Part I
Prefaces

Preface: Humans in Digital Marketplaces

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Gerald Hüther

Considering the history of mankind, not much time has passed, since Friedrich Schiller captured the dilemma of his time in a nutshell in his famous Wallenstein trilogy: "The world is narrow, wide the mind of man". Today, in our digitalized and globalized world, Friedrich Schiller would describe the dilemma precisely in the opposite way: The world has become wide, but our brains are too narrow for the new world we live in.

The articles in this book underline the wide range of opportunities for innovative business enterprises offered by digital technology in our global and connected world. There is no doubt that this rapid development will not only continue, but even accelerate during the next years. The most important perspectives and directions of this process are clearly pointed out in this book.

Technological innovations do not only alter our previous means of production or change economic developments, they also offer completely new instruments to academic research. The use of digital media allows previously inconceivable insights into the structure and the organization of complex phenomena. This does not only concern classical natural sciences, such as astrophysics, but also and above all the so-called life sciences, the research of living systems from cellular and organic systems to the ecological and social systems.

The new opportunities of data collection and analysis are particularly suitable for the research of complex relationship patterns and their underlying laws. The so far prevailing analysis of isolated phenomena in laboratories will increasingly be replaced by the research of their interactions in natural conditions. Necessarily this will help to gain new insights. The last century's predominant deterministic idea concerning the structure of living systems through genetic programs is slowly being replaced by new findings on the

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increasingly visible and measurable skill of living systems for self-organization. A majority of findings and meta-analyses show that self-organizing relationship-patterns are responsible for further structure formation on all levels of development of living systems: during the development of embryos, the development of brains, the emergence of ecosystems or during the formation of social systems. In the 21st century, as a "side effect" of the introduction of technological innovations, "self-organization" has become a key term for the understanding of development and transformation processes of living beings. Also social development and transformation processes, like the cohabitation of human beings, are the expression of such self-organizing processes.

The so called Kontratieff-cycles describe how economic developments are placed on new foundations again and again through so called basic innovations. These can entail decades-long adaption processes in all areas of production, consumption or trade that manifest in phases of economic upturn. Examples for technological innovations that trigger respective economic growth are the steam engine (1st cycle), steel production and the invention of the railway (2nd cycle), the innovations in the area of electrical technology and chemistry (3rd cycle), the introduction of cars and petrol-chemistry (4th cycle) and finally, in the second half of the last century, the development of information technology (5th cycle).

However, these cycles have not only gone along with economic growth. They were always accompanied by noticeable changes to human life, especially to the cohabitation of humans. In particular these changes led to unavoidable, not intended (self-organized) adjustment processes affecting social relationships in the corresponding era.

Currently, with the globalization and the digitalization, we are experiencing a technological innovation which is not only of economic importance but also influences all areas of human cohabitation. This time even to a previously unknown extent.

The manner how humans will live together, work together and learn from each other in the future will probably change both fundamentally and permanently. To stay with the picture of Friedrich Schiller, the brain therefore has to significantly develop further.

The key to this development are offered by the most recent findings in the area of brain science: the human brain is more vivid than assumed. The brain is able to modify, add and expand neural networks even into the old age. For this reasons humans are capable to learn throughout their whole life. And: the human brain's structure is determined more than previously assumed by social experiences, the exchange of knowledge and skills and through collaborative design performances. It is therefore an organ that is formed by and optimized through social relationships. Whoever wants to further develop and "enlarge" his brain, or the brain of others, should to invest in social relationships, in mutual exchange and in the search of joint solutions.

In case it is true that every living system reorganizes the relationships of its members until the perpetuation of the regarded system is ensured with a minimal input of energy, it is possible to predict how the future coexistence of human beings, considering digitalization and globalization, will develop at the beginning of the 21st century. The former friction losses that were part of the traditional relationships, in other words, the enormous

expenses of energy and resources that are used to maintain our current way of cohabitation, has to shrink. New digital communication technologies and learning programs can be considered helpful instruments in this regards. However, the key to the transformation of our present (energy intensive) relationship culture might be found elsewhere and is more of a fundamental nature: As long as humans treat each other like objects to achieve their own goals and objectives, those communities create too much friction loss and thereby hinder themselves to evolve their existing potentials.

As a result we infringe against a generally valid principle concerning the development of the universe that has been identified by atomic physicists. That this is about the progressive opening and development of opportunities. Gregory Bateson already reminded us that there is no opportunity to change the nature, except one comply with it. But in order to comply with human nature, we need to know how it works.

With their research neurobiologists made a huge contribution to answer this question. In a nutshell their discovery points out: humans do not exist as individual entity, just as much as the brain does not exist without the body. In order to mature as humans beings and to become the designers of our own lives, we need other humans, we need communities where their members consider each other as subjects instead of objects of their own expectations and valuations, objectives and intentions, measures and orders. This makes it clear, where digitalization might finally lead us to. What remains uncertain, is the question when the actors and designers of this digitalized World recognize that this world persist over time, if it offers a familiar and comfortable feeling to people. This can only be offered through the satisfaction of the deepest human need for solidarity and security on one side and autonomy and freedom on the other side. “Digital marketplaces unleashed” could help to transform the world into a global village. And Schiller would be right again. However, it would be better if the unleashed digitalization increases the diversity and richness of the world and its cultures into the unknown. In this case Schiller would need state: As long the world is widening, the brain can never be narrowing.

Preface: Digital Society? The Great Transformation21

2

Fredmund Malik

2.1 Digital Society

2.1.1 From the Old World to a New World

Globally, economies and societies are going through the most fundamental change in history. We are experiencing the displacement of the Old World, as we have come to know it, by the New World, which is still largely unknown. It is the origin of a new order and a new societal functioning—a new kind of societal revolution. I called this process "Great Transformation21" in my book about "Governance" back in 1997. It will change almost everything: *What* we do, *how* we do it and *why* we do it—and, lastly, *who we are*. In just a few years almost everything will be new and different: How we manufacture, transport, finance and consume, how we educate, learn, do research and innovate; how we share information, communicate and cooperate; how we work and live. That will also change *who* we are.

A new dynamic order is forming, and—more importantly—so is a new mode of functioning of society and its organizations. Digitalization is one of the most powerful of several major driving forces. Its full potential will be exploited by an equally powerful force which is a new kind of management, governance and leadership. It is the *system-cybernetic kind of managing complex systems*. As I will later show, both have much in common since they had their birth at the same time and in same place.

The Great Transformation21 is the reason why ever more organizations—in the business as well as in the non-business sector—operate in a zone of excessive challenges. The origin of bureaucratic paralysis and ossification lies in the obsolete methods of con-

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ventional mechanistic management. Today's organizations prevent solutions and even contribute to the intensification of crises with their growing inability to master complexity. Digitalization on the one hand is aggravating the difficulties and on the other hand it will be one of the major solutions.

All the social mechanisms that make organizations function will change fundamentally and irreversibly—worldwide. Millions of organizations of every kind and size will have to adapt and be rebuilt, as they no longer meet the new standards. Across the generations, people will be required to rethink and relearn.

2.1.2 The Map of Growth, Uncertainty, and Creative Destruction

Change in itself—even big change—is not unusual. There is always improvement, adaptation, innovation and also disruption. Here, I am talking not about any kind of change but about a very specific kind of change, the kind that will replace the existing with something new according to a pattern. We are talking about *substitution*. The famous Austrian economist Joseph Schumpeter called this kind of change "creative destruction". With that, he put in words the basic law of change that also governs evolution in nature.

My paradigm of the Great Transformation21 is two overlapping s-curves (Fig. 2.1). My research into this pattern goes back to the late 1970s. In the graph, the red curve represents what I call the Old World. The green curve represents the New World and the foundations of tomorrow's world.

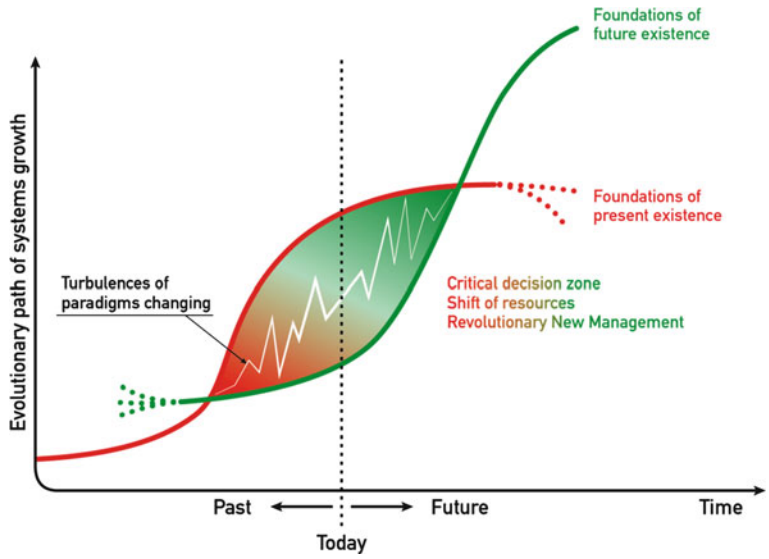

Fig. 2.1 The paradigm of the Great Transformation21

Between the curves, we see an area of increasing turbulences, as the old is replaced by the new. This is the critical decision zone; this is also where disruptions can take place; this is where the Old World starts dissolving and the New World begins to take shape.

This is the zone where the really difficult questions and risks of navigation and management occur. Previous key resources become increasingly meaningless; they have to be shifted or newly created.

In search of answers, we reflexively cling to old methods, although they are becoming increasingly useless. These old methods are what have caused the troubles in the first place.

Among other things, one key question is whether people in a "red" business will also be able to contribute to a "green" business, and all of a sudden it is doubtful as to whether you will have use for even your best people in the future. This zone of shifts is a black box—as it is named in the science of cybernetics, which is the basis for communication, control and navigation. It is a system which, due to its immense complexity, is incomprehensible, unpredictable and incomputable. However, with a new kind of management we are able to cope with it—just not with conventional methods.

2.1.3 Navigating into the Unknown by Systematically Misleading Signals

One basic rule of change is: *Whatever exists will be replaced.* Looking at it with hindsight, you know what the pattern looks like. You also know then what would have been the right decision at any given point. Standing in the here and now (Fig. 2.2), the existing

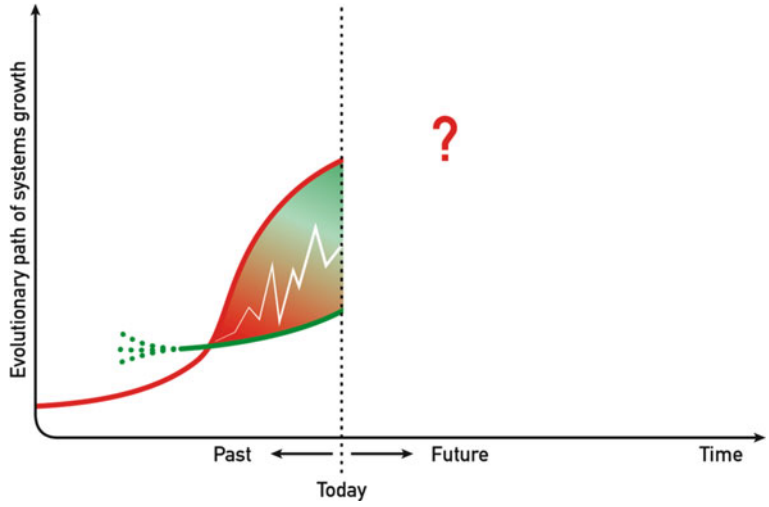

Fig. 2.2 Here and now: Navigating into the unknown with misleading signals?

information systems in our present organizations deliver systematically misleading signals as their output.

In today's world, the signals tell us to continue on the red curve. To the extent that—even if we notice the green curve at all and take it seriously—our old compass warns us not to pursue that route. Only when it is too late do our old systems sound the alarm. However, by knowing the entire pattern up to a certain degree, the risk of making wrong decisions can be circumvented.

2.1.4 Needed: Three Different Strategies and Systemic Leadership

There is yet another important challenge. We need three different strategies: The first strategy is to take advantage of the red curve as long as possible. We need a second strategy to build the green curve in time to have it when we need it. And we need a third strategy to make the transition from red to green.

At this point, it also becomes evident where we need real leadership and what it must entail. True leadership is needed for the start into an unknown future, when all visible signs seem to indicate that we should stay in the past. There are such organizations that have mastered change several times in the course of their existence, mainly by making it happen themselves. Examples include Siemens, Bosch and General Electric, but not Kodak. For instance, nothing could be more useless than having the world's best chemists in the photo industry when the substituting technology is digital. Virtually overnight Kodak's most valuable asset—the knowledge of its top people—had become worthless. What is worse, apart from having become "useless", these same people offered the strongest resistance to digitalization.

2.1.5 Being Ahead of Change

Just as there is a substitution pattern, there is also a strategic principle that successful companies and organizations adhere to: *Be ahead of change!* They actively make change happen instead of waiting for it to hit them. They take advantage of the forces of this relentless law of business—and not only business—to start into a new dimension of performance rather than fight it. They keep the initiative and determine the rules. Hence, change is not a must but a want to them. The organization itself determines what happens instead of drifting along. By outgrowing itself and its previous limits, it in effect substitutes itself. *If we don't do this, others will. It will happen one way or another*—that is their maxim.

2.2 Radical New Governance Thinking

2.2.1 From the Mechanistic to System-Cybernetic Management of Complexity

Information technology is one of the major drivers of the Great Transformation21. However, digitalization alone would soon freeze within the labyrinths of obsolete organizations and mechanistic management processes. Most probably it would just reinforce already existing bureaucracy. Successful digitalization needs system-cybernetic complexity management. Only together will they create the ability and willingness of people and organizations for fast change.

What does digitalization really mean? Properly managed it is the potential of rapidly growing interconnectedness of hitherto separated systems. And it also means doing things simultaneously which so far could only be done sequentially. As a consequence, this means an exponential increase in intelligence, adaptivity, speed and productivity. This is what challenges millions of organizations in our modern complexity society. Without functioning organizations a collapse of societal functioning looms.

The danger is real. Because the origin of most of today's organizations' morphology and principles of functioning reach far back into the last century. Therefore, they are ever less equipped to deal with the challenges of today's complexity and speed. They are too slow for the transformation, too stolid, neither efficient enough nor adaptable enough.

Decision-making processes seem paralyzed and block themselves. Collective intelligence, creativity, innovation and ability for change are lacking, as well as self-coordination, self-regulation and self-organization. If we were to stick to conventional ways of thinking and methods, a social disaster would be inevitable. On the other hand, a historically unique period of prosperity on a global scale could be reached if we rethink now. A new societal order—facilitating a *humane as well as functioning way of living together*—could thus be created, beyond the more than 200 year old and gridlocked political ideologies.

2.2.2 Digitalization and System-Cybernetic Complexity Management Have a Common Basis

Digitalization and the management of complex systems have the same hour and place of birth. The power of holistic, system-cybernetic management far surpasses the mechanistic linear management—many today call it "completely new". Its origin lies exactly in the time and place that also saw the development of today's computer technology. Partly the same pioneers were responsible who also build the fundament for modern computer technology and simultaneously for the proper management of societal organizations: They realized early on that the same principles apply to both areas.

One of them is mathematician Norbert Wiener, founder of modern cybernetics, with his book "Cybernetics: Control and Communication in the Animal and the Machine" (1948). Also the British neurophysiologist Ross W. Ashby with his revolutionary book "Design for a Brain. The origin of adaptive behavior" (1952). Add John von Neuman, the inventor of the modern computer, Claude Shannon's information theory and Heinz von Foerster's Causal Circularity.

With their early theories on information and communication, algorithms and heuristics and on the design and navigation of complex systems, they have created the prerequisites for today's real "cyberspace" as well as for the cybernetics of the management of complex systems. It was still too early for this new system-cybernetic management though. For decades, the industrialized society's mechanistic notion of management would continue to dominate, and it would be taught at thousands of universities and business schools—until today.

2.2.3 Organizations as Living Organism

The current challenge of the Great Transformation21 forces the renunciation of mechanistic management. The prevalent notion of the last decades that the company is a machine which can be steered with the linear principles of cause and effect blocked the necessary progress.

The more helpful notion is the organization as a living organism in its evolutionary environment. Management then is responsible for enabling organizations to self-organize and self-regulate wherever numerous and ever more people work together to reach common goals. Contrary to wide-spread fears this is exactly what allows people the freedom for the first time to unfold their intelligence and creativity in the digital world in a new and better way.

The new goal is the adaptive viability of a flexible organization that far surpasses the notion of sustainability. *What* needs to be done has been identified—and system-cybernetic management provides the *How* and *Whereby*. Hence, digital interconnectivity and system-cybernetic management of complexity will become the very societal functions that enable people to effectively exploit the new possibilities and opportunities.

Preface: New Computing in Digital Marketplaces Unleashed

3

Florian Leibert

We are at an inflection point where consumer technologies and innovation have forced their way into Global 2000 enterprises. People are asking themselves why enterprise software should be so much worse than someone's experience on an ecommerce travel site or searching for something on Google. And disruptive technologies such as new digital consumer devices and services have disrupted the datacenters at the heart of every large company in the world.

These advances in enterprise IT require new methods of computing, and a new breed of entrepreneur able to capitalize them. The unleashed digital market places are an exciting time that arguably began with the rise of the Worldwide Web just more than a decade ago, but really accelerated with the rise of social networks and mobile devices in the more-recent past.

Think about the shifts that have occurred since the 1990s, and have really picked up their pace in the past decade. One of the biggest is the proliferation of computing and the ability (or requirement) to reach consumers where they spend so much of their time—on their smartphones, tablets and laptops, or via connected devices that interface with those computers. A large enterprise application in 1995 might have involved thousands of client desktops connected to a single big-iron application server or database server. Now tens of thousands to millions of laptops, tablets, smartphones and other devices have to access a single application at any given time.

What happened was that giant web-scale companies such as Google, Facebook, Yahoo! and Twitter—all successful consumer web companies—grew so big, so fast that they had to invent distributed computing systems to prevent themselves from falling over or drowning in complexity. Because they were solving new classes of problems that legacy systems

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could not manage, they typically invented new open source frameworks themselves or they jumped on nascent projects coming out of top computer science universities.

Without distributed computing on the backend systems, there is no way any application could handle that much traffic—much less store, process and serve, in any reasonable amount of time, all the user and log data that millions of users can generate. This is why from Apache Spark to Apache Mesos to Apache Cassandra, almost every new technology of any real utility (and popularity) over the past decade is a distributed system.

Distributed computing is so commonplace in some areas that a single Google search or Facebook update on your smartphone touches dozens of such systems at very large scale—each spanning the equivalent of thousands to hundreds of thousands of nodes—in order to process data, rank results, serve ads, tap the social graph or knowledge graph, and much more. In fact, companies such as Google, Facebook, Microsoft and Amazon are so adept at managing and automating entire datacenters full of computers that they don't even think about units as small as server racks anymore. They buy machines by the shipping container and compete for bragging rights over who has the most, biggest and best datacenters.

3.1 From the Fringes to the Mainstream

Today, the types large-scale distributed systems, real-time data processing and service-oriented architectures these web companies built are business imperatives in corporate digital transformations. Executives and boards around the world are demanding their companies deliver products that can compete with the likes of Google, or at least can mimic Google-like efficiencies and innovation within their own IT departments. This leaves CIOs looking for new IT allies that truly understand the technologies their enterprises will need in order to deliver on these mandates.

While few organizations will ever reach that level of scale, the techniques these companies have developed to manage their datacenter environments are very useful for small startups and large traditional enterprises, as well. That mundane startup news website or innovative mobile game you love, for example, is probably running on some combination of, say, MongoDB, Elasticsearch, Spark and Amazon S3. Traditional enterprises are getting increasingly hip to distributed systems, too, targeting data analytics with systems such as Hadoop and Spark, or faster application performance with a distributed database.

More and more enterprises are exploring Docker containers and want to deploy microservice applications—that is, packaging each component of an application (sometimes dozens of them) as connected, but loosely coupled and separately-managed services. Microservices are frequently more about improving developer agility and simplifying IT operations than they are about scalability, but containers themselves have proven remarkably useful for technology pioneers such as Google, Facebook and Twitter. But even established enterprises like Verizon, Disney, and GE are embracing big data and re-architecting their computing around microservices and a containerized infrastructure.

Example

They have seen the business-changing, if not world-changing, applications that are possible when we monitor data from mobile devices, park visitors and jet engines—along with just about everything else in our physical world. They have seen the multi-billion-dollar potential of building first-of-a-kind and user-friendly consumer experiences. And they know the technologies that can help them deliver on these goals.

3.2 Distributed Computing is Hard—Good News for Entrepreneurs

For these reasons, I believe the movement toward this new distributed computing stack is inevitable. But it is not without its challenges. This creates business opportunities for entrepreneurs.

Most new distributed systems technologies require deep technical expertise to use in their raw forms. Many are open source software, oftentimes developed at large web companies and now managed by the Apache Software Foundation. They're appealing because they're free and proven to work at large scale. But you need teams of very smart engineers—who are hard to find and expensive to hire—to make it all work.

I experienced this firsthand at Twitter and Airbnb, where technologies such as Apache Mesos and Apache Hadoop helped us dramatically improve our ability to manage an ever-increasing number of servers (and the applications running on them) and process big data. However, there is no way we could have achieved those end results without some of the smartest computer scientists in Silicon Valley adapting those open source technologies to fit our specific production environments.

Example

Truly capitalizing on the distributed computing movement will require new ideas about how applications are built and new technologies to make them possible. Mainstream businesses will require software that lets developers unleash their ideas by tapping into a platform composed of thousands of servers and complex data-processing systems—without having to understand everything that's happening below the surface. They'll need software that automates the day-to-day experience of operations staff, so they can kiss goodbye the late-night outage emergencies and confusing catalogs of which applications are running on which servers.

3.3 A New Class of Startups for a New World of Computing

This means there is a golden opportunity for a new class of enterprise IT startups that is born out this datacenter-scale world. These are companies that understand the technologies at play—their founders have often worked with or created them at large consumer web companies—and understand how to turn them into products that large enterprises

will actually buy. From Day One, this new class of startups has operated with the knowledge that their success hinges on how well they can balance cutting-edge technology, real-world requirements, and an ecosystem of partners working on other pieces of the new distributed stack.

Open source software is a common, although not entirely necessary, component of the business model for many of these companies. The depth of a company's open source commitment is often tied to the technologies upon which its product is built, and to the level of software stack at which it plays. Popular infrastructure-level software, for example, is often open source today (for reasons that have more to do with innovation and lock-in than desire for *free* software), whereas application-level software is less frequently open source.

For startups, like Mesosphere, that sell products based on open source software, a lot of value lies in the community engagement and crowdsourced innovation that open source technologies facilitate. Smart enterprise IT startups understand that they don't know everything and it's impossible for them to stay current on all the latest technologies. There's a lot to be learned (and gained) from internalizing feedback from a diverse set of users, and from letting subject-matter experts bolster platform capabilities in areas in which your company is not an expert. This is a departure from many legacy IT practices, but also from the practices of web giants, who often build tools or distributions designed *specifically for their own environments* before releasing them to the world under an open source license.

Turning remarkably scalable, remarkably complex and remarkably valuable systems into easily consumable products is a huge challenge, requiring a remarkably different type of IT company. As you watch the current generation of enterprise IT startups continue to grow, to partner with one another and to innovate on the business side, you're actually watching the maturation of the next wave of IT giants in the unleased digital marketplaces—tomorrow's Microsoft, Oracle and SAP. Their technologies and their methods might seem foreign at times, but that's all part of coming of age in today's technology landscape. When it's all said, these are the companies that will dominate the era of data-center computing.

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