article/3031137/forget-trump-and-clinton-ibms-watson-is-running-for-president.html.

27 Thomas Schulz, Die Weltregierung: Wie das Silicon Valley unsere Zukunft steuert, Spiegel (4 March 2015), http://www.spiegel.de/international/germany/spiegel-cover-story-how-silicon-valley-shapes-our-future-a-1021557.html.

in exchange for responsible behavior, and therefore invests in the education and enlightenment of its citizens.[28]

[Rz 12] The above principles may be seen as the lessons learned over centuries – from many wars and revolutions. As the complexity and diversity of socio-economic systems has increased over historical periods of time, overall, their degree of participation has increased as well. Democracy may, therefore, be seen as a governance form enabling diversity and turning it into public and private benefits.[29]

[Rz 13] Of course, high levels of complexity and diversity also imply significant challenges. However, these can now be addressed by **personal digital assistants** helping individuals and companies to coordinate their activities and interact more successfully.[30] Such digital assistants may use Artificial Intelligence technology, but act on behalf of their users rather than trying to control them on behalf of companies or governments.[31] The important point is to build digital platforms, which support efficient cooperation, online deliberation, and collective intelligence. Supporting better decision-making, responsible (inter)action, self-organization, and self-regulation will be key to eGovernance. I will discuss this in more detail below.

[Rz 14] *Capitalism 2.0:* This system is built on liberalism, i.e. civil and entrepreneurial freedom in favor of high innovation rates. It is largely organized in a bottom-up way, i.e. based on self-organization and self-regulation. It is, therefore, flexible, efficient, adaptive and resilient. Strong reward mechanisms for inventions and creative products or services are the fuel of the success of this system.

[Rz 15] A novel aspect of capitalism 2.0 is the overwhelming importance of network interactions. As a consequence, everything we do has side effects, feedback effects, or cascading effects, and «systemic thinking» or – differently phrased – «ecosystems thinking» becomes key to long-term (sustainable) success.[32] In fact, the nations with the most diverse product space are those that thrive most.[33] «Ecosystems thinking» also implies new forms of competition, which are combined with cooperation (so-called «co-opetition»). This is reflected by the important roles that co-creation, co-evolution, and collective intelligence play in the now emerging digital economy.[34] As I will elaborate later, this new form of capitalism will be catalyzed by a new kind of financial system, which will fix current environmental, social, and unsustainability issues: «**socio-ecological finance**» (or «finance 4.0»).

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28 Theda Skocpol/Morris P. Fiorina (eds.) Civic Engagement in American Democracy (Brookings, 1999); Aaron Smith, Civic engagement in the digital age, PewResearchCenter (25 April 2013) http://www.pewinternet.org/2013/04/25/civic-engagement-in-the-digital-age/; Essop Pahad, Political Participation and Civic Engagement, Progressive Politics Vol 4.2 (1 July 2005), http://www.policy-network.net/uploadedfiles/publications/publications/pahad-final.pdf.

29 Timothy D. Sisk (ed.) Democracy at the Local Level, Chap. 3 (2010) http://www.idea.int/publications/dll/; Nico Stehr, Climate policy: Democracy is not an inconvenience, Nature 525 (24 September 2015), 449–450.

30 Dirk Helbing, Interaction Support Processor (2015), https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2015118455.

31 Elon Musk: «I think the best defense against the misuse of AI is to empower as many people as possible to have AI. If everyone has AI powers, then there's not any one person or a small set of individuals who can have AI superpower.» See http://www.kurzweilai.net/musk-others-commit-1-billion-to-non-profit-ai-research-company-to-benefit-humanity.

32 As a side effect, the concept of the «homo economicus» will increasingly be replaced by the concept of «homo socialis». See the Special Issue on Homo Socialis, Review of Behavioral Economics, Vol. 2 (2015), http://www.nowpublishers.com/article/Details/RBE-0032.

33 Cesar A. Hidalgo et al., The Product Space Conditions the Development of Nations, Science 317 (2007), 482–487.

34 Dirk Helbing, The Automation of Society Is Next: How to Survive the Digital Revolution (CreateSpace, 2015).

1. The perfect storm: Resource shortages and other crises

[Rz 16] Before I discuss what governance approach we should choose, we first need to discuss the situation our society is faced with. Obviously, we are confronted with an unsolved financial, economic and spending crisis, with unstable peace, with climate change, and with cyber threats, to mention just a few of our existential issues. A closer analysis reveals that they may all be rooted in a single problem: our unsustainable way of life. Industrialized countries are currently consuming 3.5 to 4.5 times the amount of renewable material resources. For some time, they managed to keep up their lifestyle by means of globalization, which made resources from other countries accessible. Now, however, globalization has reached its limits, as the exploitation of other celestial bodies (such as asteroids or Mars) is not yet possible.

[Rz 17] Already in 1972, when the Club of Rome published «The Limits to Growth»,[35] it became clear that we might run into trouble. The analysis triggered controversial debates, but it was followed up and basically confirmed by the Global 2000 report issued by the US president, and it was further refined by an update.[36] Initially, these studies have fueled an environmental movement towards the protection of our planet and more responsible consumption. Then, however, industry and public media kept suggesting for decades that there was no problem, supporting excessive consumerism. If we were running short of a certain resource, it was argued, engineers would come up with a solution that would fix the problem. The same circles kept pointing out that there would be no man-made climate change problem. This allowed them to do business as usual.

[Rz 18] The «Limits to Growth» and Global 2000 studies particularly stressed that there was an impending oil shortage and an overpopulation problem. By the end of the 21st century, our planet would host significantly less people (more than one billion people less than during the period of highest population, which is expected to occur around the year 2030). Back in 1973, during the first oil crisis, many public roads were closed during weekends (for example, in Germany). However, since then it appears to the naive consumer that the problems have been solved. In many areas of the world, energy consumption has even doubled. In fact, we are not yet running out of oil, but problems are expected to occur as soon as the global production rate of oil goes down or oil production gets less efficient, i.e. more energy and effort is required to get it out of the soil.[37] The implications become clear when considering that most of our economy today depends on oil. It fuels production processes and transportation worldwide. It is used to produce plastic and other materials. It is required to produce fertilizer, i.e. it is needed for global food production. In fact, the world population has increased by a factor of 6 in the past 150 years as a result of the oil-based economy. So, if we would run short of oil or have to use less of it (e.g. to mitigate climate change), a large number of people might die,[38] which explains why nobody wants to talk about this. And oil is not the only problem.[39]

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35 Donella H. Meadows, Limits to Growth (Signet, 1972); Donella H. Meadows et al., Limits to Growth: The 30-Year Update (Chelsea Green, 2004).

36 Gerald O. Barney, The Global 2000 Report to the President, http://www.geraldbarney.com/G2000Page.html; Gerald O. Barney, Global 2000 Revisited, http://www.geraldbarney.com/G2000Revisit.html.

37 This is sometimes phrased as «peak oil» problem.

38 Roy Scranton, Learning to Die in the Anthropocene (City Lights, 2015).

39 Bundesamt für Umwelt BAFU, Umweltzustand: Globale Megatrends, http://www.bafu.admin.ch/umwelt/12492/12803/index.html?lang=de, see also http://visual.ly/born-2010-how-much-left-me.

[Rz 19] There are many signs that the elites knew about the issues and tried to solve them, while the wider public and even many researchers were unaware of their true dimensions.[40] Entirely new billion-dollar industries were built in attempts to overcome the existing and anticipated issues. Unfortunately, none of them really fixed the world's problems – each of them created new ones. The automobile industry managed to significantly reduce fuel consumption per 100 kilometers, but the number of cars has dramatically increased. A similar thing applies to air traffic. Each flight saves a lot of fuel, but the number of passengers and miles travelled increased a lot. Electricity production turned from oil-based to nuclear technologies, but besides the risk of nuclear accidents (as in Chernobyl and Fukushima), two problems have not been solved: the long-term storage of nuclear waste and the threat of nuclear terror attacks («dirty bombs»). Nuclear fusion (as it is, for example, attempted by the ITER reactor) would potentially solve these issues, but it is still in an early stage of development – far from industrial-scale energy production. Long pipelines have been built to replace oil by gas. However, deliveries in Europe suffer from political uncertainties (the conflict with Russia and the political instability in North Africa). Besides, burning gas contributes to climate change, which endangers one sixth of all species[41] – that would be the biggest mass extinction since the death of dinosaurs. Worse comes to worse, it endangers the global food system, too.

[Rz 20] Solar power is the great hope, but depends on regions with a lot of sunshine hours such as Africa. In fact, the DESERTEC project wanted to invest 400 billion Euros to produce energy for entire Europe, but the project collapsed due to the political turbulences caused by the Arab Spring. The Arab Spring was triggered by high food prices, which were a side effect of biofuel production (which started to compete with food production), combined with financial speculation.[42] Unfortunately, biofuel production also contributes to deforestation and land erosion. Using special bacteria to turn unused biomass into fuel appears promising, but does not seem to reach sufficient production rates so far. Furthermore, large wind parks have been built to generate electricity, but electricity production is spiky, i.e. it requires efficient storage, which has been lacking in many wind-rich regions. Novel battery systems to store electrical energy seem to provide a solution now. However, it is not quite clear how efficient and environmentally friendly the production and recycling of such battery systems is.[43] The recent use of fracking technology looks like a desperate attempt to prolong the era of the oil-based economy: it has serious side effects on the environment and health,[44] and causes man-made earthquakes. Despite all this, I am confident that energy production will not be the main resource bottleneck in future. We need to understand, however, that there is not one solution that fixes all our energy problems, if we would just roll it out globally. Instead, we need to engage in diverse approaches, in local energy

40 I am convinced that public awareness and involvement must be largely increased, if we want to be able to come up with better solutions.

41 Sid Perkins, Climate change could eventually claim a sixth of the world's species, Science (30 April 2015), http://www.sciencemag.org/news/2015/04/climate-change-could-eventually-claim-sixth-world-s-species.

42 Damian Carrington, Are food prices reaching a violent tipping point, The Guardian (25 August 2011), http://www.theguardian.com/environment/damian-carrington-blog/2011/aug/25/food-price-arab-middle-east-protests; Yaneer Bar-Yam/Greg Lindsay, The real reason for spikes in food prices, Reuters (25 October 2012), http://blogs.reuters.com/great-debate/2012/10/25/the-real-reason-for-spikes-in-food-prices/.

43 Danny King, Tesla Model S fined for excessive emissions in Singapore, AutoBlog (8 March 2016), http://www.autoblog.com/2016/03/08/tesla-model-s-fined-for-excessive-emissions-in-singapore/.

44 See, for example, http://www.focus.de/gesundheit/news/gefaehrliche-krankheit-ein-dorf-lebt-in-angst-krebs-ist-die-einzige-todesursache_id_5443253.html.

generation (particularly of solar and geothermal energy), in matching energy production and consumption better (with so-called «smart grid» solutions), and in a new lifestyle (as discussed below).

[Rz 21] Of course, energy is not the only thing that counts. In other economic sectors, we have made much less progress with the buildup of a low-carbon economy. For example, the food, chemical and pharmaceutical industries largely depend on oil. In particular, oil is needed for the production of fertilizer. Fertilizer also depends on nitrogen and phosphorus – two elements human are currently overusing. Furthermore, soil is degrading in many areas of the world and becoming more arid. Water shortages are impending. This is partly due to intensive meat production, which implies further problems (not just ethical ones): it makes antibiotics less effective. Multi-resistant bacteria are spreading and may cause a global pandemic of pre-antibiotic scale, killing millions of people. The amount of vegetables produced has also increased a lot. Part of this success is based on genetically modified organisms (GMO). However, some of the most used poisons in agriculture seem to have unwanted side effects. Insect species, in particular bees that are enormously important for food production, have been dramatically reduced.[45] In humans, the rates of obesity, diabetes and various kinds of cancer have significantly increased. It is certainly true that humans managed to reduce some of the world's hunger and to increase life expectancy, but it is far from obvious how we can cover the increasing costs of our health system and sustain the world's population, which has quickly grown.

[Rz 22] The financial industry is in trouble, too. Some people are convinced that the financial crisis in 2007/08 was triggered by skyrocketing oil prices, which made the production and consumption of certain products increasingly unaffordable.[46] Others see demographic reasons.[47] The use of anti-baby pills, they say, has reduced the size of the younger population, so that there are less people who can invest in stocks and real estate. In fact, the financial meltdown started with an overvalued housing market in California.[48] This eventually triggered a financial crisis around the globe, an economic crisis, and a public spending crisis, which we have not managed to overcome yet. As a result, inequality has largely increased. It will actually soon reach levels greater than before the French revolution, which raises concerns about the possibility of social instability and political unrests.[49]

[Rz 23] Some may argue that this inequality reduces the pressure on scarce resources. However, today's kind of capitalism cannot work without perpetual growth (which is a side effect of having to pay interest rates for loans). Consequently, the current economic system is in a danger to collapse. The Federal Reserve, the European Central Bank and other National Banks are literally pumping trillions of dollars into the economy to prevent this from happening. However, the money did not boost new production sites, companies and business models to the extent needed in order to create a booming economy. Instead, there are large unemployment rates in many

45 Dramatisches Insektensterben, NABU (13 January 2016), https://www.nabu.de/news/2016/01/20033.html.

46 Justin Lahart, Did the oil price boom in 2008 cause crisis? The Wall Street Journal (3 April 2009), http://blogs.wsj.com/economics/2009/04/03/did-the-oil-price-boom-of-2008-cause-crisis/.

47 Demographics: What variable best predicts a financial crisis? (16 July 2010), http://andrewgelman.com/2010/07/16/demographics_wh/.

48 Financial crisis of 2007-08, https://en.wikipedia.org/wiki/Financial_crisis_of_2007-08.

49 Nick Hanauer: Beware, fellow plutocrats, the pitchforks are coming (12 August 2014), https://www.youtube.com/watch?v=q2gO4DKVpa8.

countries, particularly among young people. The OECD, the WEF and the IMF are all pointing out that inequality has reached a level that harms our economy.[50]

[Rz 24] Currently, 62 people own as much as the poorest half of the world population.[51] I do not have objections against rich people or inequality, in principle, but when small- and medium-sized companies disappear, the backbone of society is damaged.[52] The current problem is that the average spending power has become so low that many firms cannot sell their products well anymore. This is bad for companies and the economy. It is bad for people and our society. To make us spend more money, interest rates have been steadily reduced by the FED and central banks around the world, but instead of consuming more, people are losing their savings for difficult times,[53] which fuels populist movements.[54] In the meantime, the interest rates have effectively reached a value of zero, more or less. This means that capitalism 1.0, which was built on competitive mechanisms (such as interest rates) and on mass consumption, is basically dead.[55]

[Rz 25] In other words: our current system is broken, it will not work much longer. Attempts to cement the outdated world order of the 20th century with secret agreements may be highly counterproductive for the future of our world.[56] To keep people in check and society under control, governments have built powerful surveillance and control system. We may also see a rationing of resources. Such a system would correspond to Communism 2.0 (if organized by governments) or Feudalism 2.0 (if organized by multi-national corporations). In more serious scenarios, a nine- or ten-digit number of people could die from hunger, disease or war. The

50 Inequality hurts economic growth, finds OECD research (12 September 2014), http://www.oecd.org/newsroom/inequality-hurts-economic-growth.htm; Carter C. Price, Why inequality harms economic growth (11 December 2014), https://www.weforum.org/agenda/2014/12/why-inequality-harms-economic-growth/; Phillip Inman, IMF study finds inequality is damaging to economic growth, The Guardian (26 February 2014), http://www.theguardian.com/business/2014/feb/26/imf-inequality-economic-growth.

51 Larry Elliott, Richest 62 people as wealthy as half of world's population, says Oxfam, The Guardian (18 January 2016), http://www.theguardian.com/business/2016/jan/18/richest-62-billionaires-wealthy-half-world-population-combined.

52 Stéphanie Thompson, The digital revolution could destroy the middle class, warns Joe Biden, World Economic Forum (21 January 2016), https://www.weforum.org/agenda/2016/01/the-digital-revolution-could-destroy-the-middle-class-warns-joe-biden/; «Middle-class Joe» Biden tells Davos bosses to look after workers, Fortune (20 January 2016), http://fortune.com/2016/01/20/joe-biden-davos-workers/.

53 For Germany, this effect sums up to 125 billion EUR, see http://www.focus.de/finanzen/news/ezb-hat-den-bogen-ueberspannt-wegen-niedrigzins-deutsche-sparer-haben-100-milliarden-euro-in-fuenf-jahren-verloren_id_5442246.html; other numbers speak even of 327 billion EUR, see http://m.welt.de/finanzen/geldanlage/article153466283/Niedrigzins-kostet-Deutsche-327-Milliarden-Euro.html.

54 Thomas Fricke, Aufstieg der Rechtspopulisten: Schaut auf die Banken, Spiegel (15 April 2016), http://www.spiegel.de/wirtschaft/aufstieg-der-rechtspopulisten-liegt-an-der-finanzkrise-kolumne-a-1087139.html.

55 Paul Mason, The end of capitalsm has begun, The Guardian (17 July 2015), http://www.theguardian.com/books/2015/jul/17/postcapitalism-end-of-capitalism-begun; Carolin Haentjes, Der Kapitalismus ist am Ende, Der Tagesspiegel (6 April 2016), http://www.tagesspiegel.de/kultur/paul-mason-im-hkw-berlin-der-kapitalismus-ist-am-ende/13412300.html.

56 Of course, international trade and service agreements can make a lot of sense, but they may also amplify existing problems and inequality, too: if the roles of customers and citizens are not strengthened, such agreements will reduce the likelihood of new solutions and accelerate the accumulation of formerly public or widely spread property and power in the hands of a few big companies, promoting Feudalism 2.0. This seems to be one of the great **public concerns against the CETA, TTIP and TISA agreements,** besides the possible weakening of democracy as well as social, environmental, and legal standards. Note that replacing the precautionary principle for new products by a risk management approach, as it is demanded by the USA (see http://www.greenpeace.org/eu-unit/en/News/2016/TTIPleaks-confidential-TTIP-papers-unveil-US-position/), has at least two drawbacks: (1) It often takes decades from the first evidence of a serious product risk until this finding has been established as a widely recognized fact; during this long time period, much harm can occur. (2) If risk management is combined with big and often global solutions, a mistake can easily become a big mistake, from which it may be hard to recover (such as the overuse of carbon-based energy resources).

scenarios discussed in connection with future resource shortages are depressing and sad. It is increasingly obvious that our economy will run in an evolutionary dead end, if we go on as before. We can certainly not allow this to happen, given that the lives of so many people are at stake. Before I explain, how we can mitigate our problems by means of democracy 2.0 and capitalism 2.0, I will discuss, how we got ourselves into so much trouble that we must probably talk of a «systemic failure».

2. Why our socio-economic system fails

[Rz 26] Multiple institutional failures are actually quite typical in times when a society undergoes a transition from one historical age to another. We have seen this in the past, when the agricultural society was replaced by the industrial society, and when the industrial society became the service society. Now, we are in the middle of a transition to the digital society. History tells us that these transformations tend to come along with financial and economic crises, with revolutions and wars, but after the respective transformation has been accomplished, further growth occurs. This time, we need to be smarter. We must avoid another revolution, war, or holocaust. We must reinvent and re-organize our socio-economic system *before* it collapses.

[Rz 27] While the agricultural society was ruled in a top-down way by kings, the industrial society was self-organized in a bottom-up way by entrepreneurs, and the service society was run by administrations. I am convinced that the digital society will be based on collective intelligence. Before this can happen, however, we need to create a suitable framework for it (democracy 2.0 and capitalism 2.0, as I will argue). If we go on as before, however, our problems will further intensify, until systemic collapse is inevitable.

[Rz 28] It is important to understand that this collapse can result even when everyone applies the established success principles of the past and has the very best intentions. Politicians, for example, may try their best to listen to the interests of people, but they can talk to just a few of them. Therefore, they will most likely talk to people representing a lot of other people, for example, industrials. This will automatically lead to politics that is oriented primarily at economic interests. Particularly in times of scarcity, this seems to be the right thing to do. If Maslov's pyramid of needs were right, food and shelter would be the main thing to care about, and everything else would become secondary or even less important.[57]

[Rz 29] Consequently, the job of entrepreneurs would be to minimize the use of resources, which seems to speak for committing to «economies of scale», i.e. mass production and monopolies. In fact, every industrial sector has learned to decrease the use of valuable resources per unit delivered. Cars and planes run on less fuel. A lot of supermarket food contains less and less ingredients that we would have considered food 40 years ago.[58] Similar trends can be observed in other economic sectors.

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57 I would like to call this pyramid of needs into question: information, friendship and solidarity experience all-time heights in harsh times, too.

58 Hannes Grassegger, China auf der Zunge, ZEIT ONLINE (15 November 2013), http://www.zeit.de/wirtschaft/2013-11/china-auf-der-zunge-essen-kochen; Gesundheitsrisiko: Europol findet Rekordmenge gefälschter Lebensmittel, Spiegel (30 March 2016), http://www.spiegel.de/wirtschaft/service/europol-findet-rekordmenge-gefaelschter-lebensmittel-a-1084739.html.

[Rz 30] Today, more than a billion people have more comfortable lives than kings used to have just a few generations ago. Thanks to the access to global resources and rationalization, the economy grew and grew. The public media helped to produce the culture of materialism and consumerism, which made it happen. In fact, our economy *had* to grow, because it builds on loan-based investments that require lenders to pay an interest rate to the banks. Banks had to take an interest rate to make money and exist. Scientists and engineers invented as told within the framework of the current system. They largely worked on subjects, which allowed them to raise third-party funding: subjects that companies cared about.

[Rz 31] All in all, everyone did what they were supposed to do,[59] but the economy, politics, science, and our lives were more and more dominated by one single dimension: economic efficiency.[60] Nevertheless, since the financial crisis, this economic system has come to its limits. Globalization does not progress anymore.[61] Central banks pump trillions of dollars into the markets, but this money does not reach the average customer and does not boost real investments as expected. So far, all desperate attempts to restart the engine of the world economy have failed. The game seems to be over. After the next financial and economic crisis, which some people expect to come pretty soon, we will probably face similar conditions as in the 1930's.

[Rz 32] Politics has already prepared for this: by investing in surveillance systems, weapons and detainment camps, but also in new kinds of propaganda and censorship systems to keep people in check – every one of us (using big nudging, social media filters, and social bots,[62] for example). The Sustainable Development Agenda of the United Nations does not sufficiently distance itself from such measures. In fact, the Agenda 2030 calls for «strong institutions».[63] One should keep in mind, however, that strong institutions can be very harmful, if power falls into wrong hands or inappropriate actions are taken.[64] For example, in a state of emergency, it often happens that measures not legitimated by the public, by science or previous success, are applied, but it is impossible to prevent them.

[Rz 33] A politics of empowerment, in contrast, which enables citizens to help themselves, to help each other, and to contribute to solutions (by means of democracy 2.0 and capitalism 2.0, for

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59 In a letter dated 22 July 2009 to the Queen of England, the British Academy also came to the conclusion that even well-intended behavior may lead to systemic failure: «*When Your Majesty visited the London School of Economics last November, you quite rightly asked: why had nobody noticed that the credit crunch was on its way?* [...] *So where was the problem? Everyone seemed to be doing their own job properly on its own merit. And according to standard measures of success, they were often doing it well. The failure was to see how collectively this added up to a series of interconnected imbalances over which no single authority had jurisdiction.* [...] *Individual risks may rightly have been viewed as small, but the risk to the system as a whole was vast.* [...] *So in summary* [...] *the failure to foresee the timing, extent and severity of the crisis* [...] *was principally the failure of the collective imagination of many bright people to understand the risks to the systems as a whole.*» See http://wwwf.imperial.ac.uk/{~}bin06/M3A22/queen-lse.pdf.

60 The minimization of the use of costly resources («rationalization») is driven by the desire to maximize revenues. However, the impact on human, social, and environmental resources, particularly public ones, is often neglected.

61 The exploitation of celestial bodies is planned, but is not possible yet.

62 Joachim Laukenmann, Wie digitale Daten Wähler manipulieren können, Die Welt (20 April 2016), http://www.welt.de/wissenschaft/article154572957/Wie-digitale-Daten-Waehler-manipulieren-koennen.html; see also Joachim Laukenmann, Wie digitale Medien Wähler manipulieren, Sonntagszeitung (10 April 2016), http://www.sonntagszeitung.ch/read/sz_10_04_2016/gesellschaft/Wie-digitale-Medien-Waehler-manipulieren-59964; Christian Meier/Jennifer Wilton, Social bots: Maschinen übernehmen die Macht im Internet, Die Welt (11 April 2016), http://www.welt.de/wirtschaft/webwelt/article154223388/Maschinen-uebernehmen-die-Macht-im-Internet.html.

63 UN Sustainable Development Goals, http://www.un.org/sustainabledevelopment/peace-justice/.

64 Warnings of the totalitarian potential also come from elected parliamentarians in various countries, see e.g. https://www.youtube.com/watch?v=sES6_OXPwOU; further information about the Agenda 21 and Agenda 2030 can be easily found in various YouTube channels.

example) seems to be more promising to master the challenges of the future in a reasonable way. In particular, the past has shown that narrowing down the solution approach to one criterion (or a few) such as security or economic efficiency, deteriorates the situation and causes a socio-economic system to fail.

3. Future scenarios

[Rz 34] The question is, what will happen now? Several scenarios spring to mind:

[Rz 35] *Global war (WW 3):* One possible and not entirely unlikely scenario is global war. Besides atomic war, we may see biological warfare (through the spread of deadly diseases), chemical warfare, or digital warfare (cyber war to make the information infrastructure dysfunctional). Each of these variants would be similarly devastating. Digital warfare seems to be less destructive, but would actually cause societal collapse through cascading failures.[65] As a result of any of these scenarios, hundreds of millions of people could die – it would be a true Armageddon.

[Rz 36] *Global pandemic:* A deadly disease may naturally emerge and spread. In fact, epidemiologists are expecting a large-scale pandemic already for some time. A new concern is the spread of multi-resistant bacteria. In other words, antibiotics become increasingly ineffective, as they are overused in industrial-scale meat production, which allows bacteria to adapt.

[Rz 37] *Euthanasia:* Based on some criteria, it would be decided whose life will be terminated (or not prolonged, e.g. by refusing medical aid). Some experts consider having computers or «super-intelligent systems» make and execute such decisions, for example, with the help of implants.

[Rz 38] *Revolution:* Economic and political instability may lead to social unrest and revolutions. Elites, which have failed to live up to their promises, and their immediate beneficiaries would be killed or imprisoned for corruption. Their accumulated resources would be redistributed to relieve the scarcity of resources. If the resulting political system would use material resources more sustainably, a lot more people may survive and live on.

[Rz 39] *Citizen score:* When running short of resources, a supercomputer using artificial intelligence technology would be employed to decide who would get how much of what resource, given previous behaviors, merits, and usefulness for society. Such citizen scores are already used in China to determine the payment conditions of loans, the kinds of jobs one may get, and the travel visa to other countries. The citizen score depends not only on consumption patterns, but also on the political attitude (as documented by the Internet links clicked) and by the behavior of family and friends.[66] In effect, such a system would create a caste society: some would get everything they want, others would have no chance to get certain kinds of resources.

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65 Marc Elsberg's book «Blackout» illustrates how such cascading scenarios might unfold. For scientific analyses of cascade effects see Dirk Helbing/Hendrik Ammoser/Christian Kühnert, Disasters as extreme events and the importance of network interactions for disaster response management, in: Extreme Events in Nature and Society (Springer, 2010), pp. 319–348.

66 A similar system, called Karma Police, exists in Great Britain, see Ryan Gallagher, Profiled: From radio to porn, British spies track Web user's online identities, The Intercept (25 September 2015), https://theintercept.com/2015/09/25/gchq-radio-porn-spies-track-web-users-online-identities/.

[Rz 40] *Basic income:*[67] In order to counter the rise of populism, extremism and social unrest, governments may decide to pay everyone a basic income, and allow them to earn an additional income by paid work. This would substantially reduce peoples» fear of losing their jobs (which may happen due to the quick spread of intelligent machines and automation). It would also allow people to experiment with new kinds of production and business models. Many people care more about a meaningful life than about a high material standard of living. A lot of them would turn to creative and innovative work. The demand for material resources would go down considerably, if we had a new *Zeitgeist* focused on the immaterial sides of life. After all «the best things in life are free.»

[Rz 41] I believe that basic income (plus a new *Zeitgeist*) is the best and only acceptable (responsible, legitimate) solution among the scenarios discussed above. It comes closest to «business as usual», but this is also the greatest drawback. Below I will, therefore, propose a considerably better, data-driven solution. However, as this solution is not yet ready for use though and still needs to be implemented, we may need an intermediate solution to bridge between today's system and the future system. «Helicopter money», as it is currently discussed by economic and banking circles, may be such an intermediate solution.[68] Given that pumping trillions of dollars into the financial system in a top-down way by the central banks has not achieved the proclaimed intentions, it now seems justified and necessary to try out new and unconventional approaches such as the bottom-up infusion of money.

4. The way out: There is a better, alternative future

[Rz 42] It seems that, in the past decades, many people did not pay enough attention to the question why we have such a terribly unsustainable system in the first place. On the one hand, we have been «brainwashed» to think that «everything is ok» (or at least will be). On the other hand, our political and innovation systems have encouraged creative people to innovate within the existing system, but not over the system itself. The orientation at scientific performance indices, the requirement to raise third-party funds, and the institution of peer review encouraged this. Now, we are lacking alternatives and it has become a matter of life or death. However, it is highly unprofessional to fixate ourselves to the system that we have at the moment. There could be many more financial, economic, social and political systems that we have not explored yet – most likely many better ones.

[Rz 43] My point is: we should engage in systemic pluralism and should be much more experimental. In fact, with virtual worlds and multi-player online games, we have now the technologies to make large-scale experiments with many different kinds of systems before we implement them. For example, financial systems serve to coordinate the use of scarce resources, i.e. to decide who will get how much of what resource. However, there are many different coordination systems that can accomplish this task, and probably many better ones. The current system matches supply and demand on average, but not in detail. As a consequence, we have both, hunger and obesity in the

67 Depending on the implementation, the resulting system might be considered as *socialism 2.0* or *social market economy 2.0*.

68 Ben S. Bernanke, What tools does the Fed have left? Part 3: Helicopter money, Brookings (11 April 2016), http://www.brookings.edu/blogs/ben-bernanke/posts/2016/04/11-helicopter-money.

world, which is bad for billions of people. Mechanisms used to decide about organ transplants or to run smart grids are much more sophisticated in matching supply and demand – they do it in a context-dependent and fair way. It is important, however, to ensure that these mechanisms are transparent and fair.

[Rz 44] Today's financial system has major flaws. Not only is it prone to devastating cascading effects. It is also essentially one-dimensional. As a consequence, the only possible temporal evolution is to go up or down, which automatically produces booms and recessions. Furthermore, it ranks every person and every country on a one-dimensional scale. Therefore, there are automatically winners and losers. This makes the current financial system a control system rather than a system empowering everyone to do business and thrive.

[Rz 45] Moreover, since we give more and more weight to economic issues (as I elaborated above), we end up projecting the complexity of the world on one dimension. Money makes the world go round, and all that counts is making money. This is known as utilitarian approach and leads to an oversimplified management of our complex world (often characterized as «linear thinking»).[69] It is the one-dimensional optimization implied by today's financial system, which gradually corrupts the functionality of complex dynamical systems such as our society, which then causes major failures. For humans and societies many things matter. Neglecting some of them leads to low economic performance and societal dysfunction. It is well-known that the most diverse economies and societies perform best, not those that have the simplest organization.

[Rz 46] In fact, we should understand our financial system, the economy and society as complex dynamical systems, where many components (e.g. people, companies and institutions) adapt to each other.[70] Such systems can only be managed well with multiple different «control variables». To illustrate this, take another complex system: our body. We cannot live just on one thing, say water. We also need oxygen, carbohydrates, different kinds of proteins, vitamins, and minerals. They cannot just be substituted for each other. The shortage of any of them will cause a disease. Healing a disease will require to take medicine, but the right one. More of that medicine will not produce better results, but may poison the body. The right medicine needs to be taken at the right time, and there may be unfavorable interaction effects with other medicines, which need to be considered, too. The same applies to our society. There is not one medicine (money) that can cure all ills. Instead there are many things that matter, but these have been increasingly neglected as compared to money (GDP per capita), and that is the true reason why our economy and society are about to fail.

[Rz 47] So, what to do now? We need a multi-dimensional money or incentive system[71] – a system that I will discuss later in connection with capitalism 2.0 and socio-ecological finance. As Albert Einstein said: «We cannot solve a problem within the paradigm that has created it.»

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69 The utilitarian approach measures the value of everything in units of money. It has lead to a one-dimensional optimization, as science and politics and other societal institutions are increasingly influenced by business interests. The related lack of a multi-faceted approach has significantly contributed to the increasing dysfunctionality of many societal institutions, i.e. their difficulty to fix the problems society is faces with. For example, the resulting system does not seem to serve the majority of people well anymore, as elaborated below.

70 Bertelsmann Stiftung (ed.), To the Man with a Hammer – Augmenting the Policymaker's Toolbox for a Complex World (Bertelsmann, 2016).

71 Dirk Helbing, Qualified Money – A Better Financial System for the Future (2014), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2526022 and Dirk Helbing, Interaction Support Processor (2015), https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2015118455.

We need a paradigm shift. In fact, this paradigm shift is already on the way. In the heart of capitalism, we have seen disruptive change. With the invention of Bitcoin, the bottom-up creation of money exists. Moreover, Uber and AirBnb are new shootings stars of the digital economy. Surprisingly, the biggest service providers of transportation and accomodation do not own any vehicles or hotels. They just coordinate people and resources more efficiently. With the spread of such sharing economy models, access to services becomes more important than owning material property. A similar thing applies to the music and movie industry, where the business model of streaming seems to replace buying and lending. I, therefore, predict that principles of the sharing economy will be central to future capitalism.

[Rz 48] The exact framework will still have to be sorted out. From my point of view, doing this now is much more important than establishing free trade and service agreements. The last decades have shown that more efficient production and big solutions, which generate the greatest revenue, do not fix the world.[72] We have rather to engage in diverse, mutually complementary solutions, which requires the creation of an information, innovation, production and service *ecosystem*. As small and medium-sized enterprises are the backbone of thriving economies,[73] it is necessary to revitalize them. Remember that the most diversified economies thrive most.[74] It is also becoming increasingly clear that the civil society can play a much bigger role in addressing the challenges of the future. For example, citizen science[75] and the maker community[76] (using 3D printers and other cheap technologies to produce complex products locally themselves) are important developments in this direction.

[Rz 49] Last but not least, young generations appear to be different from previous generations in a number of relevant points: They seem to value a meaningful job more than making a steep career. They have already a larger degree of networked thinking. Friends and family tend to be more important to them than becoming rich. Owning private property is less relevant to them than access to good services. All in all, they are probably adaptable to our future. Moreover, we see new types of companies, which are organized in a bottom-up way and outperform classical, top-down organized competitors.[77] In other words, a new economy, a new society is emerging in front of our eyes. We are about to step into a new era: a digitally empowered, participatory market society.[78]However, as we do not have much time to accomplish this transformation, we must now create a suitable framework for the digital society and make the necessary steps quickly.

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72 The issue with big solutions is that, if it (later) turns out that they have serious drawbacks or side effects, then there is a *big* problem, potentially a global-scale one. Diversity hedges such risks and ensures that there are alternatives, in case one solution fails.

73 See above, footnote 52.

74 See above, footnote 33.

75 Chris Coons, The government wants you to help it do science experiments, Wired (30 September 30), http://www.wired.com/2015/09/government-wants-help-science-experiments/; see also https://www.congress.gov/bill/114th-congress/senate-bill/2113.

76 A Nation of Makers, https://www.whitehouse.gov/nation-of-makers; see also http://www.nationofmakers.org/.

77 Examples are presented in this movie (in German): https://vimeo.com/157724336, https://vimeo.com/157708354.

78 See above, footnote 34.

5. What can now be done

[Rz 50] First and foremost, we need paradigm shifts and fundamental change. What short-term action might be taken?

[Rz 51] *Big Data and Artificial Intelligence (AI):* If properly used, these technologies can help to identify inefficiencies and better solutions. However, there are a number of potential pitfalls one needs to pay attention to, otherwise one may produce more harm than good.[79] It is also important to realize that even superintelligent systems will not solve all problems of the world (for example, problems related to friendships, social capital, culture, unemployment or peace).

[Rz 52] *Water:* Given that the production of one portion of meat requires thousands of liters of water,[80] an efficient way of reducing water consumption would be to lower the consumption of meat. In fact, vegetarian and vegan restaurants are increasingly «in». It would certainly help, if there were vegetarian chef shows on TV and every restaurant menu would start with a page with tasty vegetarian dishes. Modern meat replacement products based on soy and other ingredients also seem a promising way to go.

[Rz 53] *Food:* Eating less meat also makes it easier to feed the world population. Growing vegetarian food requires one tenth of the energy required to produce the same amount of calories from meat. Further attention must be paid to the regeneration of soil. Suitable planting cycles for food can help. Furthermore, «urban mining» allows one to recycle the scarce resource of «phosphorus».[81] Nitrogen can be extracted from air. Therefore, the production of fertilizer may be sustained for a longer time. Besides, better logistic may make 50 percent more food available, which is wasted today.[82] Last but not least, urban gardening, local supply chains and local cuisine are becoming new trends.

[Rz 54] *Reproduction rates:* With the spread of Artificial Intelligence and Virtual Reality technology, human reproduction rates will go down for at least two reasons: (1) In a few decades, humans will not anymore be the smartest species on Earth, the «Crown of Creation». Robots can substitute them in some places, and people will adapt to this. (2) Virtual Worlds will become more interesting than our physical world. The current trend is that young people interact with each other more through the Internet than in physical space, which does not produce offspring.[83]

[Rz 55] *Reduction of «climate gases»:* Approximately one third of carbon dioxide (CO_2), which seems to be a major contributor to climate change, results from transportation, one third from industrial production and one third from heating. The latter can be reduced by better insulation and by reducing the amount of space heated (or other heating technologies such as infrared heat, which primarily warms up organic matter). Air transport of goods can be increasingly reduced

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79 See above, footnotes 14 and 17, and Dirk Helbing/Jeroen van den Hoven, Responsible IT innovation: How to digitally upgrade our society?, preprint (2016); Autonomous weapons: An open letter from AI & robotics researchers, http://futureoflife.org/open-letter-autonomous-weapons/; Dirk Helbing, Machine intelligence: Blessing or curse? It depends on us!, Telekom (1 March 2016), https://www.telekom.com/company/digital-responsibility/304108.

80 Ami Sedghi, How much water is needed to produce food and how much do we waste? The Guardian (10 January 2013), http://www.theguardian.com/news/datablog/2013/jan/10/how-much-water-food-production-waste.

81 Andrew Urevig, New study finds recycled Phosphorus could fertilized 100 percent of U.S. corn, Ensia (15 January 2016), http://ensia.com/notable/new-study-finds-recycled-phosphorus-could-fertilize-100-percent-of-u-s-corn/.

82 At least one third of food is wasted today, a maximum of two thirds is used. Therefore, if we can avoid wasting food, the world can eat at least 50 percent more than today without increasing food production.

83 «Generation Beziehungsunfähig»: Darum macht Tinder süchtig, Huffington Post (7 April 2016), http://www.huffingtonpost.de/2016/04/07/beziehung-tinder-suechtig_n_9632410.html.

by local production (including 3D printing). Holiday trips by plane may be replaced by local leisure activities. Virtual reality and the new technology of holoportation[84] will, in principle, allow everyone to enjoy any place in the world at home.

[Rz 56] Furthermore, car traffic can be reduced dramatically. Google (now Alphabet) is planning to offer «transport as a service» using self-driving cars. This may reduce the number of cars needed to about 15 percent of the number today, without any loss of mobility. It will also reduce the number of garages and parking lots needed, etc. In other words, the consumption of materials to offer high-quality mobility will drop dramatically. In a further step, we will see a sharing of work space and space for living. Today, we live at home half of the day and we work in another place half of the day; in between we commute and do other things. This is highly inefficient. Robotic furniture will enable reconfigurable space in the sense of working and living. Virtual reality and holographic[85] or holoportation technology will enable a new level of remote teamwork. Furthermore, coffee shops are starting to offer working environments for business meetings. All in all, this will lead to less commuting, more efficient use of urban space, and attractive, walkable, livable cities.

[Rz 57] Methane is another climate gas to care about. Reducing meat production will also lower the emission of this gas.

[Rz 58] *Energy:* Wind power combined with a battery storage system, solar power and geothermal power are most likely our sustainable energy sources of the future. It will be also important to save energy and match supply and demand better. Smart grid technologies, combined with electrical cars (as power storage systems), are making significant progress in this direction.

[Rz 59] Altogether we see a tendency towards *decentralization* in energy production. Since globalization is hitting its limits, this is also found in production (with reindustrialization, 3D printing, etc.). In the financial system decentralization is occurring, too (with BitCoin, crowd funding, etc.). The trend points to more diverse rather than big, «one size fits all» solutions. Cities around the world with similar interests will build coalitions to solve their problems together. We could also organize city olympics, i.e. competitions for the best kinds of technologies, solutions, and city-wide implementations, driven by ambition, competition, engagement and fun.[86]

[Rz 60] *Innovation:* Given that we have not seen enough innovation to solve the impending resource issues, we need to massively improve on responsible innovation. All obstacles have to be kept out of the way.

[Rz 61] Academic institutions must be put in the position to work with the data they need and the latest technologies. The equipment of many universities (and schools) today is outdated, and the organizational framework does not keep pace with the speed at which our reality changes. Education needs to get personalized, and the use of Virtual World technologies and gamification can make learning rewarding and easy. Research should be freed from political and economic dependencies. The funding system should be changed from funding of promises to refunding for successful publications and deployments. Interdisciplinary research centers for research on complex systems and Global Systems Science should be massively supported. Talented junior

84 Holoportation technology is presented in this video: https://www.youtube.com/watch?v=7d59O6cfaM0.

85 The first holographic smartphone is presented here: https://www.youtube.com/watch?v=4tM5qJFsXeM.

86 Dirk Helbing, Countering climate change with climate Olympics (4 January 2014), https://www.youtube.com/watch?v=TaRghSuzBYM,

researchers should be able to work on the subject of their interest, get a longer-term perspective and be able to join the research team they like (which should come with an overhead for the receiving institution).

[Rz 62] In the digital economy (concerning non-material goods and services) there should be no patents, or they should be opened up for everyone after a maximum period of two years.[87] After a two-year period, software code should also be made open source. Copyrights should be replaced by a simple gratification system. For example, it would be possible to develop a special search engine that compares new files with older ones to determine their degree of similarity. The result could trigger an automatic payment to gratify creators of new ideas, services and products. Such a system would massively promote open innovation.

[Rz 63] Patents concerning the material economy should be opened up for a reasonable fee to everyone. It should not be possible to buy a patent or company to take competitive technology from the market.[88] Generally, any unused resource should be opened up for the use by others for a reasonable compensation.

[Rz 64] I think these changes are necessary and justified, given that we are talking about the future survival of a lot of people. We also need to engage in mass innovation. Therefore, it is recommended to support citizen science, the maker community, and similar initiatives that are committed to open data, open source, open innovation, etc. For example, an international «Culturepedia» project could identify the success principles underlying the diverse cultures of the world and operationalize them. This would allow people from all over the world to learn from each other and to combine their success strategies in entirely new ways such that better solutions to existing problems would be generated.

6. Democracy 2.0 and capitalism 2.0: the perfect couple

[Rz 65] By now, it has become clear that we need much better solutions to the world's problems. The challenge is that nobody can fully grasp the complexity of today's world, and that many actions we take have feedback, side or cascading effects. How to come up with better solutions? We need to put the best knowledge and ideas of the greatest minds (and of artificially intelligent systems) together, i.e. we need to create collective intelligence. Surprisingly, research in the area of collective intelligence shows that the combination of several solutions (e.g. a simple average) often performs better than the best individual solution.[89] A precondition for this is that the indi-

87 I am aware that this position on patents on copyrights is controversial, but a policy change is overdue and already happening: Tesla has opened up many of its patents. Google and others have open-sourced their Artificial Intelligence software. The recent US court rulings on Google Books supports «fair use» of intellectual property. The trend to open innovation is clearly visible.

88 Large companies are often weak in terms of innovation (basically, because they are not flexible enough and «new ideas are the enemies of existing ones»). This is the reason why big business tends to buy innovative small and medium-sized enterprises. However, this takes some of the best ideas from the market, and makes them inaccessible to others. Sometimes these innovations are not used at all but just locked away. Such a situation is not in the public interest and does not use resources efficiently. By the way, even though Alphabet (formerly: Google) pursues a phenomenal number of highly ambitious projects in the Google [x] lab, it cannot considered to be a counterexample: over 90 percent of Google's revenues are made with one single product: personalized information and ads.

89 Scott E. Page, The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools, and Societies (Princeton University, 2008).

vidual solutions are diverse and independently produced (which speaks against «big nudging», as it tries to align perspectives). In other words, diversity beats the best. The Netflix Challenge, for example, demonstrated this in a very impressive way.[90] All in all, if we replace top-down decisions and majority decisions by a collective intelligence approach, solutions to complex problems will be much better.

[Rz 66] This insight calls for a digital upgrade of democracy: democracy 2.0. As I said before, it is not majorities of people that matter for good outcomes, but a suitable combination of diverse ideas. In other words, to improve over today's solutions, we need to take more minority and opposition perspectives on board.[91] If organized well, this does not have to slow down decision-making – on the contrary. **Online deliberation platforms** now offer the possibility to put all arguments on a virtual table, to organize them in argument maps and identify the different perspectives. Once this has been done, it is time to organize a round table, where the leading representatives of the different perspectives are invited to develop *integrated* solutions, which bring several perspectives under one roof. In the end, the parliament would select one or a few solutions that satisfy many perspectives. I suggest to choose as many best practice solutions as needed to reach a majority of about two third of all elected representatives.[92] From this set of most promising solutions, the relevant communities (e.g. nations, regions, cities, or spatially distributed interest groups – depending on the level of organization) would then choose the solution, which fits their local needs and culture best. This procedure would create an optimal balance between standardization and diversity.

[Rz 67] The performance of the implemented solutions and the relevant success factors would be evaluated from various perspectives. Inferior solutions would be replaced by better ones, and the best solutions would be further improved based on the experience made. This approach would capitalize on creativity, science, and intelligence (including AI), on crowd sourcing, deliberation, and success principles of nature, namely experimentation in niches and selection. The proposed approach combines bottom-up and top-down elements in an innovative way. It is also well compatible with a federal (region-based) organization and with the well-established subsidiarity principle. Considering the current centrifugal forces in the European Union and the growing polarization in other countries (e.g. between rural and urban areas, or between groups with different subcultures), it becomes increasingly clear that the over-standardized «one size fits all approach» (as decided by the majority or most powerful) does not work anymore. If we do not upgrade democracy by eGovernance, as described above, we are likely to see catastrophic failure, i.e. the fragmentation of political units or social unrest.

[Rz 68] An important element in this renovation of our political system is to enable citizens to make better decisions. This requires more access to high-quality information for all and more

90 Netflix Prize, https://en.wikipedia.org/wiki/Netflix_Prize; see also the previous reference.

91 It may seem surprising that making «compromises» with minorities would improve the overall system performance. However, the reason is well understandable. In a complex optimization problem, there is typically one solution which is best for a given goal function (perspective). However, there are often many solutions that reach 95% of the best possible performance. Among these solutions, there will be some solutions, which also perform well from other perspectives (goal functions). In other words, when a system is not over-optimized in a single dimension, there is potential to meet many different interests and needs. In this way, the solution will create opportunities for many, which creates large socio-economic benefits.

92 As of today, the parliament will usually decide for one option only with a 50 percent majority, but it over-standardizes the world (reduces necessary diversity), which disadvantages a large number of companies and people.

awareness. With the aim of making progress in this direction, my research teams at ETH Zurich and TU Delft, together with partnering teams at other universities, have started to develop the **Nervousnet** platform (see nervousnet.info). Our role models are Linux, Wikipedia and OpenStreetMap. The Nervousnet platform allows people, companies and devices to engage in three ways: (1) by generating and contributing data, (2) by analyzing the crowd-sourced datasets, and (3) by sharing code and ideas. In other words, Nervousnet's goal is it to provide real-time data for all and an App-Store for Internet-of-Things applications. Anyone is able to create data-driven services and products using a generic programming interface. The aim is to yield societal benefits, business opportunities and jobs. Nervousnet uses distributed data storage and distributed control, so that it is more robust to attacks and centralized manipulation attempts, easy to scale up, and tolerant to faults. Nervousnet's approach is also compatible with the principles of informational self-determination and, according to our judgment, with the new EU Data Protection Directive.

[Rz 69] In particular, Nervousnet will be useful to measure external effects of interactions between people, companies and the environment (so-called «externalities»). Negative externalities (such as noise, pollutants or waste) would get a price, positive ones (such as cooperation, new jobs, or recycling) would get a value. In such a way, a circular economy would be boosted. Furthermore, we can now build a **multi-dimensional incentive and exchange system,** which I call «**socio-ecological finance**» (or finance 4.0). This would use knowledge from complexity science and new financial technologies (FinTech) such as Blockchain technologies (as it is used by BitCoin).

[Rz 70] The multi-dimensional incentive and exchange system will facilitate the creation of feedback loops in the system. In such a way, it will become possible to support the ability of socio-economic systems to self-organize in a favorable way. Note that, in economics, such self-organization processes have traditionally been called «invisible hand» phenomena. From complexity science, it is known that self-organization is a natural phenomenon in complex dynamical systems (such as the financial and economic system), but it does not necessarily lead to favorable outcomes (as the financial crisis has shown). However, it is also known that desired structures, properties or functions will automatically and efficiently occur in case of suitable interactions in the system. The kinds of interactions, which are needed for this, can be determined by complexity theory, computer simulations, laboratory experiments, or multi-player online games. The multi-dimensional incentive and exchange system mentioned above will allow one to adjust interactions in socio-economic systems such that desired outcomes will result. In other words, 300 years after its invention, it now becomes possible to make the «invisible hand» work, by combining Internet of Things technology with FinTech and complexity science.

[Rz 71] The «socio-ecological finance» platform will complement the current financial system and fix its functionality (given that pumping trillions of money into the system in a top-down way could not reach the desired effects). It will allow for the bottom-up creation of multiple new currencies by means of crowd-sourcing activities (namely, by measuring externalities). This approach will enable an effort-based, affordable living without the need of a basic income or helicopter money. It will also make it possible to create taxes as basis for public investments. All of this will not depend on the level of classical employment, i.e. it will be perfectly suited for a highly automated economy.

[Rz 72] The concepts of democracy 2.0 (based on online deliberation and collective intelligence) and of capitalism 2.0 (based on socio-ecological finance and sharing economy principles) are well

compatible with each other. I consider it the «perfect marriage» between liberalism, capitalism and democracy. This marriage is enabled by novel digital technologies. The socio-economic system built on democracy 2.0 and capitalism 2.0 is organized in a participatory, decentralized and bottom-up way. It offers individual and entrepreneurial freedom. By considering externalities, it supports environmental benefits, coordination and socio-economic order with very little regulation (as compared to today). For the end customer, the consideration of externalities would not be more expensive on the long run – on the contrary. Products and services would be better and cheaper, as long-term costs would be reduced.

[Rz 73] The new system would be able to benefit everyone: citizens, politics, and the economy. It would create new opportunities and sources of income for individuals, small and medium-sized enterprises, and big business. A redistribution of money is not implied.[93] The «finance 4.0» system rather uses the fact that non-material products and services, which will increasingly characterize the digital economy of the future, are unlimited. Complementary, sharing and recycling un- and underused material resources will reduce resource shortages. Altogether, this will allow us to create a higher quality of life for more people in the world, if we just slightly adapt our socio-economic framework as outlined above. The proposed systemic changes would be «minimally invasive», but highly effective, and, therefore, their implementation is realistic.

[Rz 74] The functional principle of the finance 4.0 system may be illustrated by the following picture: the current digital economy is a little bit like a desert, in which there are just a few palm trees (corresponding to a few big IT companies). The bottom-up creation of money with the socio-ecological finance system will water the desert and add some fertilizer (compare the different currencies with different kinds of minerals added to the soil). This will turn the desert into a rain forest – a highly diverse and interdependent ecosystem (with many different kinds of companies of all sizes), in which there are more than enough opportunities for everyone, and where the biggest trees are certainly bigger than the palm trees in the desert. In other word: the «finance 4.0» system and a suitable framework for the digital economy (requiring, in particular, a sufficient degree of interoperability, exchange, and opening up of currently unused resources for use) can benefit everyone, from the poor to the rich. It is time to build this novel, future-proof system, before the current one (which certainly created many benefits but now reaches its limits) collapses.

7. Summary, discussion, and outlook

[Rz 75] I have argued that the world may soon be confronted with serious resource shortages (e.g. of water, nitrogen, phosphorus,[94] rare earths, and other materials[95]), and that big business and governments have prepared for future crises. These preparations include mass surveillance, censorship and propaganda (by means of personalized information, big nudging, social bots etc.), a behavior-based rationing of resources (potentially using Citizen Scores), armed police, and

93 In the finance 4.0 system, different kinds of money would be created by crowd sourcing (e.g. by measuring environmental impacts). This money would then «evaporate» and rise up to the top, whereby it passes all levels of society and benefits all of them.

94 Will Steffen et al., Planetary boundaries: Guiding human development on a changing planet. Science 347 (2015). http://science.sciencemag.org/content/347/6223/1259855.full-text.pdf+html, p. 736.

95 See above, footnote 39.

detainment camps – measures to enforce public order that may appear plausible in a state of emergency. However, I have also shown that the totalitarian systems, which are on the rise, are endangering freedom and diversity and thereby undermining the innovation that we need to master our future.[96] This harms the performance of the economic system and the functionality of society, which can finally lead to economic and societal collapse, as it is unfortunately quite likely now.

[Rz 76] I have also pointed out that, due to the digital revolution, business models and institutions are undergoing fundamental transformation. The digital revolution allows us to reinvent everything, and we will therefore soon live in a differently organized, digital society. This future will be based on networked thinking and collective intelligence. The paradigm of selfish optimization (also known under the label «homo economicus») will not anymore be competitive with collaborative models of the future,[97] which engage in partnerships of companies, suppliers and customers, users, citizens, and patients. The novel, partner-based approach is often characterized by terms like «co-creation» or «information, innovation, production and service ecosystem».

[Rz 77] The future digital society is able to benefit everyone, as the resources in the emerging digital economy are basically unlimited. Due to automation (Artificial Intelligence, Robotics), the old economy making money by rationalization (using «economies of scale») will be run with about 50 percent of today's manpower (if the numbers that 50 percent of today's jobs will soon be gone[98] are correct). The other 50 percent will eventually produce digital products and services in the new, non-material economy, which is now emerging. This new, digital economy encompasses, in particular, Virtual Worlds, which will be used as «experimental worlds» and for new kinds of business. In other words, in the long run I do not expect mass unemployment, but we may face intermediate challenges during the transformation process. This calls for answers bridging from the old to the new world (such as helicopter money – until the socio-ecological finance system is fully operational). Without such bridging solutions, we may, in fact, run into revolutions or wars. However, by now, we should have learned enough from history to avoid such disasters and to avoid the repetition of old mistakes.

[Rz 78] Besides the challenges we are faced with, I have sketched concrete solution approaches and, in particular, an organizational framework of the future digital economy and society: democracy 2.0 and capitalism 2.0. These will upgrade today's democracy and capitalism, and be married together by means of a combination of new technology and science: the Internet of Things, FinTech, and complexity science. Democracy 2.0 (using online deliberation platforms) and capitalism 2.0 (crowd-sourcing various kinds of money by measuring externalities in order to run a highly differentiated incentive system) are approaches complementing superintelligent systems.[99] While superintelligent systems aim at the top-down optimization of systems, democracy 2.0 and capitalism 2.0 work in a bottom-up way. They support innovation and (co-) evolution as

96 Note that most innovations happen in a bottom-up way, and many of them «by accident».

97 Dirk Helbing, Economics 2.0: The natural step towards a self-regulating, participatory market society, Evol. Inst. Econ. Rev. 10(1) (2013), pp. 3–41.

98 Carl B. Frey/Michael A. Osborne, The future of employment: How susceptible are jobs to computerisation?, Oxford Martin (2013), http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf.

99 The usefulness of superintelligent algorithms is limited not only by the data available, but also by the complexity of the system. Complex dynamical systems that need high levels of innovation, such as our economy and society, require decentralized bottom-up approaches to perform well.

well as the interaction, self-organization and coordination of diverse activities and interests, of people and resources. Future, open and participatory sharing economy platforms are part of this solution.

[Rz 79] Why are open, participatory approaches so important? Because they enable a better, more innovative use of scarce resources. I claim that not material resources are our main bottleneck, but the way we are using them. Let me illustrate this with an example from traffic flow management in cities, where we have made a remarkable discovery: When we replaced the attempt of optimal top-down control of traffic lights by a bottom-up approach based on principles of self-organization,[100] we achieved a 30 to 40 percent higher performance.[101] How is this possible? Complex optimization problems cannot be solved in real-time, even with supercomputers. One needs to make simplifications, and the optimization is, therefore, performed in a certain, simplified solution space (for example, periodically operated traffic lights). However, some of the best solutions lie outside of the solution space chosen, no matter what solution space one may choose.

[Rz 80] In contrast, the self-organization approach attempts a flexible adaptation to the actual local needs. In our approach,[102] traffic flows control the traffic lights rather the other way round. This is based on simple rules that promote the coordination of neighboring traffic lights. In other words: we do not limit the solution space – we let the system evolve according to its needs and encourage coordination by the kinds of interactions implemented between the traffic flows and the neighboring traffic lights.

[Rz 81] Why is this of general importance? In urban traffic systems, road capacity (storage space) and flow capacity are often short resources, and their management is critical, if massive traffic jams shall be avoided. In the economy, materials are the resources that may run short. Suppose we get into a situation where we can use only 20 percent less resources than usual. So, assume that everyone would get just 80 percent of the resources that were available before. Then, one may never have enough resources to produce a particular product, because certain parts or ingredients would be missing. In other words, a proportional rationing would trigger second-order shortages and make the situation worse than it would have to be. Instead, we need a flexible system, where everyone can get 100 percent of certain resources on *some* days, but 70 percent on others, to compensate for this. This corresponds to a turn-taking principle[103] (which actually bears some similarity with the coordinated switching of traffic lights).

[Rz 82] In essence, a flexible system is able to create more goods and services than one that is managed in a top-down way.[104] Today, we know how to build such flexible systems. In connection with congestion and route choice problems, for example, I have elaborated concepts that can

100 Stefan Lämmer/Dirk Helbing, Self-control of traffic lights and vehicle flows in urban road networks, J. Stat. Mech. P04019 (2008); Stefan Lämmer/Reik Donner/Dirk Helbing, Anticipative control of switched queueing systems, Eur. Phys. J. B 63 (2008), pp. 341–347.

101 Stefan Lämmer/Dirk Helbing, Self-stabilizing decentralized signal control of realistic, saturated network traffic (2010), http://www.santafe.edu/media/workingpapers/10-09-019.pdf; further publications are available here: http://stefanlaemmer.de/?content=Publikationen; for internal reports contact dhelbing@ethz.ch or traffic@stefanlaemmer.de

102 See above, footnotes 100 and 101.

103 Dirk Helbing et al., How individuals learn to take turns: Emergence of alternating cooperation in a congestion game and the prisoner's dilemma, Advances in Complex Systems 8(2005), pp. 87–116.

104 This is known from the competition between capitalism 1.0 and communism 1.0. Note that, in times of scarcity and rationing of resources, black markets emerge, which try to compensate for a lack of flexibility.

increase the traffic capacity considerably, based on principles of fairness and flexibility.[105] In connection with gas supply, we have furthermore elaborated, how fairness can be reached, based on decentralized approaches.[106] Interestingly, symmetrical interactions tend to support not only fairness, but also optimal self-organization.[107]

[Rz 83] Today, we still lose about 30 percent or more of many perishable goods (such as food) due to bad logistics. Improving logistics along the lines discussed above would allow one to set many of the currently unused resources free.[108] Rationing resources and applying citizen scores, in contrast, would reduce the amount of flexibility, and let a socio-economic system perform badly.

[Rz 84] Big Data and Artificial Intelligence are certainly useful tools to identify inefficiencies and underutilized solutions. However, like any other tool, they are not solutions for everything. We must also see their limitations and side effects. The entirely new solutions and paradigms that are now needed to master our future will not be delivered just by brute-force data mining or machine learning. We must further see the serious dual use problem of powerful digital technologies. As they have societal-scale impact, they can potentially cause much greater damage than a nuclear meltdown or atomic bomb (which is geographically limited). Think, for example, of a blackout of the Internet for a couple of days,[109] or even for months, as it might happen as a result of solar storms («space weather»).[110]

[Rz 85] Powerful tools, particularly those with a centralized architecture, imply the risk of random or triggered failure, and of serious misuse. They are attractive for organized criminals, terrorists and people with extreme agendas. We therefore need to be wary of people or institutions who may instrumentalize future crises to turn democracy into fascism 2.0, communism 2.0, or feudalism 2.0.[111] To minimize potential misuse by mistake or intention, we must create a suitable framework, which ensures security, accountability, and transparency; democratic control, scientific, responsible, ethical and pluralistic use; forgetting, privacy and informational self-determination. One should also aim at openness (open data, open source, open innovation) and participatory opportunities to enable co-creation and benefits for everyone (as much as justified and possible). Altogether, the goal should be to create an information, innovation, production and service ecosystem for people, ideas, resources and initiatives, including an open sharing economy platform. The Nervousnet platform mentioned above could contribute to this ecosystem.

[Rz 86] Last but not least, it must be realized that centralized information systems may be unsustainable on the long run. Cybercrime causes a damage of around 1 trillion dollars per year and

105 Dirk Helbing, Dynamic decision behavior and optimal guidance through information services: Models and experiments, in: Michael Schreckenberg/Reinhard Selten (eds.), Human Behaviour and Traffic Networks (Springer, 2004).

106 Rui Carvalho et al., Resilience of natural gas networks during conflicts, crises and disruptions. PLoS ONE 9(3): e90265 (2014).

107 Dirk Helbing/Tamás Vicsek, Optimal self-organization, New Journal of Physics 1 (1999), 13.1–13.17.

108 Dirk Helbing/Stefan Lämmer, Method for coordination of competing processes or for control of the transport of mobile units within a network, https://www.google.com/patents/US8103434.

109 Rod Beckstorm, What if a hacker caused a large-scale Internet outage, WEF (12 June 2012), https://www.weforum.org/agenda/2012/06/what-if-a-hacker-caused-a-large-scale-internet-outage/; Matthias Schüssler, Die unterschätzte Gefahr eines Internetblackout, TagesAnzeiger (12 April 2016), http://www.tagesanzeiger.ch/digital/internet/Die-unterschaetzte-Gefahr-eines-Internetblackout/story/30794811.

110 Sonnenforscher warnen vor dem «Big One», Der Bund (8 April 2016), http://www.derbund.ch/wissen/natur/sonnenforscher-warnen-vor-dem-big-one/story/25117391; Geoffry Reeves, The space weather threat...and how to protect ourselves, HUFFPOST Science (19 April 2016), http://www.huffingtonpost.com/lab-notes/the-unpredictability-of-s_b_9721612.html.

111 In this connection, determining who financially supports populist movements is strongly advised.

is exponentially increasing.[112] Adding more devices to the Internet increases its vulnerability. CIA chief Clapper considers the Internet of Things to be the greatest threat to the USA.[113] In fact, there is no 100 percent security anywhere. The US military has been hacked, the Pentagon, the White House, the German Bundestag, and probably every company, too. The idea that systems (particularly learning ones) can be made 100 percent secure if we just control them more and more is a dangerous illusion – and tends to end in a loss of freedom *and* security.[114] Therefore, we may need a new security paradigm oriented at resilience, which could be inspired by the human immune system: even though this is attacked by bacteria millions of times every day, we live more than 70 years on average. Remarkably, the immune system is decentrally organized, which ensures that there is no single point of failure. For this and other reasons, the Nervousnet platform will be a decentralized system. Error and attack tolerance have been guiding principles since the creation of the Internet – we should not forget about this.

8. Heading towards the illuminated age

[Rz 87] As the experience in the past decades has shown, despite great achievements, technology alone cannot solve our problems. Human behavior and civil society need to be part of the solution. In order to make quick progress, I am summarizing below some of the steps that can be taken within the next few years:

- Business models and policies that do not comply with human dignity and human rights should be banned.
- Underused resources should be opened up for use for a reasonable compensation. For example, sharing economy platforms can offer opportunities to improve the use of underused resources. Furthermore, new solutions should be pursued to reward people and companies for innovative solutions and creative products.
- A centrally managed one-size-fits-all approach will not be diverse enough to create the innovation rates, collective intelligence and societal resilience needed. One should, therefore, support international interdisciplinary initiatives developing new solutions to impending crises,

112 Elinor Mills, Study: Cybercrime cost firms $1 trillion globally, CNET (29 January 2009), http://www.cnet.com/news/study-cybercrime-cost-firms-1-trillion-globally/; Jana Rooheart, Cyber crime to reach $2 trillion by 2019, business.com (19 April 2016), http://www.business.com/internet-security/cyber-crime-to-reach-2-trillion-by-2019-what-can-we-do/.

113 Kelsey D. Atherton, Clapper: America's greatest threat is the Internet of Things, Popular Science (9 February 2016), http://www.popsci.com/clapper-americas-greatest-threat-is-internet-things.

114 Benjamin Franklin: «Those who surrender freedom for security will not have, nor do they deserve, either one.» http://www.goodreads.com/quotes/140634-those-who-surrender-freedom-for-security-will-not-have-nor.

based on both, competition and collaboration.[115] In this connection, a Culturepedia project, climate olympics and similarly engaging formats might be fruitful.

- One should support the ability of people to help themselves and each other. Big Data, Artificial Intelligence, innovation and production should be democratized by supporting open data and open innovation. Furthermore, one should catalyze an information, innovation, production and service ecosystem by requiring or rewarding interoperability. Then, SMEs, NGOs, citizen scientists and the maker community could better contribute to solving the problems of the world, based on the principle of glocality («think global, act local»).
- One should build «democracy 2.0» («digital democracy»), which requires suitable platforms for online deliberation and eGovernance. Such platforms can now be created. They can help to bring the best knowledge and ideas together, which is key to master the challenges of the future. (They may also integrate Artificial Intelligence technology.) «Pluralistic» solutions that are acceptable from diverse perspectives have the advantage that they can serve multiple purposes and functions. The parliament could decide for, say, one, two or three of such solutions, giving communities a choice to implement a locally and culturally fitting solution. This approach would reach a good balance between standardization and diversity.
- Last but not least, one should build «capitalism 2.0» by adding a «socio-ecological finance» system to our current financial system, where various new currencies measure social and environmental impacts and attribute a certain value or cost to them. This socio-ecological finance system would provide a new, multi-dimensional incentive and exchange system, enabling to support the self-organization and coordination in complex dynamical systems such as our economy and society. If suitably specified, socio-ecological finance will foster a circular and sharing economy, which implies the more efficient use of scarce resources and a good quality of life for many people. The system will allow everyone to earn money by crowdsourcing (e.g. by measuring environmental impacts). Taxes for public investments can be automatically created as well. Capitalism 2.0 offers many dimensions to «do well». It also considers non-material value. Finally, as the approach takes externalities into account, it can effectively support environmental care and social cooperation (including peace between cultures) while supporting individual and entrepreneurial freedom.

[Rz 88] Until we have created the public framework of the participatory market society to come, we may go through a period of troubled waters. However, we should see it as a time of adventure and discovery, a time where individuals and groups can change the world to the better more than it has been possible in the past. The resulting data-driven society will not be run like a

115 Social and cultural diversity is as important as biodiversity for human survival. It hedges risks with respect to unexpected events, which will surely happen at a high rate as we undergo the transformation from the service society to the digital society and from the carbon-based economy to a low-carbon economy. How to reduce conflict under these stressful conditions in a highly diverse world? The idea is to familiarize people with other points of view (which corresponds to breaking «filter bubbles»). The relevant scientific experiment was performed by Muzafer Sherif, see https://en.wikipedia.org/wiki/Realistic_conflict_theory#Robbers_cave_study. In essence, it has been found that big challenges requiring team work can overcome tensions between different groups, see also https://www.youtube.com/watch?v=37QvponcEDc from minute 13. Real-world success stories of this approach are the European exchange program between cities and for students (Erasmus), which have managed to overcome post-war sentiments and establish a basis for peace in Europe. Now, this approach can be scaled up to global scale. Using Virtual Reality (VR), one can enable people to put themselves into other peoples» shoes and understand their perspectives. VR can help to overcome cultural barriers and support international collaborative projects. The advantage of this approach is that it can create social cohesion across national boundaries while allowing for diverse approaches. In a sense, Virtual Reality technology, if used in this way, may be seen as a tool to speed up the evolution of other-regarding preferences, i.e. to turn homo economicus into homo socialis, who has the ability to consider the points of views of others.

giant machine or clock tower, but rather like a well-coordinated system of diverse and largely autonomous, self-organizing systems, activities and processes. Among the data-driven societies discussed above, the combination of democracy 2.0 and capitalism 2.0 is certainly the most innovative and efficient socio-economic system, and the best possible basis for a thriving society.

[Rz 89] In the era to come, material goods will be more efficiently produced, thanks to Big Data, Artificial Intelligence and robotics. Principles of the circular and sharing economy («reduce, reuse, recycle») will mitigate or even overcome upcoming resource shortages. Ownership will become less important than opportunities to use products and services. Today's mobility may be provided by less than 20 percent of today's vehicles, and 50 percent of today's buildings would be enough to provide enough space for work and life. All in all, cities will probably become more livable than today.

[Rz 90] Besides the old, material economy, we will see the growth of a new, digital economy. This will be more or less unlimited, as it is immaterial, and will allow everyone – from individuals to big corporations – to benefit, if we get the framework right. We can see already that information plays an ever more important role in our lives (when measured in number of hours spent with information systems). Creative products and ideas will become increasingly important. This also implies that human values will be key again. It is clearly visible that people are currently seeking for new ways of leading meaningful lives. Soon, we will see a new *Zeitgeist*. The consumption of immaterial goods and services will increasingly replace the consumption of material ones, and consumption will become more active, as it is reflected by the terms «co-creation» and «prosumer» (co-producing consumer).

[Rz 91] Furthermore, rather than maximizing gross domestic product (GDP) per capita, many nations around the globe may maximize happiness, soon. The «economics of happiness»[116] shows that people actually do not need a lot of material resources to be happy: water, shelter, information access, and a meaningful life. The latter requires a society built on values and trust; it requires friendships, opportunities for personal self-development, a good health system, and social security.

[Rz 92] What kind of values may be guiding us in the densely connected, digital society of the future? Perhaps the following ones, which are the outcome of extensive discussions I had with many people:[117]

[Rz 93]

1. **Respect:** Treat all forms of life respectfully; protect and promote their (mental, psychological and physical) well-being.
2. **Diversity and non-discrimination:** Support socio-economic diversity and pluralism (also by the ways in which Information and Communications Technologies are designed and operated). Counter discrimination and repression, prioritize rewards over punishment.

116 Bruno S. Frey, Happiness: A Revolution in Economics (MIT Press, 2010); Rudolf Hermann, Glücksforschung: Die dänische Theorie des Glücks, NZZ (2 April 2016), http://www.nzz.ch/lebensart/gesellschaft/die-daenische-theorie-des-gluecks-1.18720975. Evidence of the psychological literature, specifically self-determination theory (SDT), implies that the following factors largely contribute to happiness: social inclusion, competence, and experience of autonomy; for a related review see Richard M. Ryan/Edward L. Deci, On Happiness and Human Potentials: A Review of Research on Hedonic and Eudaimonic Well-Being, Annual Review of Psychology 52, 141–166 (2001), http://www.annualreviews.org/doi/full/10.1146/annurev.psych.52.1.141.

117 See above, footnote 34.

3. **Freedom:** Support the principle of informational self-determination; respect creative freedom (opportunities for individual development) and the freedom of non-intimidating expression.
4. **Participatory opportunities:** Enable self-determined decisions, offer participatory opportunities and a choice of good options. Ensure to properly balance the interests of all relevant (affected) stakeholders, particularly political and business interests, and those of citizens.
5. **Self-organization:** Create a framework to support flexible, decentralized, self-organized adaptation, e.g. by using suitable reputation systems.
6. **Responsibility:** Commit yourself to timely, responsible and sustainable actions (or omissions), by 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:** Reduce negative externalities that are directly or indirectly caused by your own decisions and actions, and fully compensate the disadvantaged parties (in other words: «pay your bill»); reward others in a fair way for positive externalities.
9. **Protection:** Protect others from harm, damage, and exploitation; refrain from aggressive or war-like activities (including cybercrime, cyberwar, and misuse of information).
10. **Resilience:** Reduce the vulnerability of systems and increase their resilience (e.g. through decentralization, self-organization and diversity).
11. **Sustainability:** Promote sustainable systems and long-term societal benefits; increase systemic benefits.
12. **Compliance:** Engage in protecting and complying with these fundamental principles.

[Rz 94] To summarize the above even more briefly, the most important rule is to *increase positive externalities, reduce negative ones, and ensure fair compensation.* This might be considered as an operationalization of the **golden rule:** Behave in such a way, as you would expect it from others, if affected by that decision (where «others» also includes the environment and ecosystem around us). Shall we give it a try?

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