PETER HESSELDAHL

GROUND RULES FOR THE 21ST CENTURY
Chapter 2

EVERYTHING AND EVERYONE ARE CONNECTED, EVER CLOSER, AND IN EVER LARGER SYSTEMS

If we went back to the primeval soup in which life arose on earth, and fast forwarded through time, we would see cells arising from molecules, that by connecting to each other managed to keep a stable chemical process running. Later individual cells grouped, forming organisms with more specialized functions, and they in turn connected to configure a myriad of species that co-exist in an intricate ecosystem. One of these species was us - humans, who, having formed families and tribes, connected even further, in ever more advanced collaborations. We created societies, cities, nations and global events like the World Cup and Olympics.
The increasing interconnection has been supported by technology: language, writing, money, print art, ships, roads, airplanes, technical standards, free trade agreements - and of course the Internet, mobile phones and other digital information technology. This project of continued linking and connecting has been running for billions of years and it would be a complete reversal of the history of evolution, if things did not continue to connect.
All in all: When attempting to guess at what the future may bring, it is the progressive linking which is the deep, main undercurrent that pulls everything else with it.

It is the arrow of time that everything and everyone are connecting and linked ever closer in larger and more complex contexts.

One of the reasons for this is that in the struggle for survival it is generally an advantage to join forces. You become stronger against enemies, you can draw on more skills and by being part of a group you spread risk. Once someone has found ways of collaborating with others, they have typically gained an advantage, which meant that they did better in the fight for survival than others who would not cooperate. And therefore they could continue in the grand game of evolution. On their own, a Stone Age hunter could catch a hare, but when he teamed up with others, they could kill a mammoth together.

From farms to cities to space colonies

The tendency to connect is found in any realm: In science, observations are connected to form a coherent understanding. In economics, products and services are assembled in global supply chains and we are building huge and ever more elaborate systems for the exchange of goods, services and money. Culturally, we meet and influence each other in increasing numbers and regardless of distance through the media and the Internet. And at the practical, physical level, we are connected by a still more extensive and efficient infrastructure of roads, container ships, pipelines and other heavy-duty hardware.

The increasing interconnection in larger systems and more complex communities has reached a level where humanity as a species, seem to be in the midst of a historic transformation - a kind of quantum leap in our stage of civilization. In 2008 we

passed the point where over half the planets population were urban dwellers, and urbanization is even only just coming up to speed. Over the next few decades, hundreds of millions of people will move from a life in the countryside and huddle close together in cities.
It is not only physically, that we will be closer to each other. At the turn of 2009, the ITU, the International Telecommunication Union, estimated that half the planet's inhabitants now had a cell phone. And then there's the Internet: About a quarter of the globe's population, according to internetworldstats.com, have some form of access to the Internet - but this is definitely a figure, one should not leave un-checked for too long in ones powerpoint presentation, because the numbers are growing significantly each month.
Mobile phones, however, are spreading even faster. Every year half a billion new subscribers are added, and with the still more features and smartness of mobile phones, it is likely to be the handheld devices rather than the PC, which will dominate the next jump in global online connectivity and interaction. People buy cell phones before they get running water or proper toilets, because even for people who live among open sewers and have no electricity at home, the benefits of connectivity are obvious. With billions connected to the same news, pop culture, banks and markets, we are seeing global interaction at an entirely different scale and depth than previously.
In effect, we are becoming a single coherent system; humanity is so closely connected that in many respects it can best be described as *a global organism.*

In principle, one of the probable next steps would be expanding our connections to other planets. So far, however, we have our hands full ensuring that humanity's interconnection here on earth will not end in a collapse of civilization. Our technological development is amazing, but evolution does not issue guarantees for continued success. It is far from obvious that humans will be the species that bring the unique spark of life further outwards from earth towards the universe.

Change is accelerating
Things are moving faster and faster. The closer we are connected, the faster our interactions run. We are eliminating delays and obstacles. We don't have to wait for the mailman to bring our letters; we don't have to wait for our photos to be processed or for the computer to churn through a complicated analysis. We can move straight ahead.
Seen in a longer, historical context, there is a clear tendency for technological change to accelerate. Previously, the same discovery or invention would be made in many places independently. These days we just need to invent the wheel once because knowledge can be shared globally and further developed by others immediately.

Acceleration is self-reinforcing; every technological improvement enables us to speed up the development of the next, even more powerful technology to support our interaction.

One could say, that we live in an era of exponential curves. Much of the developments that are crucial for us, exhibit the characteristic ever-steeper climb in speed and power.
Some of the curves are worrisome. Looking far back in history, the growth in the number of humans and our impact on nature was slow. As late as in the early 1800's,

there were only 1 billion people on the planet - but then development certainly started to pick up pace. Populations grew, wealth increased, the consumption of food, energy and commodities shot up. The trend has accelerated ever since, and it is frankly hard not to worry, where the continued acceleration will take us.

Luckily, there are other curves of development that are encouraging and which suggest how we might resolve the challenge of slipping through the narrowing funnel of growing consumption and shrinking resources.

Our technology is evolving faster and faster. The clearest example is probably Moore's law, originally stated back in 1965 by Intel CEO Gordon Moore. Moore's Law predicts that the computing power of chips doubles every 18 months and in fact, the industry has succeeded in keeping up that extreme pace of development ever since the first integrated circuit in 1957.
Back then, Fairchild, one of the pioneers in the industry, sold their first series of transistors for 150 dollars *a piece*. At the time of writing this, for twice that price - $300 – you can buy an Intel i7 processor with 781 million transistors on the chip. Historically, it is unique that a fundamental technology has improved by over 40% every year for a stretch of five decades. Furthermore, it's not only computing power, which has increased at the pace of Moore's Law. The development of chips has been accompanied by similar rapid improvements in memory and transmission speeds - and it seems that the computer industry will manage to maintain that speed of development, at least for a few more doublings of capacity.
In other words: Although computers, mobile phones and the Internet have connected humanity at an amazing speed and extent in recent decades, it's still just the beginning.

Sciences converge at the scale of life
IT has changed the world over the past decade, now it seems that the coming decades will be shaped by advances in biotechnology and nanotechnology, as well as by rapid developments in the understanding of the brain and of the ways we think – the field known as *cognitive science*.

The four sciences, Nano, Bio, IT and Cognitive science, are often collectively referred to as NBIC, a term which highlights that in many respects, the disciplines are converging. All four technologies are operating at a scale where bits, genes, atoms and neurons start to share a common language and a common toolbox. When working way down "at the scale of life", the traditional disciplinary boundaries between chemistry, physics, electronics and biology dissolve.
So the general trend to connect and merge is affecting the technologies that are crucial to our future – the insights of the different sciences all become parts of the same system. Furthermore, as the American inventor and author Ray Kurzweil points out, all four technologies are developing exponentially - faster and faster.

All objects are equipped with the Digital Force
As Moore's Law makes computing power ever cheaper, more of our everyday objects will be equipped with what one might call "the digital force"; the combination of sensors, processing power and an ability to communicate - and thus they are spun into in a larger context. They become part of *the Internet of things* where all our objects, whether it's a running shoe or a car, will exchange information and coordinate their

activities through the network - just like we do.

A car equipped with the digital force, is not only a means of transport, but also a platform for a series of new services, all based on networked functions. The driver can receive traffic updates, but the car can also *send* information into the network, reporting on its speed or road conditions to the traffic system, which can then adjust signals and traffic lights to direct traffic flows. Both driver and passengers receive all sorts of information and media along the way. Shops and restaurants en route can send advertising; you can reserve parking space in advance, etc.

One can imagine many other examples of this kind of networked and integrated services: The bathroom can become a platform for delivering personal health updates based on analysis and information gathered from the bathroom scale, the shower, toilet or toothbrush. Similarly, environments such as hospitals, clinics, offices, classrooms, shops or museums could become platforms for a host of new services based on the devices in the room that can sense a little about what is going on and coordinate their observations with the other objects in the network.

Products and services become more complex

The tendency towards increasing integration and increasing complexity of our technology goes way back to antiquity. Some of the simplest tools you can imagine are sticks to hit with, stems used as a rope, and flint stones used as a knife. But someone in the Stone Age found out to combine the three technologies into hatchets, spears and arrows - and thus we have continued to develop our technology by combining existing tools in new ways.

One of my favorite museums is London's Museum of Science, and in particular, I am fascinated by the long central hall, where you walk along a timeline from the end of the 1700s up to the present, seeing the progress of technology along the way. Initially, the machines and objects on display are typically made of a handful of different materials; leather, iron, wood and glass. They're pretty rough, and the devices can typically be produced by a single company making all the parts itself. As one moves forward through industrialization, the goods get more refined in the processing and finish, and they are made from more components and different materials. It is no longer something that can be produced in a single workshop - now the devices are assembled from components from a variety of specialized subcontractors.
The trend continues up to today, where cars, computers and aircraft are composed of ten-thousands of parts, each of them a piece of highly sophisticated and specialized technology, which has demanded its own elaborate production system to produce.

From Robinson Crusoe inventors to innovation networks

A few hundred years ago it was lonely geniuses like Thomas Edison, James Watt and Marconi, who in their workshops made inventions that changed the world. But who invented the cell phone? What does it mean to "invent a cell phone"? Is it the transmitter, which is the crucial new component? Or is it the software, the infrastructure and networks of antennas? Is it the battery, or the particularly hardy computer chips? The phone we have in our pocket is a combination of thousands of big and small innovations.

Not only are the individual products far more complex, but also their value and functionality is increasingly dependent on a much larger surrounding system.

Electric cars will not work effectively and succeed on a grand scale before a large number of surrounding elements in place. Battery technology must be mature, there must be an infrastructure of charging stations in place, business models have to be developed, there has to strong political objectives to support renewable energy, the prices of gasoline should be high - and so on. The project will not be a success for anyone involved before the whole system works.
Similarly, with high-definition TV, home banking, smart electricity grids or high-speed trains. These are not standalone products, but complexes of closely interrelated and interdependent technologies, developing in concert, as waves rolling forward.

The consequence in business is that companies that previously prided themselves on being independent and self-sufficient, are becoming much more interdependent. Whether it's a product or service that you produce, its success in the market is closely linked to the quality of the entire infrastructure of other products and services that together create the user experience. If just one of the pieces is missing, the whole system stalls, and therefore it is in the participants' interest to cooperate and coordinate to ensure that everyone is up to speed. You need to coordinate technical standards, data exchange, user interfaces, billing, marketing, etc. with other companies to create a smooth and coherent experience for the users.

Collective intelligence
The more complex services are, the less likely it is that a single company will have all the skills needed in-house. Apple designs their Iphones in California, but they also outsource most of the technical development and production to a variety of mainly Asian subcontractors. And the services that in a sense are the real value that the Iphone provides - communication, music, video and a host of programs to facilitate daily life – most of those are created by thousands of small and large third party producers.

In his book The Rational Optimist, the British science journalist Matt Ridley, compares two objects that he keeps on his desk. One is a flint ax from the early Stone Age; the other is the mouse for his computer. They have roughly the same shape and size, but they represent two completely different types of manufacturing. The flint hatchet was made by a man for his own use, from the materials he had at hand. The computer mouse, in contrast, consists of materials and parts, which are assembled from around the world. The plastic is made from oil drilled in the Middle East, the metals are extracted in remote mines, the computer chip is manufactured in Korea, the software is written in India, and the design was done in the U.S. Furthermore, the mouse has no value without the support of electricity, and of the software that can interpret its input. Ridley estimates that if you really go all the way back through the supply chain, a computer mouse could be the result of a million humans' efforts. As he notes, there is no single person who knows everything that is required to produce a mouse. In effect, our tools are the result of a form of collective knowledge - or intelligence.

One of the consequences of integration is that we as individuals have to take on new roles. We still need classical inventors with brilliant and original ideas, but in many

cases there is no lack of new ideas. Rather, the shortage is in the ability to translate ideas into a product that makes it to the market and creates real value.
To complete the entire chain from idea to market requires the coordination of many ideas and solutions. That's why we are moving away from the "Robinson Crusoe inventor" towards innovation in networks, as Eric Von Hippel, a professor of innovation and entrepreneurship at MIT, puts it.

This is one of the crucial rules of the new game: You have to understand yourself as part of a larger context. It is not enough to think of your self when your destiny is closely linked to others. This applies to small and large businesses, to nation states as well as individuals.

We are going from 'me-thinking "to" we-thinking" as the English writer and consultant Charles Leadbeater puts it. Focus shifts; from me towards us - and this is a different approach than what most people are accustomed to.
"We-thinking" implies that you go from thinking about your company and its products as stand-alone, and instead you see them as linked and integrated with a surrounding context. You must be willing to cultivate and exploit synergies with partners, users - and even competitors.
In many respects this is similar to the concept of "open innovation": That you must look outwards, exchange information with the world outside your organization. You need to open your platforms for others and to adjust your components to fit on the platforms where everyone else is interacting.
Traditionally, companies compete by being closed and by trying to control the rest of the players on the market. But as we move forward, a closed and self-centered strategy will mean that you exclude yourself from being part of building up and creating the new levels of value and functionality that can emerge in the interaction with others.
We shall return to the ideas of open innovation and we-thinking later. For now, the message can be summarized thus:

Openness is risky, but exclusivity and isolation is increasingly inadequate.

<u>Our fate is shared</u>
This is true in general. Our circumstances and the challenges we are facing are increasingly complex and integrated. The global economy has become tightly connected and the players are increasing interdependent: Commodity prices are moving up and down in sync everywhere, as are the global financial markets.
If you zoom out all the way, it's clear that the major crises that the world faces are closely intertwined: energy, food, climate, health, economics, water, refugees, security - these are areas that can not be understood or even handled as individual problems. Humanity is increasingly a single coherent system, and fluctuations in one part spreads rapidly to the rest.
To develop and solve our problems, we are forced to connect - just as primal man had to find some buddies to go hunting with.

To sum up, any object, any technology, any person, company or nation is woven closer and closer together with others. Connecting in ever larger networks and contexts is changing the rules of our interactions, whether it's in international politics, science, culture, finance or business.

As I have described, this is not new - it's a fundamental driving force running throughout the history of evolution. What is new is the pace of the interaction, the scale of the system and the density, which we have reached.

This requires a major shift in our self-perception: In the future it becomes more important that we understand ourselves, our actions and the products we manufacture and consumer, as part of a much larger context.
We must recognize that we are interdependent - our destinies are linked, for better or worse.
Development and progress happens when ideas and resources that used to be separate are combined, so we need to learn to encourage and exploit much more interaction.

This last point; that something completely new can emerge when you combine old ideas in new ways, is our source of hope.
It's almost like magic; that something different and more valuable than the simple sum of its parts can emerge. This extra quality and value that arises is what makes it an advantage to cooperate rather than to fight each other. It is not always easy but the closer we are lumped together, the more necessary it will be.
In this book we will look at the preconditions for achieving true progress - and how they have changed dramatically in the era of the network. We will begin by examining the fundamental mechanisms that characterize systems in which many different elements interact closely - what we call complex systems.