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Digital Transformation in business and society

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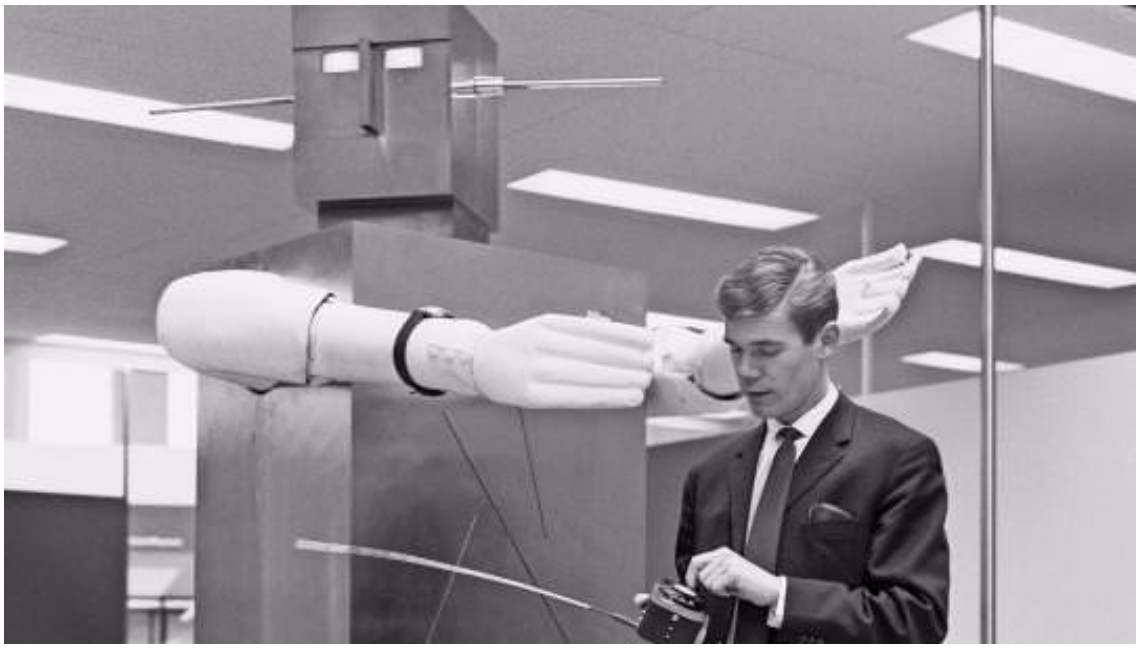

(Photo: Photopress-Archiv / Keystone)

By Sylvain Cottong, strategybuilders.eu

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Foreword by the Chamber of Commerce

Just as in the previous industrial revolutions where the steam engine or electrification revolutionized entire industries and the society on the whole, so will the digital revolution transform companies and condition our ways to conduct business as well as our social and cultural norms. There is a widespread recognition among most actors in industry and society that the emergence of disruptive digital technologies may fundamentally alter our perception of how we interact, communicate and exchange services, goods and knowledge.

Although the process of digitalisation is an omnipresent topic in news and media, a large majority still lacks a profound understanding of how the current technologies may affect human behaviour, businesses and management. The disruptive power should not be underestimated and their progressive development is happening quick and swiftly uncovering a number of challenges that need be apprehended and understood but offering at the same time unparalleled opportunities for value creation.

Becoming a digital enterprise or even a digital nation requires far more substantial changes than purely devoting resources to the latest digital technologies or building up digital infrastructures. Digital transformation will push traditional stakeholders to fundamentally question their current strategies, operating and business models and underlying culture in order to stand firm in the face of the shifts that progress at a sheer exponential rate.

The disruptive nature of digitalisation and the implications it may have on business and society is the primary reason why the Chamber of Commerce took the decision to get engaged in this topic. This document covers a wide array of topics linked to the process of digitalisation and aims to raise awareness among actors in economy and society by outlining the main digital artefacts and assessing, amongst others, the socio-economic implications and consequences. It is for the first time that such a comprehensive document has been published by the Chamber of Commerce for the broader public in Luxembourg and the Chamber of Commerce aspires to step up its efforts to become an active partner in the context of digital transformation. This document offers a first introduction into the world of digital artefacts. For actors who are less acquainted with the ramifications of digitalisation, this is a very comprehensive guide to get a first general overview. It is left up to the reader to reflect on the various digital trends and the possible implications they might have on its environment. The document can be considered as a toolbox and used as guidance to take the necessary actions that may help to keep up with the pace of digital transformation or even to move a step ahead.

This is the general mind-set that should inspire the decision makers in society, politics and economy as Luxembourg has no choice other than becoming a world class digital adopter and creator in order to remain competitive and attractive on the global stage. This can only happen if all the major stakeholders in Luxembourg embrace digital technologies and perceive them as a formidable opportunity for growth and not as an incessant threat. Luxembourg offers numerous advantages to be a great playground for testing new innovations and enabling technologies. While Luxembourg's innovation ecosystem seems to be well set-up, several hurdles still need to be redressed in order to be fully able to engage the path towards a digitally integrated economy and society. Solutions supported by partnerships between government agencies and private companies (PPPs) will be key to drive the success of the country's digitization initiatives as they offer the opportunity to forge collaboration and to identify the right inspiring questions that are fundamental for future policies, practices and strategy recommendations.

Moreover, the document displays a clear link with the project "Third Industrial Revolution" that the Chamber of Commerce launched in cooperation with the Ministry of Economy and IMS Luxembourg. It is an ongoing initiative that focuses to encourage a greater number of companies to strengthen their capacity to adapt to future megatrends by capitalising on the digitalized communication internet which is converging with the energy internet and a digitalized automated transportation and logistics network. Those key enabling technologies are supposed to unleash new productivity gains and render the economy and society on the whole more sustainable and prepare the path for future quality growth and assure the long-term competitiveness of the Luxembourg economy, and hence the continuation of its unparalleled social welfare model.

The report was prepared in collaboration with Sylvain Cottong from strategybuilders.eu, whom we would like to thank for his support and his invaluable expertise. We are confident that the findings and recommendations will contribute to improve the awareness about digital transformation in business and society.

Introduction

Digital transformation is definitely a topical issue today.

Indeed, the way we live, work, and relate to each other has fundamentally changed since the advent of the Internet, undoubtedly the biggest innovation in communication since the invention of the book press. At the same time, the pace at which network technologies and computing has evolved ever since is currently disrupting at an almost daily basis many of our known systems and behaviours while heavily challenging existing business models and governance processes. We may experience that evolution like an unknown and sometimes mysterious and fretful science-fiction world approaching us but also we feel like passionate pioneering creators of the completely new, a unique chance for solving the world's most pressing problems and a high potential for creating a whole new era of economic growth and prosperity. Therefore, our society is at an inflection point: are we becoming a dystopian control society or a human-centred knowledge society?

Lengthy philosophical discussions could be held about how fast and how selective we want to digitally transform our society and our economy but the fact is that digital transformation happens anyway, with or without Luxembourg. As a small country and open economy centrally located in Europe with an already very dense, open and connected economic activity and a considerable proportion of technology intensive economic sectors we simply have no choice other than becoming a world class digital adopter and creator in most areas to keep pace with our partners and the rest of the world in the globally hyper-connected marketplace. This requires that the role of the ICT sector has to be strengthened in its own right, but also as a partner and an enabler of digital transformation. At the same time, we must carefully tackle the challenges and threats of this super-fast evolution and develop innovative policies and regulation without falling into the trap of killing innovation through over regulation. Luxembourg's success has often been built on such an attitude, by making a business case out of pioneering regulation, such as in the financial sector, in intellectual property management and more recently in space mining. But digital transformation goes deeper than merely creating something new: It also questions our existing culture and way of thinking, and thus the management models that we embraced over the last 200 years.

The Chamber of Commerce believes that digital transformation is a key ingredient, next to a more sustainable way of relating to resources, of the future socio-economic state of Luxembourg. Therefore, the objective of this document is twofold: first of all, we would like to raise awareness regarding the process of digital transformation, taking stock of its main artefacts and ramifications. Second, we touch upon the socio-economic consequences of digital transformation - both in macroeconomic and in microeconomic terms - with a clear focus on providing a first set of proposals and public policy conclusions as a way to leverage digital transformation as an opportunity, rather than a threat.

More formally, in this document, first we situate the so called 3rd or 4th Industrial Revolution in more long-term economic history[1].

We then draw a short picture of the current state of the world, as any evolution always has also to be seen in the broader context in which it happens.

As digital transformation transcends many different areas of our economy, society, environment and personal lives[2], we will then identify the most important ones and give a brief overview on current states, practices and expected near future evolution for each of them.

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[1] For simplicity and clarity, we will use « 3rd industrial revolution », as defined by Jeremy Rifkin, as an expression for describing the current transformation processes that our economies experience worldwide throughout this report, given the fact that different authors use either expression but meaning the same phenomena.

[2] Disruptive technologies: Advances that will transform life, business, and the global economy, http://www.mckinsey.com/business-functions/business-technology/our-insights/disruptive-technologies & full report under http://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Business%20Technology/Our%20Insights/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx

We then draw a general picture of the current situation in Luxembourg in terms of digital transformation (economy and society) and identify challenges and opportunities at different levels.

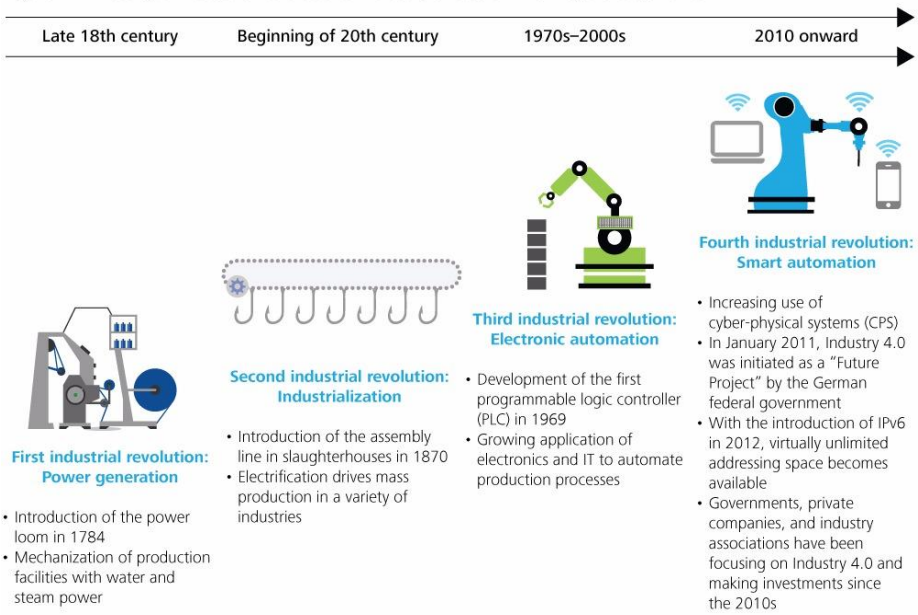
While it is clear that this document is a mere introduction to a very broad topic, it aims to open the debate and to contribute to embark and guide Luxembourg on the path of its digital transformation.

> *The future is already here — it's just not very evenly distributed. » -* William Gibson [3].

Which revolution?

According to **Klaus Schwab, the founder and chairman of the World Economic Forum**, the current industrial revolution is triggered by the confluence of electronics, IT and automated production starting around 1969. Today, we witness a second phase in the 3rd industrial revolution which is the emergence of cognitive task automation via artificial intelligence and learning machines. That's the reason why Schwab talks about a 4th industrial revolution whilst being a vivid proponent of the disruptive character and reminder of the challenges of digital transformation which he qualifies as the current emergence and evolving dominance of « cyber-physical systems » [4].

Figure 1. A history of industrial revolutions: Industry evolution with key developments



Sources: Germany Trade & Invest, "INDUSTRIE 4.0—Smart manufacturing for the future," July 1, 2014; National Academy of Science and Engineering, "Securing the future of German manufacturing industry: Recommendations for implementing the strategic initiative Industry 4.0," April 2013; Deloitte analysis.

Graphic: Deloitte University Press | DUPress.com

Source[5]

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[3] William Ford Gibson (born 17 March 1948) is an American-Canadian writer who has been called the "noir prophet" of the cyberpunk subgenre of science fiction. Gibson coined the term "cyberspace" in his short story "Burning Chrome" and later popularized the concept in his debut novel, Neuromancer (1984), https://en.wikiquote.org/wiki/William_Gibson

[4] The Fourth Industrial Revolution: what it means, how to respond https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond

[5] http://d27n205l7rookf.cloudfront.net/wp-content/uploads/2016/02/DUP_2898_Figure_1.jpg

Schwab writes [6]

> *There are three reasons why today's transformations represent not merely a prolongation of the Third Industrial Revolution but rather the arrival of a Fourth and distinct one: velocity, scope, and systems impact. The speed of current breakthroughs has no historical precedent. When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance.*

According to Schwab [7], since the turn of the century with its much more ubiquitous and mobile internet, the digital acceleration is driven by smaller and more powerful sensors that have become cheaper combined with artificial intelligence and machine learning.

And the big questions associated with that transformation turn around empowerment: how governments will relate to their citizens; how enterprises will relate to their employees, shareholders and customers; or how superpowers will relate to smaller countries.

The fourth Industrial Revolution would have four main effects on business across industries:

- customer expectations are shifting
- products are being enhanced by data, which improves asset productivity
- new partnerships are being formed as companies learn the importance of new forms of collaborative innovation,
- and operating models and organizational forms are being transformed into new digital models.

Schwab also considers the two competing effects that technology exercises on employment: The fourth Industrial Revolution seems to be creating fewer new jobs in new industries than previous revolutions.

In his book [8], he summarizes 23 deep shifts in technology[9] that fuel the current transformation:

1. Implantable Technologies
2. Our Digital Presence
3. Vision as the New Interface
4. Wearable Internet
5. Ubiquitous Computing

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[6] The Fourth Industrial Revolution: what it means, how to respond https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond

[7] http://www.goodreads.com/book/show/28570175-the-fourth-industrial-revolution

[8] http://www.goodreads.com/book/show/28570175-the-fourth-industrial-revolution

[9] See also: Deep Shift - Technology Tipping Points and Societal Impacthttp://www3.weforum.org/docs/WEF_GAC15_Technological_Tipping_Points_report_2015.pdf

6. A Supercomputer in Your Pocket
7. Storage for All
8. The Internet of and for Things
9. The Connected Home
10. Smart Cities
11. Big Data for Decisions
12. Driverless Cars
13. Artificial Intelligence and Decision-Making
14. AI and White-Collar Jobs
15. Robotics and Services
16. Bitcoin and the Blockchain
17. The Sharing Economy
18. Governments and the Blockchain
19. 3D Printing and Manufacturing
20. 3D Printing and Human Health
21. 3D Printing and Consumer Products
22. Designer Beings
23. Neurotechnologies

The **« Second Machine Age[10] » by Erik Brynjolfsson and Andrew McAfee** is another noteworthy book about the consequences of digital transformation.

While the different technologies and concepts identified as disruptive forces roughly correspond to Schwab's and other authors predictions[11], their book is clearly a more techno-optimist writing in that it claims continued prosperity and world-most-pressing-problem-solving through the data economy and the autonomous machine age, within a liberal capitalistic economic system. They fully acknowledge the possible negative effects of digital transformation on the job market, and therefore propose a basic income guarantee (BIG) by turning the Earned Income Tax Credit into a fully-fledged Negative Income Tax (NIT) by making it larger and making it universal. But that would mean that under skilled workers would be incentivized to do « unnecessary work » as the authors consider work as an end by itself for human well-being. That perspective collides with that of the proponents of an unconditional basic income (UBI) as a more humanistic form of BIG to respond to the expected deep shifts in the economy and the job market.

In The Second Machine Age, the great software-defined businesses of tomorrow will be the ones that usher in breakthrough innovations that do new things entirely — the kind of innovation that generates new value by opening up unforeseen market opportunities: new products, new services, new ways of servicing customers, and new jobs. But much of the innovation we still see today is efficiency-based in nature: it is about doing familiar things in cheaper, more efficient ways.

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[10] The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, http://www.goodreads.com/book/show/23316526-the-second-machine-age

[11] MIT Initiative on the Digital Economy, http://mitsloan.mit.edu/100years/pdfs/Erik*Brynjolfsson.pdf*

There have been many discussions about these authors arguments, especially in the light of the many unresolved challenges and risks that come with digital transformation, some of which are going to be outlined in the remainder of this report [12], [13], [14].

> *Digital technologies are doing for human brainpower what the steam engine and related technologies did for human muscle power during the Industrial Revolution. They're allowing us to overcome many limitations rapidly and to open up new frontiers with unprecedented speed. It's a very big deal. But how exactly it will play out is uncertain[15].*

Another famous analyst, namely **US economist, foresight expert and sociologist Jeremy Rifkin, in his book, The Third Industrial Revolution [16]** puts things slightly differently.

Rifkin suggests that fundamental economic change evolves with the confluence of a new communication technology, a new form of energy supply and new transportation mechanisms, by considerably increasing their aggregated efficiency. This was the case during the 1st and the 2nd Industrial Revolution, and happened again at the starting point of the current 3rd Industrial Revolution.

1. The first Industrial Revolution (19th century) was caused by the convergence of steam-power, letterpress printing and railways.
2. The second industrial revolution (=20th century) can be attributed to electric communication and the combustion engine as well as road transportation.
3. The third industrial revolution (which is – according to Jeremy Rifkin – currently happening) is triggered by the co-occurrence of the internet, renewable energies and sustainable mobility. And both elements promote the development of the local, collaborative and lateral societal and economic structures of the green economy (or the so-called « low carbon economy[17], [18] »).

According to Rifkin, the foundation of the green economy consists of 5 pillars – each of which only functions in combination with the others:

1. Transition from fossil to renewable energies
2. Transformation of all buildings into mini-generating power plants

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[12] THE SECOND MACHINE AGE: WORK, PROGRESS AND PROSPERITY IN A TIME OF BRILLIANT TECHNOLOGIES, https://itp.nyu.edu/classes/ede-spring2014/the-second-machine-age-work-progress-and-prosperity-in-a-time-of-brilliant-technologies/

[13] JUSTICE FOR "DATA JANITORS", http://www.publicbooks.org/nonfiction/justice-for-data-janitors

[14] A CRITIQUE OF THE SECOND MACHINE AGE (Or the Need to Shed our Romantic Ideas about Wage Labour), http://declineofscarcity.com/?p=3436

[15] The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee, https://hbr.org/2015/06/the-great-decoupling

[16] http://www.thethirdindustrialrevolution.com

[17] https://en.wikipedia.org/wiki/Low-carbon_economy

[18] Decarbonation is the sum of measures and techniques used to reduce the amount of carbon, more specifically CO2, in energy, or even in an entire economy.

These measures may include the search for alternatives that emit less carbon dioxide (renewable energy, nuclear energy, natural gas), processes that are more energy efficient (energy performance, cogeneration), cleaner production methods (telecommuting, services) or even the capture and sequestration of CO2 before or after the use of fuels., http://www.futura-sciences.us/dico/d/sustainable-development-decarbonation-50000842/

3. Development and build-up of energy storage technologies and capacities (e.g. hydrogen)
4. Capitalizing the internet technology for the development of a smart and bidirectional (peer-to-peer) energy-sharing-grid
5. Transformation of the transportation system to electric plug-in and fuel-cell vehicles

Furthermore, the traditional, hierarchical organization of economic and political power will give way to a more laterally distributed model across society

In his book, « The Third Industrial Revolution », he also gives a short summary of what has to be achieved technology-wise in order to build a low-carbon economy.

His interpretation of the current industrial revolution thus is much more energy supply centric, also arguing that developed countries are unable to further increase their aggregate productivity (which in fact more or less stagnates since the 1990s) in a considerable way unless they put in place connected and data driven technologies to increase energy use efficiency in terms of production and distribution[19], [20] (by « smart grids ») and considerably increase the use of renewable and low-carbon energy forms via those technologies. Those technologies exist today, and Rifkin is advising an increasing number of countries in the developed world on how to implement strategies and investment plans to realize this potential[21].

For convenience and consistency reasons, we will qualify the current industrial revolution as the 3rd industrial revolution throughout this document, knowing that we have entered a new phase within that industrial revolution, namely the addition of **cognitive automation** (possibilities) that emerged as a « natural » prolongation out of the fundamentals of IT and mechanistic automation (see Box 1).

Cognitive automation is what makes the current industrial revolution fundamentally different from the previous ones. Machines will be able to simultaneously take over from humans ever more demanding cognitive tasks (i.e.movement, face, voice and text recognition and deep learning) in combination with ever more complicated motoric tasks.

Former levels of automation made possible by the previous industrial revolutions always gave rise to new types of jobs and new industries that were often more stimulating and less unhealthy. When machines came to the fields, farmers started to work in plants that built and maintained the machines. When robots entered the production lines, workers took over the production and maintenance of these robots, and whole new job categories were created at the same time. Prior revolutions have always been accompanied by mass migration of labour: from the fields to the factories, from the factories to the service provided. But how will the current industrial revolution affect jobs and the job market?

Economist study the radical shifts brought by agricultural and industrial revolutions through what they call « Economics of the Singularity », meaning that each « revolution » was a « singularity »[22], [23], [24].

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[19] https://en.wikipedia.org/wiki/Efficient_energy_use

[20] The International Energy Efficiency Scorecard, http://aceee.org/portal/national-policy/international-scorecard

[21] He's currently also advising the Luxembourg government in that area http://www.troisiemerevolutionindustrielle.lu. More on that later.

[22] Economics Of The Singularity, http://spectrum.ieee.org/robotics/robotics-software/economics-of-the-singularity/seconsb

[23] Economics Of The Singularity, http://spectrum.ieee.org/robotics/robotics-software/economics-of-the-singularity

[24] Special Report: The Singularity, http://spectrum.ieee.org/static/singularity

Today, some scholars say that we are at the eve of a « technological singularity »[25], [26],[27].

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If we look back at human development history, we can say that technological progress was often and in most cases driven by better and easier communication and better and easier transportation, including energy distribution. There seems to be a natural incentive in mankind for both as they appear to be the main drivers for a more comfortable and valuable life closely tied to economic development. We have now entered an era where, to some respect, both communication and transportation have almost become substitutes, as data and communication networks are used for distribution of more and more immaterial goods, on the one hand, and energy on the other.

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[25] « The result for me has been an increasingly close integration of physical science and computer science, bringing the programmability of the digital world to the physical world. But whether computers are merged with reality or reality is merged with computers, the result is the same: the boundary between bits and atoms disappears. » - Ray Kurzweil and Neil Gershenfeld: Two Paths to the Singularity, http://spectrum.ieee.org/computing/hardware/ray-kurzweil-and-neil-gershenfeld-two-paths-to-the-singularity

[26] The technological singularity (also, simply, the singularity) is the hypothesis that the invention of artificial superintelligence will abruptly trigger runaway technological growth, resulting in unfathomable changes to human civilization. According to this hypothesis, an upgradable intelligent agent (such as a computer running software-based artificial general intelligence) would enter a 'runaway reaction' of self-improvement cycles, with each new and more intelligent generation appearing more and more rapidly, causing an intelligence explosion and resulting in a powerful superintelligence that would, qualitatively, far surpass all human intelligence. Science fiction author Vernor Vinge said in his essay The Coming Technological Singularity that this would signal the end of the human era, as the new superintelligence would continue to upgrade itself and would advance technologically at an incomprehensible rate. - https://en.m.wikipedia.org/wiki/Technological_singularity

[27] Business Models and the Singularity, http://www.digitaltonto.com/2012/business-models-and-the-singularity/

BOX 1: THE COGNITIVE REVOLUTION

Michel Serres, the renowned French academic, philosopher and science historian takes an interesting different perspective on the current digital revolution: He argues that the new digital technologies are radically changing time, space and cognition. According to him, we are moving from a physical space towards what he calls a « topological space »[28], [29].

He thus puts digital transformation in the perspective of the emission, processing and reception of information:

1. Appearance of language
2. Appearance of writing
3. Appearance of the bookpress
4. Appearance of the Internet

Each of these « revolutions » profoundly changed our way of living and made us successively lose part of our memory. But what we lost in formality we gained in universality.

The Current State of the World - From stability and predictability to uncertainty and ambiguity

Any evolution always happens in the context of its time. We can say that the **digital revolution** started in the early 70s of the 20th century with the advent of the first mainframes and personal computers and is really accelerating exponentially since the beginning of the 21st century. The famous Moore's law, co-founder of Intel,

> *observed that the number of transistors per square inch (that directly define a computer's processing power) on integrated circuits had doubled every year since the integrated circuit was invented. Moore predicted that this trend would continue for the foreseeable future. In subsequent years, the pace slowed down a bit, but data density has doubled approximately every 18 months, and this is the current definition of Moore's Law, which Moore himself has blessed*[30].
>
> *Intel stated in 2015 that the pace of advancement has slowed, starting at the 22 nanometer (nm) feature width around 2012, and continuing at 14 nm. Brian Krzanich, CEO of Intel, announced that "our cadence today is closer to two and a half years than two." This is scheduled to hold through the 10 nm width in late 2017. He cited Moore's 1975 revision as*

[28] La révolution cognitive: http://www.agoravox.fr/actualites/technologies/article/la-revolution-cognitive-120540#_jmp0_

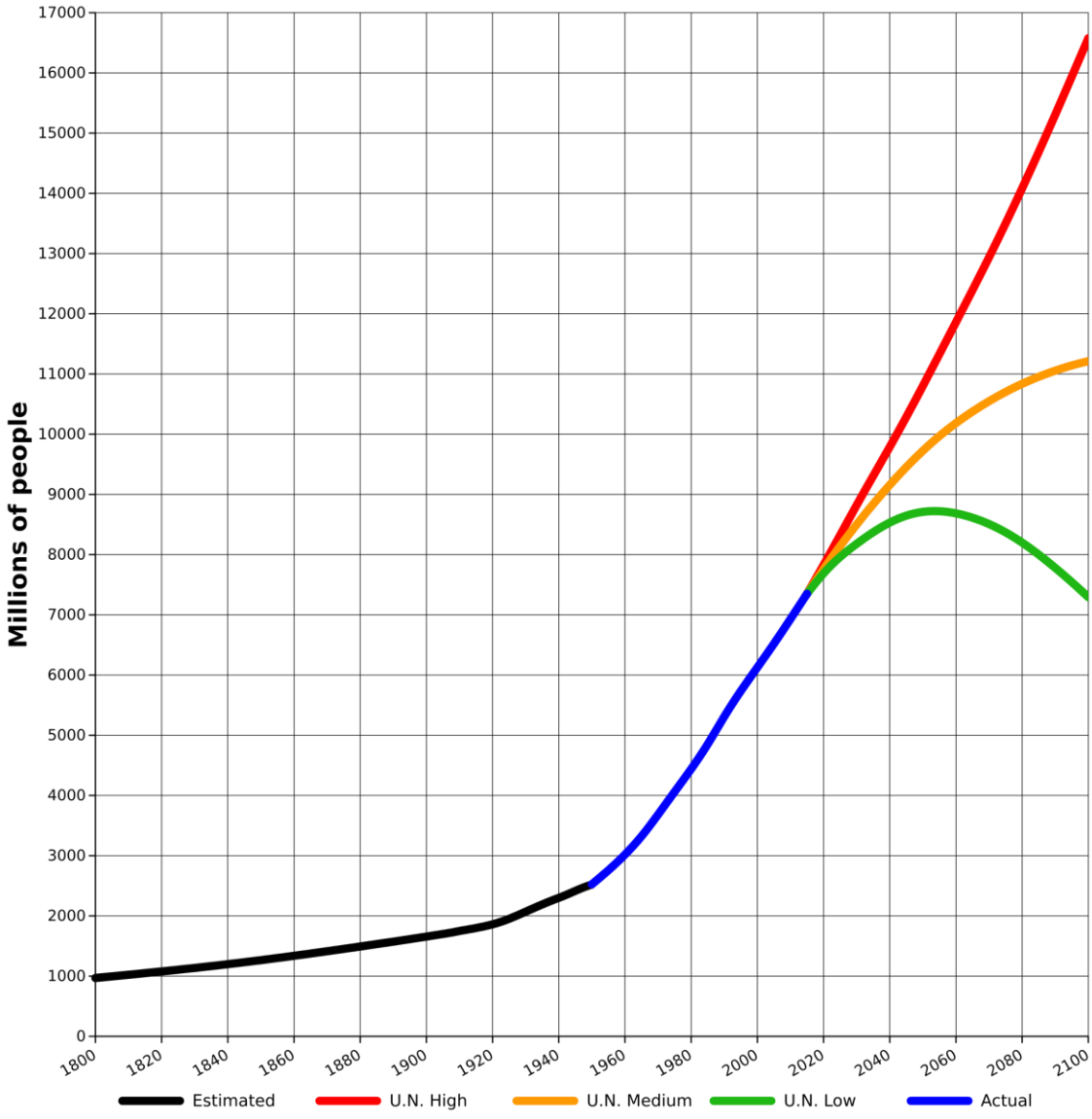
[29] MICHEL SERRES : La révolution culturelle et cognitive: http://www.inexplique-endebat.com/article-michel-serres-la-revolution-culturelle-et-cognitive-115499161.html

[30] http://www.webopedia.com/TERM/M/Moores_Law.html

> *a precedent for the current deceleration, which results from technical challenges and is "a natural part of the history of Moore's law [31].*

At the same time, world leaders opted for the **liberalization of international financial markets** in the 1970s which can also be considered as the real beginning of globalization, the latter being a natural consequence of the former.

Taking a look at the **world population** increase in the same time, we clearly see an interrelated exponential evolution[32]:



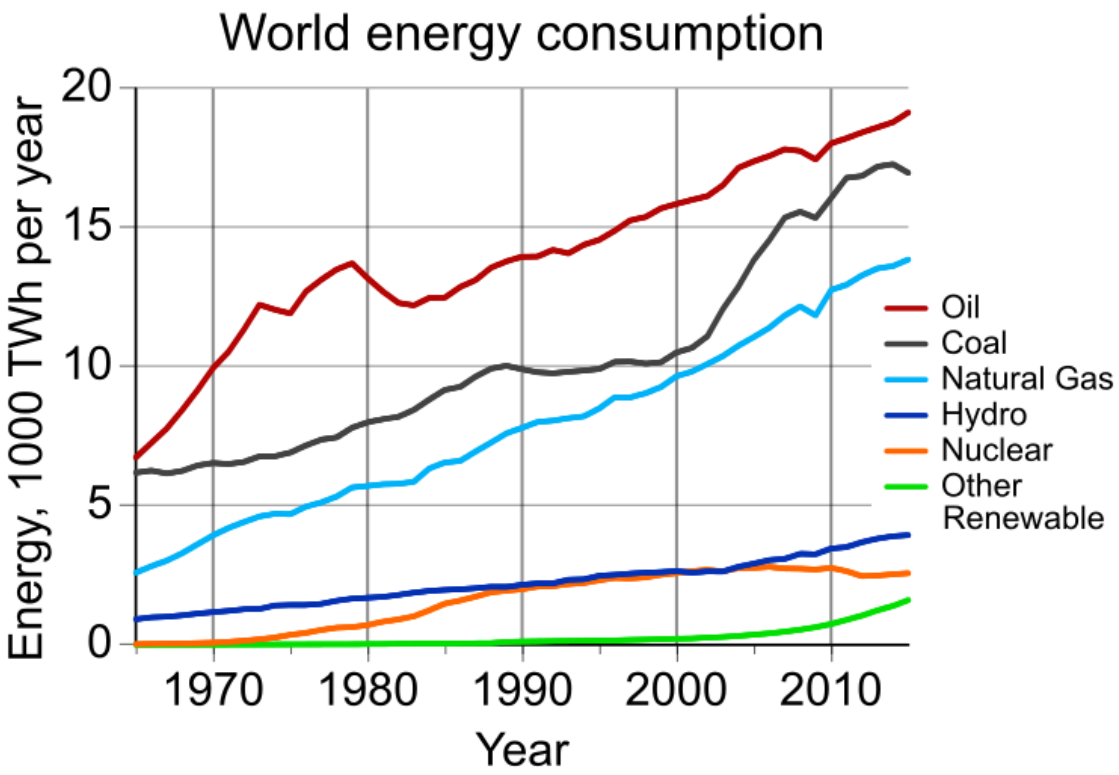
Source[33]

[31] https://en.wikipedia.org/wiki/Moore%27s_law

[32] https://en.wikipedia.org/wiki/World_population

[33] https://upload.wikimedia.org/wikipedia/commons/thumb/5/56/World-Population-1800-2100.svg/2000px-World-Population-1800-2100.svg.png

The picture concerning worldwide **energy consumption** shows a similar pattern[34]:



Source[35]

In terms of world governance, we witness additional bold shifts that all happen at the same time, especially during the last 15 years:

- Increased economic globalization
- Exponentially increased speed and complexity of society and the economy
- Migratory flows
- Climate change
- Ubiquitous terrorism threats
- The 2008 financial crisis
- The EU crisis (« Exit scenarios », questioning of the Schengen acquis)
- Cyberthreats
- Increasing wealth gap between and within economies
- Widespread « fear » about the future

[34] https://en.wikipedia.org/wiki/World_energy_consumption

[35] https://en.wikipedia.org/wiki/World_energy_consumption#/media/File:World_energy_consumption.svg

- Rising populism and the associated emergence of « post-truth » politics[36], [37], [38], [39], [40]
- Re-emerging nationalism
- And last but not least: DIGITAL TRANSFORMATION.

In strategic leadership, the term VUCA (**V**olatility, **U**ncertainty, **C**omplexity, **A**mbiguity) [41], [42] describes this new reality best:

[36] https://en.wikipedia.org/wiki/Post-truth_politics

[37] http://www.newstatesman.com/politics/uk/2015/09/we-live-volatile-age-post-truth-politics-and-so-brexit-cannot-be-ruled-out

[38] https://www.washingtonpost.com/posteverything/wp/2016/06/16/why-the-post-truth-political-era-might-be-around-for-a-while/

[39] http://www.salon.com/2016/06/19/trumps_lies_arent_unique_to_america_post_truth_politics_are_killing_democracies_on_both_sides_of_the_atlantic/

[40] https://www.theguardian.com/commentisfree/2016/may/13/boris-johnson-donald-trump-post-truth-politician

[41] VUCA is an acronym used to describe or reflect on the volatility, uncertainty, complexity and ambiguity of general conditions and situations. The notion of VUCA was introduced by the U.S. Army War College to describe the more volatile, uncertain, complex and ambiguous multilateral world which resulted from the end of the Cold War. The common usage of the term VUCA began in the 1990s and derives from military vocabulary. It has been subsequently used in emerging ideas in strategic leadership that apply in a wide range of organizations, including everything from for-profit corporations to education.

[42] https://en.wikipedia.org/wiki/Volatility,_uncertainty,_complexity_and_ambiguity

Source[43]

This new reality fundamentally questions our traditional governance models that were more or less stable for a few hundred years and rather based on linear, command-and-control, top-down approaches. The reason is that in a complex world, where no single organization can control and understand every constituent of a situation, behaviour or emerging trend, a free-flow of ideas and initiatives in an open collaboration fashion is as superior way to respond, as it unleashes and taps into collective creativity and intelligence. We will see later on how the concepts of open innovation and collaboration enter current management practices.

David John Snowden[44] a Welsh academic, consultant and researcher in the field of knowledge management developed the CYNEFIN framework[45] as an orientation map for dealing with this new complexity:

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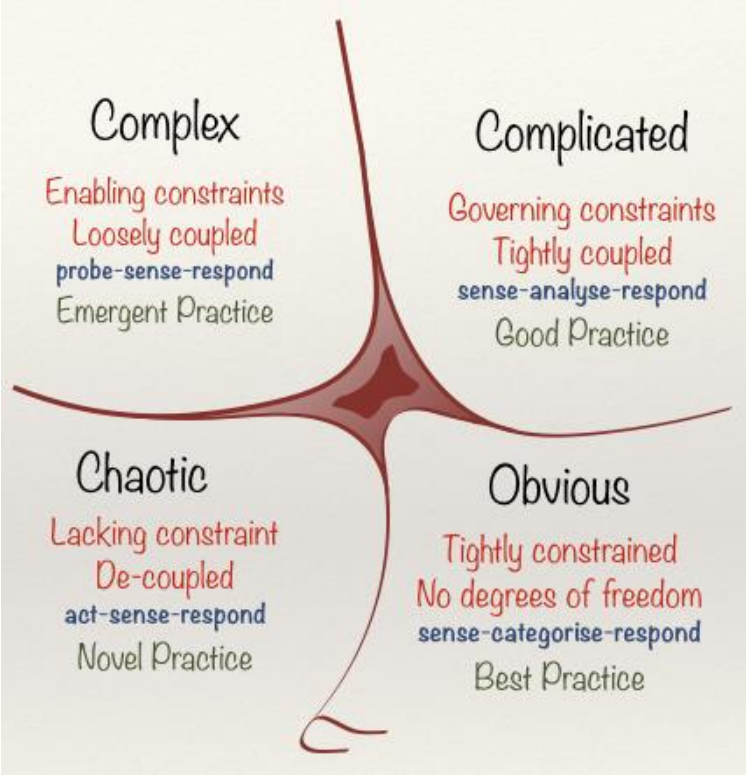
[43] Organizations in Challenging Times, http://organisatieleren.be/

[44] https://en.wikipedia.org/wiki/Dave_Snowden

[45] https://en.wikipedia.org/wiki/Cynefin_Framework

The framework provides a typology of contexts that guides what sort of explanations or solutions might apply. It draws on research into complex adaptive systems theory, cognitive science, anthropology, and narrative patterns, as well as evolutionary psychology, to describe problems, situations, and systems. It "explores the relationship between man, experience, and context" and proposes new approaches to communication, decision-making, policy-making, and knowledge management in complex social environments.



Source[46]

Obvious situations: Causal-effect relationships are simple and well-known. ***There is typically one « best practice .»***

Complicated situations: Causal-effect relationships can be found through rigorous analysis. ***There are multiple « good practices »***

Complex situations: Causal-effect cannot be found through analysis. ***Systematic experimentation is needed to discover what works.***

Chaotic situation: The situation must be stabilized quickly. ***Solutions are unique.***

Needless to say, we have entered a world where we have to deal with an increasing number of complex and chaotic situations: politically, socially, environmentally, technologically and, of course, economically.

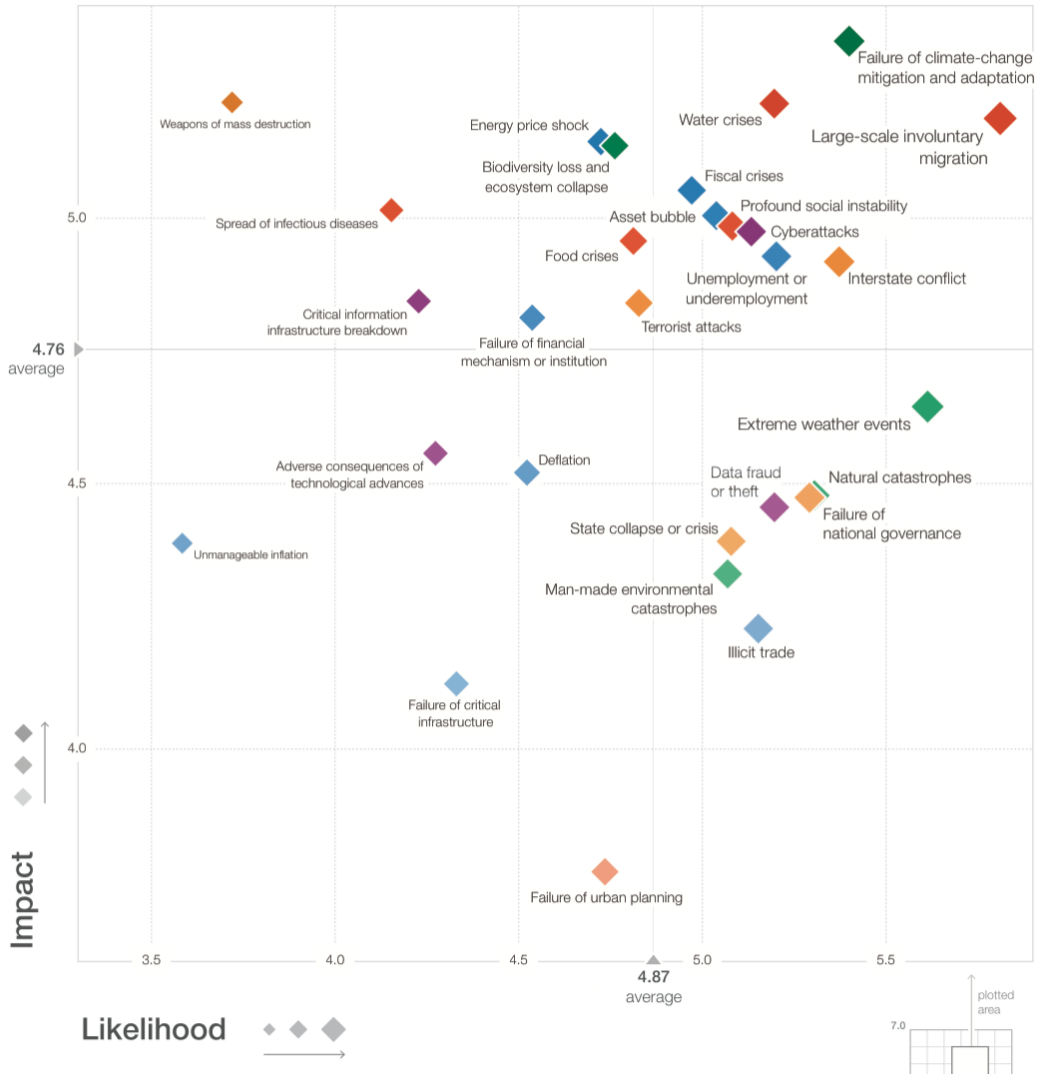
[46] https://en.wikipedia.org/wiki/Cynefin_Framework#/media/File:Cynefin_as_of_1st_June_2014.png

BOX 2: THE GLOBAL RISK REPORT - WORLD ECONOMIC FORUM

It is worth mentioning the very comprehensive global risk report that the World Economic Forum publishes on an annual basis[47].

Here are some of the main revelatory illustrations taken from that report:

Figure 1: The Global Risks Landscape 2016



[47] http://www3.weforum.org/docs/Media/TheGlobalRisksReport2016.pdf

Table A: Global Risks 2016

- Asset bubble in a major economy
- Deflation in a major economy
- Failure of a major financial mechanism or institution
- Failure/shortfall of critical infrastructure
- Fiscal crises in key economies
- High structural unemployment or underemployment
- Illicit trade (e.g. illicit financial flow, tax evasion, human trafficking, organized crime, etc.)
- Severe energy price shock (increase or decrease)
- Unmanageable inflation
- Extreme weather events (e.g. floods, storms, etc.)
- Failure of climate-change mitigation and adaptation
- Major biodiversity loss and ecosystem collapse (land or ocean)
- Major natural catastrophes (e.g. earthquake, tsunami, volcanic eruption, geomagnetic storms)
- Man-made environmental catastrophes (e.g. oil spill, radioactive contamination, etc.)
- Failure of national governance (e.g. failure of rule of law, corruption, political deadlock, etc.)
- Interstate conflict with regional consequences
- Large-scale terrorist attacks
- State collapse or crisis (e.g. civil conflict, military coup, failed states, etc.)
- Weapons of mass destruction
- Failure of urban planning
- Food crises
- Large-scale involuntary migration
- Profound social instability
- Rapid and massive spread of infectious diseases
- Water crises
- Adverse consequences of technological advances
- Breakdown of critical information infrastructure and networks
- Large-scale cyberattacks
- Massive incident of data fraud/theft

Table B: Trends 2015

- Ageing population
- Changing landscape of international governance
- Climate change
- Environmental degradation
- Growing middle class in emerging economies
- Increasing national sentiment
- Increasing polarization of societies
- Rise of chronic diseases
- Rise of cyber dependency
- Rising geographic mobility
- Rising income and wealth disparity
- Shifts in power
- Urbanization

New economics

The 2008 financial crisis certainly can be considered as the result of increased complexity in a VUCA and CYNEFIN sense.

It turns out that traditional economic textbooks were of little help during that crisis. Many established economists and policymakers had to admit this in the aftermath.

In search for new economic models that better reflect the world of complexity, a (not so) new economic thinking is emerging: New economics.

Eric Beinhocker, the Executive Director of the Institute for New Economic Thinking at the Oxford Martin School, University of Oxford gives a comprehensive overview of its concept in a landmark article entitled « How the Profound Changes in Economics Make Left Versus Right Debates Irrelevant » [48].

Here is an excerpt on how he defines new economics:

[48] https://evonomics.com/the-deep-and-profound-changes-in-economics-thinking/ The article is adapted from a publication by the Institute for Public Policy Research, entitled « Complex new world: Translating new economic thinking into public policy » http://www.ippr.org/publications/complex-new-world-translating-new-economic-thinking-into-public-policy

Defining what new economics is provides a greater challenge. As of yet there is no neatly synthesised theory to replace neoclassical orthodoxy (and some argue there never will be as the economy is too complex a system to be fully captured in a single theory). Rather new economics is best characterised as a research programme that encompasses a broad range of theories, empirical work, and methods. It is also highly interdisciplinary, involving not only economists, but psychologists, anthropologists, sociologists, historians, physicists, biologists, mathematicians, computer scientists, and others across the social and physical sciences.

It should also be emphasised that new economics is not necessarily new. Rather it builds on well-established heterodox traditions in economics such as behavioural economics, institutional economics, evolutionary economics, and studies of economic history, as well as newer streams such as complex systems studies, network theory, and experimental economics. Over the past several decades a number of Nobel prizes have been given to researchers working in what today might be called the new economics tradition, including Friedrich von Hayek, Herbert Simon, Douglass North, James Heckman, Amartya Sen, Daniel Kahneman, Thomas Schelling and Elinor Ostrom.

The following box compares the approach to various key topics within traditional economics on the one hand and new economics on the other hand.

	Traditional economics	New economics
Individuals	Perfectly rational, use deductive reasoning, have access to perfect information	Use both inductive and deductive reasoning, rely on rules of thumb, subject to errors, capable of learning, access to local, imperfect information
Networks and institutions	Network relationships don't matter, all interactions that matter are through price system	Network structures matter, non-price interactions matter (eg social relationships, trust, reciprocity)
Institutions	Institutions are rational optimisers and thus efficient – details of institutional design can be ignored (eg no banks in most macro models)	Institutions are imperfect, often inefficient, and constantly evolving – details of institutional design can matter (eg fragility of banking system)
Dynamics	Economy automatically goes to equilibrium where social welfare is maximised	Economy is a highly dynamic system that can go far from equilibrium and become trapped in suboptimal states
Innovation	Innovation is a mysterious, unpredictable, external force	Technological and social innovation are evolutionary processes that are central to economic growth and change
Emergence	Macro phenomena (inflation, unemployment, bubbles) result from the linear addition of individual decisions – heterogeneity doesn't matter	Macro patterns emerge non-linearly from dynamic interactions of heterogeneous agents, small changes can have big effects and big changes can have small effects

[49]

Traditional economics is rather governed by a mechanistic view of policymaking where agents can be « controlled » and driven in the right direction by economic incentives. In a complex world where the interplay of more and more diverse dynamics is shaping human behaviour, this predictive modelling makes total abstraction of what is called the network dynamics, which assumes that agents' decisions are driven by the choice of other agents and not merely by linear (price driven) and « rational » incentives. In order to achieve better results in economic policy making, new economics pleads for a more experimental and discovery-driven approach, where there is not only one possible solution[50].

This order of thinking is by the way totally in line with contemporary innovation management models (promoted by almost every innovation expert or innovation academic in the world) that rely on openness, connectedness and multidisciplinary exchange and on trial an error approaches (i.e. design thinking, lean startup, open innovation, co-creation…etc.) to quickly achieve product-market or service-market fit out of an initial often blurry idea (and thereby bringing in line modes of macroeconomic policy making with microeconomic, experience-based value creation).

New economics thus is a tentative to adapt economic theory towards the reality of complexity (and potentially chaos).

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[49] https://evonomics.com/the-deep-and-profound-changes-in-economics-thinking/ The article is adapted from a publication by the Institute for Public Policy Research, entitled « Complex new world: Translating new economic thinking into public policy » http://www.ippr.org/publications/complex-new-world-translating-new-economic-thinking-into-public-policy

[50] The Future of Economics Uses the Science of Real-Life Social Networks, http://evonomics.com/the-future-of-economics-uses-the-sciiece-of-real-life-social-networks/

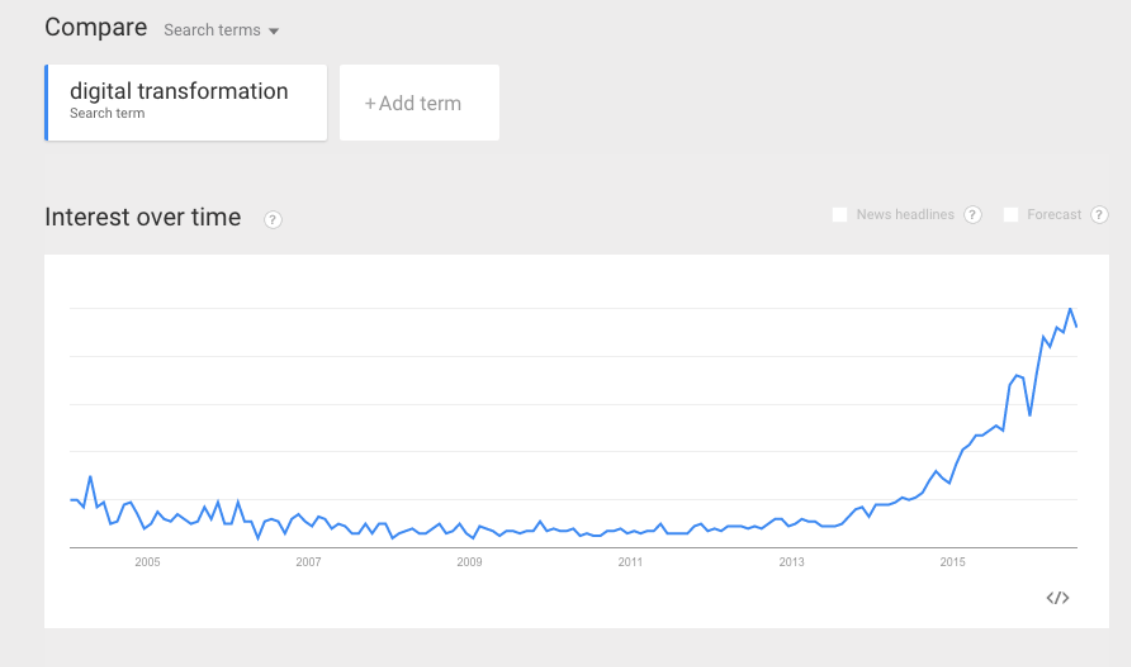
By taking a closer look at the different artefacts of digital transformation - that we will deepen throughout this document - it appears that digital era economics encompasses the following phenomena:

- network dynamics and systems thinking[51] are at the core of its mechanisms at different levels and that
- the sheer unlimited possibilities for new products and services requires a much deeper understanding of human behaviour and motivations in order to produce viable and desirable market outcomes by applying a more experimental process

We conclude that new economics and digital transformation can be considered as closely interdependent.

About Digital Transformation

After a short excursion in context, we now get back to the question of Digital Transformation (DT) (and the current associated Industrial Revolution). A search on digital transformation yields about 5,610,000 hits on Google (as of 25 July 2016) and is certainly one of the major buzzwords in business and politics in recent years as illustrated by the following Google Trends graph (as of 25 July 2016)[52]:



Source[53]

What is currently written and expressed about DT varies considerably in scope of application and also depends on the point of view of the different contributors. In other words, a physician looks at digital transformation differently than a marketing professional, an economist, a production engineer, a politician or a sociologist.

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51 i.e. Sharing Economy, Open Government, Citizen Science, Open Innovation, Co-Creation, Open Source, Industrie 4.0…etc.; we will get back to these emerging economic concepts in more depths later on.

52 https://www.google.com/trends/explore#q=digital%20transformation

53 https://www.google.com/trends/explore#q=digital%20transformation

Many experts, scholars, authors and forward-thinkers though qualify what is happening as the biggest upheaval in history in decades.

The intensity of the discussion illustrates the strategic challenges at stake, pointing to a radical shift that is underway to alter fundamentally our economies and societies.

In this report we will try to list the essential management, business and economic aspects of digital transformation, whilst also discussing other relevant aspects which we consider necessary to really grasp its 'paradigmatic shift' character in a more systemic way.

In summary, we would like to touch on the following points:

1. What is **the essence** of digital transformation?
2. What are the digital transformation's underlying **main technologies and concepts** (« artefacts »)?
3. What are the **business aspects** of digital transformation? At the firm level, at industry levels and at the broader market levels?
4. What is the **future of work and jobs**?
5. What are the security and privacy issues related to digital transformation?
6. What about the **regulatory aspects** of digital transformation?
7. What are the important **ethical and societal challenges** associated with digital transformation?
8. What are the **cultural dimensions** of digital transformation?
9. What about **governance in the digital age**?

The Essence of Digital Transformation

In its essence, DT can be described as confluence of

- **Digitization**: dematerialization of more and more « things » and their translation into datasets
- **Connectivity**: connection and communication between things (and humans)
- **Automation**: automated management of connected things and systems

All this is already happening and accelerating at a sheer exponential rate every single day.

The Internet plays a central role in this process, as it provides the infrastructure for the interplay between the three.

Every year, the amount of data produced doubles. In other words, in 2015 alone the amount of data produced equals the amount of data produced in the whole human history until 2014[54].

In five years, the Internet of Things (IoT), (which in fact is an Internet of Services) will contribute with nearly 2 trillion $ to worldwide economic value creation. This is roughly equivalent to the Italian GDP. In order to

[54] Wie Algorithmen und Big Data unsere Zukunft bestimmen - Spektrum der Wissenschaft, http://www.spektrum.de/news/wie-algorithmen-und-big-data-unsere-zukunft-bestimmen/1375933

participate in that value creation, we have to think in terms of software and services[55],[56]. In fact, what we witness is what seem describe as « software is eating up the world »[57].

Half of all IoT related activities will be driven by startups, and 80 % of them will be software and service companies [58].

In ten years' time, there might be 150 billion networked sensors. By then, the amount of data double every 12 hours…

Today already, every minute, we post hundreds 10th of millions Google searches, Facebook posts and Tweets. They reveal what we think and feel.

Digital Transformation's underlying main technologies and concepts

The Internet with its broadband and mobile connectivity[59] as well as the rapidly growing computing power (approximately doubling every two years according to Moore's law) which is more and more distributed worldwide in an interconnected cloud of so-called « server farms » (cloud computing, see Box 3 below) is the basic infrastructure of digital transformation.

It is this rapidly developing basic infrastructure (in terms of volume and performance) that made possible the recent emergence of new disruptive technologies. In fact they are rather technological concepts as they combine different elements of the already existing,

- Everything « smart »: smart cities, smart factories (Industry 4.0), smart (energy) grids, smart homes & smart buildings, smart mobility including autonomous vehicles, smart clothes (wearables), smart humans (augmented humans), smart contracts (blockchain technology)…etc.
- The Internet of (Every)thing(s)
- Big data
- Deep learning and artificial intelligence
- Machine automation and robots
- Virtual Reality and Augmented Reality
- 3D printing (additive manufacturing)

This can be considered as a consolidated and simplified list of Klaus Schwab's « deep shifts ».

Taken together, they form the technological foundation of the current vague of DT. They are also all linked in a way or another: The « everything smart » is essentially driven by the Internet of (Every)thing(s), makes use of big data insights and also produces big data, uses artificial intelligence as well as robots and 3D printing to steer the whole ecosystem which is experienced through Virtual & Augmented Reality.

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55 See also: What is Servitization?, Andy Neely, Head of the Institute for Manufacturing at Cambridge University and Director of the Cambridge Service Alliance. http://andyneely.blogspot.fr/2013/11/what-is-servitization.html

56 See also: Service-dominant logic, http://www.sdlogic.net/index.html & https://en.wikipedia.org/wiki/Service-dominant_logic

57 Why Software Is Eating The World, Marc Andreesson http://www.wsj.com/articles/SB10001424053111903480904576512250915629460

58 Gartner, November 2013

59 With an estimated 2 billion smartphones in the world at the beginning of 2016 - http://thehub.smsglobal.com/smartphone-ownership-usage-and-penetration

There is no single way to classify and describe all these existing and emerging technology enablers and artefacts of DT, and the classification opted for in the present paper is therefore subjective too.

BOX 3: CLOUD COMPUTING

Definition

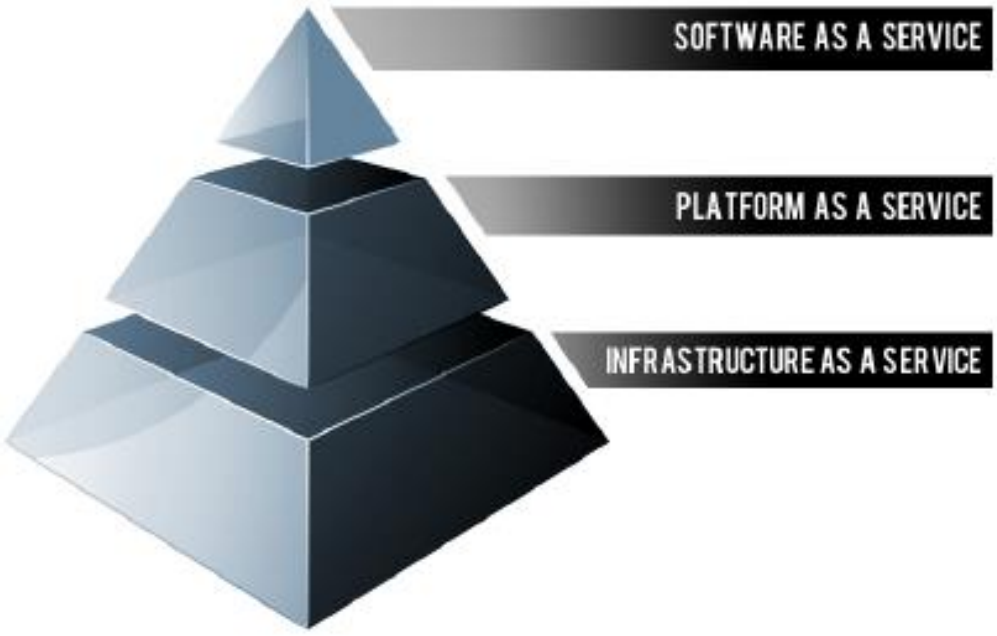
> *Cloud computing, often referred to as simply "the cloud," is the delivery of on-demand computing resources—everything from applications to data centers—over the Internet on a pay-for-use basis.*

A cloud can be

> ***Public:*** *Public clouds are owned and operated by companies that offer rapid access over a public network to affordable computing resources. With public cloud services, users do not need to purchase hardware, software, or supporting infrastructure, which is owned and managed by providers.*
>
> ***Private:*** *A private cloud is infrastructure operated solely for a single organisation, whether managed internally or by a third party, and hosted either internally or externally.*
>
> ***Hybrid:*** *A hybrid cloud uses a private cloud foundation combined with the strategic integration and use of public cloud services.*

The cloud stack

There are mainly 3 different types of cloud infrastructures:



> ***Software as a service (SaaS)****: Using a software application running on someone else's system.*

***Platform as a service (PaaS)**: PaaS brings the benefits that SaaS brought for applications, but over to the software development world. It's bascially a rented development platfrom by software developers used to develop and distribute their SaaS developments.*

***Infrastructure as a service (IaaS)**: IaaS is a way of delivering Cloud Computing infrastructure – servers, storage, network and operating systems – as an on-demand service.*

Cloud characteristics

Cloud computing has some specific characteristics:

- ***On-demand self-service:** The ability for an end user to sign up and receive services without the long delays that have characterized traditional IT*
- ***Broad network access:** Ability to access the service via standard platforms (desktop, laptop, mobile etc)*
- ***Resource pooling:** Resources are pooled across multiple customers*
- ***Rapid elasticity:** Capability can scale to cope with demand peaks*
- ***Measured Service:** Billing is metered and delivered as a utility service*

Cloud Pros and Cons

Pros

- *Lower upfront costs and reduced infrastructure costs.*
- *Easy to grow applications.*
- *Scale up or down at short notice.*
- *Only pay for what is usded.*

- *Everything managed under Service Level Agreements (SLAs).*

- *Potentially overall environmental benefit (lower carbon emissions) of many users efficiently sharing large systems.*

Cons

- *Greater dependency on service providers. Will problems be resolved quickly, even with SLAs?*

- *Risk of being locked into proprietary or vendor-recommended systems? How easily users can you migrate to another system or service provider if there is a need to?*

- *What happens if the cloud supplier suddenly decides to stop supporting a product or system the user come to depend on?*

- *Potential privacy and security risks of putting valuable data on someone else's system in an unknown location?*

- *If a significant number of people migrate to the cloud, where they're no longer free to push new developments themselves, what does that imply for the future development of the Internet and innovation in general ?*

- *Dependency on a reliable Internet connection.*

Sources[60], [61], [62], [63], [64]

The cloud market

[60] Cloud computing introduction, http://www.explainthatstuff.com/cloud-computing-introduction.html

[61] What is cloud computing?, https://www.ibm.com/cloud-computing/what-is-cloud-computing

[62] Understanding the Cloud Computing Stack: SaaS, PaaS, IaaS, https://support.rackspace.com/white-paper/understanding-the-cloud-computing-stack-saas-paas-iaas/

[63] What is the cloud ?, http://www.salesforce.com/eu/cloudcomputing/

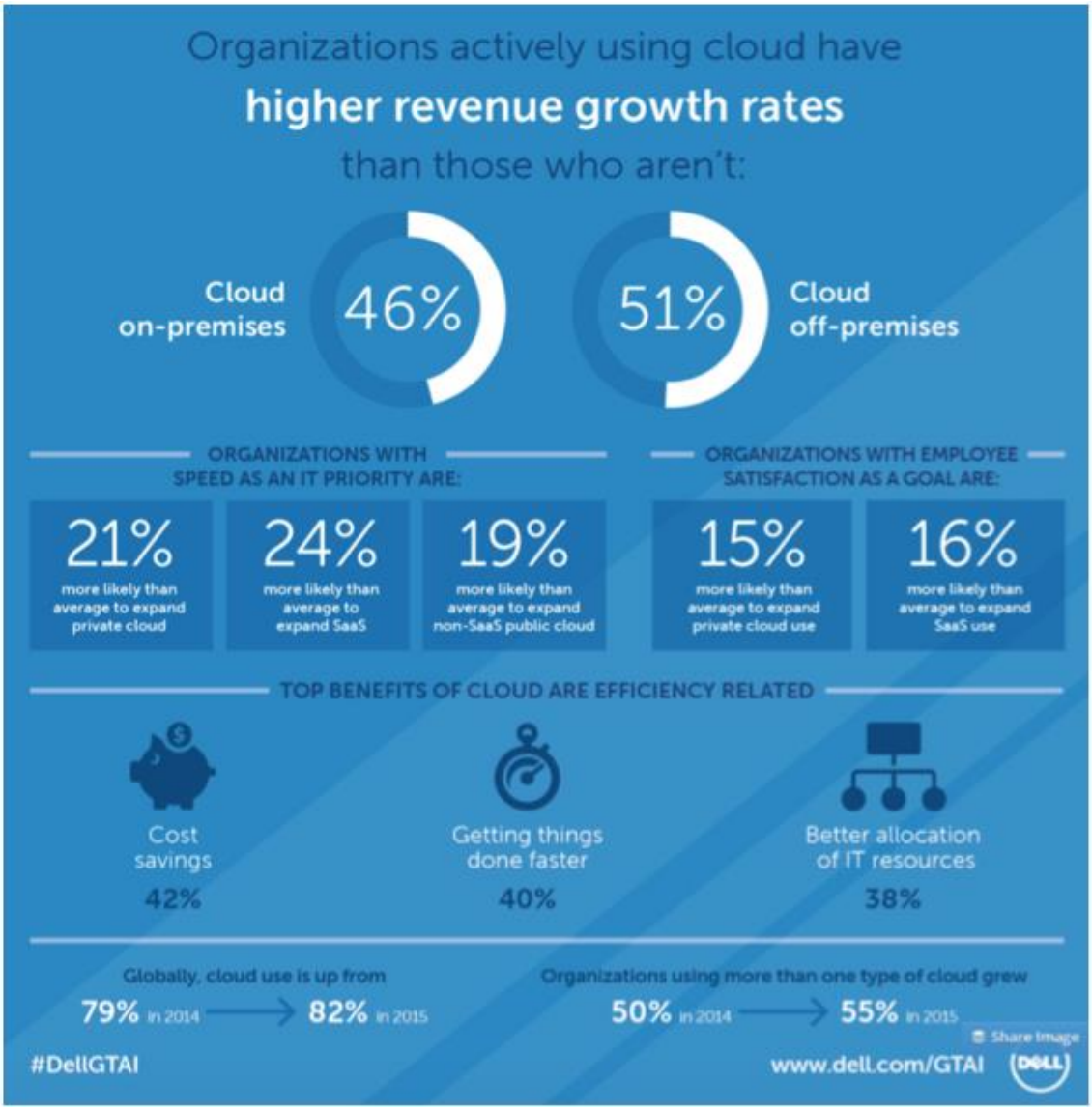
[64] What is Cloud Computing?, http://www.interoute.com/cloud-article/what-cloud-computing

Cloud computing[65] is one of the most disruptive forces in IT history and is the enabling basic infrastructure of digital transformation.

Cloud computing is used in business and in consumer environments[66].

$111 billion worth of IT spending will shift to the cloud in 2016, and that number will almost double to $216 billion by 2020[67].

Organizations actively using cloud tend to have higher revenue growth rates.



[65] Help for CIOs Who Struggle With Cloud Computing, http://www.v3b.com/2016/02/help-for-cios-who-struggle-with-cloud-computing/

[66] What Is Cloud Computing?, http://www.pcmag.com/article2/0,2817,2372163,00.asp

[67] Cloud Computing's Big, Disruptive Multiple Hundred Billion Dollar Impact, http://fortune.com/2016/07/21/cloud-computing-multiple-billion-dollar-impact/

(Source[68])

Everything smart

The concept of smart things lies at the heart of digital transformation. « Smart » is in fact the result of digitization, connectedness and automation. It describes objects or concepts that are becoming « intelligent » by using all of the available disruptive technologies: The Internet, all kinds of embedded sensors, cloud computing, GPS, big data and artificial intelligence and advanced software algorithms.

Smart cities & smart mobility

> *According to Frost & Sullivan, the global Smart Cities market is projected to reach US$1.56 trillion by 2020. With rapid urbanization and ageing populations, cities are facing increasing strain on infrastructure, transportation, energy and healthcare resources. To address these urban challenges, governments are embracing the concept of the smart city and looking to apply new technologies to improve sustainability, liveability and quality of life for citizens[69]*
>
> *A smart city is an urban development vision to integrate multiple information and communication technology (ICT) and Internet of Things IoT solutions in a secure fashion to manage a city's assets. The city's assets include, but are not limited to, local departments information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services. The goal of building a smart city is to improve quality of life by using technology to improve the efficiency of services and meet residents' needs. ICT allows city officials to interact directly with the community and the city infrastructure and to monitor what is happening in the city, how the city is evolving, and how to enable a better quality of life. Through the use of sensors integrated with real-time monitoring systems, data is collected from citizens and devices - then processed and analysed. The information and knowledge gathered are keys to tackling inefficiency and consequently to make the most efficient use out of the city's assets and services. [70]*

[68] Cloud, Mobility, Security, and Big Data: The Big Four for Business Growth, http://www.v3b.com/2016/01/cloud-mobility-security-and-big-data-the-big-four-for-business-growth-study/

[69] Top Smart Cities in the world today, http://www.enterpriseinnovation.net/article/top-smart-cities-world-today-676169304

[70] https://en.wikipedia.org/wiki/Smart_city

A city can be defined as « smart » when social capital, traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life [71].

« Thus, a smart city is a city that uses digital technologies or information and communication technologies—connected via an intelligent network—to address challenges within city communities and across vertical industries. These challenges may include parking, traffic, transportation, street lighting, water and waste management, safety and security, even the delivery of education and healthcare. A smart city relies on technological solutions that enhance its existing process to better support and optimize the delivery of urban services, to reduce resource consumption and contain costs, and to provide the means and the opportunities to engage actively and effectively with its citizens, with its visitors and with its businesses [72]. » [73], [74], [75], [76], [77], [78], [79], [80], [81] .

« Our cities are becoming these kind of cyber-physical systems. Cyber-physical includes both the physical and the biological, and that means

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71 (Adapted from Caragliu et al. 2009)

72 Anil Menon, Cisco's deputy chief globalization officer in « The world's smartest cities: What IoT and smart governments will mean for you », in http://www.techrepublic.com/article/smart-cities/

73 Smart Mobility – A tool to achieve sustainable cities, http://www.vt.bgu.tum.de/fileadmin/w00bnf/www/VKA/2014_15/150212_Smart_Mobility_v5_TUM.pdf

74 The Future of Mobility: Realizing a Smart Mobility Society, http://www.toyota-global.com/innovation/intelligent_transport_systems/mobility/

75 How Big Data and the Internet of Things Create Smart Cities, http://www.datasciencecentral.com/profiles/blogs/how-big-data-and-the-internet-of-things-create-smart-cities

76 How the Internet of Things is affecting urban design, http://mashable.com/2015/02/23/urban-design-internet-of-things/#6NOJfE9VTPqf

77 DATA-DRIVEN CITY MANAGEMENT

A Close Look at Amsterdam's Smart City Initiative, http://sloanreview.mit.edu/case-study/data-driven-city-management/

78 Autonom und ohne Ampeln, http://www.heise.de/tr/artikel/Autonom-und-ohne-Ampeln-3175720.html

79 Big Data, IoT: Solving the world's water woes, http://www.smartgridnews.com/story/big-data-iot-solving-worlds-water-woes/2016-02-18

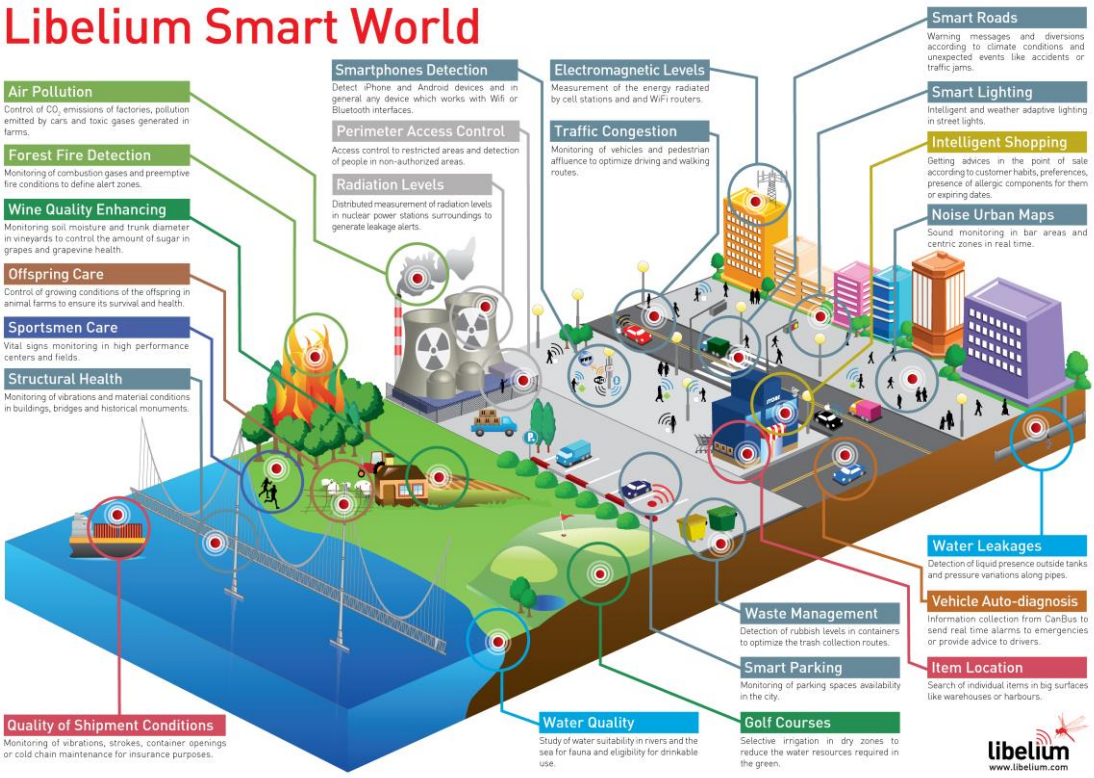
80 Shaping Tomorrow's Cities Through Technology, http://cityminded.org/shaping-tomorrows-cities-technology-15848

81 How Crowdsourcing And Machine Learning Will Change The Way We Design Cities, http://www.fastcodesign.com/3031368/slicker-city/how-crowdsourcing-and-machine-learning-will-change-how-we-design-cities

> *that we have a great wealth of information to understand them and to transform them.*

That is radically changing architecture, cities, planning and so on, because it's the natural entry space in creating this hybrid system[82], [83], [84] »

The following graphs an overview of possible smart city applications:



Source[85]

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82 Carlo Ratti, director of MIT's Senseable City Lab, which investigates and anticipates how digital technologies are changing the way people live at an urban scale, http://www.dezeen.com/tag/carlo-ratti-associati/

83 Chicago installs "fitness tracker for the city" to improve infrastructure and residents' health. http://www.dezeen.com/2016/08/31/chicago-installs-array-of-things-city-fitness-tracker-improve-services-residents-health/?

84 …understand things like road conditions better, because the Array of Things will show us where water is collecting," said Brenna Berman, the City of Chicago's chief information officer. "It will help us predict vehicular and pedestrian traffic patterns better, so we can offer better services." Two cameras also obtain data about vehicle and foot traffic, standing water, sky colour and cloud cover. The information gathered will be accessible to all via open platforms (open data), including on the University of Chicago website. For example, asthmatics could be informed about which areas of the city are experiencing poor air quality., http://www.dezeen.com/2016/08/31/chicago-installs-array-of-things-city-fitness-tracker-improve-services-residents-health/?

85 A Simple Explanation Of 'The Internet Of Things', http://www.forbes.com/sites/jacobmorgan/2014/05/13/simple-explanation-internet-things-that-anyone-can-understand/#526c19486828

Recent insights though urge policymakers and city managers to concentrate more on the human factor of smart cities as well as on governance issues and avoid getting easily caught up in the latest gee-whiz technology[86].

Smart grids

> *A smart grid is an electrical grid which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources. Electronic power conditioning and control of the production and distribution of electricity are important aspects of the smart grid.*
>
> *Smart grid policy is organised in Europe as Smart Grid European Technology Platform [87], [88], [89].*
>
> *Roll-out of smart grid technology also implies a fundamental re-engineering of the electricity services industry, although typical usage of the term is focused on the technical infrastructure[90], [91], [92].*

Smart grids are essential components of smart cities and rely on other relevant technologies that are considered part of the digital transformation like the Interne of Things, cloud connectivity, sensors, mobile apps and Big Data.

The main objective is to increase energy efficiency and increase the use of renewable energies in the light of environmental pressures, potential system-wide cost savings and the emergence of new concepts like electric cars.

In 2014, the European Commission survey « Smart Grid Projects Outlook 2014[93] » listed 450 smart grid projects since the year 2002 amounting to a total investment volume of €3.15 billion.

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86 Human factors limit smart cities more than technology, http://readwrite.com/2016/09/25/human-factors-limit-smart-cities-technology-cl4/

87 Smart Grids European Technology Platform, http://www.smartgrids.eu/

88 US Department of Energy's Office of Electricity Delivery and Energy Reliability (OE) smart grid initiative, https://www.smartgrid.gov/

89 Policy in the United States is described in 42 U.S.C. ch. 152, subch. IX § 17381, https://www.law.cornell.edu/uscode/text/42/chapter-152/subchapter-IX

90 https://en.wikipedia.org/wiki/Smart_grid

91 An alternative definition of smart grids "Smart grid" generally refers to a class of technology people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. These systems are made possible by two-way communication technology and computer processing that has been used for decades in other industries. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers -- mostly seen in big improvements in energy efficiency on the electricity grid and in the energy users' homes and offices., http://energy.gov/oe/services/technology-development/smart-grid

92 See also: Définition des smarts grids http://www.smartgrids-cre.fr/index.php?p=definition-smart-grids

93 Smart Grid Projects Outlook 2014, http://ses.jrc.ec.europa.eu/smart-grids-observatory

Smart factories (Industry 4.0)

> *Industry 4.0 is the current wording for automation, connectivity and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things and cloud computing.*
>
> *Industry 4.0 creates what has been called a "smart factory". Within the modular structured smart factories, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real time, and via the Internet of Services, both internal and cross-organizational services are offered and used by participants of the value chain.*[94]

Smart homes & smart buildings

> *A smart house is a house that has highly advanced automatic systems for lighting, temperature control, multi-media, security, window and door operations, and many other functions.*
>
> *A smart home appears "intelligent" because its computer systems can monitor many aspects of daily living. For example, the refrigerator may be able to inventory its contents, suggest menus, recommend healthy alternatives, and order groceries. The smart home systems might even take care of cleaning the cat's litter box and watering the plants*[95]*.* [96]*,* [97]*,* [98]*,* [99]

« The Edge » for example, located in Amsterdam is currently said to be the smartest building in the world, embedding more than 28.000 sensors[100] !

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http://ses.jrc.ec.europa.eu/sites/ses.jrc.ec.europa.eu/files/u24/2014/report/ld-na-26609-en-n_smart_grid_projects_outlook_2014_-_online.pdf

94 https://en.wikipedia.org/wiki/Industry_4.0#/media/File:Industry_4.0.png

95 http://architecture.about.com/od/buildyourhous1/g/smarthouse.htm

96 Making Buildings Smarter, https://www.ideo.com/work/making-buildings-smarter

97 Honeywell, I'm Home! The Internet of Things and the New Domestic Landscape, http://www.e-flux.com/journal/honeywell-im-home-the-internet-of-things-and-the-new-domestic-landscape/

98 What Is A Smart Home?, http://www.makeuseof.com/tag/smart-home/

99 MOBILITY AND CONNECTIVITY - KEYWORDS OF THE 21ST CENTURY, http://www.ramboll.com/megatrend/feature-articles/mobility-and-connectivity

100 The Smartest Building in the World, http://www.bloomberg.com/features/2015-the-edge-the-worlds-greenest-building/

Ambient assisted living is a special use case of smart homes, and essentially deals with systems to assist elderly people to live a longer healthy and save life at home[101], [102].

Smart clothes and wearable technology

> *Wearable technology, wearables, fashionable technology, wearable devices, tech togs, or fashion electronics are clothing and accessories incorporating computer and advanced electronic technologies. The designs often incorporate practical functions and features.*
>
> *Wearable devices such as activity trackers are a good example of the Internet of Things, since they are part of the network of physical objects or "things" embedded with electronics, software, sensors and connectivity to enable objects to exchange data with a manufacturer, operator and/or other connected devices, without requiring human intervention*[103]. [104], [105], [106]

Wearable technology also includes fitness tracking & medical self-assessment devices that mostly come with Bluetooth technology and smartphone apps connected to the cloud. These are on the market for a while now and are at the origin of the « quantified-self » movement.

Human augmentation (Bionics)

> *In the context of engineering, human enhancement can be defined as the application of technology to overcome physical or mental limitations of the body, resulting in the temporary or permanent augmentation of a person's abilities and features. By this definition, human enhancement entails both the treatment of disease and disability, as well as the upgrading of human aptitude. Furthermore, human enhancement is dichotomous in nature: while it heavily implements theoretical ideas by raising important questions about the human application of a diverse array of emerging technology, it also uses applied science and current*

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101 Active and Assisted LIving Programme, http://www.aal-europe.eu/about/objectives/

102 SMART CARPET DETECTS YOUR GAIT, KNOWS IF YOU'VE FALLEN, http://www.popsci.com/science/article/2012-09/smart-carpet-knows-if-youve-fallen-and-you-cant-get

103 https://en.wikipedia.org/wiki/Wearable_technology

104 WHY SMART CLOTHES, NOT WATCHES, ARE THE FUTURE OF WEARABLES - http://www.digitaltrends.com/wearables/smart-clothing-is-the-future-of-wearables/

105 The best smart clothing: From biometric shirts to contactless payment jackets, http://www.wareable.com/smart-clothing/best-smart-clothing

106 A Look at Smart Clothing for 2015, https://www.wearable-technologies.com/2015/03/a-look-at-smartclothing-for-2015/

> *technology, often borrowing from interdisciplinary scientific fields and methods[107].*

Beyond its potential to help people with disabilities, human augmentation can upgrade the capabilities of healthy people which in turn raises important ethical questions[108], also with regard to a potential unequal access to these augmenting technologies, as for example the robot suit HAL developed by the Japanese[109]. [110], [111]

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[107] Human Enhancement, http://dujs.dartmouth.edu/2013/11/human-enhancement/#.V5pkDpN97u0

[108] Die Menschen von morgen werden zu Maschinen

DARTH VADER, IRON MAN, ROBOCOP UND INSPECTOR GADGET HABEN EINES GEMEINSAM: SIE SIND CYBORGS. DURCH TECHNISCHE OPTIMIERUNG IHRER KÖRPER WURDEN SIE ZU ÜBERMENSCHEN UND SO ZU DEN HELDEN UNSERER KINDHEIT. NOCH SIND SOLCHE ÜBERMENSCHEN FIKTION. VIELLEICHT NICHT MEHR LANGE.

Teil 1: Die volle Kontrolle, http://www.aquarius.biz/de/blog-articles/2015/11/23/die-menschen-von-morgen-werden-zu-maschinen-(1/2)/

Teil 2: Das Fleisch ist schwach doch der Roboter ist stark?, http://www.aquarius.biz/de/blog-articles/2015/12/08/die-menschen-von-morgen-werden-zu-maschinen-(2/2)/

Teil 3: Ein neues Update für Ihr Gehirn ist jetzt verfügbar!, http://www.aquarius.biz/de/blog-articles/2015/12/18/die-menschen-von-morgen-werden-zu-maschinen-%283/3%29/

[109] https://www.youtube.com/watch?v=2Ysb-Oko3Bg

[110] See also: ROBOTIC EXOSKELETONS ARE HERE, AND THEY'RE CHANGING LIVES, http://www.popsci.com/watch-paralyzed-man-take-stroll-bionic-exoskeleton-video / NEW ROBOTIC EXOSKELETON TECHNOLOGY IS HERE FROM PANASONIC, http://www.digitaltrends.com/cool-tech/panasonic-exoskeleton/ & http://eksobionics.com/

[111] In combination with 3D Printing technology, hand prothesis can now for example bee produced at a fraction of the price of traditionally manufactured hand prothesis: Man Compares His $42k Prosthetic Hand to a $50 3D Printed Cyborg Beast, https://3dprint.com/2438/50-prosthetic-3d-printed-hand/

Furthermore, brain computer interfaces[112], [113], [114], [115]and other bionic augmentation devices[116], [117]are becoming market ready, and the somewhat spooky and ethically questionable concept of transhumanism[118], [119] comes closer to reality.[120]

The market though for human augmentation applications is predicted to growing exponentially the coming years, from $91.8 million in 2013 to to $1135 million by 2020[121].

Ray Kurzweil by the way, who is the director of engineering at Google, predicts that humans will be hybrids by 2030 and that our brains will be able to directly connect to the cloud….[122]

Smart contracts and the blockchain

> *The term « smart contract » refers to any contract capable of automatically enforcing (and adapting) itself, without a third party between individual participants. Smart contracts are written as computer programs rather than in legal language on a printed document. The program can define strict rules and consequences in the same way that a traditional legal document would, but unlike a traditional contract it can also take information as an input, process it through the rules set out in the contract, and take any actions required of it as a result.*

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112 Emotov brainware, http://emotiv.com/

113 8 Mind-blowing Gadgets You Can Control Just With Your Brain, http://www.hongkiat.com/blog/brain-controlled-gadgets/

114 A Brain-Computer Interface That Works Wirelessly, https://www.technologyreview.com/s/534206/a-brain-computer-interface-that-works-wirelessly/

115 Harvard creates brain-to-brain interface, allows humans to control other animals with thoughts alone, http://www.extremetech.com/extreme/162678-harvard-creates-brain-to-brain-interface-allows-humans-to-control-other-animals-with-thoughts-alone

116 The past, present, and future of bionic eyes, http://www.extremetech.com/extreme/142411-the-past-present-and-future-of-bionic-eyes

117 Upgrade your ears: Elective auditory implants give you cyborg hearing, http://www.extremetech.com/extreme/150194-upgrade-your-ears-elective-auditory-implants-give-you-cyborg-hearing

118 Transhumanism (abbreviated as H+ or h+) is an international and intellectual movement that aims to transform the human condition by developing and creating widely available sophisticated technologies to greatly enhance human intellectual, physical, and psychological capacities. Transhumanist thinkers study the potential benefits and dangers of emerging technologies that could overcome fundamental human limitations, as well as the ethics of using such technologies. The most common transhumanist thesis is that human beings may eventually be able to transform themselves into different beings with abilities so greatly expanded from the natural condition as to merit the label of posthuman beings., https://en.wikipedia.org/wiki/Transhumanism

119 What is transhumanism, or, what does it mean to be human?, http://www.extremetech.com/extreme/152240-what-is-transhumanism-or-what-does-it-mean-to-be-human

120 Putting a computer in your brain is no longer science fiction - boosting intelligence, memory and other cognitive tasks, https://www.washingtonpost.com/news/the-switch/wp/2016/08/15/putting-a-computer-in-your-brain-is-no-longer-science-fiction/

121 http://www.marketsandmarkets.com/PressReleases/human-augmentation.asp & http://moneymorning.com/2015/03/13/the-human-augmentation-market-just-got-red-hot/

122 http://money.cnn.com/2015/06/03/technology/ray-kurzweil-predictions/

> *The concept was defined in 1994 by cryptographer Nick Szabo, but in practice remained unrealised because the technological infrastructure needed to support it did not yet exist. Nowadays, the advent of crypto protocols and the blockchain is changing that, and as a result the idea is seeing a revival*[123],[124].

Smart contracts are thus the type of contracts that are made possible by the nervously hyped blockchain technology, to which we dedicate a box hereafter.

[123] Smart contracts: the ultimate automation of trust?, https://www.bbvaresearch.com/wp-content/uploads/2015/10/Digital_Economy_Outlook_Oct15_Cap1.pdf

[124] See also: Making Sense of Blockchain Smart Contracts, http://www.coindesk.com/making-sense-smart-contracts/- A gentle introduction to smart contracts, https://bitsonblocks.net/2016/02/01/a-gentle-introduction-to-smart-contracts/ - Unpacking the term 'Smart Contract', https://medium.com/@ConsenSys/unpacking-the-term-smart-contract-e63238f7db65#.ov0eums0e

BOX 4: BLOCKCHAIN TECHNOLOGY

Blockhain[125] is currently probably the most hyped technology in terms of potential disruptive business impact, as it basically concerns the economics of transfers and proof of ownership. It is foremost discussed in the financial industry, but it is said to potentially have many other areas of application such as in government[126], [127], [128], [129], [130], voting, the sharing economy, the music industry, the Internet of Things[131], smart cities[132], rare collectables, the energy grid[133], [134], [135]patents and copyrights or healthcare[136] to name but a few[137], [138], [139], [140], [141].

At the same time it is a very delicate concept, as the blockchains' underlying principle is to make every (money and ownership) transaction that is executed via the blockchain completely transparent and trackable for everybody. Which also means potentially significant consequences (threats but also opportunities) for whole industries that currently operate as intermediaries in transaction processes playing

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125 All you need to know about blockchain, explained simply, https://www.weforum.org/agenda/2016/06/blockchain-explained-simply/

126 Report Urges UK Government to Test Blockchain Tech, http://www.coindesk.com/report-uk-government-test-blockchain-tech/

127 Bitland, a blockchain based tamper-proof land register for Ghana,http://www.bitland.world/

128 Distributed Ledger Technology: beyond block chain: A report by the UK Government Chief Scientific Adviser, https://www.scribd.com/doc/295987915/Distributed-Ledger-Technology-beyond-block-chain

129 U.K. Considering Government Applications of Blockchain Technology, https://bitcoinmagazine.com/articles/u-k-considering-government-applications-of-blockchain-technology-1462379719

130 UK looking at bitcoin technology for tracking taxpayer money, says minister, https://www.theguardian.com/technology/2016/apr/26/bitcoin-blockchain-tracking-taxpayer-money-minister

131 Quels liens entre blockchain et objets connectés ?, http://www.usine-digitale.fr/article/quels-liens-entre-blockchain-et-objets-connectes.N386324

132 Blockchain Drives Wanxiangs 30b Smart City Project, http://readwrite.com/2016/09/24/blockchain-drives-wanxiangs-30b-smart-city-project-cl4/

133 The Energy Blockchain: How Bitcoin Could Be a Catalyst for the Distributed Grid, http://www.greentechmedia.com/articles/read/the-energy-blockchain-could-bitcoin-be-a-catalyst-for-the-distributed-grid

134 How Blockchain Technology Could Decentralize The Energy Grid, http://www.fastcoexist.com/3058380/world-changing-ideas/how-blockchain-technology-could-decentralize-the-energy-grid

135 Wie Blockchain-Technik das Energiesystem revolutionieren kann, http://www.sueddeutsche.de/wissen/energie-wie-blockchain-technik-das-energiesystem-revolutionieren-kann-1.3117309

136 Blockchain in healthcare getting a lot of attention, http://searchhealthit.techtarget.com/news/450303012/Blockchain-in-healthcare-getting-a-lot-of-attention

137 The Impact of the Blockchain Goes Beyond Financial Services, https://hbr.org/2016/05/the-impact-of-the-blockchain-goes-beyond-financial-services

138 Banking Is Only The Start: 20 Big Industries Where Blockchain Could Be Used, https://www.cbinsights.com/blog/industries-disrupted-blockchain/

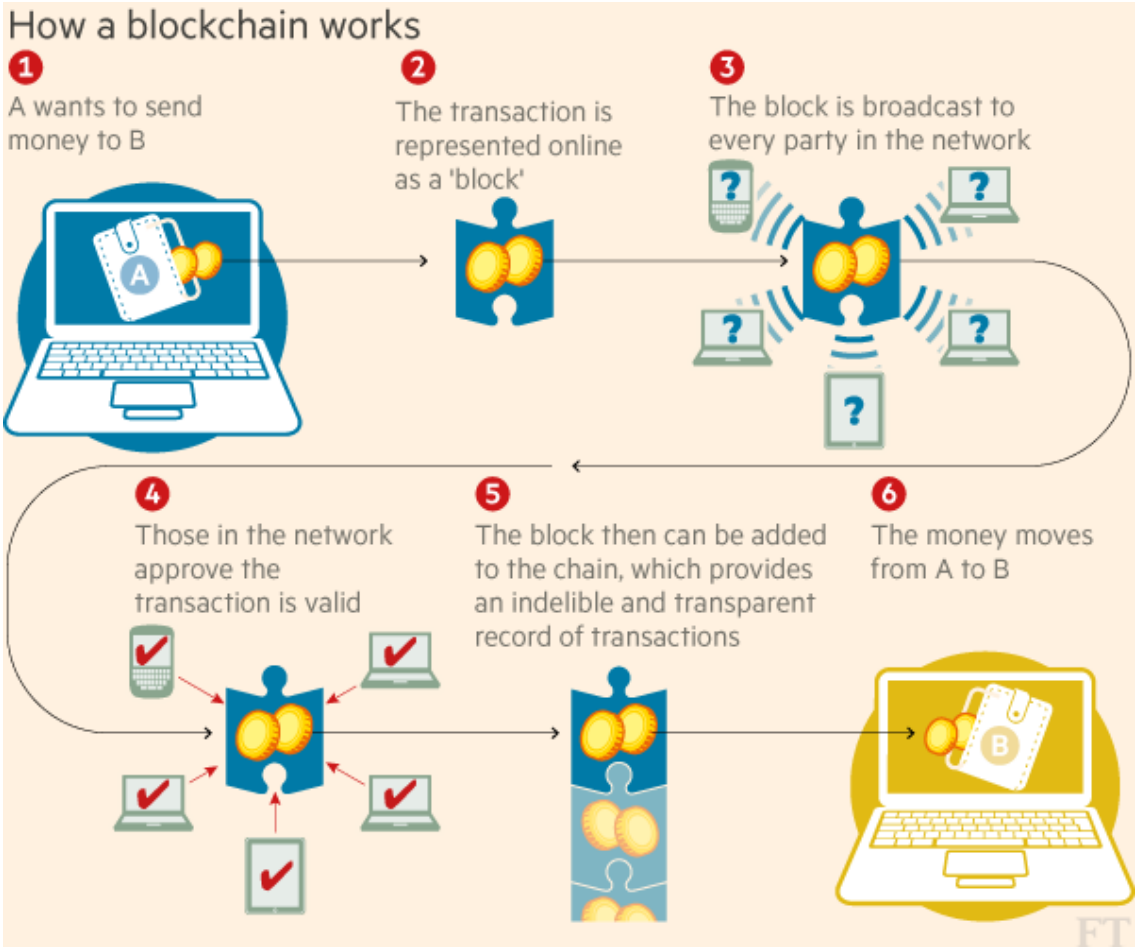
139 Four genuine blockchain use cases, http://www.multichain.com/blog/2016/05/four-genuine-blockchain-use-cases/

140 6 Reasons Why Blockchain is Worth Getting Excited, https://www.entrepreneur.com/article/279095

141 The trust machine: The technology behind bitcoin could transform how the economy works, http://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine

the role as trusted third parties such as banks or clearing houses, for example. Blockchains definitely have a strong disruptive potential on many current economic processes[142].

The simple flowchart below explains the underlying logic of how blockchain technology works, with the example of a simple money transfer from a party A to a party B.



Source[143]

Here is a more formal definition [144] of blockchain technology:

> *Blockchain is a peer-to-peer public ledger maintained by a distributed network of computers that requires no central authority or third party intermediaries. It consists of three key components:*

- *a transaction,*

[142] How blockchains could change the world, http://www.mckinsey.com/industries/high-tech/our-insights/how-blockchains-could-change-the-world

[143] Image: Financial Times

[144] Blockchain Technology: The Ultimate Disruption in the Financial System, https://www.bbvaresearch.com/wp-content/uploads/2015/07/150710_US_EW_BlockchainTechnology.pdf

- *a transaction record*
- *and a system that verifies and stores the transaction.*

> *The blocks are generated through open-source software and record the information about when and in what sequence the transaction took place. This "block" chronologically stores information of all the transactions that have taken place in the chain, thus the name blockchain. In other words, blockchain is a database of immutable time-stamped information of every transaction that is replicated on servers across the globe*

Blockchain ledgers bypass centralised financial infrastructure. This undoubtedly leads to the development of new businesses and the overhaul of existing ones. For the financial sector it could imply the biggest disruption to date.

According to the World Economic Forum (WEF) blockchain will become 'beating deart' of the Global Financial System and could eventually reshape banks as institutions in a fundamental way[145], [146], [147].

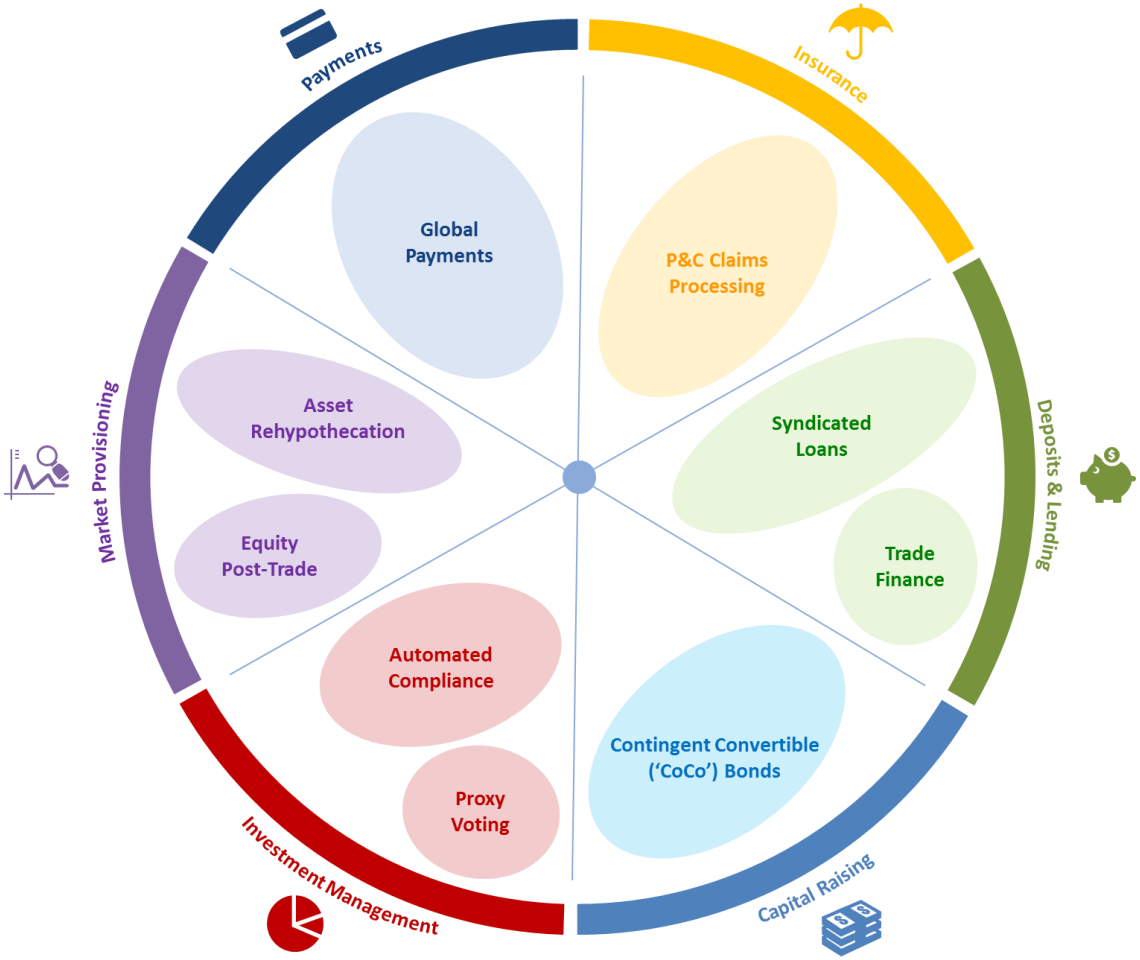
Blockchain use cases according to the WEF:

[145] Blockchain Will Become 'Beating Heart' of the Global Financial System, https://www.weforum.org/press/2016/08/blockchain-will-become-beating-heart-of-the-global-financial-system/

[146] The future of financial infrastructure

An ambitious look at how blockchain can reshape financial services, http://www3.weforum.org/docs/WEF_The_future_of_financial_infrastructure.pdf

[147] Weltwirtschaftsforum: Blockchains als "schlagendes Herz" der Finanzwelt, http://www.heise.de/newsticker/meldung/Weltwirtschaftsforum-Blockchains-als-schlagendes-Herz-der-Finanzwelt-3294948.html



Blockchain technology is also the foundation of the cryptocurrency Bitcoin[148].

Knowing about the importance of the financial sector including the fund distribution business for Luxembourg's economy, Luxembourg economic actors are urged to closely monitor, early adopt and being very vigilant about what is happening in that area.

Currently, however, the blockchain and the cryptocurrency bitcoin still has **a major drawback which is its high amount of energy consumption**[149]: The energy to mine bitcoins[150], [151] by 2020 is estimated to the equivalent of the energy consumption of Denmark[152]. Today, a bitcoin transaction consumes five times more energy than a conventional credit card transaction.

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148 https://en.wikipedia.org/wiki/Bitcoin

149 Bitcoin et blockchain: un bilan énergétique très lourd, http://paperjam.lu/news/bitcoin-et-blockchain-un-bilan-energetique-tres-lourd

150 Yes, bitcoins are « mined » by computer farms, yet another area where digital transformation and dematerialization hits strong, and yes, the Chinese are heavy bitcoin miners as well, see: We looked into a secret Chinese bitcoin mine,

http://www.bbc.com/future/story/20160504-we-looked-inside-a-secret-chinese-bitcoin-mine

151 We got a look inside a vast Icelandic bitcoin mine, http://www.businessinsider.com/photos-iceland-bitcoin-ethereum-mine-genesis-mining-cloud-2016-6?r=UK&IR=T

152 Bitcoin Could Consume as Much Electricity as Denmark by 2020, http://motherboard.vice.com/read/bitcoin-could-consume-as-much-electricity-as-denmark-by-2020?utm_source=mbtwitter

BOX 5: AUTONOMOUS VEHICLES

Self-driving cars are probably one of the most popular and most mediatised artefacts of digital transformation, given the importance of mobility and its sustainable future as well as the predominance of the car-driving experience to modern societies.

Google's self-driving car project[153] is constantly in the media and the recent self-driving Tesla fatal accident[154], [155] further reinforced public consciousness about this new technology and its very real challenges and multiple ramifications.

Conceptwise, self-driving cars[156] are just one example of a new category, namely autonomous vehicles[157] that emerge out of the aggregated possibilities of new technologies such as sensors, lidars, odometry, computer visions, big data, AI and cloud computing[158]. Put simply, autonomous vehicles are vehicles capable of sensing their environment and navigating autonomously, without human input.

Self-driving trucks[159], delivery drones[160], [161] and crewless, remote-controlled cargo ships[162] are all simultaneoulsy on developers' agenda. Helsinki is currently testing an autonomous commuting bus [163]and Airbus plans to test an autonmous flight taxi in Singapore next year[164]. Self-driving metro trains are already reality[165]. And Uber is even considering using "VTOL" (Vertical Take-off and Landing) flight taxis in the next 10 years[166] !

Recently, a positively concluding test in 22 major cities around the world including London and Düsseldorf has been carried out with an autonomous delivery robot that has a 15 km radius reach where customers

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153 Google self driving car project, https://www.google.com/selfdrivingcar/

154 Inside the Self-Driving Tesla Fatal Accident, http://www.nytimes.com/interactive/2016/07/01/business/inside-tesla-accident.html?_r=0

155 Fatal crash prompts federal investigation of Tesla self-driving cars, https://www.theguardian.com/technology/2016/jul/13/tesla-autopilot-investigation-fatal-crash

156 Driverless cars trialled on UK roads for first time in four towns and cities - Drivers will be passengers in their own cars by 2030, a government report predicts, http://www.independent.co.uk/news/uk/home-news/driverless-cars-officially-trialled-on-uk-roads-for-first-time-in-four-towns-and-cities-10037737.html

157 Autonomous vehicles, http://www.wired.com/tag/autonomous-vehicles/

158 Autonomous car, https://en.wikipedia.org/wiki/Autonomous_car

159 Convoy of self-driving trucks completes first European cross-border trip, https://www.theguardian.com/technology/2016/apr/07/convoy-self-driving-trucks-completes-first-european-cross-border-trip

160 Miniflugzeuge als Dienstleister: Wie Drohnen das Arbeiten lernen, http://www.spiegel.de/wirtschaft/unternehmen/drohnen-ersetzen-flugmaschinen-bald-menschliche-arbeiter-a-906185.html

161 Google lässt sich Drohnen-Notrufsäule patentieren, http://www.heise.de/newsticker/meldung/Google-laesst-sich-Drohnen-Notrufsaeule-patentieren-3164304.html

162 Remote-controlled and crewless: is this the cargo ship of the future?, https://www.weforum.org/agenda/2016/07/remote-controlled-and-crewless-is-this-the-future-of-cargo-shipping

163

164 Airbus will 2017 autonomes Flugtaxi testen, http://www.heise.de/newsticker/meldung/Airbus-will-2017-autonomes-Flugtaxi-testen-3299975.html

165 List of automated urban metro subway systems, https://en.wikipedia.org/wiki/List_of_automated_urban_metro_subway_systems

166 Uber entdeckt den Luftraum: Senkrechtstarter in Planung, http://m.heise.de/newsticker/meldung/Uber-entdeckt-den-Luftraum-Senkrechtstarter-in-Planung-3331825.html

can control the location via an app and have a conversation with a human operator once the robot reaches their homes[167], [168], [169], [170].

Beyond security and privacy questions[171], [172] that autonomous vehicles raise, they will - as does machine automation in general - have a considerable impact down the nested value chains of the mobility service[173] (including the car insurance industry for example[174]) and transport manufacturing industry[175], [176], [177]. The job market will be affected as well and regulation will be one of the biggest challenges on top[178], [179].

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167 https://www.starship.xyz/

168 Starship's Delivery Robot May Be Coming to a Sidewalk Near You, http://www.bloomberg.com/news/articles/2016-05-19/starship-s-delivery-robot-may-be-coming-to-a-sidewalk-near-you

169 Autonomous delivery robots hit London, https://www.theengineer.co.uk/autonomous-delivery-robots-hit-london/

170 So geht die Post ab - Paketzustellung in der Zukunft, http://www.spiegel.de/auto/aktuell/iaa-nutzfahrzeuge-so-veraendert-sich-die-paketzustellung-a-1113130.html

171 Autonomes Fahren: Die Vertrauensfrage, http://www.spiegel.de/auto/fahrkultur/autonomes-fahren-die-vertrauensfrage-a-1099352.html

172 The Moral Dilemmas of Autonomous Vehicles, http://dujs.dartmouth.edu/2016/07/the-moral-dilemmas-of-autonomous-vehicles/#.V5pkOpN97u0

173 State Farm Plans for a Driverless Future, http://blogs.wsj.com/moneybeat/2016/07/27/state-farm-plans-for-a-driverless-future/

174 Autonome Autos: Versicherungen drohen Milliardenverluste, http://t3n.de/news/autonome-autos-versicherungen-745503/

175 Ten ways autonomous driving could redefine the automotive world, http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world

176 Driverless car market watch - Foracst, http://www.driverless-future.com/?page_id=384

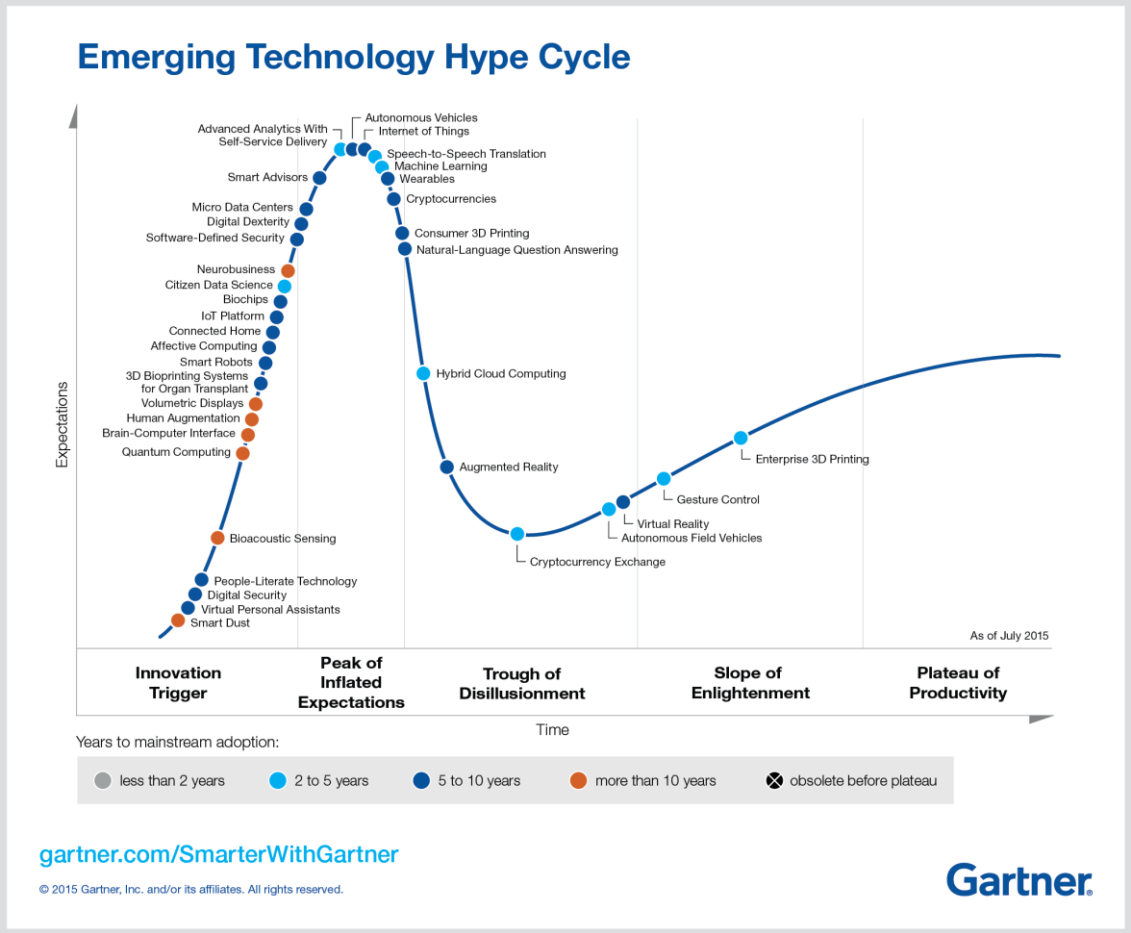
177 Roadmap to the autonomous car, http://www.psa-peugeot-citroen.com/en/featured-content/autonomous-car

178 Autonomous Vehicle Technology - A Guide for Policymakers, http://www.rand.org/pubs/research_reports/RR443-2.html - http://www.rand.org/content/dam/rand/pubs/research*reports/RR400/RR443-2/RAND*RR443-2.pdf

179 Should Self-Driving Cars Have Drivers Ready To Take Over?, http://www.npr.org/sections/alltechconsidered/2016/02/23/467836500/should-self-driving-cars-have-drivers-ready-to-take-over

The Internet of (Every)thing(s)

The Internet of Things or as more and more analysts start to call it, The Internet of Everything[180] is currently at the peak of the Gartner hype cycle[181] of Emerging technologies[182], [183].



It is indeed a hot topic within the business and tech community and increasingly also in mainstream media.

The basic idea behind IoT is that all kinds of objects can be connected to the Internet through sensors and chips and will communicate between each other and humans through the cloud infrastructure the interplay of which will build new types of intelligence. IoT is somehow the cornerstone of the emerging digital world, and is embedded in every other technology described in this chapter: From Industry 4.0, Smart Cities, energy optimisation, autonomous vehicles to wearables, baby monitoring, intelligent self-ordering and freshness monitoring fridges and many other types of home appliances. At the same time, the exploding

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180 The “Internet of Everything” builds on the foundation of the "Internet of Things" by adding network intelligence that allows convergence, orchestration and visibility across previously disparate systems, http://ioeassessment.cisco.com/learn/ioe-faq

181 Hype Cycles provide a graphic representation of the maturity and adoption of technologies and applications, and how they are potentially relevant to solving real business problems and exploiting new opportunities - Gartner Hype Cycle,http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp

182 What’s New in Gartner’s Hype Cycle for Emerging Technologies, 2015, http://www.gartner.com/smarterwithgartner/whats-new-in-gartners-hype-cycle-for-emerging-technologies-2015/

183 For the remainder of this document, « IoT » will refer to the Inter of Things or Everything as it’s commonly used abbreviation.

number of IoT devices are central to the occurrence of massive amounts of big data from all types of processes triggered by IoT devices[184].

Here is one possible definition of IoT:

> *The Internet of Things refers to the networking of physical objects through the use of embedded sensors, actuators, and other devices that can collect or transmit information about the objects. The data amassed from these devices can then be analysed to optimize products, services, and operations[185].*

Market growth potential seems to be enormous: Up do over 30 billion IoT objects by 2020 with an annual 15-20% growth til then[186], [187], [188], [189], [190], [191], [192], [193].

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184 THE INTERNET OF EVERYTHING: 2015 SLIDE DECK, http://uk.businessinsider.com/internet-of-everything-2015-bi-2014-12?op=1

185 The Internet of Things: Sizing up the opportunity, http://www.mckinsey.com/industries/high-tech/our-insights/the-internet-of-things-sizing-up-the-opportunity

186 The Internet of Things: Sizing up the opportunity, http://www.mckinsey.com/industries/high-tech/our-insights/the-internet-of-things-sizing-up-the-opportunity

187 IoT Market, https://postscapes.com/internet-of-things-market-size/

188 Roundup Of Internet of Things Forecasts And Market Estimates, 2015, http://www.forbes.com/sites/louiscolumbus/2015/12/27/roundup-of-internet-of-things-forecasts-and-market-estimates-2015

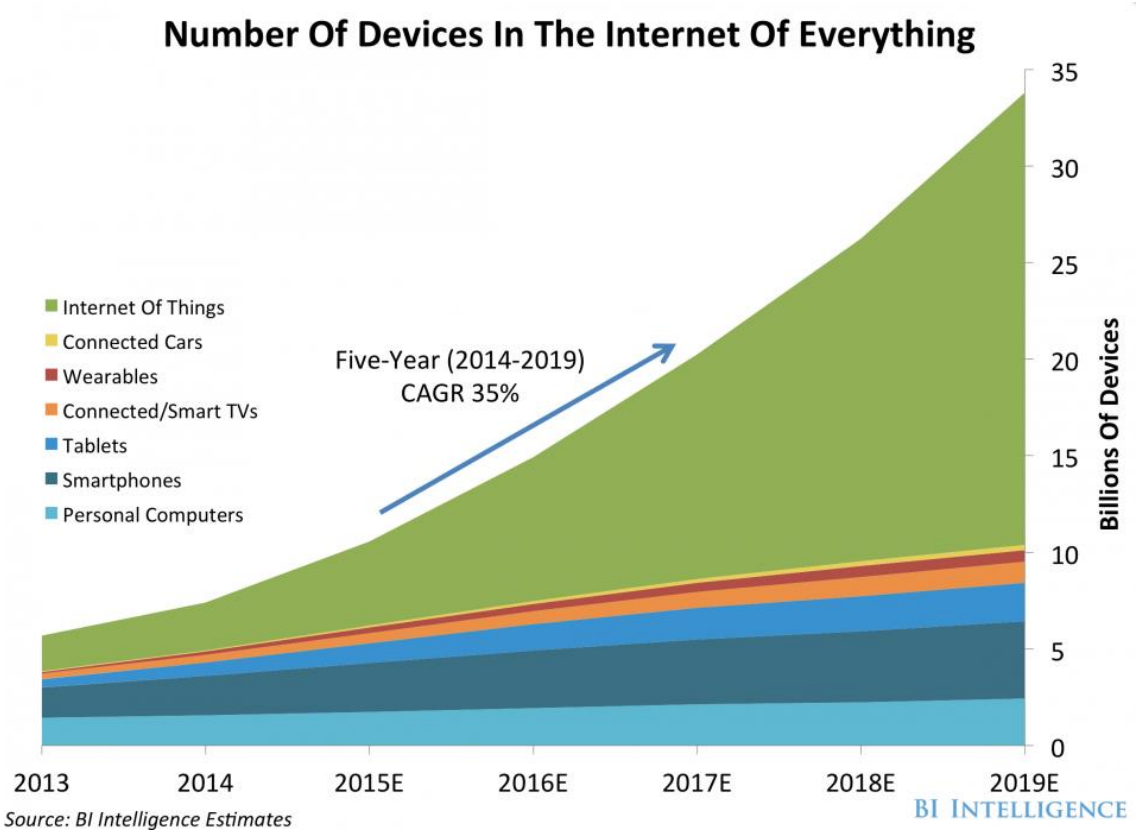
189 The 'Internet of Things' Will Be The World's Most Massive Device Market And Save Companies Billions Of Dollars, http://uk.businessinsider.com/how-the-internet-of-things-market-will-grow-2014-10

190 Western European Internet of Things Spending Forecast to Reach Nearly $250 Billion in 2019, Representing 19% of the Worldwide IoT Spending, http://www.idc.com/getdoc.jsp?containerId=prEMEA40958015

191 The Internet of Things: A new path to European prosperity, http://www.atkearney.fr/documents/10192/7125406/The+Internet+of+Things-A+New+Path+to+European+Prosperity.pdf/

192 State of the Market: Internet of Things 2016, https://www.verizon.com/about/sites/default/files/state-of-the-internet-of-things-market-report-2016.pdf

193 The Internet Of Things Heat Map, 2016, https://www.cloudera.com/content/dam/www/static/documents/analyst-reports/forrester-the-iot-heat-map.pdf



The way business is done and value is created will be fundamentally affected by IoT in terms of new business models (including customer experience[194], [195], [196], radical innovation, increased efficiency and lower costs[197], [198], [199], [200], [201].

In two recent articles in Harvard Business Review, Michael E. Porter & James E. Heppelmann deliver an in-depth analysis on how smart, connected products are transforming competition and companies[202], [203].

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194 The Internet of Things Is Changing How We Manage Customer Relationships, https://hbr.org/2015/06/the-internet-of-things-is-changing-how-we-manage-customer-relationships

195 Why Johnnie Walker joined the Internet of Things, http://www.cio.com/article/2926218/innovation/why-johnnie-walker-joined-the-internet-of-things.html

196 Kuvée raises $6 million for smart wine bottles, https://techcrunch.com/2016/03/28/kuvee-raises-6-million-for-smart-wine-bottles/

197 An executive's guide to the Internet of Things, http://www.mckinsey.com/business-functions/business-technology/our-insights/an-executives-guide-to-the-internet-of-things

198 CISCO on IoThttp://www.cisco.com/c/m/en_emear/internet-of-everything-ioe/index.html

199 The Internet of Things Opportunities and challenges, http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/557012/EPRS_BRI(2015)557012_EN.pdf

200 The Internet of Things: Evolution or Revolution?, http://www.aig.com/content/dam/aig/america-canada/us/documents/business/casualty/aigiot-english-report.pdf

201 The Internet of Things Is Far Bigger Than Anyone Realizes, http://www.wired.com/insights/2014/11/the-internet-of-things-bigger/

202 How Smart, Connected Products Are Transforming Competition, https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition

203 How Smart, Connected Products Are Transforming Companies, https://hbr.org/2015/10/how-smart-connected-products-are-transforming-companies

They write a.o.

> *Smart, connected products offer exponentially expanding opportunities for new functionality, far greater reliability, much higher product utilization, and capabilities that cut across and transcend traditional product boundaries. The changing nature of products is also disrupting value chains, forcing companies to rethink and retool nearly everything they do internally.*
>
> *These new types of products alter industry structure and the nature of competition, exposing companies to new competitive opportunities and threats. They are reshaping industry boundaries and creating entirely new industries. In many companies, smart, connected products will force the fundamental question, "What business am I in?"*

and

> *…how the nature of smart, connected products substantially changes the work of virtually every function within the manufacturing firm. The core functions—product development, IT, manufacturing, logistics, marketing, sales, and after-sale service—are being redefined, and the intensity of coordination among them is increasing. Entirely new functions are emerging, including those to manage the staggering quantities of data now available. All of this has major implications for the classic organizational structure of manufacturers. What is under way is perhaps the most substantial change in the manufacturing firm for more than a century.*
>
> *All smart, connected products, from home appliances to industrial equipment, share three core elements:* ***physical components*** *(such as mechanical and electrical parts);* ***smart components*** *(sensors, microprocessors, data storage, controls, software, an* ***embedded operating system****, and a digital user interface); and connectivity components (ports, antennae, protocols, and networks that enable communication between the product and the product cloud, which runs on remote servers and contains the product's external operating system).*

The two articles also contain some highly insightful illustration of the forces and systems and systems at stake.

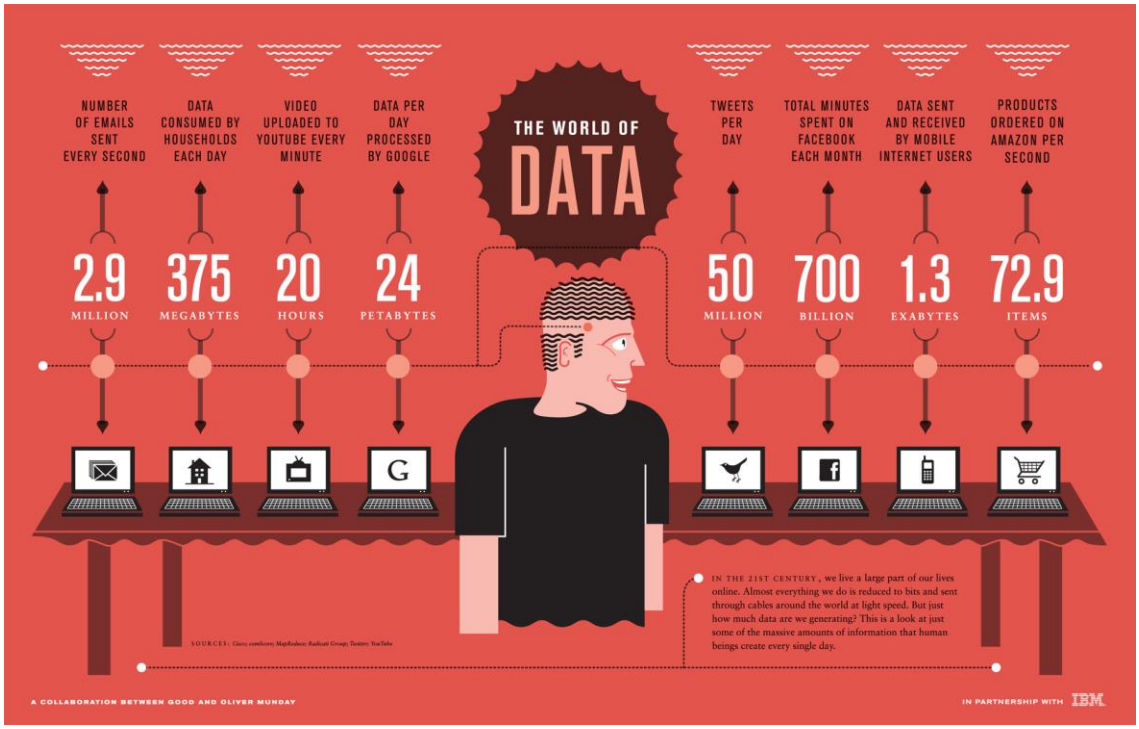
IoT, though, implies an important yet unsolved issue which is cybersecurity: it is hardly imaginable that all kinds of already existing and upcoming IoT appliances have embedded state-of-the-art security mechanisms and professional media starts pointing to the issue.[204], [205], [206].

In terms of innovation using IoT, possibilities seem endless. Knowing what to do and understanding (hidden) problems at the customer side that can be solved using IoT is therefore an essential skill set, to avoid losing focus and a lot of time and money in developing products and services that nobody wants. Design skills are thus more important than ever for any company that wants to create new value with IoT[207].

Big data

« Data is the new currency » or « Data is the new oil » are sentences that we hear and read these days when talking about the future of business and economics.

The ever-growing computing power and cloud interconnectivity, combined with more and more objects and appliances that are equipped with all kinds of sensors and trackers (machine-to-machine communication) as well the data streams that we as humans produce online by using our connected devices for work and life altogether generate volumes and qualities of structured, semi-structured and unstructured data that never existed before. The following graph underlines the staggering quantity of data produced every month, day or even second.



[204] IoT Could Be Used To Spy, Admits James Clapper, https://techcrunch.com/2016/02/10/iot-could-be-used-to-spy-admits-james-clapper/

[205] Consumers don't care if their connected car can get hacked - here's why that's a problem, http://www.businessinsider.stfi.re/smart-car-hacking-major-problem-for-iot-internet-of-things-2016-3

[206] At Black Hat, the 'Internet of Things' Gets Put Through Its Paces, http://www.wsj.com/articles/at-black-hat-the-internet-of-things-gets-put-through-its-paces-1469957403

[207] The Internet of Things needs design, not just technology, https://hbr.org/2016/04/the-internet-of-things-needs-design-not-just-technology

Source[208]

Heavy computing power combined with mathematical algorithms and statistical science are now able to unveil hidden patterns of behaviour of people and processes and potentially discover many yet undiscovered opportunities in the governance and value creation of society, science and the economy. Automation generates big data and big data insights in turn are used to pilot automation. The effect on business will be better understanding of processes and stakeholder behaviour and considerable efficiency and productivity increases.

There are many possible definitions or descriptions of big-data[209], [210], [211], [212], [213].

Googling « big data definition » returns[214]

> *Big Data are extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions. «Currently, much IT investment is going towards managing and maintaining big data »*

In that light, it is easy to understand that the primary and secondary markets for big data will be enormous and that companies or other institutions that do not start tapping into big data might soon be obsolete.

Big data is often characterized by the 4 Vs: Volume, Velocity, Variety and Veracity, as wrapped up by the following graph[215] ,[216]:

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208 https://assets.goodstatic.com/s3/magazine/assets/536765/original/open-uri20140703-4674-ghcvv3

209 12 Big Data Definitions: What's Yours?, http://www.forbes.com/sites/gilpress/2014/09/03/12-big-data-definitions-whats-yours/#2b9e3e8021a9

210 Definitions of Big Data, http://www.opentracker.net/article/definitions-big-data

211 What Is Big Data?, https://datascience.berkeley.edu/what-is-big-data

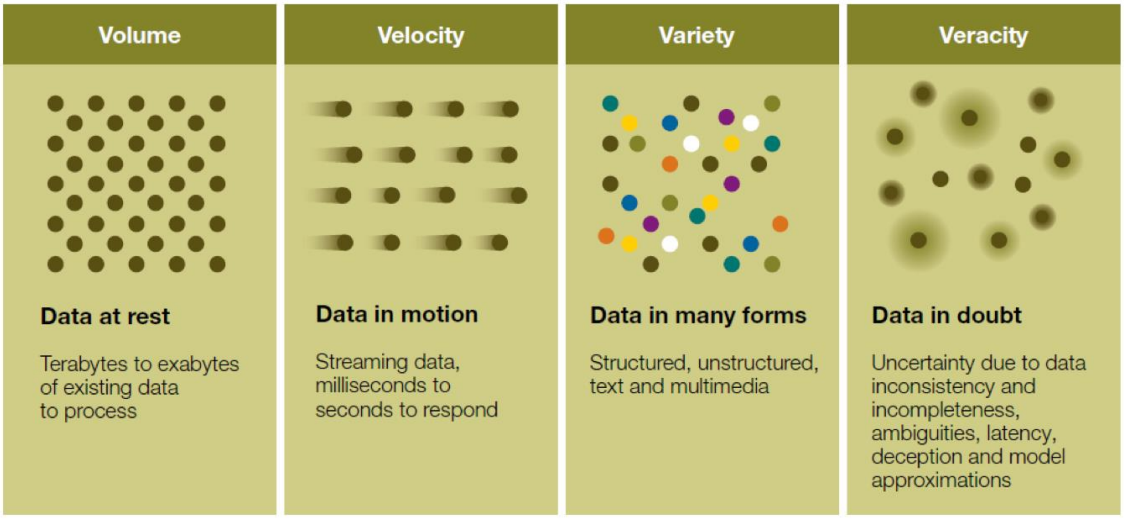
212 What is Big Data? Explain Big Data, Define Big Data, Big Data Examples, https://www.youtube.com/watch?v=tkOwlXUaGMM

213 Big Data: mehr, schnell, gut genug, http://www.hantschk-klocker.com/uploads/filemanager/dokumente/leseraum/strategie/hkp_artikel_big_data.pdf

214 https://www.google.fr/search?q=big+data+definition&oq=big+data

215 http://www.slideshare.net/infoDiagram/big-data-cloudappsvisualiconpptinfodiagramtoolbox

216 See IBMs Big Data & Analytics hub for a more detailed illustration: http://www.ibmbigdatahub.com/infographic/four-vs-big-data



The technology landscape of Big Data is already rather crowded.

Big Data[217] virtually hits every sector and type of activity in the value chain[218] with a strong disruptive tendency: marketing and customer experience[219], [220], manufacturing (Industry 4.0), health and precision medicine [221], [222], [223], [224], [225], [226], [227], government, education[228], infrastructure, finance, HR, etc.[229], [230], [231]

Analysing business and other data to better understand behavioural patterns and make better predictions is nothing new. Business intelligence[232] software for Data Mining[233] and Predictive Analytics[234] have been around for a while. The difference with big data is that the sheer amount of data available in recent years

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217 Living Lab Big Data, https://www.iais.fraunhofer.de/content/dam/iais/gf/bda/Downloads/FraunhoferIAIS_Living-Lag-Big-Data_2012-12-10.pdf

218 Big Data – Perspectives for Germany Seize the Opportunity, http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/First_German-Indian_Workshop/Wrobel_Indo-German_Workshop_2013-03.pdf

219 How Companies Learn Your Secrets, http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html?pagewanted=all&_r=1

220 Big Data-Driven Decision-Making At Domino's Pizza, https://www.linkedin.com/pulse/big-data-driven-decision-making-dominos-pizza-bernard-marr

221 According to the US National Institutes of Health (NIH), precision medicine is "an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment, and lifestyle for each person." This approach will allow doctors and researchers to predict more accurately which treatment and prevention strategies for a particular disease will work in which groups of people. It is in contrast to a "one-size-fits-all" approach, in which disease treatment and prevention strategies are developed for the average person, with less consideration for the differences between individuals., https://ghr.nlm.nih.gov/primer/precisionmedicine/definition

222 How Obama's Precision Medicine Initiative Will Revolutionize Healthcare, http://io9.gizmodo.com/how-obamas-precision-medicine-initiative-will-revolutio-1680866890

223 FACT SHEET: President Obama's Precision Medicine Initiative, https://www.whitehouse.gov/the-press-office/2015/01/30/fact-sheet-president-obama-s-precision-medicine-initiative

224 How Big Data Is Transforming The Healthcare Sector, https://www.linkedin.com/pulse/how-big-data-transforming-healthcare-sector-bernard-marr

225 Making predictive analytics a routine part of patient care, https://hbr.org/2016/04/making-predictive-analytics-a-routine-part-of-patient-care

226 Enabling Precision Medicine to treat and prevent inflammation-caused diseases, http://www.innventis-pharma.com/

227 Big data, source d'opportunités et de productivité pour la santé, http://hubinstitute.com/2016/01/big-data-source-dopportunites-et-de-productivite-pour-la-sante/

228 Data driven innovation for education: http://www.slideshare.net/OECDEDU/data-driven-innovation-for-education

229 Big data - Vorsprung durch Wissen - Innovationspotentialanalyse, https://www.fraunhofer.de/content/dam/zv/de/forschungsthemen/kommunikation/bigdata/Innovationspotenzialanalyse_Big-Data_Fraunhofer-IAIS.pdf

230 Big Data – Vorsprung durch Wissen

Chancen erkennen und nutzen,

https://www.iais.fraunhofer.de/content/dam/iais/gf/bda/Downloads/FraunhoferIAIS_Big-Data_2012-12-10.pdf

231 How big data is changing disruptive innovation, https://hbr.org/2016/01/how-big-data-is-changing-disruptive-innovation

232 https://en.wikipedia.org/wiki/Business_intelligence

233 https://en.wikipedia.org/wiki/Data_mining

234 https://en.wikipedia.org/wiki/Predictive_analytics

combined with ever more powerful computer processing capacities allows for much more than in the previous area. And that is precisely the reason the term « Big Data » was coined[235], [236].

But “Big data” in itself does not have a high intrinsic value. Big data can even be considered as noise. What matters is to make sense out of big data, by analysing it and by mining it via algorithms. In view of these developments, it is not surprising that the job market is going hot for an emerging new job profile: the **data scientist**[237], [238], [239], [240].

And last but not least, big data raises many questions[241] about ethics, privacy and security. We will get back to these subjects in later dedicated sections.

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235 Who coined the term 'big data’?, https://www.quora.com/Who-coined-the-term-big-data

236 The Origins of ‘Big Data': An Etymological Detective Story, http://bits.blogs.nytimes.com/2013/02/01/the-origins-of-big-data-an-etymological-detective-story/

237 Future of Data Science and Data Scientists, https://www.linkedin.com/pulse/future-data-science-scientist-mohammad-islam

238 The data science ecosystem, https://www.instapaper.com/text?u=https%3A%2F%2Fmedium.com%2F%40balazskegl%2Fthe-data-science-ecosystem-678459ba6013%23.4xuwskt2i

239 Data science, https://en.wikipedia.org/wiki/Data_science

240 Data Science Central: The industry's online resource for big data practitioners, http://www.datasciencecentral.com/

241 Big Data: Wenn Menschen bereit sind Ihre Daten zu teilen, eine europäische Studie, http://www.vodafone-institut.de/wp-content/uploads/2016/01/VodafoneInstitute-Survey-BigData-Highlights-de.pdf

BOX 6: OPEN DATA

> *Open data is data that can be freely used, shared and built-on by anyone, anywhere, for any purpose* [242].

Open data is data that anyone can access, use or share. When large companies or governments release non-personal data, they enable small businesses, citizens or for instance medical researchers to develop resources which make crucial improvements to their communities and create economic value. The following chart provides a (non-exhaustive) overview of data that, as of today, can be accessed free of charge by users.

Source[243]

[242] Defining Open Data, http://blog.okfn.org/2013/10/03/defining-open-data/

[243] http://blog.okfn.org/2013/10/03/defining-open-data/

In 2009, Open Data became visible in the mainstream, with various governments, such as the USA, UK, Canada and New Zealand, announcing new initiatives towards opening up public information. In the meantime, hundreds of initiatives around the world followed the example[244], [245], [246], [247], [248], [249], [250], including Luxembourg[251], [252].

A bold move in open data is NASA's recent decision to make all its research available online free of charge[253]

Open Data[254] is an essential component of **open government**, a movement triggered by the societal transformations caused by the widespread availability of the Internet, affordable high performance computing power, ubiquitous access via computers, tablets and smartphones and multiple connected communities.

The open definition's criteria[255] for open data can be summarized as follows[256]:

> ***Availability and Access****: the data must be available as complete sets and at no more than a reasonable reproduction cost, preferably by downloading over the internet. The data must also be available in a convenient and modifiable form.*
>
> ***Re-use and Redistribution****: the data must be provided under terms that permit re-use and redistribution including the intermixing with other datasets.*
>
> ***Universal Participation****: everyone must be able to use, re-use and redistribute the underlying data. There should be no discrimination against fields of endeavour or against persons or groups. For example,*

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244 A COMPREHENSIVE LIST OF 2600+ OPEN DATA PORTALS AROUND THE WORLD, https://www.opendatasoft.com/a-comprehensive-list-of-all-open-data-portals-around-the-world/

245 World Bank Open Data - Free and open access to global development data, http://data.worldbank.org/

246 World Bank's Open Data initiative, http://datacatalog.worldbank.org/

247 Tracking the state of government open data, http://index.okfn.org/

248 The home of the U.S. Government's open data - Here you will find data, tools, and resources to conduct research, develop web and mobile applications, design data visualizations, and more., https://www.data.gov/

249 The Open Data Institute, http://theodi.org/

250 Lessons from the Open Data Challenges, http://opendatachallenges.org/wp-content/uploads/2015/11/LESSONS-from-the-ODCS-Report2.pdf

251 https://data.public.lu/en/

252 OPEN DATA: THE MINISTRY FOR SUSTAINABLE DEVELOPMENT AND INFRASTRUCTURE LEADS THE WAY, http://www.digital-luxembourg.public.lu/en/actualites/innovation/2016/ITW-Francois-Bausch/index.html

253 Want to learn more about Martian tsunamis or keeping fit in space? Now you can, http://www.independent.co.uk/news/science/nasa-research-available-free-online-a7200011.html

254 OPEN DATA HANDBOOK - Guides, case studies and resources for government & civil society on the "what, why & how" of open data., http://opendatahandbook.org/

255 Open Definition 2.1, http://opendefinition.org/od/2.1/en/

256 http://open.canada.ca/en/open-data-principles

> *'non-commercial' restrictions that would prevent 'commercial' use, or restrictions of use for certain purposes (e.g. only in education), are not allowed.*

In 2013, it was estimated that open data—public information and shared data from private sources helps create $3 trillion a year of value in seven areas of the global economy[257]. The use of open data

1. ***has a large potential economic value*** *from its benefits, including increased efficiency, new products and services, and a consumer surplus (cost savings, convenience, better products and services)*

2. ***enhances big data's impact*** *by creating transparency, exposing variability, and enabling experimentation; helping companies to segment populations and thus to customize actions directed at them; replacing or supporting human decision making; and spurring innovative business models, products, and services*

3. ***creates multiple business opportunities****, such as the potential to raise productivity, to improve new products and services, and to enable entirely novel lines of business for both established companies and new entrants*

4. ***benefits consumers even more than businesses****, by increasing price transparency and product transparency as well as new channels to provide feedback that improves the quality of goods and services (including public ones).*

5. ***entails business risks****, including reputational issues related to the potential release of negative information (i.e. emergence of new job profiles such as corporate community managers whose job is it to supervise the company's reputation in online (social) media); the potential consumer backlash from aggressive open-data use (for instance, in ads that target online consumers by following social-media activity); and the inadvertent release of confidential information, such as benchmarking data*

6. ***requires governments to play a central role*** *by developing and implementing policies to mitigate consumer and business concerns about the misuse of open data and to help set standards that will allow the potential economic and social benefits to materialize*

7. ***faces barriers****, including privacy concerns and the need for legal and regulatory frameworks* [258].

Open data is also critical for creating social and environmental innovation.

Artificial intelligence

Artificial intelligence (AI) is a concept in computer science that exists for a while but experienced several important drawbacks over time. But as computing power continues to develop quickly, combined with advances in other technologies and especially algorithmic mathematics, artificial intelligence today is back on the scene. Currently, there is almost no day in tech news and more and more often also in the mainstream news without some announcement of breakthroughs in AI.

At the same time, there are other related concepts hyped at the same time, namely

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257 Open data: Unlocking innovation and performance with liquid information, http://www.mckinsey.com/business-functions/business-technology/our-insights/open-data-unlocking-innovation-and-performance-with-liquid-information

258 Open data: Unlocking innovation and performance with liquid information, http://www.mckinsey.com/business-functions/business-technology/our-insights/open-data-unlocking-innovation-and-performance-with-liquid-information

- machine automation, autonomous machines, or more commonly « robots »[259]
- machine learning and the so calles « deep learning »

In practice, these concepts deal essentially with the same objective and are fuelled by AI but also create AI themselves. The objective is to build intelligent machines and systems that can learn by themselves and behave autonomously.

Put that way, the disruptive potential on business processes but also on all other types of processes managed and triggered by machines and computers of AI become immediately clear.

Let's tap first into the definitions:

> ***Artificial intelligence (AI)*** *is « intelligence » exhibited by machines. In computer science, an ideal "intelligent" machine is a flexible rational agent that perceives its environment and takes actions that maximize its chance of success at some goal. Colloquially, the term "artificial intelligence" is applied when a machine mimics « cognitive » functions that humans associate with other human minds, such as « learning » and « problem solving »[260].*
>
> ***Machine learning*** *is a subfield of computer science (more particularly soft computing and granular computing) that evolved from the study of pattern recognition and computational learning theory in artificial intelligence[261].*
>
> ***Deep learning*** *(also known as deep structured learning, hierarchical learning or deep machine learning) is a branch of machine learning based on a set of algorithms that attempt to model high-level abstractions in data by using a deep graph with multiple processing layers, composed of multiple linear and non-linear transformations.[262]*

or in a more simple way:

> Deep Learning *is a new area of Machine Learning research, which has been introduced with the objective of moving Machine Learning closer to one of its original goals: Artificial Intelligence[263].*

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259 What Is a Robot?, http://www.theatlantic.com/technology/archive/2016/03/what-is-a-human/473166/

260 https://en.wikipedia.org/wiki/Artificial_intelligence

261 https://en.wikipedia.org/wiki/Machine_learning

262 https://en.wikipedia.org/wiki/Deep_learning

263 http://deeplearning.net/

Deep learning[264] relies upon neural networks, which are inspired by biological neural networks, typically the central nervous systems of animals and in particular the brain.[265], [266]

> ***Autonomous machines*** *(or robots[267]): A robot is autonomous if it has the computational resources - both in terms of hardware and software - other than real-time interference from a human agent, to estimate how it is physically embedded in the environment to compute best possible actions bounded by some constraints to perceive and move if needed, to achieve a set of goals[268].*

The current advancements in self-driving cars[269] for example (autonomous vehicles) clearly illustrates the disruptions to come in terms of AI and robotics. Other areas of application include care[270], medicine[271], industrial manufacturing (as a component of Industry 4.0), logistics, etc.[272], but also autonomous weapons. A vivid discussion on ethics of autonomous machines unsurprisingly takes currently place for several reasons, **including the threat to millions of actual jobs through automation**[273], [274],and we will get back to it later on in a section on « ethical and societal challenges of digital transformation ».

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264 Computer science: The learning machines: http://www.nature.com/news/computer-science-the-learning-machines-1.14481

265 https://en.wikipedia.org/wiki/Artificial_neural_network

266 See also: Deep Learning Machine Teaches Itself Chess in 72 Hours, Plays at International Master Level - In a world first, a machine plays chess by evaluating the board rather than using brute force to work out every possible move, https://www.technologyreview.com/s/541276/deep-learning-machine-teaches-itself-chess-in-72-hours-plays-at-international-master/

267 Robots at Work and Play, http://www.theatlantic.com/photo/2014/11/robots-at-work-and-play/100856/

268 https://www.researchgate.net/post/What_is_an_autonomous_robot

269 Google self-driving car project: http://www.google.com/selfdrivingcar/

270 Who will care for us in the future? Watch out for the rise of the robots, https://www.theguardian.com/commentisfree/2016/mar/06/who-will-care-for-us-in-the-future-robots-outsourcing-humantiy

271 IBM's Watson Could Diagnose Cancer Better Than Doctors, http://www.qmed.com/news/ibms-watson-could-diagnose-cancer-better-doctors

272 How a Japanese cucumber farmer is using deep learning and TensorFlow, https://cloud.google.com/blog/big-data/2016/08/how-a-japanese-cucumber-farmer-is-using-deep-learning-and-tensorflow (Sorting cucumbers is as hard and tricky as actually growing them. Each cucumber has different color, shape, quality and freshness)

273 Künstliche Intelligenz: Dieser Herr macht bald Ihren Job, http://www.spiegel.de/netzwelt/web/google-will-maschinen-denken-beibringen-a-1069072.html

274 Deep Learning Is Going to Teach Us All the Lesson of Our Lives: Jobs Are for Machines, https://medium.com/basic-income/deep-learning-is-going-to-teach-us-all-the-lesson-of-our-lives-jobs-are-for-machines-7c6442e37a49#.p8lxitu0e

This year's winning of Googles' AlphaGo ('DeepMind' AI platform) computer against the world best GO player was celebrated as a turning point in human history[275]. AlphaGo is built upon deep learning and neural networks [276] and is now even capable of learning without human input[277], [278].

Again Big Data, meaning the application of data mining[279] to large amounts of data is central to autonomous systems, AI and deep learning.

In any case, «The Age of Autonomous Robots Is Upon Us »[280], [281]

At the current speed of technological progress, AI will be impacting business in many ways[282]. The market for AI and robots will also develop at a high speed, especially in the following domains[283]:

[275] 'A Perfect and Beautiful Machine': What Darwin's Theory of Evolution Reveals About Artificial Intelligence, http://www.theatlantic.com/technology/archive/2012/06/-a-perfect-and-beautiful-machine-what-darwins-theory-of-evolution-reveals-about-artificial-intelligence/258829/

[276] Software-Sieg im Brettspiel: Es geht um weit mehr als Go, http://www.spiegel.de/netzwelt/gadgets/alphago-sieg-wendepunkt-der-menschheitsgeschichte-a-1082001.html

[277] Google's 'DeepMind' AI platform can now learn without human input, http://thenextweb.com/artificial-intelligence/2016/10/17/deepmind-ai-platform-can-now-learn-without-human-input/

[278] Google's AI can now learn from its own memory independently, http://www.sciencealert.com/the-deepmind-ai-can-now-learn-how-to-use-its-own-memory

[279] https://en.wikipedia.org/wiki/Data_mining

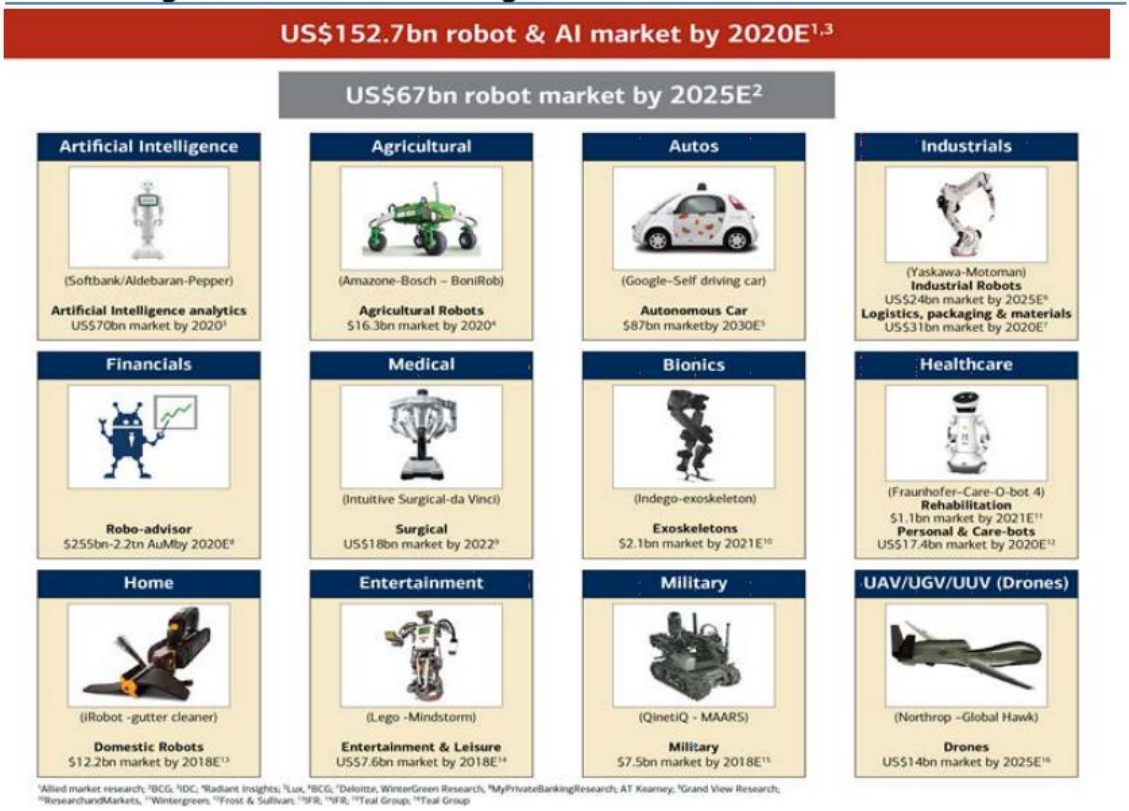
[280] Startups that build robots are on the rise,http://fortune.com/2016/03/29/autonomous-robots-startups/

[281] Buddy, the first companion robot,http://www.bluefrogrobotics.com/en/buddy/

[282] Artificial Intelligence Is Almost Ready for Business, https://hbr.org/2015/03/artificial-intelligence-is-almost-ready-for-business

[283] Thematic Investing Robot Revolution – Global Robot & AI Primer, http://www.bofaml.com/content/dam/boamlimages/documents/PDFs/robotics_and_ai_condensed_primer.pdf

Exhibit 1: The global robots & artificial intelligence market



Source: BofA Merrill Lynch Global Research

Deep learning research [284] is currently hot on the academic agenda and at the same time large corporations are enticing deep learning and AI researchers from academia, who are attracted by competitive wages and better data processing conditions, and by doing so, influence the way how research is done in academia[285].

AI is also impacting business processes, from customer experience, marketing through hiring to name but a few. Businesses will have to adapt their hierarchies, structures and budget as a consequence[286].

The following graph provides an indicative list of machine learning application across six main industries that are manufacturing, retail, healthcare[287] and life sciences, travel and hospitality, financial services and, finally, energy, feedstock and utilities.

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284 see for ex MIRI: Machine Intelligence Reserach Institute, https://intelligence.org/

285 Die Stunde der KI-Firmen, http://www.spektrum.de/news/kuenstliche-intelligenz-unternehmen-werben-universitaeten-die-ki-forscher-ab/1416122

286 How to prepare your business to benefit from AI, http://www.techrepublic.com/article/how-to-prepare-your-business-to-include-ai/

287 How Machine Learning, Big Data And AI Are Changing Healthcare Forever, http://www.forbes.com/sites/bernardmarr/2016/09/23/how-machine-learning-big-data-and-ai-are-changing-healthcare-forever/#ed9c65c4f49e

Figure 2: Machine Learning applications across industries

Source[288]

AI will impact our life and socio-economic systems in many ways[289], [290] but the cultural shift associated with it will be difficult and not without turbulence.

Virtual and Augmented Reality

Virtual Reality (VR) and Augmented Reality (AR) are basically Human-Computer Interface technologies that have also been around for a while, without however having received significant mainstream attention or widespread business application until recently. But that is changing.

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[288] Machine Learning Is Redefining The Enterprise In 2016, https://www.enterpriseirregulars.com/107506/machine-learning-redefining-enterprise-2016/

[289] Using artificial intelligence to pick the perfect bottle of wine, http://www.cnbc.com/2016/07/29/artificial-intelligence-and-wine.html

[290] Venture capitalist Marc Andreessen explains how AI will change the world, http://www.vox.com/new-money/2016/10/5/13081058/marc-andreessen-ai-future

Virtual Reality (VR)[291], [292], [293], [294], [295] has already been used for many years in computer gaming for example but also in medical imagery, training and education and cultural heritage a.o.. AR[296] is used in complex maintenance tasks for example, such as airplanes or military equipment but also in marketing, retail, health a.o.[297], [298], [299], [300], [301], [302], [303], [304].

The difference between VR and AR is that VR constructs a complete virtual world whereas AR adds virtual elements to the real world.

Both technologies need heavy computing power in order to work seamlessly. That's the reason why we only see now more widespread applications by smaller businesses and in the mass market made possible by the exponential development in computing power, both at the device and at the network level[305], [306].

But talking about AR is not possible any more without mentioning the global Phenomenon of the Smartphone game ***Pokémon Go***. Having initially being released on July 7, 2016, the game reportedly has been downloaded over 75 million times worldwide since then[307].

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[291] How Virtual Reality Works, http://electronics.howstuffworks.com/gadgets/other-gadgets/virtual-reality6.htm

[292] 9 industries using virtual reality, http://www.techrepublic.com/article/9-industries-using-virtual-reality/

[293] Virtual reality uses beyond gaming, http://www.livescience.com/53392-virtual-reality-tech-uses-beyond-gaming.html

[294] Applications Of Virtual Reality, http://www.vrs.org.uk/virtual-reality-applications/

[295] Was VR in fünf Jahren kann – und wie das die Welt verändert, http://www.heise.de/newsticker/meldung/Was-VR-in-fuenf-Jahren-kann-und-wie-das-die-Welt-veraendert-3343484.html

[296] Augmented Reality – What is it?, http://www.vrs.org.uk/augmented-reality/

[297] Top 10 Augmented Reality Use Cases, http://www.t-immersion.com/augmented-reality/use-cases

[298] FINALLY – 4 REAL-WORLD USES FOR AUGMENTED REALITY, https://www.theprimacy.com/blog/finally-4-real-world-uses-for-augmented-reality/

[299] 11 extraordinary uses of Augmented Reality (AR), https://searchenginewatch.com/2016/04/28/11-extraordinary-uses-of-augmented-reality-ar/

[300] 8 Uses of Virtual Reality and Augmented Reality for the Enterprise, http://www.itbusinessedge.com/slideshows/8-uses-of-virtual-reality-and-augmented-reality-for-the-enterprise.html

[301] Ten industries using augmented reality and virtual reality, http://www.zdnet.com/article/ten-industries-using-augmented-reality-and-virtual-reality/

[302] 10 Examples of Augmented Reality in Retail, http://www.creativeguerrillamarketing.com/augmented-reality/10-examples-augmented-reality-retail/

[303] 6 cool uses for augmented reality in healthcare, http://www.techrepublic.com/article/6-cool-uses-for-augmented-reality-in-healthcare/

[304] Bitkom: "Virtual Reality hat riesiges Potenzial », http://www.heise.de/newsticker/meldung/Bitkom-Virtual-Reality-hat-riesiges-Potenzial-3310341.html

[305] See for example:
Best VR headsets to buy in 2016, whatever your budget, http://www.pocket-lint.com/news/132945-best-vr-headsets-to-buy-in-2016-whatever-your-budget

[306] The Ultimate Dream of Flying: The intention of Birdly® is to fulfill people's ancient dream of flying. With virtual reality (VR) and robotics technology SOMNIACS creates an extremely vivid full-body experience that makes you instantly forget the mechanics and computer codes behind this spectacular apparatushttp://www.somniacs.co/

[307] Pokémon Go (stylized Pokémon GO) is a free-to-play, location-based augmented reality game developed and published by Niantic for iOS and Android devices. It was initially released in selected countries in July 2016. In the game, players use a mobile device's GPS capability to locate, capture, battle, and train virtual creatures, called Pokémon, who appear on the screen as if they were in the

Beyond being addictive and deeply immersive, and having already created hundreds of funny and strange (and sometimes scary)[308] stories experiences around the world, the game is also considered by business experts as being a kind of final proof of concept readiness for widespread AR adoption in different domains of application and industries. The games' developers are backed by Google, so they can rely on Googles cloud computing power and combined with the chip power commonly present in most recent smartphones, AR can now unleash its full potential.

It is a social game, and interestingly most players say they love the game because they can go outdoors, alone but often also in groups, and spontaneously meet other players on the streets and get in touch with them, instead of sitting home alone behind a computer screen and a gaming console[309].

Additionally, the game has a « plus » version where players can buy different things to enhance the game, and the turnover it generates is important[310], [311].

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same real-world location as the player. The game supports in-app purchases for additional in-game items., https://en.wikipedia.org/wiki/Pok%C3%A9mon_Go

[308] 8 hilarious (and terrifying) Pokemon Go stories from the week, http://www.phonearena.com/news/8-hilarious-and-terrifying-Pokemon-Go-stories-from-the-week_id83132

Just a giant collection of Pokemon Go stories, http://edition.cnn.com/2016/07/18/health/the-best-and-worst-pokemon-go-stories-trnd/

6 OF THE CRAZIEST POKEMON GO STORIES, http://www.ign.com/articles/2016/07/24/6-of-the-craziest-pokemon-go-stories

The Strangest, Funniest And Most Shocking Things That Have Happened To Pokémon Go Players, http://www.nme.com/blogs/nme-blogs/pokemon-go-launch-weird-stuff

16 crazy Pokémon Go stories yu don't want to miss http://phandroid.com/2016/07/13/cool-crazy-funny-pokemon-go-stories/

«Pokémon GO»: La première chasse géante de France organisée jeudi à Paris, http://www.20minutes.fr/paris/1887971-20160712-pokemon-go-premiere-chasse-geante-france-organisee-jeudi-paris

Le Sénat annule la première chasse "Pokémon Go" prévue à Paris, http://www.francetvinfo.fr/internet/pokemon-go/le-senat-annule-la-premiere-chasse-pokemon-go-prevue-a-paris_1546351.html,

Une horde de joueurs sur la trace des Pokémon (Grand-Duché de Luxembourg), http://www.lessentiel.lu/fr/luxembourg/story/Une-horde-de-joueurs-sur-la-trace-des-Pokemon-12350031

[309] This has to considered in the context of the socio-psychological profile of many typical computer gamers.

[310] Pokémon Go real-time stats, http://appinstitute.com/pokemongo-realtime-stats/

[311] Pokémon Go crosses $200M in global revenue one month into launch, https://techcrunch.com/2016/08/07/pokemon-go-crosses-200m-in-global-revenue-one-month-into-launch/

But the discussion about what Pokémon Go means as a « disruptive game » means for AR technology and it's possible application to other areas in the near future is already launched (i.e. Learning, teambuilding, leadership…etc.) [312], [313], [314].

Considering all these recent developments in VR and AR, it is difficult not to strategically reflect on the near future effects on business and society, although AR and VR are merely « the interfaces », or the end of the chain in the digital transformation continuum described in this section from a technological point of view.

3D Printing (Additive Manufacturing)

3D Printing[315] [316](also called additive manufacturing) is another revolutionary technology that is disruptively impacting business, manufacturing and the whole value chain in many different ways[317].

> *Additive Manufacturing (AM)[318] is an appropriate name to describe the technologies that build 3D objects by adding layer-upon-layer of material, whether the material is plastic, metal, concrete or one day…human tissue (bioprinting)[319].*
>
> *3D printing turns digital 3D models into solid objects by building them up in layers. The technology was first invented in the 1980s, and since that time has been used for rapid prototyping (RP). However, in the last few years, 3D printing has additionally started to evolve into a next-generation manufacturing technology that has the potential to allow the local, on-demand production of final products or parts thereof.*
>
> *Already today it is possible to 3D print in a wide range of materials that include thermoplastics, thermoplastic composites, pure metals, metal*

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312 Is Pokémon Go Augmented Reality's Killer App?, http://deloitte.wsj.com/cio/2016/08/01/is-pokemon-go-augmented-realitys-killer-app/

313 POKÉMON GO WILL MAKE YOU CRAVE AUGMENTED REALITY, http://www.newyorker.com/tech/elements/pokemon-go-will-make-you-crave-augmented-reality

314 Pokémon Go und neue Lernformate: eine Lernreise (1) , https://www.linkedin.com/pulse/pok%C3%A9mon-go-und-neue-lernformate-eine-lernreise-1-hans-gaertner

Pokémon Go und neue Lernformate: eine Lernreise (2), https://www.linkedin.com/pulse/pok%C3%A9mon-go-und-neue-lernformate-eine-lernreise-2-hans-gaertner

Pokémon Go und neue Lernformate: Eine Lernreise (3), https://www.linkedin.com/pulse/pok%C3%A9mon-go-und-neue-lernformate-eine-lernreise-3-hans-gaertner

315 What is 3D printing?, http://3dprinting.com/what-is-3d-printing/

316 3D Printing (collection of articles), http://mashable.com/category/3d-printing/

317 3D Printing Industry, http://3dprintingindustry.com/

318 What is Additive Manufacturing?, http://additivemanufacturing.com/basics/

319 Bioprinting, http://explainingthefuture.com/bioprinting.html

> *alloys, ceramics and various forms of food. Right now, 3D printing as an end-use manufacturing technology is still in its infancy. But in the coming decades, and in combination with synthetic biology and nanotechnology, it has the potential to radically transform many design, production and logistics processes[320].*

3D Printing has made exponential advances in recent years and will continue to do so. Already now, a fully functional hand prosthetic can be 3D printed at the fraction of the price of traditional prosthesis manufacturing[321], [322], as much as food[323], [324], entire houses[325] [326] and even human tissue in the years to come[327]!

The technology is developing very quickly, with new types of 3D printed materials on the horizon such as 4Dprinting for example where the "fourth dimension" represents change—4D printing simply refers to printers that create objects that can transform over time and, in some cases, self-assemble[328], [329].

The impact of 3D Printing on business and the manufacturing's firm value chain will be manifold:

- In 2014, 11% of US manufacturing firms had already adopted 3DPrinting technology. According to Gartner analysts, a technology is "mainstream" when it reaches an adoption level of 20%[330].
- The US 3D printing market is expected to grow to US$16.2 billion in 2018[331].
- In 2014 sales of industrial-grade 3D printers in the United States were already one third the volume of industrial automation and robotic sales. Some projections have that figure rising to 42% by 2020[332].
- Among the numerous companies using 3D printing to ramp up production are GE (jet engines[333], medical devices, and home appliance parts), Lockheed Martin and Boeing (aerospace and defence), Aurora Flight Sciences (unmanned aerial vehicles), Invisalign

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320 3D Printing, http://explainingthefuture.com/3dprinting.html

321 3D PRINTED PROSTHETIC HAND, http://enablingthefuture.org/tag/3d-printed-prosthetic-hand/

322 Man Compares His $42k Prosthetic Hand to a $50 3D Printed Cyborg Beast, https://3dprint.com/2438/50-prosthetic-3d-printed-hand/

323 Foodini, a 3D food printer, https://www.naturalmachines.com/

324 WHY 3D FOOD PRINTING IS MORE THAN JUST A NOVELTY — IT'S THE FUTURE OF FOOD, http://www.digitaltrends.com/cool-tech/3d-food-printers-how-they-could-change-what-you-eat/

325 Interview: Architect Adam Kushner on Building the World's First 3D-Printed Estate, http://www.6sqft.com/interview-architect-adam-kushner-on-building-the-worlds-first-3d-printed-estate/

326 Dubai debuts world's first fully 3D-printed building, http://inhabitat.com/dubai-debuts-worlds-first-fully-3d-printed-building/

327 Why 3D printing will save your life one day, http://www.techradar.com/news/world-of-tech/why-3d-printing-will-save-your-life-one-day-1325678

328 This Is Why 4D Printing Is Cool, http://gizmodo.com/this-is-why-4d-printing-is-cool-1473482371

329 Why Is the US Army Investing In 4D Printing?, http://gizmodo.com/why-is-the-us-army-investing-in-4d-printing-1442964294

330 3D Printing and the news shape of industrial manufacturing, http://www.pwc.com/us/en/industrial-products/assets/3d-printing-next_manufacturing-pwc.pdf

331 3D printing market to grow to US$16.2 billion in 2018, https://www.canalys.com/newsroom/3d-printing-market-grow-us162-billion-2018

332 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

333 GE Will Make Jet Part with Additive Manufacturing, https://www.technologyreview.com/s/513716/additive-manufacturing/

(dental devices), Google (consumer electronics), and the Dutch company LUXeXcel (lenses for light-emitting diodes, or LEDs)[334]

- The U.S hearing aid industry converted to 100% additive manufacturing in less than 500 days, according to one industry CEO, and not one company that stuck to traditional manufacturing methods survived[335]
- Fabricating an object layer by layer, according to a digital "blueprint" downloaded to a printer, allows not only for limitless customization but also for designs of greater intricacy [336]
- Additive manufacturing creates myriad new options for how, when, and where products and parts are fabricated, thus challenging the optimal mix between the traditional network of supply chain assets and the combination of old and new processes[337]
- Whole commercial ecosystems begin to form around the new realities of 3D printing, thereby challenging many established business models[338]
- Additive manufacturing doesn't yet provide the economies of scale of traditional moulding manufacturing designed for mass production, but offers a much higher flexibility and endless customization options[339]
- 3D Printing parts and products can be designed with more-complex architectures, such as honeycombing within steel panels or geometries previously too fine to mill [340].
- Additive manufacturing can also use multiple printer jets to lay down different materials simultaneously [341].

And the list could go on. From there, it is clear that additive manufacturing is an essential layer of the Industry 4.0 concept, and puts pressure on manufacturing firms in terms of redesigning their offerings, repoptimizing their operations reconfiguration of the ecosystems they operate in, not to talk about the platform opportunity (platform economy[342]).

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334 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

335 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

336 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

337 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

338 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

339 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

340 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

341 The 3D Printing revolution, https://hbr.org/2015/05/the-3-d-printing-revolution

342 "A platform or complement strategy differs from a product strategy in that it requires an external ecosystem to generate complementary product or service innovations and build positive feedback between the complements and the platform. The effect is much greater potential for innovation and growth than a single product-oriented firm can generate alone.", http://blogs.wsj.com/cio/2016/02/12/the-rise-of-the-platform-economy/

BOX 7: INDUSTRIE 4.0

The term Industry 4.0 has been coined by the German Ministry of the Economy to brand its action plan for the digital transformation of its important manufacturing industry and to undermine a certain inertia of the German industry compared to the dynamism and innovation speed of the US digital economy.

Industry 4.0 is thus the German vision for the future of manufacturing, one where smart factories use information and communication technologies to digitize their processes and reap huge benefits in the form of improved quality, lower costs, and increased efficiency while digitally integrating nested value chains and ecosystems of partners and developing new innovative digital business models.

The acronym 4.0 refers to the stages of subsequent industrial revolutions: from steam machines, to electrification, automation and now digitisation.

> *Industry 4.0, Industry 4.0 or the fourth industrial revolution, is the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things and cloud computing. Industry 4.0 creates what has been called a « smart factory »*[343]

In the broader literature, however, the term Industry 4.0 is used interchangeably for machine-to-machine communication, the Internet of Things, the digital economy as a whole, digital transformation, the digital platform economy and even the 4th Industrial Revolution (which in our terminology corresponds to the « cognitive automation » (2nd) phase of the 3rd Industrial Revolution.).

A 2016 study of the Boston Consulting Group[344] analyzes the state of Industrie 4.0 adoption on both sides of the Atlantic (Germany and the US). They found that:

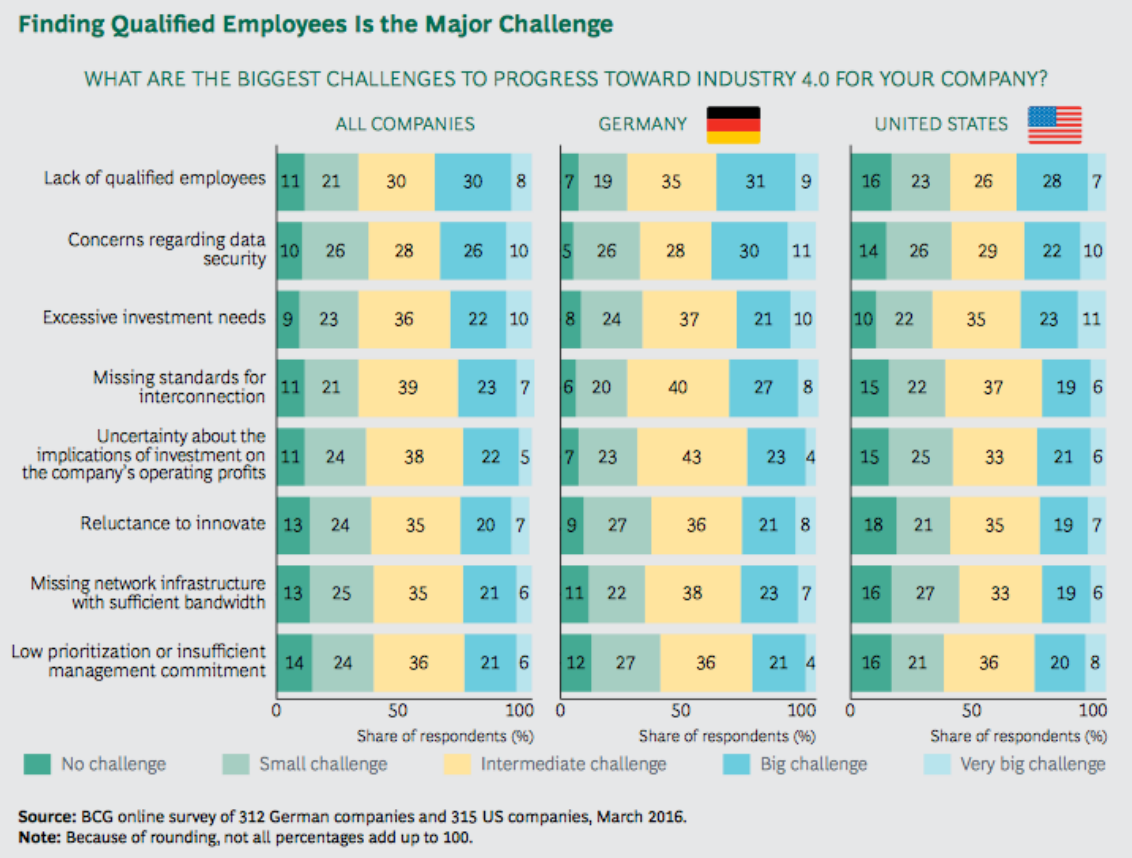
- The pace of Industry 4.0 adoption is similar in both countries but Germany seems to be better prepared than the US
- Industry 4.0 is having a significant impact on the industrial workforce and helps reduce labor costs and raise productivity

The lack of qualified employees is the top challenge followed by data security and important investment needs.

The following graph provides a more in-depth comparision as to the key challenges related to Industry 4.0 in Germany and the US:

[343] https://en.wikipedia.org/wiki/Industry_4.0

[344] INSIDE OPS: ARE YOUR OPERATIONS READY FOR A DIGITAL REVOLUTION?, http://media-publications.bcg.com/BCG-Inside-OPS-Jul-2016.pdf

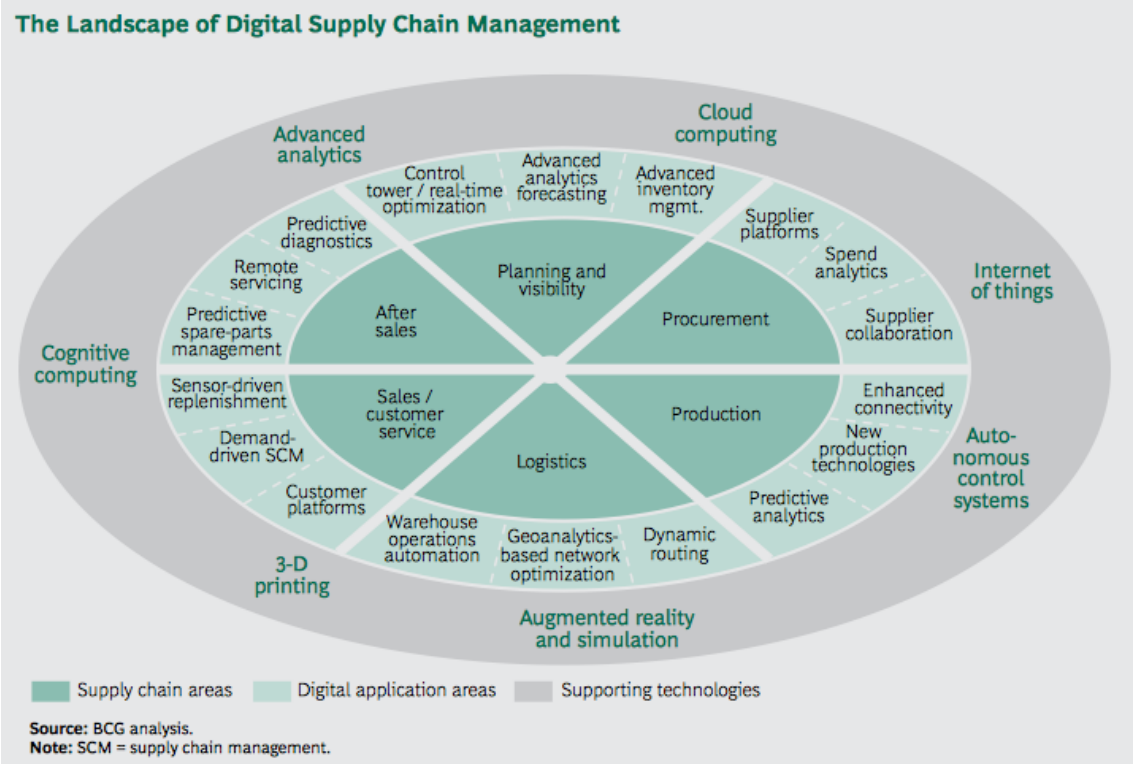


Source[345]

The same study also concluded that companies use digital supply chain technologies to improve service levels and reduce costs. It stresses that some customers will pay more for up-to-the minute supply chain information.

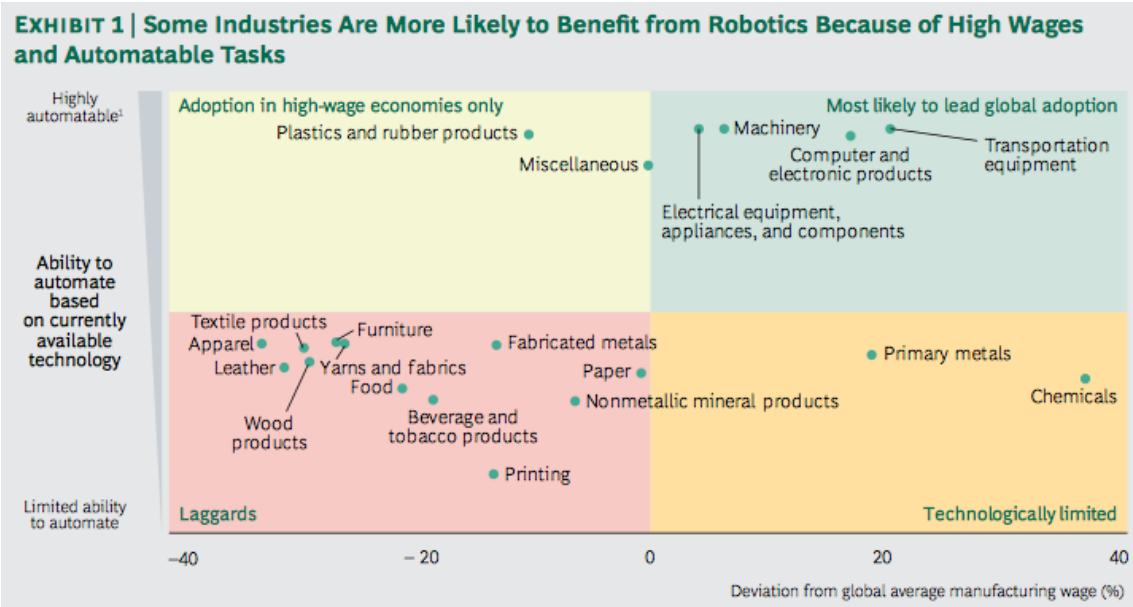
Building products closer to the customer in mobile manufacturing units can speed delivery substantially. The landscape of digital supply chain management will become widely disrupted.

345 http://media-publications.bcg.com/BCG-Inside-OPS-Jul-2016.pdf



Source: BCG analysis.
Note: SCM = supply chain management.

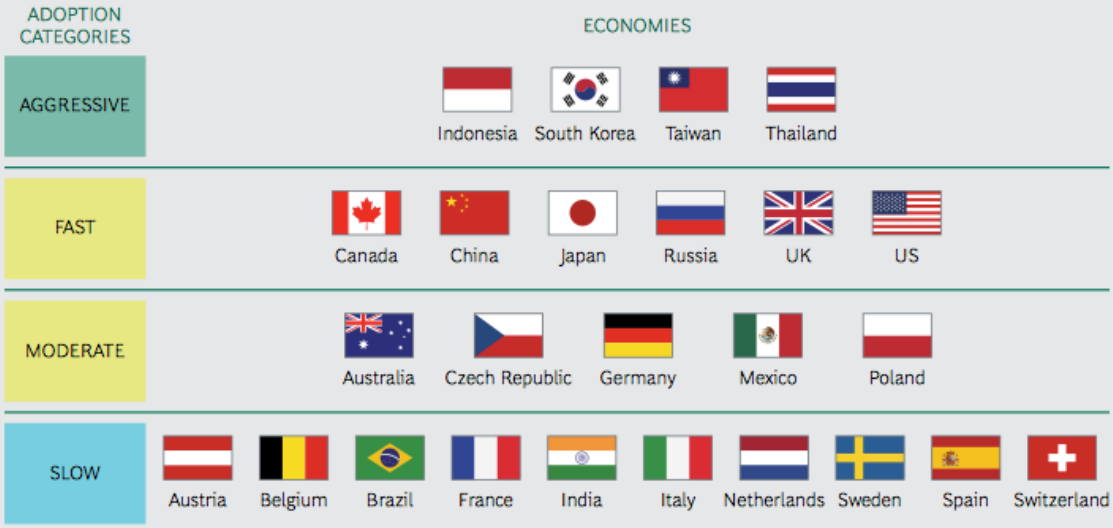
Robotics, another key artefact of Industry 4.0 is seen as a means for improving productivity, the traditional way to gain advantages



Sources: US Bureau of Labor Statistics, "International Labor Comparison of Hourly Compensation Costs in Manufacturing Industries, 2012"; BCG analysis.
Note: Petroleum and coal manufacturing are not depicted because of a high and variable wage premium, consistent with immovable, resource-intensive industries.
[1]These are defined as occupational tasks that have the potential to be replaced with advanced robotics.

Robotics adoption is different from country to country

EXHIBIT 2 | Major Goods-Exporting Economies Follow Four General Patterns of Robotics Adoption



Sources: The Economist Intelligence Unit; Organisation for Economic Co-operation and Development; The Fraser Institute; ETUI's website www.worker-participation.eu; Ius Laboris; L&E Global; Thomson Reuters Practical Law; BCG analysis.

Big data helps to manage and optimize logistics and maintainance in terms of time spent at and physical travel distances between different operations and activities.

Digital services are a game changer in industrial goods through new digital offerings and new business models. A tire manufacturer for example can collect data on fuel consumption, GPS location and tire pressure of a truck fleet. The remote monitoring enables optimized tire management by the manufacturer including his supply chain and provides valuable information to the customer.

Finally, sales can be increased through digitization (via online marketing and e-commerce directly integrated into the supply chain management), and last but not least, service providers will need to shift their overall culture toward agility and innovation.

As we treat each of these subjects in other chapters of the present report, it would be redundant to further deepen the concept of Industry 4.0 here again.

However, a series of additional references around Industry 4.0 are worth mentioning[346], [347], [348], [349], [350], [351], [352], [353], [354], [355], [356], [357], [358], [359], [360], [361], [362], [363], [364], [365], [366], [367], [368], [369] [370], [371], [372], [373], [374], [375].

Additional technologies

[346] Industrie 4.0 und Digitale Wirtschaft - Impulse für Wachstum, Beschäftigung und Innovation, https://www.bmwi.de/BMWi/Redaktion/PDF/I/industrie-4-0-und-digitale-wirtschaft,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

[347] Monitoring-Report Wirtschaft DIGITAL 2015, http://www.bmwi.de/BMWi/Redaktion/PDF/M-O/monitoring-report-wirtschaft-digital-2015,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

[348] BMWi - Industrie 4.0, http://www.bmwi.de/DE/Themen/Industrie/industrie-4-0.html

[349] BMWi - Digitale Agenda, http://www.bmwi.de/DE/Themen/Digitale-Welt/digitale-agenda.html

[350] BMWi - Digitale Wirtschaft, http://www.bmwi.de/DE/Themen/Digitale-Welt/digitale-wirtschaft.html

[351] Kompendium Industrie 4.0, http://plattform-maerkte.de/wp-content/uploads/2015/11/Kompendium-High.pdf

[352] Kompendium Digitale Standortpolitik, http://www.stiftung-nv.de/sites/default/files/kompendium_digitale_standortpolitik_2013.pdf

[353] Keine Angst vor 4.0, http://www.heise.de/tr/artikel/Keine-Angst-vor-4-0-2880799.html?view=print

[354] Industrie 4.0: Plattformisierung der Wirtschaft, http://plattform-maerkte.de/

[355] Was ist Industrie 4.0?, http://www.plattform-i40.de/I40/Navigation/DE/Industrie40/WasIndustrie40/was-ist-industrie-40.html

[356] Industrie 4.0 – viel Lärm um nichts?, http://derstandard.at/2000042066282/Industrie-4-0-viel-Laerm-um-nichts?ref=rec

[357] Industrie 4.0 - jetzt aber richtig, z.B. mit klarer Wertorientierung durch die Value Landscape 4.0!, https://www.linkedin.com/pulse/industrie-40-diesmal-endlich-richtig-zb-2-durch-winfried-felser

[358] Industrie 4.0: Fast jedes zweite deutsche Unternehmen macht kaum Fortschritte, https://www.linkedin.com/pulse/industrie-40-fast-jedes-zweite-deutsche-unternehmen-macht-hattrup

[359] Industrie 4.0: Was vom Hype übrig bleibt, https://netzoekonom.de/2016/03/09/industrie-4-0/

[360] Germany's vision for Industrie 4.0: The revolution will be digitized, http://www.zdnet.com/article/germanys-vision-for-industrie-4-0-the-revolution-will-be-digitised/

[361] A Strategist's Guide to Industry 4.0, http://www.strategy-business.com/article/A-Strategists-Guide-to-Industry-4.0?gko=7c4cf

[362] Industry 4.0 after the initial hype: Where manufacturers are finding value and how they can best capture it, https://www.mckinsey.de/files/mckinsey*industry*402*016.pdf*

[363] Industry 4.0: Building the digital enterprise, https://www.pwc.com/gx/en/industries/industries-4.0/landing-page/industry-4.0-building-your-digital-enterprise-april-2016.pdf

[364] Industry 4.0: Building the digital enterprise - Asia Pacific Highlights, https://www.pwc.com/sg/en/publications/assets/industry-40-ap.pdf

[365] Industry 4.0 - Opportunities and challenges of the industrial internet, http://www.strategyand.pwc.com/media/file/Industry-4-0.pdf

[366] Why manufacturers must understand the new digital success models, http://www.content-loop.com/why-manufacturers-must-understand-the-new-digital-success-models/

[367] Shaking and reshaping: industry 4.0 and industry 4.1, http://www.paristechreview.com/2015/11/30/industry-4-0-and-industry-4-1/

[368] Industry 4.0 - Challenges and solutions for the digital transformation and the use of exponential technologies, http://www2.deloitte.com/content/dam/Deloitte/ch/Documents/manufacturing/ch-en-manufacturing-industry-4-0-24102014.pdf

[369] Industry 4.0 and manufacturing ecosystems - Exploring the world of connected enterprises, http://dupress.com/articles/industry-4-0-manufacturing-ecosystems-exploring-world-connected-enterprises/

Although not digital at the core, two other technologies need to be mentioned in the context of the current industrial revolution:

- **Synthetic biology**, still in its infancy, could become transformative, for instance allowing petroleum-based products to be manufactured from sugar-based microbes, thereby greening production processes.
- **Nanotechnology** – which uses the properties of materials and systems below the 100 nanometre scale – could make materials stronger, lighter and more electrically conductive, among other properties.

Quantum computing on the digital end may well be the future of most high-end data centres. This is because, as the demand to intelligently process a growing volume of online data grows, so the limits of silicon chip microprocessors are increasingly going to be reached.

There are more emerging technologies[376], not all digital at first. Investigating them further would go beyond the scope of the current report though.

Business Aspects of Digital Transformation

The technological and social developments of the current Industrial Revolution affect businesses and management in many ways. In this section, we will try to wrap up the major effects on key business functions and on business strategy as a whole[377], [378], [379] by starting with an overall picture.

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370 Machine learning - Manufacturers must learn to behave more like tech firms, http://www.economist.com/news/leaders/21678786-manufacturers-must-learn-behave-more-tech-firms-machine-learning

371 Benefiting from the Next Production Revolution, http://oecdinsights.org/2016/02/23/benefiting-from-the-next-production-revolution/

372 L'industrie européenne prévoit d'investir 140 milliards d'euros par an d'ici 2020 dans l'Industrie 4.0, http://www.pwc.fr/fr/espace-presse/communiques-de-presse/2015/mars/lindustrie-europeenne-prevoit-dinvestir-140-milliards-euros.html

373 Un aperçu de l'industrie 4.0, http://paperjam.lu/news/un-apercu-de-lindustrie-40

374 European Parliament briefing: Industry 4.0 Digitalisation for productivity and growth,http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568337/EPRS*BRI(2015)568337* EN.pdf

375 INDUSTRY 4.0: The new industrial revolution. How Europe will succeed,https://www.rolandberger.com/publications/publication*pdf/roland*berger*tab*industry*40201 40403.pdf*

376 These are the top 10 emerging technologies of 2016, https://www.weforum.org/agenda/2016/06/top-10-emerging-technologies-2016/

377 Strategy in a digital age: How to develop corporate and business-unit strategies in a digitally disrupted world, http://www.mckinsey.com/global-themes/strategy-in-a-digital-age

378 The Digital Imperative, https://www.bcgperspectives.com/content/articles/digital_economy_technology_strategy_digital_imperative/

379 Acting on the Digital Imperative, https://www.bcgperspectives.com/content/articles/technology-digital-strategy-acting-on-digital-imperative/

Dematerialization of the entire value-chain: Towards the economy 4.0

More and more products, services and processes that were formerly produced in a physical fashion are being dematerialized, meaning that they are replaced by software and intelligent machines.

An example given by **Karl-Heinz Land and Prof. R. Ralf T. Kreutzer in their excellent book « Dematerialisierung - Die Neuverteilung der Welt in Zeiten des digitalen Darwinismus »**[380] illustrates the dynamics at force are very appropriately:

If a key becomes an app, the physical key won't be produced anymore, which implies that also the machines that produce the keys are not needed any more. The same applies to the machines that were manufacturing spare parts for the production machines. And finally the keys do not need to be shipped and distributed anymore. At the end of that process many of the attached jobs might disappear. That is dematerialization. And keys are certainly not the only product that are currently prone to dematerialization.

Many of us already use a smartphone to read news in the morning, listen to music while commuting to work, order a taxi via an app, take photos and scan documents on the move, use a translation app, make a wire transfer or other financial transaction, control the phone via voice control to name but a few of the activities during a typical day. Only a few years ago, those were all still largely physical activities. In the meantime, whole industries have been disrupted, the media industry, the music industry, retail banking, the travel industry and even money and large parts of the underlying value chains have been dematerialized through digitization. The value of using our smartphones does not come from the physical product « smartphone », but from the many different services it provides and we use is it for. The phone has in fact been degraded to a « service avatar » that has many different, often interconnected digital shadows in the cloud that have become the real value creators through the service they offer. On top, marginal production costs of these services tend towards zero, as any additional unit can be produced at almost no cost with the effect that productivity may rise towards the infinite[381].

Many of these services also become more and more intelligent, up to a point where software and machines can take over cognitive activities from human beings, such as manufacturing robots that can learn new tasks just by observing humans, software that is writing news articles or composing music, recognizes faces, voices, translates languages, chatbots[382] for customer support, roboadvisers for financial planning, smart devices that automate our homes to name but a few.

Industry 4.0 tightly integrates different business partners that might be widely distributed from a spatial and a legal point of view and automates many of the underlying operational processes, on top the already existing value chain integration.

Adding up new technologies like the Internet of Things, Big Data, Machine Learning and Artificial Intelligence, robots that take over more and more routine work but also cognitive tasks - combined with new production techniques like 3D printing and nanotechnology - tie processes, data and things together in a way that was not possible until recently. A completely new economic system arises, of which the parts are currently widely distributed.

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380 https://www.amazon.de/Dematerialisierung-Neuverteilung-Zeiten-digitalen-Darwinismus/dp/3981726804

381 Digital technologies allow you to make copies at almost zero cost. Each copy is a perfect replica, and each copy can be transmitted almost anywhere on the planet nearly instantaneously. Those were not characteristics of the First Machine Age, but they are standard for digital goods, and that leads to some unusual outcomes, such as winner-take-most markets.

In many industries, the widening wage gap between people with and without a college education has been dwarfed by bigger changes among the highest income brackets. From 2002 to 2007, the top 1% reaped two-thirds of all the gains from the growth in the U.S. economy. - The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee, https://hbr.org/2015/06/the-great-decoupling

382 The Bot Economy Is Growing Even Faster Than the App Economy Did, http://www.bloomberg.com/news/articles/2016-09-15/the-bot-economy-is-growing-even-faster-than-the-app-economy-did

But if productivity can rise to the infinite and shed a potentially significant number of jobs that still exist today in certain industries, what will generate economic growth in the future ?

Schumpeterian creative destruction might be the only answer to these upcoming dynamics by radically reinventing business models as well as management models. Most companies will be a digital companies in the future or they might not survive and new a economic system is on the horizon: The Economy 3.0 .

This whole trend is amplified by the sharing economy which basically makes producers out of consumers and vice-versa, the so-called prosumers, and who co-create value together gradually. Access replaces ownership in many respects, trending towards servitization of the economy as a whole. In car sharing alone, estimates are that only 30 % of cars in Germany (of the current German car park) will be needed if car sharing would be implemented on a very large base, by maximizing value in use (i.e. efficiency in the utilisation of the physical resources "cars") of these remaining cars, a decline of the car park size further amplified by the fact that millennials do often not consider car ownership as a status symbol anymore[383]. The same applies to accommodation sharing and all other types of sharing (with all the consequences for the car manufacturing and accommodation industries and their underlying value chain). And the sharing economy itself is a child of the combination of these new technologies and the digitization of value chains and the exponential developments that they allow for, which nicely illustrates how all these dynamics interact in a complex system that will be difficult to control.

But , if we assume that new jobs and profiles that will emerge will not in quantitative terms compensate "middle class" manufacturing and service sector jobs that might disappear, what if the remaining work and jobs won't be sufficient to employ large parts of the population ? Will we have much shorter working times with full salary compensation? Will we invent, after already successfully migrating from the fields to the shop floors and then to the service sector, a "new sector" providing mass jobs? In the public sector, in the private sector, in a combination of both? Many observers, which cannot be placed on a traditional "left-wing" – "right-wing" political sphere[384], suggest to introduce an unconditional basic income for everybody. Will humans find ways to "reallocate" their time not spend any more in other sectors where a high degree of empathy is required and interaction with other human, like the social sector, elderly and childcare? How will we be able to sustain our welfare state? Will we tax robots and machines as a replacement for the lost labour generated tax? Many open questions waiting for answers.

It becomes clear that only those companies and economic actors that will be able to mobilize the operational and the cultural capabilities to creatively participate in the economy 4.0 will survive whereas others will likely become the victims of the so-called « Digital Darwinism »[385], [386].

And of course, governments, legislators and regulators must proactively follow the trend, under the risk of being disrupted themselves.

New management models

In the light of the fundamental transformation in the value creation processes that digitization implies, most business functions have to be fundamentally questioned and adapted or better reinvented accordingly to strengthen innovation capacities and to ensure organizational resilience and survival :

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383 Millennials are shifting car ownership model; ask Toyota, http://www.reuters.com/article/us-autos-toyota-millennials-idUSKCN0VI295

384 Allocation universelle à la luxembourgeoise : un cadeau empoisonné ?, Muriel Bouchet, http://www.fondation-idea.lu/wp-content/uploads/2015/08/Allocation-universelle-%C3%A0-la-luxembourgeoise_un-cadeau-empoisonn%C3%A9.pdf

385 Which is an illustration of Jack Welch's, the former CEO of GE famous quote: « If the rate of change on the outside exceeds the rate of change on the inside, the end is near

« https://www.quora.com/When-and-where-did-Jack-Welch-say-his-famous-quote-If-the-rate-of-change-on-the-outside-exceeds-the-rate-of-change-on-the-inside-the-end-is-near

386 Retiring Cisco CEO delivers dire prediction: 40% of companies will be dead in 10 years, http://uk.businessinsider.com/chambers-40-of-companies-are-dying-2015-6#_jmp0_

- Strategy
- Leadership
- Products/Services
- Operations
- Culture
- People
- Governance
- Technology

Without treating each of these functions in an academic fashion, we will point to several key areas of interest and current trends.

Innovation Management

When it comes to ensuring future resilience of a business, innovation is probably the single most important activity. Today, key innovation issues are manifold[387]. Many different definitions of innovation can be found in business literature, but there is a common sense that innovation is about creating (inventing) something new, execute it, trigger adoption and create sustainable economic value.

Fundamentally, innovation can be triggered by asking the following six questions:

Source[388]

Innovation is more than ever a requirement for maintaining a business' sustained competitive advantage:

---

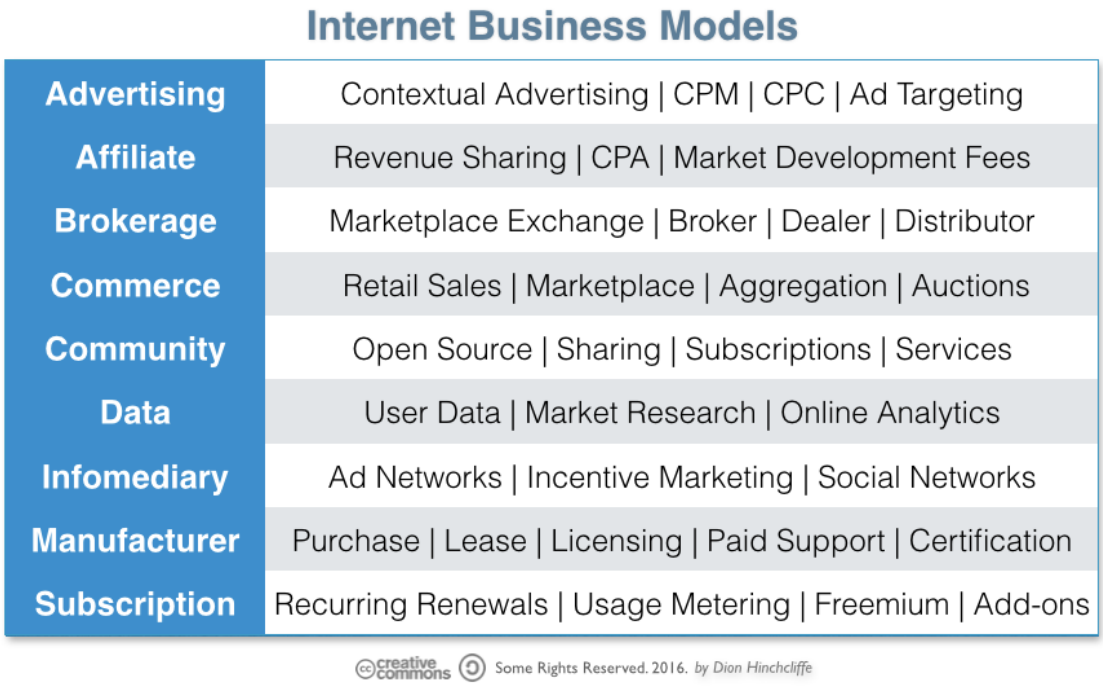
387 Key Innovation Issues for 2016 and Beyond, http://integrative-innovation.net/?p=1056

388 http://www.innovationexcellence.com/blog/2012/01/09/the-innovation-genome-project/

> *Sustained competitive advantage in production is increasingly based on innovation, which in turn is driven by investments in R&D and design, software and data, as well as organisational capital, firm-specific skills, branding and marketing, and other knowledge-based assets*[389].

Innovation is not only about technological innovation[390], but more and more also about business model innovation[391], [392] (especially also in the context of digital transformation which generated many new business models), management innovation, process innovation, product innovation, service innovation, marketing innovation, customer experience innovation…etc.[393],[394]

And new business models are indeed emerging in many different sector, as the chart below clearly illustrates.



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389 Benefiting from the Next Production Revolution, http://oecdinsights.org/2016/02/23/benefiting-from-the-next-production-revolution/

390 Key Innovation Issues for the Near Future, http://www.innovationexcellence.com/blog/2016/04/25/key-innovation-issues-for-the-near-future-%25e2%2580%2593-part-1/

391 +30 BUSINESS & REVENUE MODEL EXAMPLES, http://www.boardofinnovation.com/business-revenue-model-examples/

392 The Building Blocks of Digital Transformation: Community, Tech, Business Models, and a Change Platform, https://dionhinchcliffe.com/2016/06/18/the-building-blocks-of-digital-transformation-community-tech-business-models-and-a-change-platform/

393 TEN TYPES OF INNOVATIONhttps://www.doblin.com/dist/images/uploads/Doblin*TenTypesBrochure*Web.pdf

394 The Ten Types of Corporate Innovation Programs, http://www.web-strategist.com/blog/2016/07/26/the-ten-types-of-corporate-innovation-programs/

Source[395]

Shorter product lifecycles in a faster competitive landscape too increase the pressure on companies forevermore rapid and iterative innovation[396].

During the last 10 to 15 years, innovation management literature has seen an exponential development illustrating the relevance of innovation in a high speed, globalized and complex world[397]. New methods and

[395] https://dionhinchcliffe.com/2016/06/18/the-building-blocks-of-digital-transformation-community-tech-business-models-and-a-change-platform/

[396] A Model for Integrative Innovation Management, http://integrative-innovation.net/?p=1157

[397] Top 25 most influential Innovation Blogs & Experts, http://www.improvides.com/2014/12/21/top-25-innovation-blogs-experts-2014-winners/

concepts have emerged, such as **Design Thinking**[398][399][400], [401], [402], [403], [404], [405], [406], [407], [408], [409], [410], [411], [412], [413],**Lean Startup** [414], [415][416], [417], [418], [419] as illustrated by the following charts.

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398 Design Thinking is a methodology used by designers to solve complex problems, and find desirable solutions for clients. A design mindset is not problem-focused, it's solution focused and action oriented towards creating a preferred future. Design thinking seeks to build ideas up, unlike critical thinking which breaks them down. Design Thinking draws upon logic, imagination, intuition, and systemic reasoning, to explore possibilities of what could be, and to create desired outcomes that benefit the end user (the customer). - Design Thinking as a Strategy for Innovation, http://www.creativityatwork.com/design-thinking-strategy-for-innovation/

399 Design has become crucial for business success. As Diego Tamburini, an executive at Autodesk notes, design no longer just applies to physical systems, but "has permeated to other non-physical areas such as software, services, and the overall "emotional experience" of using a product that also require designers." Design is no longer something that we add to enhance a product, it is the product. Design is not merely about aesthetics; it's about applying the principles of design to the way people work. The increasing importance of design is in large part a response to the increasing complexity of modern technology and modern business. A design centric culture is characterised by focusing on users' experiences, especially their emotional ones, creating models to examine complex problems, using prototypes to explore potential solutions, tolerating failure and exhibit thoughtful restraint.

400 On Design Thinking, http://www.sylvaincottong.com/tools-methods/on-design-thinking/

401 Design Thinking... What is That?, http://www.fastcompany.com/919258/design-thinking-what

402 Design Thinking + Business Model Innovation, http://www.innovationmanagement.se/2015/08/25/design-thinking-business-model-innovation/

403 Welcome to the virtual crash course in design thinking, http://dschool.stanford.edu/dgift/

404 Infosys CEO On Mission To Transform His Company Into Design Thinkers, https://techcrunch.com/2015/05/16/infosys-ceo-on-mission-to-transform-his-company-into-design-thinkers/

405 How to Apply the Design Thinking Process to Your Business, http://www.business.com/entrepreneurship/how-to-apply-the-design-thinking-process-to-your-business/

406 How Design Thinking Transformed Airbnb from a Failing Startup to a Billion Dollar Business, http://firstround.com/review/How-design-thinking-transformed-Airbnb-from-failing-startup-to-billion-dollar-business/

407 5 Key Trends In Design Leadership, https://www.fastcodesign.com/3058483/5-trends-in-design-leadership

408 A Radical Shift Toward Design, http://www.digitaltonto.com/2011/a-radical-shift-toward-design/

409 Design Is Eating The World, http://www.digitaltonto.com/2014/design-is-eating-the-world/

410 Design Thinking Comes of Age, https://hbr.org/2015/09/design-thinking-comes-of-age

411 IBM Invests $100 Million To Expand Design Business, https://www.fastcodesign.com/3028271/ibm-invests-100-million-to-expand-design-business

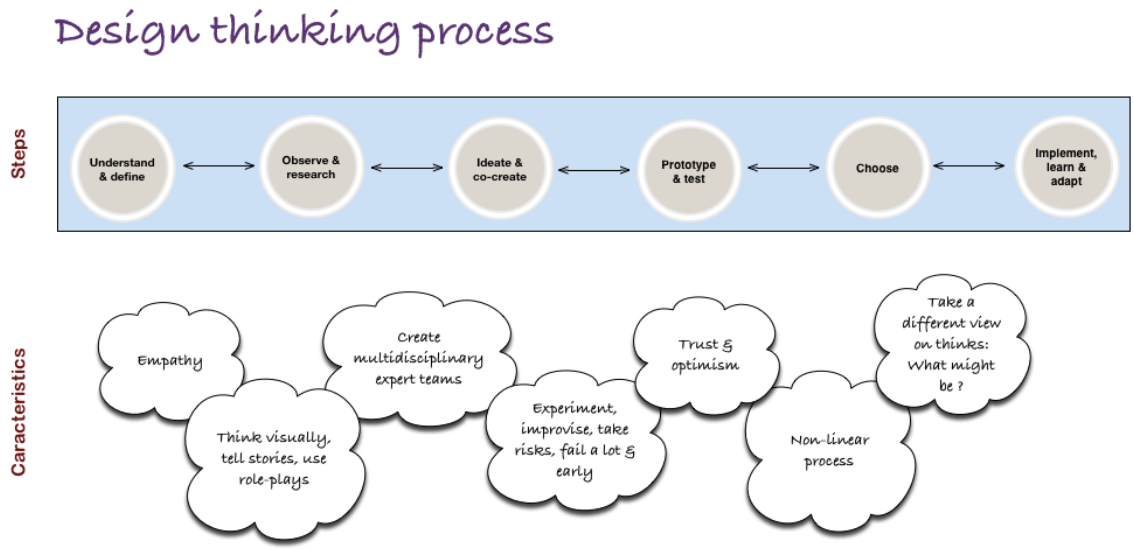
412 Big Corporations Are Buying Design Firms in Droves, http://www.wired.com/2013/05/accenture-fjord/

413 Consulting Giant McKinsey Buys Itself a Top Design Firm, http://www.wired.com/2015/05/consulting-giant-mckinsey-bought-top-design-firm/

414 Lean Startup methodology is a practice for developing products and businesses based on 'validated learning', getting customer feedback quickly and often. The objective is to eliminate uncertainty in the product development - The Lean Startup, http://theleanstartup.com/ process.

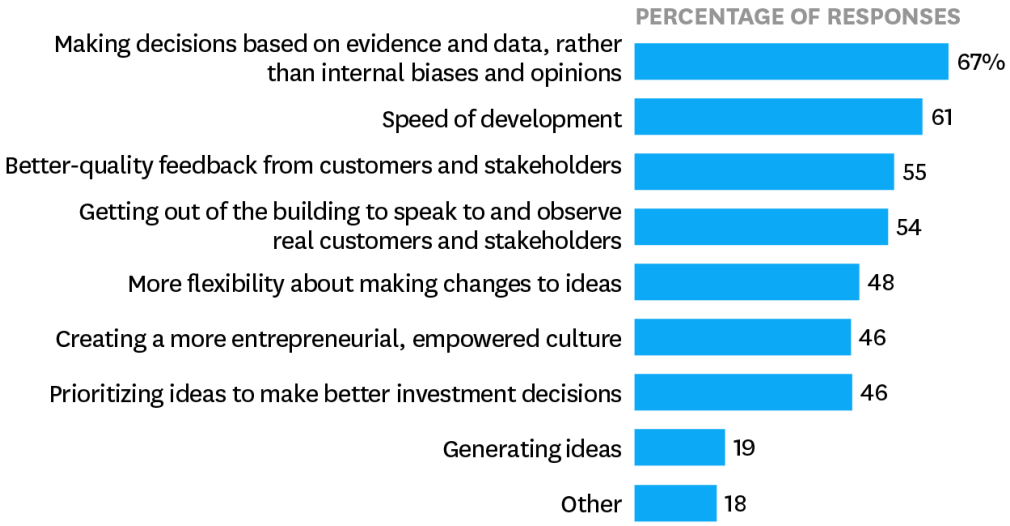
415 The Lean Startup: A summary of the book, http://www.kimhartman.se/wp-content/uploads/2013/10/the-lean-startup-summary.pdf

416 Integrating Lean Startup and Design Thinking, http://www.innovationexcellence.com/blog/2014/04/15/integrating-lean-startup-and-design-thinking/



Source[420]

The Benefits Large Organizations Say Can Be Gained from a Lean Start-Up Approach



SOURCE *INNOVATION LEADER* SURVEY OF 165 EXECUTIVES AT LARGE COMPANIES © HBR.ORG

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417 Why the Lean Start-Up Changes Everything, https://hbr.org/2013/05/why-the-lean-start-up-changes-everything

418 A Dedicated Team of Problem Solvers Can Help Big Companies Act Like Lean Startups, https://hbr.org/2016/08/a-dedicated-team-of-problem-solvers-can-help-big-companies-act-like-lean-startups

419 How Lean Startup Techniques Can Work Even Better For Established Businesses , http://www.digitaltonto.com/2016/how-lean-startup-techniques-can-work-even-better-for-established-businesses/

420 On Design Thinking, http://www.sylvaincottong.com/tools-methods/on-design-thinking/

Source[421]

but also**Open innovation** and **Crowdsourcing** [422], [423], [424], [425], [426], [427], [428], [429], [430].

Open innovation is about including all stakeholders and actors of a firms' broader stakeholder ecosystem into its innovation processes, thereby tapping into **collective intelligence**. Today, no single person or firm has the right answer to its problems and challenges. Open innovation is, of course, greatly facilitated by new social and collaborative technologies.

Partners in an open innovation mindset can be customers, users, citizens, other firms, even competitors, startups, nascent startups, startup accelerators and incubators (bigger firms more and more install their own startup incubators) professional organizations, governments, universities and research institutions.

Crowdsourcing is the process of obtaining needed services, ideas, or content by soliciting contributions from a large group of people, especially an online community, rather than from employees or suppliers[431].

Crowdsourcing means involving a lot of people in small pieces of a project[432]. Crowfunding means crowdsourced fundraising.

Crowdsourcing and Open Innovation are conceptually related. Both favor collaboration over competition.

Moving from closed innovation to open innovation 2.0, requires, according to the European Commission:

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421 The Barriers Big Companies Face When They Try to Act Like Lean Startups, https://hbr.org/2016/08/the-barriers-big-companies-face-when-they-try-to-act-like-lean-startups

422 What is Open Innovation?

, http://www.openinnovation.eu/open-innovation/

423 Open Innovation 2.0: A New Paradigm, http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?action=display&doc_id=2182

424 Twelve principles for open innovation 2.0, http://www.nature.com/news/twelve-principles-for-open-innovation-2-0-1.19911

425 Open Innovation 2.0 Yearbook 2016, ec.europa.eu/newsroom/document.cfm?action=display&doc_id=16072

426 Open Innovation in SMEs, http://www.innovationmanagement.se/2012/05/10/open-innovation-in-smes/

427 Eleven Ways to use Crowdsourcing, http://www.destination-innovation.com/articles/eleven-ways-to-use-crowdsourcing/

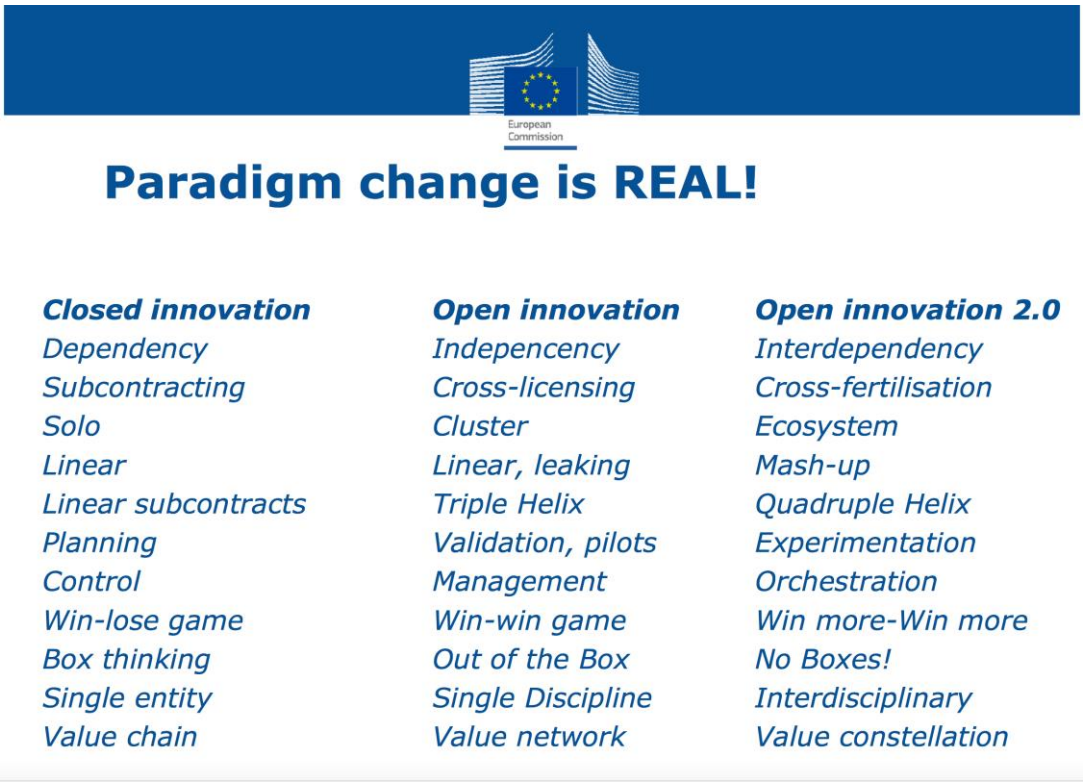
428 Massive platforms for cocreation: the new normal? (1/2) , https://nbry.wordpress.com/2014/06/23/massive-platforms-for-cocreation-the-new-normal-12/

429 Massive platforms for cocreation: the new normal? (2/2), https://nbry.wordpress.com/2014/06/27/massive-platforms-for-cocreation-the-new-normal-22/

430 CROWDSOURCING SOLUTIONS TO GLOBAL PROBLEMS, http://gsnetworks.org/wp-content/uploads/Williams-Crowdsourcing.pdf

431 https://en.wikipedia.org/wiki/Crowdsourcing

432 What is Crowdsourcing? And how does it apply to outreach?, http://www.idea.org/blog/2013/02/19/what-is-crowdsourcing-and-how-does-it-apply-to-outreach/



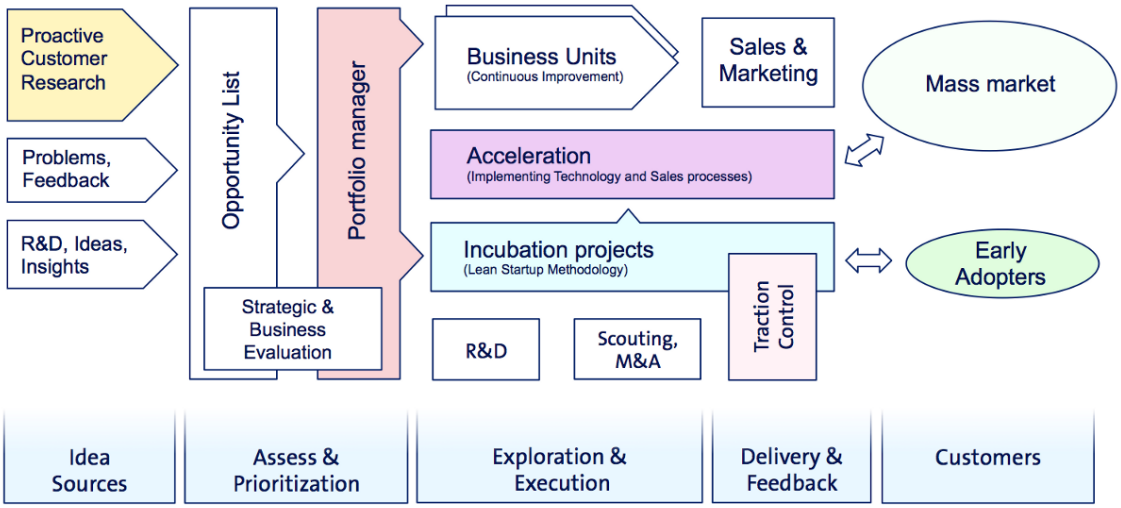
Open innovation thus largely differs from « closed innovation ». The following table confronts both principles.

Closed Innovation Principles	Open Innovation Principles
The smart people in the field work for us.	Not all the smart people work for us, so owe must find and tap into the knowledge and expertise of bright individuals outside our company.
To profit from R&D, we must discover it, develop it, and ship it ourselves.	External R&D can create significant value: internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to the market first.	We don't have to originate the research to profit from it.
The company that gets an innovation to the market first will win.	Building a better business model is better than getting to the market first.
If we create the most and the best ideas in the industry, we will win.	If we make the best use of internal and external ideas, we will win.
We should control our intellectual property (IP) so that our competitors don't profit from our ideas	We should profit from others' use of our IP, and we should buy others' IP whenever it advances our business model.

Source[433]

At a general level, corporate innovation can be considered as a system of connected phases, actions and characteristics:

[433] http://www.openinnovation.eu/open-innovation/



Source[434]

Companies need to build innovation capabilities and capacities. Elements include :

Dynamic capabilities: The firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments

Absorptive capacity: The firm's ability to recognize the value of new, external information, assimilate it, and apply it to commercial ends.

Resilience: The property of a material that enables it to resume its original shape or position after being bent, stretched or compressed

Agility: The firm's ability to adjust rapidly to changing market conditions and capitalize on emergent business opportunities (in a non-sequential way)[435].

These elements can also be found in what is called **Intellectual Capital Reporting**[436], which is an approach to picture the real value of a company and serve as a strategic planning tool. Research in intellectual capital reporting (also called « intangibles reporting » or « integrated reporting ») is more important than ever[437], [438] as the mere financial figures do not necessarily explain much of a firm's current and future potential (i.e. The significant difference in market capitalization and balance sheet figures of companies like Apple). Today, intangible assets make up approximately 80% of corporate market value of most quoted companies and these intangibles play an ever more important role in the networked platform economy[439].

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434 Corporate Innovation as a System, https://medium.com/@petzov/corporate-innovation-system-3b05e6a2fa7f#.tk65t7iu1

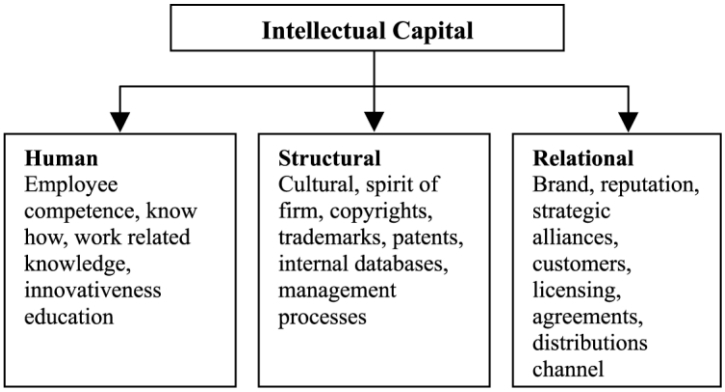
435 Why agility pays, http://www.mckinsey.com/business-functions/organization/our-insights/why-agility-pays

436 https://en.wikipedia.org/wiki/Intellectual_capital

437 WICI, the world's business reporting network, http://www.wici-global.com/

438 Supporting Investment in Knowledge Capital, Growth and Innovation, http://www.oecd-ilibrary.org/docserver/download/9789264193307-sum-en.pdf?expires=1471467481&id=id&accname=guest&checksum=F1AA8ED30DB6D33B4098731AEB1F8571

439 Pay Attention To Innovation And Intangibles -- They're More Than 80% Of Your Business' Value, http://www.forbes.com/sites/maryjuetten/2014/10/02/pay-attention-to-innovation-and-intangibles-more-than-80-of-your-business-value/#6386a1846812



Source[440]

A whole new set of software tools is available today on the market that are called « **Innovation management suites**[441] ». Those tools are built upon the concept of openness and collaborative (social) generation and evaluation of ideas and include public social networks. But tools alone won't do it, the organization and its people will have to fully embrace the underlying mindset for social innovation to work. Otherwise there is a high risk for the following formula to become true:

« **Old organization + New Technology = (Very) Expensive Old Organization** »

which, by the way, is true for every type of new technology deployed in a firm.

Innovation can also be **incremental** (improving the existing) or **radical** (creating the entirely new). It is clear that adapting to digital transformation mainly requires a radical innovation approach.

In anyway, innovation has to be actively managed[442] if it has to respond effectively towards the disruptive threats of digital transformation. For existing firms, it requires **« organizational ambidexterity[443], [444] »** and the application of corresponding models like the 3 Horizon's model[445], [446].

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440 What is Intellectual Capital ?, http://www.strategybuilders.eu/news/intellectual-capital-reporting/

441 Top Idea Management Software Products, http://www.capterra.com/idea-management-software/

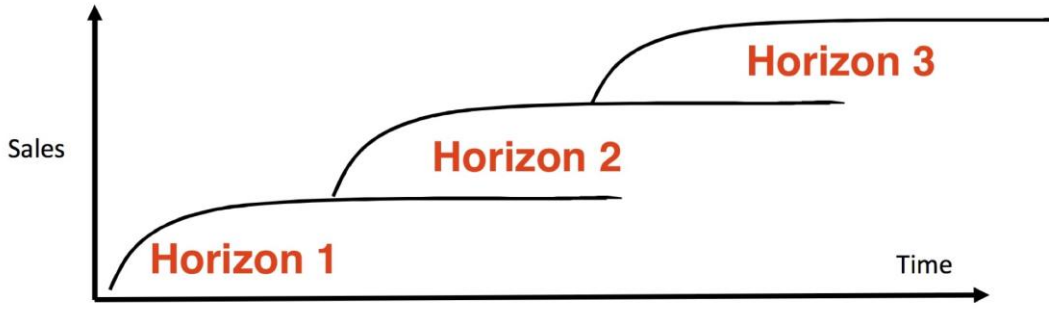
442 A Breakthrough Innovation Culture and Organization, https://www.bcgperspectives.com/content/articles/innovation_growth_digital_economy_breakthrough_innovation_culture_organization/

443 Organizational ambidexterity, http://integrative-innovation.net/?p=1016

444 The Ambidextrous Organization, https://hbr.org/2004/04/the-ambidextrous-organization

445 Lean Innovation Management – Making Corporate Innovation Work , https://steveblank.com/2015/06/26/lean-innovation-management-making-corporate-innovation-work/

446 A Model for Dual Corporate Innovation Management, http://innovationexcellence.com/blog/2016/10/08/a-model-for-dual-corporate-innovation-management/



	Mature Business	Rapidly Growing Business	Emerging Business
Focus	Executing to defend, Extend, and increase Profitability of existing businesses	Resourcing initiatives to build new businesses	Uncovering options for future opportunities and placing bets on selected options
Output	Annual planning and forecasting; Detailed plans for growth through adjacencies	Business building strategies: investment budget, detailed business plans for new ventures	Decisions to explore: initial project plan, project milestones

Source: Baghai, Coley, White

	Horizon 1	Horizon 2	Horizon 3
Time frame	Short-term	Mid-term	Long-term
Scope	Core business	Growth business	Future business
Strategic focus	Exploit and optimize existing business, incremental innovation	Expand existing and build new business, adjacent innovation	Explore options, place small bets on emerging opportunities, radical/business model innovation
Metrics	Return on Investment (ROI), Net Present Value (NPV)	Real Option Value	Real Option Value
People	Maintainers	Builders, Intrapreneurs	Champions, Explorers, Mavericks
Capabilities	Fully assembled	To be acquired or developed	Requirements uncertain

The Ambidextrous Organization

The Ambidextrous Organization, HBR, O'Reilly and Tushman

Alignment of:	Exploitative Business	Exploratory Business
Strategic intent	Cost, profit	Innovation, growth
Critical tasks	Operations, efficiency, incremental innovation	Adaptability, new products, breakthrough innovation
Competencies	Operational	Entrepreneurial
Structure	Formal, mechanistic	Adaptive, loose
Controls, rewards	Margins, productivity	Milestones, growth
Culture	Efficiency, low risk, quality, customers	Risk-taking, speed, flexibility, experimentation
Leadership Role	Authoritative, top-down	Visionary, involved

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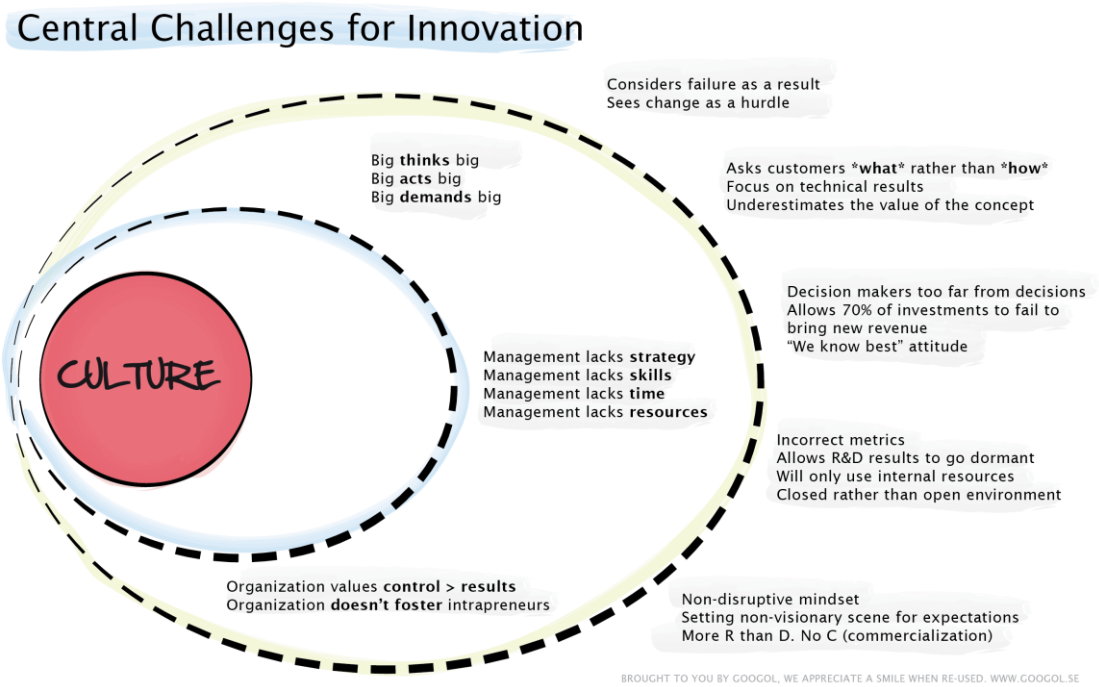
In practice, there can be many **barriers to innovation**[447], [448],

[447] The 3 Biggest Barriers To Innovation, And How To Smash Them, http://www.fastcodesign.com/1665442/the-3-biggest-barriers-to-innovation-and-how-to-smash-them

[448] The Hidden Innovation Barriers: Company Culture and your Brain, http://www.innovationmanagement.se/2014/06/02/the-hidden-innovation-barriers-company-culture-and-your-brain/



Source[449]

the most important one generally being culture and fear[450] of failure[451]: The cultural legacy from command-and-control, top-down management models and knowledge « hiding » eras are weakening strategic positions in times of digital transformation. It is therefore of utmost importance to overcome those barriers. A true culture of experimentation and discovery[452] is needed in response to a complex and fast-competitive environment, and CIOs (Chief Information Officers) are equally concerned.

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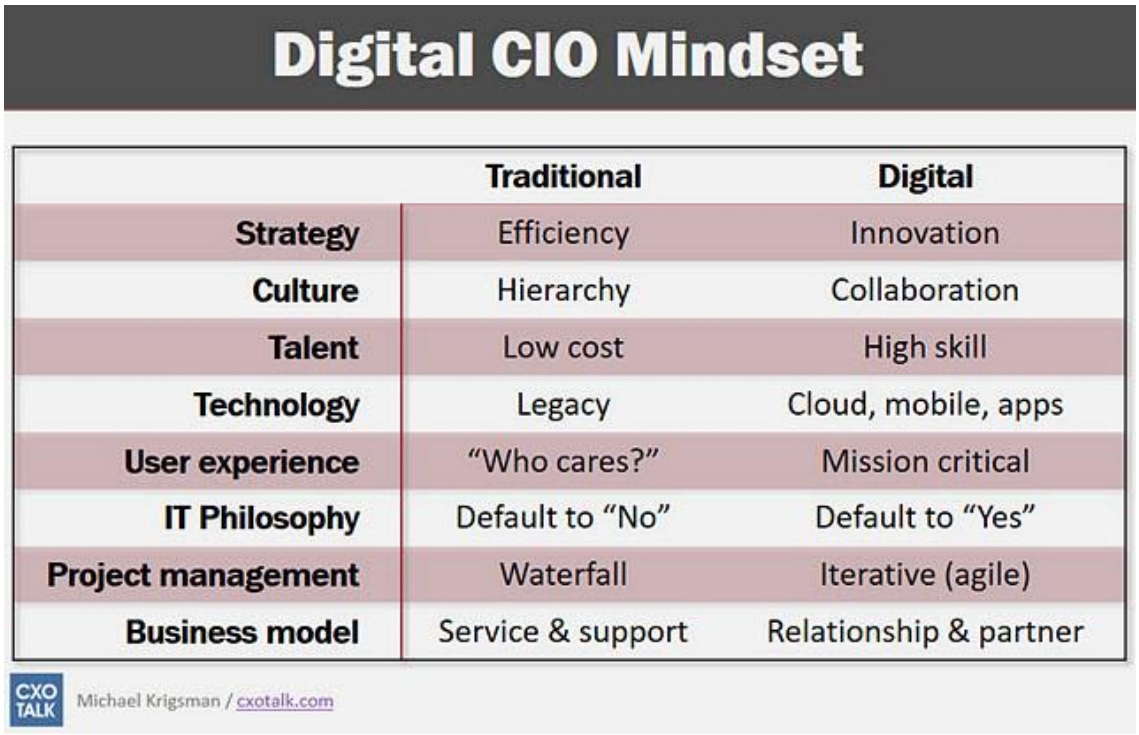
449 http://www.dariushghatan.com/wp-content/uploads/DG_central-challenges.png

450 Jeder dritte Innovationschef verhindert Innovation aus ANGST, http://www.2bahead.com/de/studien/trendstudie/detail/trendindex-20161-trendklima-steigt-aber-jeder-dritte-innovationschef-verhindert-innovation-au/

451 How to Fight the Fear of Change, http://www.destination-innovation.com/articles/how-to-fight-the-fear-of-change/

452 Why Innovators Hate M.B.A.'s - Peter Thiel, Scott Cook, and Elon Musk have all spoken out about why B-school grads hurt rather than help innovation. But is it really true?, http://www.inc.com/nathan-furr/why-innovators-hate-mbas.html



We conclude that mastering innovation management models and techniques is more than ever important in times of digital transformation that are full of disruptive surprises[453], [454], [455], [456], [457]

Marketing & Value Proposition

Marketing in the digital age has also changed[458]. Marketing as a function is less considered as a mechanism for « convincing » potential customers but more as an additional value provision.

Marketing has become part of the service that the main product delivers, and customer expectation has evolved in that way. This is known as « content marketing ».

> *Content marketing is a strategic marketing approach focused on creating and distributing valuable, relevant, and consistent content to attract and*

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453 Autodiagnostic de l'innovation par le numérqiue, http://www.cefrio.qc.ca/media/uploader/Autodiagnostic-Rsultats-version*finale.pdf*

454 bcg perspectives: Breaking through is hard to do, https://www.bcgperspectives.com/most_innovative_companies

455 Innovating in the digital era, http://d27n205l7rookf.cloudfront.net/wp-content/uploads/2016/02/DUP_TechTrends2016.pdf

456 How Big Data Is Changing Disruptive Innovation, https://hbr.org/2016/01/how-big-data-is-changing-disruptive-innovation

457 Mapping innovation across the three horizons, https://paul4innovating.com/2013/02/18/mapping-innovation-across-the-three-horizons/

458 10 raisons d'adopter les technologies Big Data et Data-Mining de toute urgence pour doper son marketing !, http://www.leptidigital.fr/webmarketing/10-raisons-adopter-big-data-data-mining-de-toute-urgence-doper-marketing-4563/?utm_content=34156704&utm_medium=social&utm_source=twitter

> *retain a clearly-defined audience — and, ultimately, to drive profitable customer action.*[459]

Permission marketing is the opposite of « interruption marketing »; instead of interrupting the customer with unrequested information, permission marketing aims to sell goods and services only when the prospect gives consent in advance to receive the marketing information (with « opt-in » email being a prime example) [460].

It can be argued that these conceptual transformations in marketing have at least partly been triggered by digital transformation, both as cause and effect[461].

But marketing has also become much more complex and conceptual itself, and the highest-performing companies use new types of **marketing automation**[462], [463], [464] software suites that once configured right, automate and coordinate most marketing processes. Companies are well advised to tap into these new software tools for operational efficiency but also for branding purposes.

Customer relationship management software (CRM)[465], stands at the cornerstone of marketing automation, it's the central repository into which every other automated marketing function is connected to.

> *Customer relationship management (CRM) is a term that refers to practices, strategies and technologies that companies use to manage and analyse customer interactions and data throughout the customer lifecycle, with the goal of improving business relationships with customers, assisting in customer retention and driving sales growth.*[466]
>
> *CRM is a strategy for managing all of a company's relationships and interactions with customers and potential customers. It helps them stay connected to them, streamline processes and improve their profitability.*[467]

Also, customers today care about what a company stands for in terms of societal engagements and visions for the future: **sensemaking** [468]through Corporate Social Responsibility programs i.e. that are sincere (and not a mere « greenwashing » act) are becoming an essential differentiator in the marketing arena. Customers now opt more often for suppliers with whom they share purpose and vision.

Also, « trust » in customer relationships has become part of that trend.

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459 http://contentmarketinginstitute.com/what-is-content-marketing/

460 https://en.wikipedia.org/wiki/Permission_marketing

461 Digital in 2016: The year of consumer-led communications marketing, http://www.slideshare.net/EdelmanInsights/digital-in-2016-executive-summary

462 The power of marketing automation, https://www.quarry.com/assets/downloads/MarketingAutomationMindMap*Quarry.pdf*

463 4 Things Every CEO Should Know About Marketing Automation, http://www.iris.xyz/digital-marketing/4-things-every-ceo-should-know-about-marketing-automation

464 What is Marketing Automation?, http://www.pardot.com/what-is-marketing-automation/

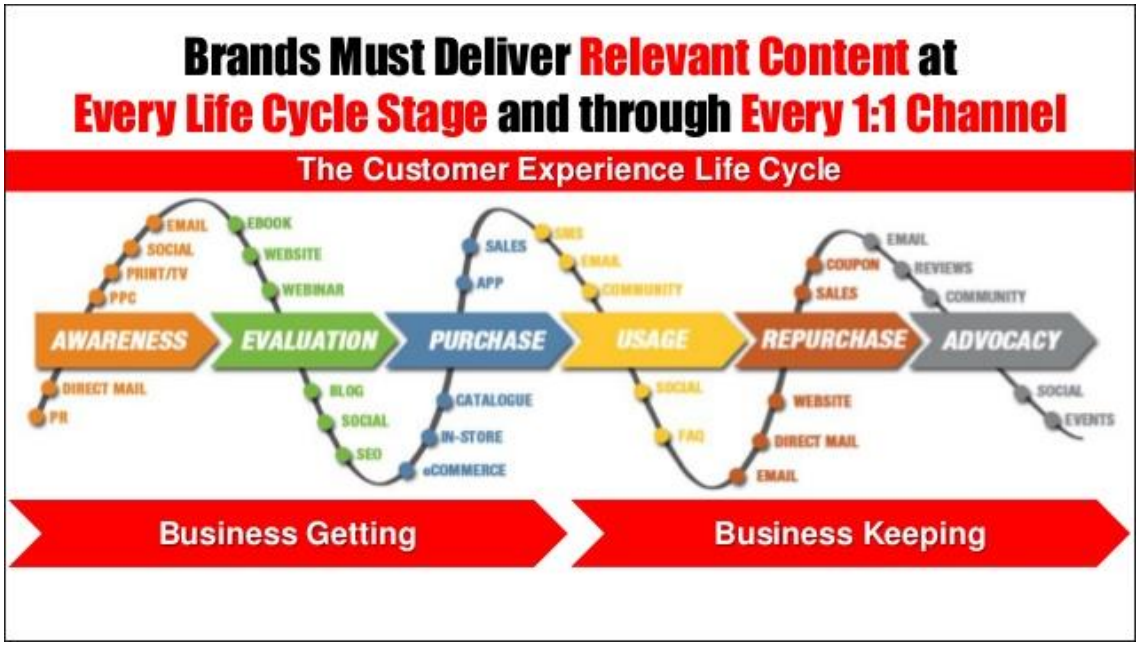
465 https://en.wikipedia.org/wiki/Customer_relationship_management

466 http://searchcrm.techtarget.com/definition/CRM

467 http://www.enmain.com/blog/customer-relationship-management-crm/

468 Sensemaking in Organizations: Reflections on Karl Weick and Social Theory, https://www.epicpeople.org/sensemaking-in-organizations/

Mastering the **digital marketing life cycle** is a central part of digital capacity building for today's companies.



Source[469]

The battle for consumer's attention in the digital world has coined the term « Attention Economy », as explained in Box 8.

[469] How Smart Brands Use Digital Marketing to Acquire, Engage, & Retain Customers, http://www.slideshare.net/marketingcloud/how-smart-brands-use-digital-marketing-to-acquire-engage-retain-customers

BOX 8: The Attention Economy

In today's information overloaded digital media world, attention has become a scarce resource and is the new currency of the media business. The term « attention economy[470], [471], [472], [473], [474], [475] » reflects organisations' quest for the audience's attention. Organisations offer services and added value to potential customers in exchange for their attention. A typical example would be a news feed with embedded advertisements.

> *The term "attention economy" is commonly used nowadays to refer to the economy of digital worlds and especially of the internet. It relates to a longstanding idea, put forward by Herbert Simon, that in a situation of informational abundance, scarcity lies with the processing of that information. In the 1970s, Simon (1971) used the term to denote the rational processes that had gained currency in organizations. After falling out of use for a number of years, the concept re-emerged in the late 1990s in the writings of essayists, bloggers and academics, who analysed the saturation of attention as a stylized fact of the Internet's development (Goldhaber, 1997), the knowledge economy (Benkler, 2006) and cognitive capitalism (Moulier Boutang, 2012).*
>
> *One of the first observers of the market side of the attention economy was unquestionably Adam Smith[476].*

Customer Knowledge

New technologies (web activity, smartphones, social media, in store activity…etc.) allow for a much deeper and granular customer activity capture, also combined with new anthropological methods (industrial and

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470 Attention Economy, https://wiki.p2pfoundation.net/Attention_Economy

471 May I Have Your Attention, Please?, https://medium.com/the-mission/may-i-have-your-attention-please-19ef6395b2c3#.twvprxti9

472 The Attention Economy: An Overview, http://readwrite.com/2007/03/01/attention_economy_overview/

473 IN THE FUTURE, OUR ATTENTION WILL BE SOLD, https://markmanson.net/attention

474 The attention economy and the demise of the middle ground, https://www.theguardian.com/media-network/2016/jul/06/attention-economy-demise-middle-ground

475 The attention economy and the implosion of traditional media, http://fortune.com/2015/08/12/attention-economy/

476 The Attention Economy Between Market Capturing and Commitment in the Polity: One of the first observers of the market side of the attention economy was unquestionably Adam Smith. Many studies have shown that interest, highlighted in The Wealth of Nations as the main driver of individual action, had to be understood in relation to the quest for social recognition described in The Theory of Moral Sentiments. It is only in relation to others' recognition and the benefits that it can generate for society that personal enrichment has meaning. Luc Boltanski and Laurent Thévenot (2006) see Adam Smith as the founding father of the market society, in their economies of worth model.https://oeconomia.revues.org/1123#ftn2

commercial ethnography; design research) for understanding customer behaviour and needs (explicit and tacit, hidden ones) such as service design[477], [478], [479] (inspired by design thinking).

Customer relationship management (CRM) software suites and other tracking and analytics tools reveal a much more accurate picture of the individual customer, his needs and behaviour, which in turn allows for more innovative and « mass-personalised » products and services enabling mass-personalization. It also provides a complete overview of the transaction history between the customer and the firm at the different touchpoints.

In today's competitive landscape, this information is of high value as it allows a firm to differentiate from its competitors and much better identify churn signals and anticipate customer dissatisfaction and jump-off probability in order to react early with customer retention actions and offers.

Having this data and being able to make sense out of it (big data) is one of the prerequisites for creating outstanding customer experience strategies.

Customer Experience Management

In order for a company to provide its customers with a good experience, it needs to gather solid **customer knowledge.**

New technologies (web activity, smartphones, social media, in-store activit, etc.) allow for a much deeper and granular customer activity screening, and in combination with more qualitative anthropological methods (industrial and commercial ethnography; design research) helps it better understanding customer behaviour as well as clients' explicit and tacit needs. It is not surprising that new disciplines such as service design[480], [481], [482] which is inspired by design thinking (see section on innovation management) gained popularity at the same time when digital transformation increased the complexity of customer interaction.

Customer experience management (CEM)[483] is the collection of processes a company uses to track, oversee and organize every interaction between a customer and the organization throughout the customer lifecycle. The goal of CEM is to optimize interactions from the customer's perspective in a digitally interconnected multi-channel environment, and, as a result, foster customer loyalty.

Having this data and being able to make sense out of it (big data) is one of the prerequisites for creating outstanding customer experience strategies.

The following graph on about the « digital business stack » summarizes the digital technologies architecture enabling digital marketing and customer experience management.

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477 Service Design 101, http://www.cooper.com/journal/2014/07/service-design-101

478 What is Service Design?, http://trydesignlab.com/blog/what-is-service-design/

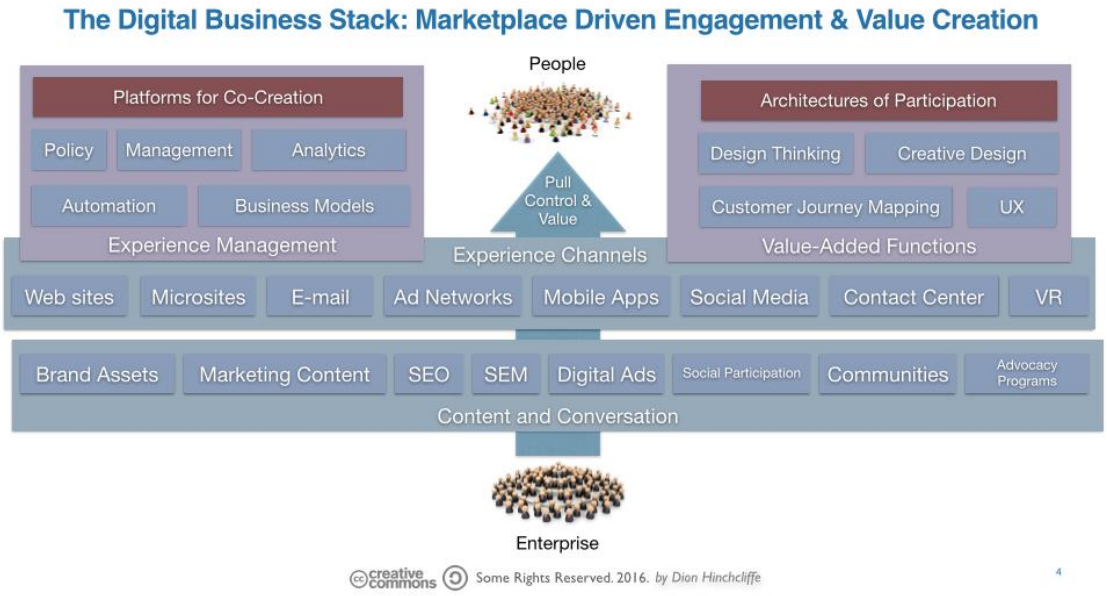
479 Video: What is service design?, http://www.designcouncil.org.uk/news-opinion/video-what-service-design

480 Service Design 101, http://www.cooper.com/journal/2014/07/service-design-101

481 What is Service Design?, http://trydesignlab.com/blog/what-is-service-design/

482 Video: What is service design?, http://www.designcouncil.org.uk/news-opinion/video-what-service-design

483 Customer Experience Management - What it is and why it matters, http://www.sas.com/en_us/insights/marketing/customer-experience-management.html



Source[484]

As social media and other types of conversational platforms and customer communities have become ubiquitous in most people's lives, **the customer now owns the conversation** and companies have to follow that conversation which basically means an overthrow of power forces between the customer an the company.

Understanding the customer's journey, from his point of view, has become central for achieving and sustaining customer satisfaction. Customer journey mapping[485], [486], [487], [488], [489] basically connects every single touchpoint and activity between the company and the customer on a timeline and maps the customer's experience while traveling on that timeline. The customer evaluates the journey as a whole, but firms traditionally managed these touchpoints out of their organizational silos: marketing, sales, distribution, service, finance, training…. etc. In case the customer has a disastrous experience at a crucial touch point (a « moment of truth » in Service Design terminology, from his point of view, he or she considers the whole service experience as a failure. The company, however, tends to consider it as a failure of a department or worse of somebody in a department only. However, that is not necessarely true anymore, as the following graph illustrates.

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484 https://dionhinchcliffe.com/2016/06/18/the-building-blocks-of-digital-transformation-community-tech-business-models-and-a-change-platform/

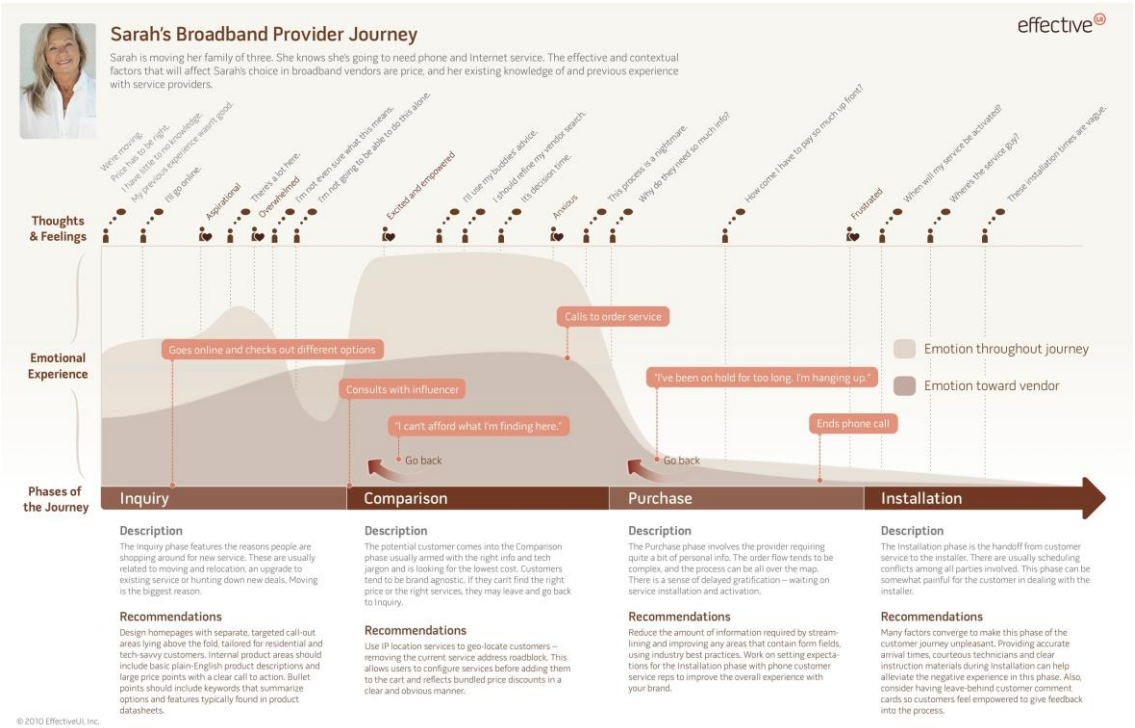
485 Mapping Experiences: Five Key Questions to Get Started, https://experiencinginformation.wordpress.com/2016/06/12/five-key-questions-to-start-mapping-experiences/

486 Sorting Things Out: Customer Journey Maps, Experience Maps and Service Blueprints, https://experiencinginformation.wordpress.com/2016/03/12/sorting-things-out-customer-journey-maps-experience-maps-and-service-blueprints/

487 Experience maps, user journeys and more…, http://www.ux-lady.com/experience-maps-user-journey-and-more-exp-map-layout/

488 The Value of Customer Journey Maps: A UX Designer's Personal Journey, http://www.uxmatters.com/mt/archives/2011/09/the-value-of-customer-journey-maps-a-ux-designers-personal-journey.php

489 5 Tips To Get You Started with Customer Journey Mapping, http://www.customerexperience.io/posts/7N3Csp7F9q3TDXfAX/5-tips-to-get-you-started-with-customer-journey-mapping



Source[490]

Customer journey mapping can (and schould) be applied as much in a B2C than a B2B setting[491], [492].

That's where Service Design[493] comes in as a « service innovation framework », which can help organisations to deal with their customers' experience in whole new and more holistic ways.

Emphatically understanding customer jobs-to-be-done[494] in an overcrowded and often saturated marketplace is crucial to create valuable and disruptive innovation[495], [496], and the new stars from the digital economy tend to be better at understanding customer's job-to-be done than many traditional companies[497], [498]. But it equally applies to all kinds of companies, sectors, products and services[499].

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490 http://www.ux-lady.com/experience-maps-user-journey-and-more-exp-map-layout/

491 Customer Journey Map in B2B projects, http://www.slideshare.net/SDDMilan/customer-journey-map-in-b2b-projects

492 B2B Buyer Journey Mapping Basics, http://blogs.forrester.com/lori_wizdo/15-05-25-b2b_buyer_journey_mapping_basics

493 https://en.wikipedia.org/wiki/Service_design

494 Jobs-To-Be-Done Framework, http://strategyn.com/customer-centered-innovation-map/

495 Customer-driven Innovations Deliver 8 Times the Revenue as Employee Ideas, http://customerthink.com/customer-driven-innovations-deliver-8-times-the-revenue-as-employee-ideas/

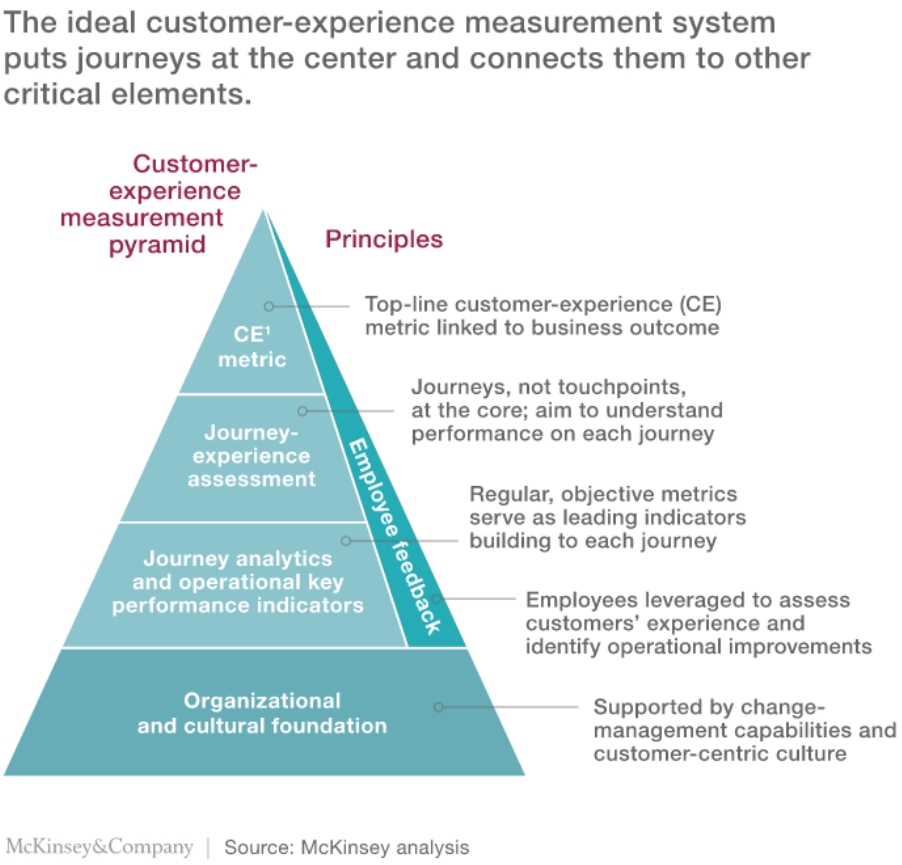
496 Avoiding innovation errors through jobs-to-be-done analysis, http://customerthink.com/avoiding-innovation-errors-through-jobs-to-be-done-analysis/

497 What Airbnb Understands About Customers' "Jobs to Be Done", https://hbr.org/2016/08/what-airbnb-understands-about-customers-jobs-to-be-done

498 The Rise of UX Leadership, https://hbr.org/2013/07/the-rise-of-ux-leadership

499 Know Your Customers' "Jobs to Be Done", https://hbr.org/2016/09/know-your-customers-jobs-to-be-done

As a consequence, companies need to **switch to organizational models that put the customer at the centre of their attention and activity**[500], meaning that they need to almost completely break their organizational silos[501] to maintain their competitiveness[502]. That means a big cultural shift for many companies. Customer experience management should also be included in companies' measurement systems:



Source[503]

Ubiquitous adoption and availability of digital technologies and the resulting **omnichannel connectedness** definitely changed customer expectation[504]. Customers expect to be connected to companies 24 x 7, in seamless integration across all digital and non-digital channels.

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500 The CEO guide to customer experience, http://www.mckinsey.com/business-functions/operations/our-insights/the-ceo-guide-to-customer-experience

501 HOW TO OVERCOME ORGANIZATIONAL SILOS?, https://beyondphilosophy.com/how-to-overcome-organizational-silos/

502 Restructuring the C-Suite for Digital Business: The Future of the CMO, CCO, CIO, and CDO,https://dionhinchcliffe.com/2016/04/24/restructuring-the-c-suite-for-digital-business-the-future-of-the-cmo-cco-cio-and-cdo/

503 http://www.mckinsey.com/business-functions/operations/our-insights/the-ceo-guide-to-customer-experience

504 The Internet of Things Is Changing How We Manage Customer Relationships, https://hbr.org/2015/06/the-internet-of-things-is-changing-how-we-manage-customer-relationships

> *A superior customer experience can serve as a sustainable differentiator, and in today's digitally powered ecosystem, technology and customer experience are inseparable.*
>
> *Everything from a simple inquiry to troubleshooting to problem resolution takes place on the digital sphere. Today's customers live in a hyper-connected environment, and their expectations from their service and solution providers are scaled up in line with this.*[505]

Different industry studies also consistently found that customer experience is considered as a top priority and strategy concern by most executives[506], considering the setting of a digital vision and strategy, measuring digital success and ensuring organizational readiness as the top challenges in that field [507], [508], [509].

New types of software platforms and technology combinations help companies to manage and measure their customer experience in different ways[510], [511].

Personalized **customer self-service**[512], [513] through online media and other digital services has also grown increasingly popular in recent years. Customer self-service does not require the assistance of a customer service representative and is available 24x7 including in nomad situations via mobile devices. Customers also share their experiences, and help other customers to tackle their product or service support inquiries. Over time, the customer knowledge base grows as does its value for the seller and for customers alike.

The customer thereby becomes an active partner in the value creation process and saves time in getting help and answers. The company saves resources in traditional, usually people intensive customer support service and the customer gets a better experience. Customer self-service done the right way thus is a win-win situation. More recently, customer self-service includes intelligent chatbots[514], [515], [516] and even robo-

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505 IT'S DO OR DIE TIME FOR MOBILE ENGAGEMENT STRATEGIES, http://blog.boldchat.com/boldchat-news/mobile-engagement-strategies/

506 The CEO guide to customer experience, http://www.mckinsey.com/business-functions/operations/our-insights/the-ceo-guide-to-customer-experience

507 Improving Customer Experience is Top Business Priority for Companies Pursuing Digital Transformation, According to Accenture Study, https://newsroom.accenture.com/news/improving-customer-experience-is-top-business-priority-for-companies-pursuing-digital-transformation-according-to-accenture-study.htm

508 Digital transformation in the age of the customer, https://www.accenture.com/us-en/insight-digital-transformation-age-customer

509 Lessons from the Leading Edge of Customer Experience Management, https://www.sas.com/content/dam/SAS/en*us/doc/whitepaper2/hbr-leading-edge-customer-experience-mgmt-107061.pdf*

510 16 Best Customer Experience (CX) Enterprise Software Platforms, http://usabilitygeek.com/16-best-customer-experience-cx-enterprise-software-platforms/

511 50 Important Customer Experience Stats for Business Leaders,http://www.huffingtonpost.com/vala-afshar/50-important-customer-exp_b_8295772.html

512 Customer Self Service (CSS), https://www.techopedia.com/definition/1460/customer-self-service-css

513 Customer Self Services, https://de.wikipedia.org/wiki/Customer_Self_Services

514 Artificial Intelligence 'Chatbots' – When or if?, http://www.kdnuggets.com/2016/05/ai-chatbots-when-if.html

515 How can I build an intelligent chat bot?, https://www.quora.com/How-can-I-build-an-intelligent-chat-bot

516 List Of Chat Bots, http://ai.wikia.com/wiki/List_Of_Chat_Bots

advising[517] in finance (through learning algorithms and artificial intelligence) Customers are become active partners in the value creation process and the whole process becomes more transparent.

The customer base has also become much more diverse in their individual needs and preferences, overthrowing the validity of traditional socio-demographic clustering.

Most importantly, however, a constant transparent and trusted dialogue with customers collecting their feedback and experiences, desires and values, helps companies to constantly improve their offerings and create new innovative product and service solutions.

And even beer will in future be improved by combining AI with modern customer feedback concepts[518] !

As customer experience is becoming an ever more important competitive differentiator in a post-materialistic economy, some analysts have coined the term « **Experience Economy** », as a way for institutionalizing that point of view.

« Experience economy » means that value in use for customers stems from their judged quality of (emotionally engaging, thematised and meaningful) experience provided by a product or service, composed of many different elements, some general and some more individual [519], [520].

Servitization

Manufacturing activity has steadily declined over the last 15 years in the EU as a relative part of overall economic activity as measured in GDP terms. In order to innovate and regain market share and thereby increase manufacturing output again in the coming years in increasingly globalized and competitive markets, manufacturing companies are moving into transforming their business models into what is called « servitization[521] », which means developing capabilities to provide services and solutions to supplement their traditional product offering.

These service ecosystems usually rely on digital technologies and business models, made possible by new concepts and technologies like the Internet of Things and smart connected products. These digital ecosystems are the enablers for new value creation. Europe is lagging behind the US in that respect[522].

At the same time, a new line of thought has developed and perfectly backs the servitization trend: **service-dominant logic**[523], [524]. Without going into too much detail, the basic assumption here is that the fundamental basis of exchange is service, and that products are service avatars that provide value in

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517 The Rich Are Already Using Robo-Advisers, and That Scares Banks, http://www.bloomberg.com/news/articles/2016-02-05/the-rich-are-already-using-robo-advisers-and-that-scares-banks

518 Besseres Bier mit Feedback-System und Künstlicher Intelligenz, http://www.heise.de/newsticker/meldung/Besseres-Bier-mit-Feedback-System-und-Kuenstlicher-Intelligenz-3297949.html

519 The term Experience Economy was first described in an article published in 1998 by B. Joseph Pine II and James H. Gilmore, titled "The Experience Economy". In it they described the experience economy as the next economy following the agrarian economy, the industrial economy, and the most recent service economy., https://en.m.wikipedia.org/wiki/The_Experience_Economy

520 Experience Economy, Economy Of Experiences, Or.., https://wimrampen.com/2013/07/25/experience-economy-economy-of-experiences-or/

521 What is Servitization?, http://andyneely.blogspot.fr/2013/11/what-is-servitization.html

522 Services in European manufacturing: servinomics explained: Making the manufacturing sector more competitive is vital to restore economic growth in Europe. Changing business models to sell services as well as products can provide useful revenue to manufacturers., http://bruegel.org/2016/03/services-in-european-manufacturing-servinomics-explained/

523 Introducing S-D Logic and its 10 foundational premises, http://www.tobiaskoehler.com/2011/07/introducing-s-d-logic-and-its-10-foundational-premises/

524 Currently, the text in which the logic was presented is the most cited marketing academic article of the century: Evolving to a New Dominant Logic for Marketing, https://www.iei.liu.se/fek/frist/722g60/filarkiv-2011/1.256836/VargoLusch2004a.pdf

use[525]. In other words, products are nothing else than gadgets that transport a service[526]. SD-logic as well, wouldn't have developed without the fundamental changes in society and in the way business is done in an ever more digitized and connected environment. Thinking SD-Logic thus opens new paths to how a product can be marketed and what business models can be associated with it[527].

Organizational design

Organizational design, including organizational culture, is central for a successful digital transformation of any organization[528], [529].

In other words, the digital economy's underlying structural algorithms of transparency, total connectedness, self-organizing networks, or automation puts pressure on organizational models to move into that same direction, in order to be able to fully face digital transformation challenges. Management models did not really see major innovation over time but today need to undergo the same radical transformation as technology and economic structures.

> *Organisational change, workplace innovation, management and skills are some of the areas where firms will need to invest to support rapid technological change, supported by complementary public investments in education, research and infrastructure. Enabling resources to flow to the most productive and innovative firms is also essential. Trust will also be critical to maximising the social and economic benefits of the digital economy. And, as our dependency on digital technologies increases, so too do our vulnerabilities, thus making on-line security, privacy, and consumer protection ever more essential[530].*

Management models and processes, human resource management as well as leadership cultures are equally affected[531].

Command-and-control, top-down management models (including fear of failure) more and more reveal themselves as not being able and agile enough to cope with the competitive challenges of digital

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525 #1 Service is the fundamental basis of exchange. #2 Value is cocreated by multiple actors, always including the beneficiary. #3 All social and economic actors are resource integrators. #4 Value is always uniquely and phenomenologically determined by the beneficiary. #5 Value cocreation is coordinated through actor-generated institutions and institutional arrangements. - From beginning to end: everything is service!, https://www.linkedin.com/pulse/from-beginning-end-everything-service-mauricio-manhaes-ph-d-

526 i.e.: A toothbrush provides the service of brushin teeth and hasn't a value in itself.

527 What Does a Service-Dominant Logic Really Mean for Manufacturing Firms?, http://www.ep.liu.se/ecp/077/029/ecp10077029.pdf

528 Is Your Work Culture Conducive to Digital Transformation? — The Data, http://www.netjmc.com/digital-transformation-and-work-cultures/

529 Digital Transformation Requires Total Organizational Commitment, https://techcrunch.com/2016/01/31/digital-transformation-requires-total-organizational-commitment/

530 Benefiting from the Next Production Revolution, http://oecdinsights.org/2016/02/23/benefiting-from-the-next-production-revolution/

531 Microsoft will in München neue Welt des Arbeitens vorleben, http://www.heise.de/newsticker/meldung/Microsoft-will-in-Muenchen-neue-Welt-des-Arbeitens-vorleben-3344822.html

transformation. Instead, strong collaboration[532] in looser networks based on flat hierarchies (« wirearchies[533] ») reveal being far more performant in this new era of complexity[534], [535], [536].

In other words, collaboration is the new competitive advantage and agility trumps strategy. Today success is driven by the resources you can access, and not so much anymore by the resources that you control.

> *The most critical 21st century skill is empathy and calls for a shift in emphasis from "knowledge workers" to "relationship workers." In a world of exponentially increasing complexity, no one person or firm can do it all, so those that can work well with others have a distinct advantage. We use platforms to access ecosystems of technology, talent and information.*
>
> *In the past, we could dominate by accumulating resources and driving efficiency, but now it is agility and interoperability that rule the day. We need to shift our focus from assets and capabilities to empathy, design and networked organizations [537].*

At the same time, a new generation of workforce has entered the job market: The so-called generation-Y, or millennials[538], and they will represent half of the workforce by 2030. They embrace a different set of values than the former generations[539], [540]:

- They have grown up digitally in a connected social media world and they require the tools they use as consumers at their workplace as they fully understand their superiority in terms of getting-things-done and user experience (otherwise they create their own « shadow IT » by bringing their own devices (BYOD) thereby increasing IT risks within companies. Research shows that BYOD is more prevalent in high-performing, customer-oriented workforces[541].)
- They add purpose to careers and status[542]

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532 Collaboration Flows from a Strong Business Mission, http://www.cmswire.com/digital-workplace/collaboration-flows-from-a-strong-business-mission/

533 What Is Wirearchy ?, https://www.linkedin.com/pulse/20141124231801-69412-what-is-wirearchy

534 Organize for Complexity, http://www.slideshare.net/npflaeging/special-edition-paper-organize-for-complexity-part-iii

535 What is wrong with hierarchy ? http://www.oscarberg.net/2014/02/what-is-wrong-with-hierarchy.html

536 La transformation numérique implique un changement de modèle managérial, http://mobile.lemondeinformatique.fr/lire.php?id=64986

537

538 https://en.wikipedia.org/wiki/Millennials

539 Témoignage d' Emmanuelle Duez- Les 3 caractéristiques de la Génération Y, https://www.youtube.com/watch?v=vPc-69JQAFk

540 Et si l'innovation RH était la clef pour transformer nos entreprises ?, http://m.lesechos.fr/redirect_article.php?id=cercle_142909&fw=1

541 Tracking the Trends in Bringing Our Own Devices to Work, https://hbr.org/2016/05/tracking-the-trends-in-bringing-our-own-devices-to-work

542 Millennials, die neuen Gutmenschen, http://www.zeit.de/wirtschaft/2016-08/world-economic-forum-umfrage-weltbuerger

- They require flexibility, freedom and mobility
- They care about sustainability and a liveable future, thus about shared value[543] , [544], [545], [546]. The shared value movement can be considered as the microeconomic offshoot of the Beyond GDP [547] and the GPI (Geniune Progress Indicator)[548] discussion.
- More of them are keen to start their own business (« startup boom »)

If companies want to attract talent and retain it[549], they have to take into account the generation Y's (and upcoming generations) aspirations. (At the same, business needs to strategically adapt to them as customers[550] And talents are more than ever the scarce resource for any organization.

At the same time, new technologies such as big data, enterprise social networks, gamification[551], [552] and other open collaborative community platforms[553] are reshaping the organization[554] including the human resource management practice and companies are well advised to stay up to speed here. Artificial Intelligence is also transforming human resource management: data analytics from internal collaboration and HR platforms can decide which co-workers should take coffee breaks together based on their shared interest, which is about « social physics »[555]. Internet of Things is being used to monitor and improve office

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543 A summary of Michael E. Porter's seminal article "Creating Shared Value" (Harvard Business Review, Jan 2011) and "Competing by Saving Lives" (FSG, 2012): Creating Shared Value: Becoming a Movement, http://sharedvalue.org/sites/default/files/2014%20Summit/Presentation%20Decks/20140513-FSG%20Shared%20Value%20Leadership%20Summit*MEP%20Keynote*Revised*13*May*2014%20-FINAL%20FOR%20POSTING%20REVISED.pdf*

544 A Call for Stakeholder Activists, http://www.huffingtonpost.com/marc-benioff/a-call-for-stakeholder-activists_b_6599000.html

545 Apple CEO Tim Cook: 'Companies should have values, like people do', http://uk.businessinsider.com/apple-ceo-tim-cook-companies-should-have-values-like-people-2016-8?r=US&IR=T

546 Salesforce CEO Slams 'The World's Dumbest Idea': Maximizing Shareholder Value, http://www.forbes.com/sites/stevedenning/2015/02/05/salesforce-ceo-slams-the-worlds-dumbest-idea-maximizing-shareholder-value/#6e0954cf5255

547 Beyond GDP – is it time to rethink the way we measure growth?, https://www.weforum.org/agenda/2016/04/beyond-gdp-is-it-time-to-rethink-the-way-we-measure-growth/

548 Beyond GDP: US states have adopted genuine progress indicators, https://www.theguardian.com/sustainable-business/2014/sep/23/genuine-progress-indicator-gdp-gpi-vermont-maryland

549 How multinationals can attract the talent they need, http://www.mckinsey.com/business-functions/organization/our-insights/how-multinationals-can-attract-the-talent-they-need

550 Sie erfüllen die Erwartungen einfach nicht, http://www.zeit.de/wirtschaft/2016-08/generation-y-millennials-usa-wirtschaft-konsum/komplettansicht

551 Gamification, http://www.slideshare.net/sylvain/gamification-8024454

552 Gamification - Förderung der Kollaboration in Netzwerken, https://www.linkedin.com/pulse/gamification-f%C3%B6rderung-der-kollaboration-netzwerken-roman-rackwitz?forceNoSplash=true

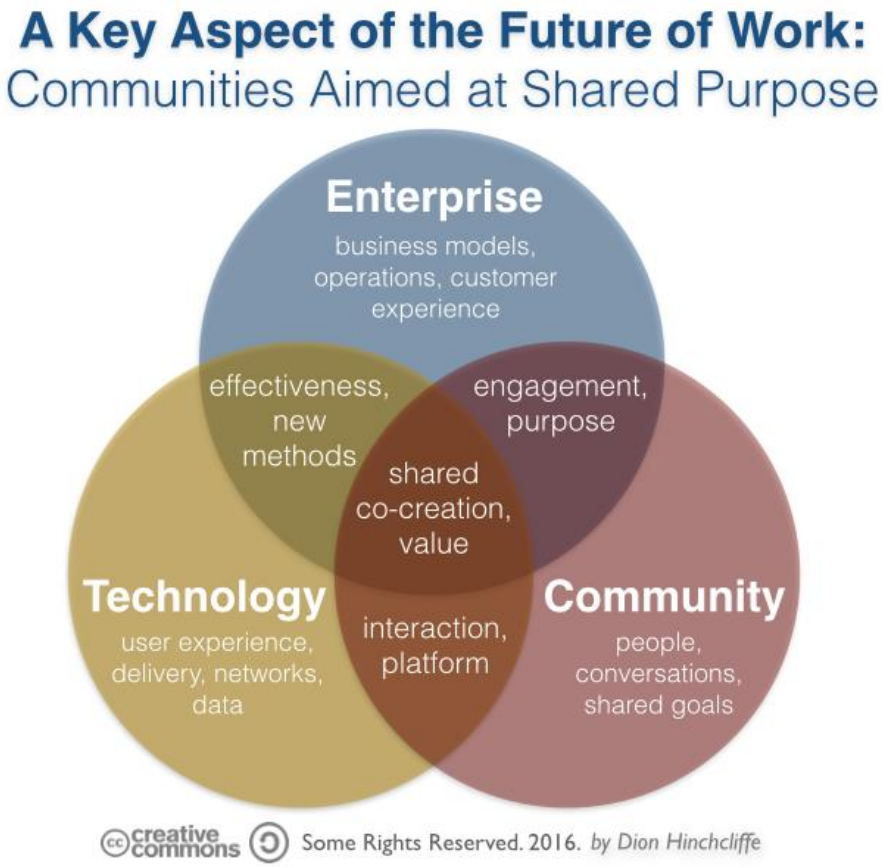
553 More Evidence Online Community is Central to the Future of Work, https://dionhinchcliffe.com/2016/06/05/more-evidence-online-community-is-central-to-the-future-of-work/

554 How social tools can reshape the organization, http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/how-social-tools-can-reshape-the-organization

555 Your next manager may be a machine, http://fortune.com/2015/10/15/automated-management-software/

spaces and experience and create personalised environments[556]. And even employee onboarding can be disrupted by new technologies such as chatbots relying on AI and voice recognition for example[557]. Intelligent « Knowledge graphs » will thus automate ever more management processes[558] and robots are even starting to define business and management strategy[559], [560], [561]!

The following chart illustrates how communities of people, technology and a company's goal are tied together in the future of work:



Source[562]

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556 Carlo Ratti's Office 3.0 uses Internet of Things to create personalised environments, http://www.dezeen.com/2016/06/03/office-3-0-carlo-ratti-internet-of-things-personalised-environments-turin-italy/

557 Chatbot Talla soll Bewerber auswählen und neue Mitarbeiter einweisen, http://www.heise.de/newsticker/meldung/Chatbot-Talla-soll-Bewerber-auswaehlen-und-neue-Mitarbeiter-einweisen-3290503.html

558 Using Artificial Intelligence to Humanize Management and Set Information Free, http://sloanreview.mit.edu/article/using-artificial-intelligence-to-humanize-management-and-set-information-free/

559 Rise of the Strategy Machines, http://sloanreview.mit.edu/article/rise-of-the-strategy-machines/

560 Designing the Machines That Will Design Strategy: Welcoming the Chief Strategy Robot, https://hbr.org/2016/04/welcoming-the-chief-strategy-robot

561 McKinsey Solutions, http://www.mckinseysolutions.com/solutions.aspx

562 https://dionhinchcliffe.com/2016/06/05/more-evidence-online-community-is-central-to-the-future-of-work/

Talent management, employer branding, nomad workers, employee well-being, employee experience and engagement, swarm intelligence, BYOD and distributed workforce a.o. are the new buzzwords en vogue.

Leadership culture as well as the C-level suite[563] capabilities are equally challenged. Leadership through vision and influence replaces leadership through command-and-control.

Leadership by example, leadership as a service, distributed leadership and digital leadership are the concepts that are fundamentally altering the leadership practice.

This rapid and fundamental change is seen as the most important barrier to maintaining competitiveness in the digital age and requires a very substantial **change management** effort to make the cultural DNAs fit for the high paced innovative digital age[564], [565], [566].

But the fact is that in a world connected by digital technology, power no longer lies at the top of hierarchies, but at the center of networks[567], [568].

Formal maturity models of digital workplace dimensions help to strategically plan transformation towards the digital workplace[569], [570].

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563 C-level, also called the C-suite, is an adjective used to describe high-ranking executive titles within an organization. C, in this context, stands for chief ,http://searchcio.techtarget.com/definition/C-level

564 The Enterprise Transformation Conundrum, https://techcrunch.com/2015/05/23/the-enterprise-transformation-conundrum/

565 " Il est plus rapide de changer une technologie que les pratiques de collaboration », http://www.usine-digitale.fr/article/il-est-plus-rapide-de-changer-une-technologie-que-les-pratiques-de-collaboration.N377717

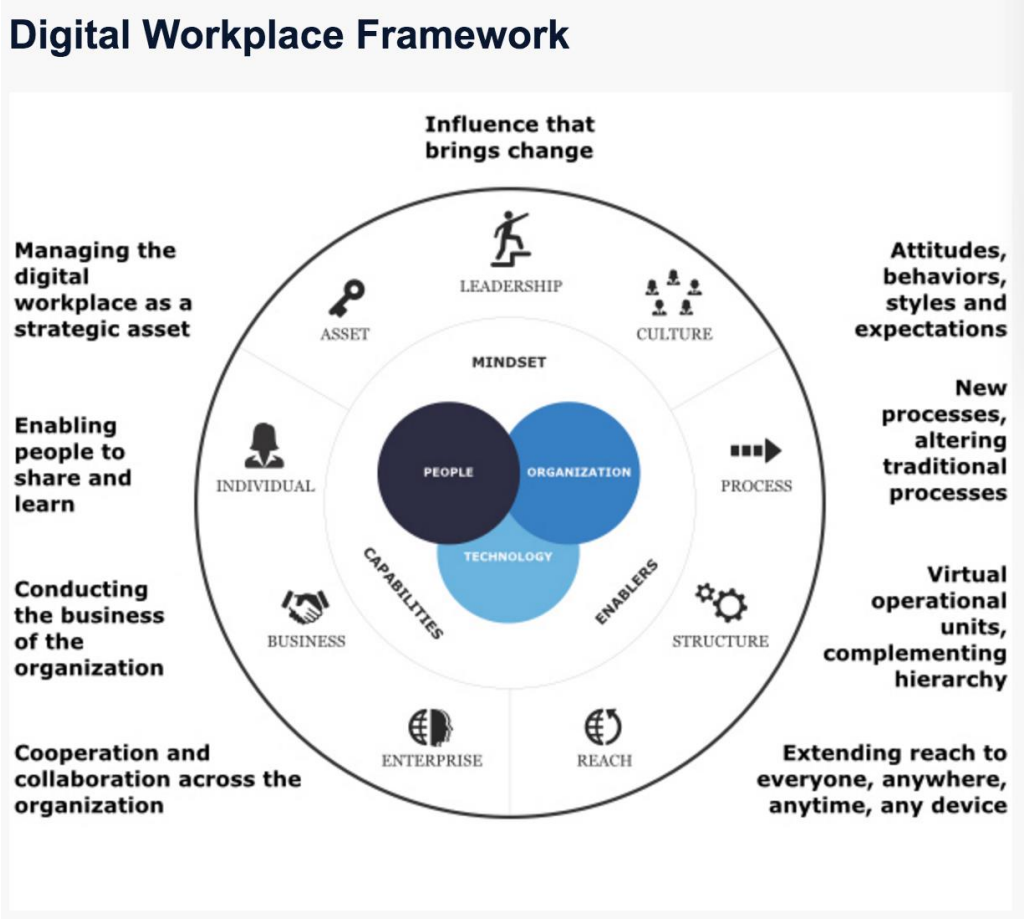
566 The Future of Digital Industrial Enterprises and the Quest for New Management Capabilities, http://www.futurelab.net/blog/2016/01/future-digital-industrial-enterprises-and-quest-new-management-capabilities

567 We Need To Switch Our Mental Models From Hierarchies To Networks, http://www.digitaltonto.com/2016/we-need-to-switch-our-mental-models-from-hierarchies-to-networks/

568 The Tony Soprano Problem, http://www.digitaltonto.com/2015/the-tony-soprano-problem/

569 The 9 Dimensions of the Digital Workplace Framework, http://www.netjmc.com/the-9-dimensions-of-the-digital-workplace-framework/

570 The Intersection of People, Organization and Technology, http://www.netjmc.com/digital-workplace-framework-and-maturity-scale/



Source[571]

Globally, digitization is affecting every aspect of the workplace and of organizational designs[572].

[571] http://www.netjmc.com/digital-workplace-framework-and-maturity-scale/

[572] The organization in the digital age, http://www.netjmc.com/wp-content/uploads/2015/11/ORGANIZATION-DIGITAL-AGE-2015-EXEC.pdf

Source[573]

Digital technology is also considered as a driver for emerging and radical different types of organizational models such as self-organization which we outline in Box 9.

There is an abundant and current literature about these digital transformation artefacts at the workplace and a lot more would need to be said regarding the utmost importance of these subjects. However, this would exceed the objective of the current report. The interested reader is invited to dig into an extensive selection of references we provide in Appendice I.

[573] L'espace de travail de demain, http://www.itnation.lu/lespace-de-travail-de-demain/

BOX 9: Self-organization

In recent years, a growing community of scholars in management and leadership science talk about an upcoming paradigm shift: The move away from a mechanistic view of the organization towards a more humanistic, « living system » view of the organization.

The assumption in the old mechanistic view of organizations is that they need a strong leader who controls and commands the organization via a strict hierarchy. While this organizational model worked well in stable and predictable markets requiring repetitive actions and processes, it turns out that it can be almost a productivity and efficiency inhibitor in uncertain times and markets full of blurring signals and high innovation pressure which is the case of the current VUCA world we live in. In terms of leadership, the choice reverts to authoritarian or democratic leadership.

Self-organizing teams are increasingly considered as a superior management model in terms of sustainable growth, environmental sustainability, customer satisfaction and employee satisfaction as a number of prominent authors and publications suggest while also providing more and more research-based evidence [574], [575], [576], [577], [578].

It is not surprising that this shift in consciousness in terms of organizational design happens at a time where the world has become complex and unpredictable, where digital transformation disrupts almost everything and where a new type of workforce enters the job market, namely the millennials and subsequent generations[579].

New economic models

The current substantial transformation of society through the confluence of disruptive technologies and capabilities fundamentally affects our economic system.

New economic mechanism emerge, such as

- The sharing economy
- The access or « on-demand » economy
- The Data economy
- The App economy

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574 The New Science of Leadership: An Interview with Margaret Wheatley, http://www.scottlondon.com/interviews/wheatley.html

575 It's time to reinvent organizations, http://www.reinventingorganizations.com/

576 HOLACRACY: A COMPLETE SYSTEM FOR SELF-ORGANIZATION, http://www.holacracy.org/

577 Spiral Dynamics: Mastering Values, Leadership and Change, http://www.goodreads.com/book/show/204687.Spiral_Dynamics

578 The hot management trend of self-organising workplaces without managers: will Left or Right be first to embrace it?, http://www.enliveningedge.org/columns/the-hot-management-trend-of-self-organising-workplaces-without-managers-will-left-or-right-be-first-to-embrace-it/

579 In a recent interview on digital transformation, Daimler AG and Mercedes CEO Dieter Zetsche announced that he would bring about 20 % percent of the corporation's staff into a self-organising "swarm organisation" and that he would personally supervise the implementation. The aim is the connect staff members around certain subjects without being embedded in strict hierarchies. They will act highly autonomously and connected outside of organisational silos and departments and the whole process will not be limited to certain projects but will be a lasting "structure". That is a great example of leadership in digital transformation.

Daimler baut Konzern für die Digitalisierung um: Das Unternehmen eilt von Rekord zu Rekord, aber Ausruhen ist nicht erlaubt. Der Vorstandsvorsitzende Dieter Zetsche bricht alte Strukturen auf, erzählt er im Interview, http://www.faz.net/aktuell/wirtschaft/daimler-baut-konzern-fuer-die-digitalisierung-um-14424858.html

- The Platform economy
- The Circular economy

The speed and depth by which different parts of the world adapt to and benefit from this new mechanisms varies between different regions of the world, such as Europe, the US and the Asian-Pacific region.

The different terminologies tend to be used in a confusing way and the underlying concepts are overlapping, each one taking a different perspective as a starting point:

While most « sharing economy » offers are in fact access economy (or on-demand economy[580]) offers, the data economy is the enabling process and knowledge system for both but also for other Industry 4.0 concepts and business models, the app economy is about the interface to these new economies whereas the platform economy is about the techno-commercial infrastructure and market place for these economies.

The circular economy, which uses all the above concepts has an additional objective, which, in simple words, is a maximum reuse of goods and services (« recycling ») and a minimization of waste for environmental protection and sustainability purposes.

But they all share in common to fundamentally impact the traditional market economy's market structures, firms' production functions and consumers' utility functions and as a whole are fuelled by the aggregated possibilities of the underlying technologies of digital transformation (Big data, cloud, IoT, AI, robots…etc).

The Access (On-Demand) Economy and the Sharing Economy

Qualifying Uber[581], [582] (taxi services) or AirBnB (accommodation) [583] as sharing economy operators as it is often done, is misleading[584]. They are in fact access economy[585] operators.

> *Sharing is a form of social exchange that takes place among people known to each other, without any profit. Sharing is an established practice, and dominates particular aspects of our life, such as within the family. By sharing and collectively consuming the household space of the home, family members establish a communal identity. When "sharing" is market-mediated — when a company is an intermediary between consumers who do not know each other — it is no longer sharing at all. Rather, consumers are paying to* ***access*** *someone else's goods or services for a particular period of time. It is an economic exchange (a quantity of a certain good or service at a given price), and consumers are after utilitarian, rather than social, value.*

580 Powering the future of the on-demand economy, https://theondemandeconomy.org/

581 https://www.uber.com/

582 Uber is valuation today is 60 billion $ and Goldman Sachs is one of it's major investors: Goldman Sachs confirms $1.6B investment in Uber. http://venturebeat.com/2015/01/21/goldman-sachs-confirms-1-6b-investment-in-uber/ -

583 https://www.airbnb.com/

584 Other examples include the parking space sharing service https://www.carmanation.com/ and the boat sharing service SAILO, http://fortune.com/2015/08/04/sailo-airbnb-of-boats/

585 Access economy, https://en.m.wikipedia.org/wiki/Access_economy

This insight – that it is an access economy rather than a sharing economy – has important implications for how companies in this space compete. It implies that consumers are more interested in lower costs and convenience than they are in fostering social relationships with the company or other consumers.

Competition between companies will not hinge on which platform can provide the most social interaction and community, contrary to the current sharing economy rhetoric. Research shows[586] that consumers simply want to make savvy purchases, and access economy companies allow them to achieve this, by offering more convenience potentially at a lower price. Companies that emphasize convenience and price over the ability to foster connections will have a competitive advantage.

Consumers think about access differently than they think about ownership. And most of our best practices in marketing are built upon an ownership model.

The access economy is changing the structure of a variety of industries, and a new understanding of the consumer is needed to drive successful business models [587].

The access economy is expected to show massive growth in the coming years[588], [589], [590]. The following graph explains the on-demand business framework.

[586] Sharing isn't always caring: Why don't consumers take care of their Zipcars?, http://phys.org/news/2012-07-isnt-dont-consumers-zipcars.html

[587] The Sharing Economy Isn't About Sharing at All, https://hbr.org/2015/01/the-sharing-economy-isnt-about-sharing-at-all

[588] The 'On-Demand Economy' Is Revolutionizing Consumer Behavior — Here's How, http://www.businessinsider.com/the-on-demand-economy-2014-7?IR=T

[589] The On-Demand Economy Is Growing, and Not Just for the Young and Wealthy, https://hbr.org/2016/04/the-on-demand-economy-is-growing-and-not-just-for-the-young-and-wealthy

[590] The On-Demand Economy Is Here To Stay, And Now Is The Time To Put It To Use For Your Business, http://www.forbes.com/sites/zalmiduchman/2015/07/14/the-on-demand-economy-is-here-to-stay-and-now-is-the-time-to-put-it-to-use-for-your-business/#4c8a400343f8

Source[591]

But it also presents a series of challenges as compared to the traditional institutional arrangements: beyond the question of privacy of the generated big data, which is a general challenge within digital transformation and will be discussed later on, it also creates a new type of job insecurity because of less institutional protection than traditional economy workers have benefited from but also transfers operating costs to the worker (such as for example car maintenance, car insurance..etc. in the case of the Uber taxi drivers). Also, customer protection and security is undermined by less institutional control. And tax collection from Uber drivers or AirBnB landlords is more difficult. It is for those reasons that many countries, regions and cities at present try to find new ways of regulating these emerging economic

591 http://static1.businessinsider.com/image/53bd6797eab8eaa341617710-608-651/on-demand-03.jpg

models[592], [593], [594], [595]. How viable some on demand economy business models will be over time is another open question[596].

Real sharing economy offers don't have a commercial operator as an intermediary and are real socially collaborative, non-for-profit, peer-to-peer communities where interaction and connection between members are important, such as for example sharing neighbourhood communities[597], [598].

Both the real sharing economy and the access economy[599], [600] do share some characteristics in common such as the importance of trust in mutual trading relationships but also the impact down the nested economic value chain by using and sharing things rather than owning them, as in case of goods for example, the same stock can be used much more efficiently thereby lowering the demand for total production of these goods, but with a positive effect on sustainability. Another form of dematerialization through digitization.

For workers, on-demand economy jobs can mean casualization of work. The term « Gig economy » has been coined to describe the phenomenon[601]:

> *Not so long ago, the only people who looked for "gigs" were musicians. For the rest of us, once we outgrew our school dreams of rock stardom, we found "real" jobs that paid us a fixed salary every month, allowed us to take paid holidays and formed the basis for planning a stable future.*
>
> *Today, more and more of us choose, instead, to make our living working gigs rather than full time. To the optimists, it promises a future of empowered entrepreneurs and boundless innovation. To the naysayers, it*

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592 Angestellte bei Airbnb und Uber: "Diese Jobs schaffen ein neues Prekariat », http://www.spiegel.de/wirtschaft/airbnb-und-uber-was-steckt-hinter-der-sharing-economy-a-1083971.html

593 The truth about working for Deliveroo, Uber and the on-demand economy, https://www.theguardian.com/money/2016/jun/15/he-truth-about-working-for-deliveroo-uber-and-the-on-demand-economy

594 The 'Sharing Economy' Isn't About Sharing: The Dark Reality Behind This Major Workplace Shift, http://www.alternet.org/labor/sharing-economy-isnt-about-sharing-dark-reality-behind-major-workplace-shift

595 Uberisation: le temps de la contre-attaque, http://www.paristechreview.com/2016/01/21/uberisation-contre-attaque/#.VqjzVZGit-A.twitter

596 Uber: Deshalb verbrennt das Unternehmen Milliarden, http://www.spiegel.de/wirtschaft/unternehmen/uber-deshalb-verbrennt-das-unternehmen-milliarden-a-1109596.html

597 Netzwerke für Nachbarn: Online wird die Stadt zum Dorf, http://www.spiegel.de/netzwelt/web/nebenan-de-wirnachbarn-nextdoor-netzwerke-fuer-nachbarn-a-1106979.html

598 https://nebenan.de

599 Gutes Teilen, schlechtes Teilen, http://www.zeit.de/wirtschaft/2016-07/sharing-economy-teilen-tauschen-airbnb-uber-trend/komplettansicht

600 The Shared Economy Now and Later, http://cityminded.org/the-shared-economy-now-and-later-14584

601 The 'gig economy' is coming. What will it mean for work?, http://www.theguardian.com/commentisfree/2015/jul/26/will-we-get-by-gig-economy?CMP=Share_iOSApp_Other

> *portends a dystopian future of disenfranchised workers hunting for their next wedge of piecework.*

The Circular Economy

Resource scarcity, environmental limits as well as climate change have been pushing policymakers and corporations for new economic concepts and new production, distribution and recycling mechanisms for a few decades already now, aiming at reducing the environmental impact of human activity.

As the challenges amplify over time, more resources are invested in developing innovative solutions and as the aggregated effects of new technologies and Industry 4.0 progress, the concept of a « circular economy[602] » has been refined during recent years in many developed countries and more and more action plans, also in Luxembourg, are put forward by policymakers to react to one of the biggest challenges of humanity, namely the limitation of natural resources on our planet.

> *A circular economy is an alternative to a traditional linear economy (make, use, dispose) in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life.*

Objectives, a.o.

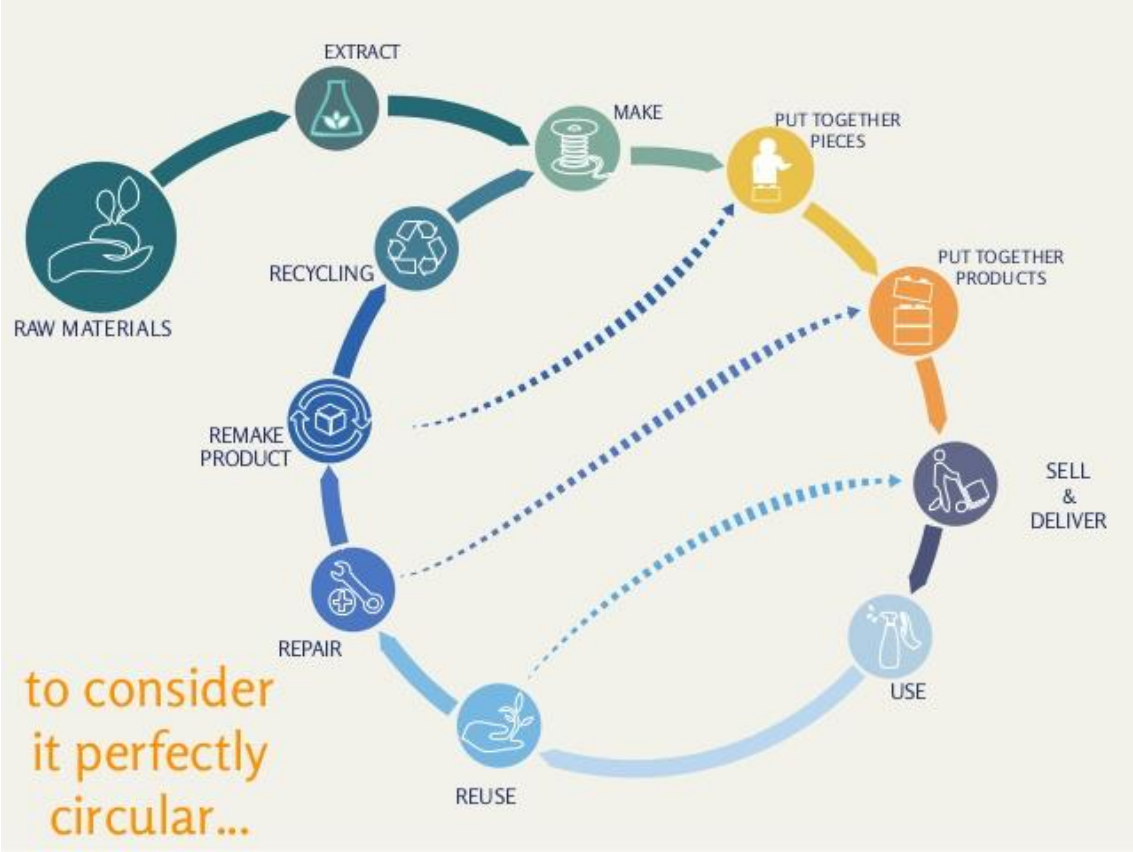
> - *reduce waste*
> - *drive greater resource productivity*
> - *deliver a more competitive economy.*
> - *address emerging resource security/scarcity issues in the future.*
> - *help reduce the environmental impacts of economic production and consumption[603].*

> *A circular economy is one that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times, distinguishing between technical and biological cycles[604].*

602 https://en.m.wikipedia.org/wiki/Circular_economy

603 What is a circular economy?, http://www.wrap.org.uk/about-us/about/wrap-and-circular-economy

604 Allen Macarthur Foundation, https://www.ellenmacarthurfoundation.org/circular-economy



Source[605]

The circular economy[606], [607], [608] is thus more than just recycling[609].

The following chart develops six approaches that translate across industries — regenerate, share, optimize, loop, virtualize and exchange — along with examples of both international start-ups and bigger companies jumping on the bandwagon show specific business models that incorporate the idea[610].

[605] Design, an easy tool to integrate the Circular Economy, http://www.slideshare.net/wiithaa/design-an-easy-tool-for

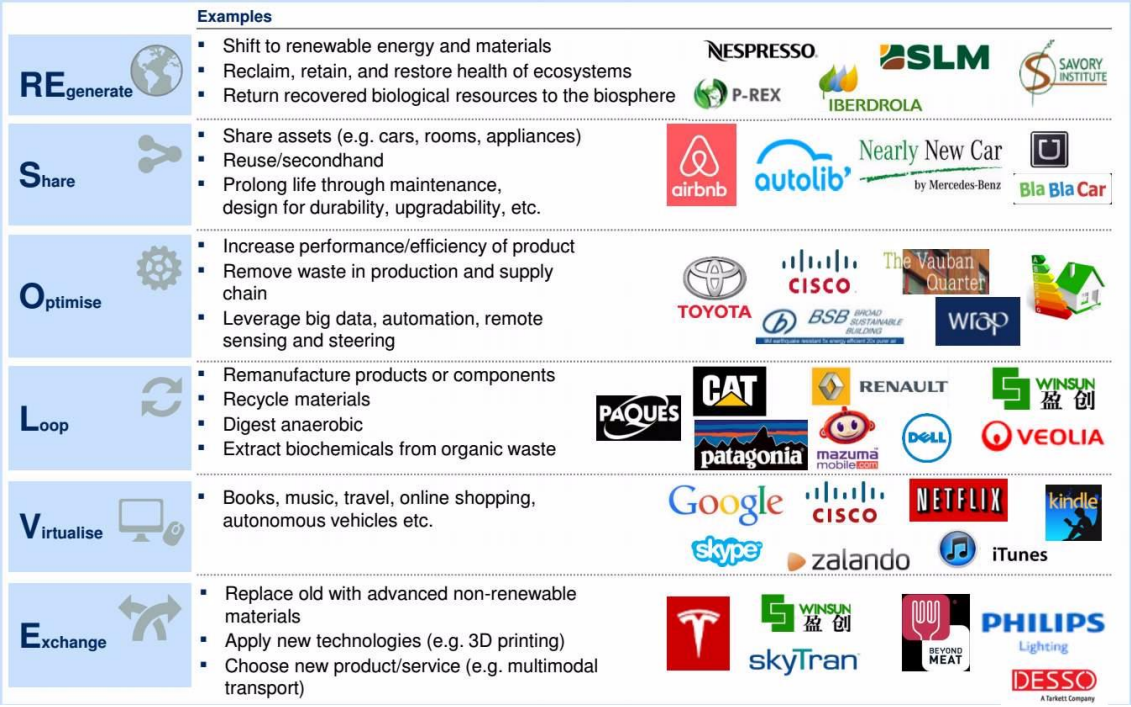
[606] Moving toward a circular economy, http://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/moving-toward-a-circular-economy

[607] 10 things you need to know about the circular economy, http://www.sandbirch.com/10-things-you-need-to-know-about-the-circular-economy/

[608] The Circular Economy - Designing Out Waste, http://www.slideshare.net/Dell/circular-economy-45454403

[609] 10 things you need to know about the circular economy, https://www.theguardian.com/sustainable-business/10-things-need-to-know-circular-economy

[610] GreenBiz 101: Defining the circular economy, https://www.greenbiz.com/article/defining-circular-economy-beyond-recycling-material-reuse



Source[611]

More and more other case studies incorporate the circular economy concept[612], [613], and the sharing and on-demand economies can be considered as one possible element of a circular economy, driven by digital technology.

The App Economy

For more and more people, apps (on smartphones, tablets and computers) have become the gateway to our modern life, as consumers, as workers and as citizens.

« Is there an app for that? » is a question that was commonly heard in 2016[614].

> *App economy refers to the range of economic activity surrounding mobile applications. Mobile apps created new fortunes for entrepreneurs and changed the way business is done. The app economy encompasses the sale of apps, advertising revenue or public relations generated by free apps, and the hardware devices on which apps are designed to run[615].*

611 https://www.greenbiz.com/article/defining-circular-economy-beyond-recycling-material-reuse

612 Building Blocks of a Circular Economy, https://www.ellenmacarthurfoundation.org/circular-economy/building-blocks

613 The joy of less stuff: Less clutter. Less stress. Less impact on the planet., http://www.stuffstr.com/

614 The Future of Firms. Is There an App for That?, https://medium.com/@EskoKilpi/movement-of-thought-that-led-to-airbnb-and-uber-9d4da5e3da3a#.t8tbg9mx2

615 https://www.techopedia.com/definition/28141/app-economy

The app[616] economy is a fast growing market, and is now bigger than the film industry in Hollywood[617], [618], [619], [620] in terms of total earnings. Apps are enablers for business innovation as much as for public and social innovation[621].

The global app economy was valued at more than £35 billion in 2015 and is forecast to double by 2020 when downloads of mobile apps will have reached a staggering 284 billion[622], [623], [624].

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616 App stands for a service on a smartphone or a tablet, independant of the technology used for designing that service or « app ».

617 The iOS App Store distributed $10 billion to developers in 2014, which, Dediu points out, is just about as much as Hollywood earned off U.S. box office revenues the same year, http://www.theatlantic.com/technology/archive/2015/01/the-app-economy-is-now-bigger-than-hollywood/384842/

618 The State Of Mobile And The App Economy In 2015, http://www.forbes.com/sites/eladnatanson/2015/05/26/the-state-of-mobile-and-the-app-economy-in-2015/#6ef220d76f48

619 What's next for the app economy?, http://www.itproportal.com/2016/07/20/whats-next-for-the-app-economy/

620 App Economy jobs in the United States, http://www.progressivepolicy.org/slider/app-economy-jobs-part-1/

621 6 innovative mobile apps for citizens, http://www.enterpriseinnovation.net/article/6-innovative-mobile-apps-citizens-1659286554

622 Report: The App Economy, http://raconteur.net/app-economy

623 State of the App Economy 2016, https://actonline.org/wp-content/uploads/2016*State*of*App*Economy.pdf

624 Winners and loser in the Global App Economy 2016, http://cariboudigital.net/wp-content/uploads/2016/02/Caribou-Digital-Winners-and-Losers-in-the-Global-App-Economy-2016.pdf

And here's a snapshot of the EU app economy in 2014[625]:

• 406,000 professional app developers

• 667,000 thousand direct app economy jobs

• 1 million direct and indirect jobs

• $16.5 billion in revenues

• 19% of global app economy revenues

• 12% annual growth rate

The Platform Economy

Platforms are on their way to conquer and replace most of the traditional market structures of modern economics. They are disruptive and real game changers and press many companies and industries to review and even invert their established strategies.

In simple terms, a platform is a digitally governed marketplace for partners sharing a common commercial interest.

The following paragraphs are extracts from recent literature about the Platform Economy:

> *"Platforms" are "frameworks that permit collaborators – users, peers, providers - to undertake a range of activities, often creating de facto standards, forming entire ecosystems for value creation and capture [626].*
>
> *A platform or complement strategy differs from a product strategy in that it requires an external ecosystem to generate complementary product or service innovations and build positive feedback between the complements and the platform. The effect is much greater potential for innovation and growth than a single product-oriented firm can generate alone[627].*
>
> *The application of big data, new algorithms, and cloud computing will change the nature of work and the structure of the economy. But the exact nature of that change will be determined by the social, political, and business choices we make.*

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625 European Mobile & Mobility Industries Alliance, http://www.mobilise-europe.mobi/the-european-app-economy

626 Choosing a Future in the Platform Economy: The Implications and Consequences of Digital Platforms, http://www.brie.berkeley.edu/wp-content/uploads/2015/02/PlatformEconomy2DistributeJune21.pdf

627 The Rise of the Platform Economy, http://blogs.wsj.com/cio/2016/02/12/the-rise-of-the-platform-economy/

A digital platform economy is emerging. Companies such as Amazon, Etsy, Facebook, Google, Salesforce, and Uber are creating online structures that enable a wide range of activities[628].

The European Commission defines online platforms as "search engines, social media, e-commerce platforms, app stores, and price comparison websites". "A platform is simply a building block or template on top of which lots of people can innovate".

And creating value is something they are doing in bucket-loads. Gawer and Evans' report[629] – based on a comprehensive survey of the 176 platform companies around the world – found the aggregate market value of platforms to be over $4.3 trillion. So from automobiles to Zipcar and the Uber app, platforms are hugely influential and exciting policymakers, businesses and individuals alike.[630].

Having a platform strategy and the business know-how to exploit it is more important than 'owning' an ecosystem. By 2018, International Data Corporation (IDC) predicts[631] that more than 50 percent of large enterprises—and more than 80 percent of enterprises with advanced digital transformation strategies— will create and/or partner with industry platforms and that the number of industry clouds will reach 500 or more by 2018, up from today's 100-plus[632].

Platforms have unique characteristics, with a central feature being the presence of network effects. Network effects are prevalent in platforms, and they mean that more users beget more users, a dynamic which in turn triggers a self-reinforcing cycle of growth.

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628 The Rise of the Platform Economy,http://issues.org/32-3/the-rise-of-the-platform-economy/

629 The Rise of the Platform Enterprise: A Global Survey, http://thecge.net/wp-content/uploads/2016/01/PDF-WEB-Platform-Survey*01*12.pdf

630 What you should know about the platform economy, http://readie.eu/what-you-should-know-about-the-platform-economy/

631 IDC Predicts the Emergence of "the DX Economy" in a Critical Period of Widespread Digital Transformation and Massive Scale Up of 3rd Platform Technologies in Every Industry, https://www.idc.com/getdoc.jsp?containerId=prUS40552015

632 Platform Economy: Technology-driven business model innovation from the outside in, https://www.accenture.com/fr-fr/_acnmedia/PDF-2/Accenture-Platform-Economy-Technology-Vision-2016-france.pdf

Platforms create value in two principal ways. The first way, which corresponds to what we call transaction platforms, facilitates transactions between different types of individuals and organizations that would otherwise have difficulty finding each other. Obvious examples include Uber, Google Search, Amazon Marketplace, and eBay. This type of platform is sometimes called a multi-sided market

There are also innovation platforms, which consist of technological building blocks that are used as a foundations on on top of which a large number of innovators can develop complementary services or products.

5. Platform Typology

While platforms have common underlying dynamics these are expressed differently as firms organize and apply them in the market. As a result, it makes sense to separate platform companies into four types: transaction platforms, innovation platforms, integrated platforms and investment platforms. We define each of these platforms types as follows:

Transaction platforms

A transaction platform is a technology, product or service that acts as a conduit (or intermediary) facilitating exchange or transactions between different users, buyers, or suppliers.

Innovation platforms

An innovation platform is a technology, product or service that serves as a foundation on top of which other firms (loosely organized into an innovative ecosystem) develop complementary technologies, products or services.

Integrated platforms

An integrated platform is a technology, product or service that is both a transaction platform and an innovation platform. This category includes companies such as Apple, which has both matching platforms like the App Store and a large third-party developer ecosystem that supports content creation on the platform.

Investment platforms

Investment platforms consist of companies that have developed a platform portfolio strategy and act as a holding company, active platform investor or both.

Source[633]

> *Platforms change what it means to lead organizations, forcing them to re-think their strategies, business models, leadership, organizational structures, and approaches to value creation and capture systems. Aiming to become a platform leader entails a vision that extends beyond one's own firm, and aims to build and sustain an ecosystem of partners, where the platform leader has to be the equivalent of a captain.*
>
> *The largest in the world, such as Facebook, Amazon, and Alibaba, facilitate hundreds of millions or even billions of interactions per day[634].*

In a way, a plateform is a bureaucracy in the sense of Max Weber[635] (mechanization and increase in scale leading to a more rational form of organization). Plateforms are mechansims to access (« access economy ») ecosystems of talents, technology and information. They also change the basis of competition: Competitive advantage is no longer the sum of all efficiencies, but the sum of all connections. Business strategy, therefore, must be focused on deepening and widening networks of talent, technology and information which is done by accessing ecosystems through platforms. As a consequence, power is shifted from corporations to plateforms.[636], [637].

For a matter of comparison and illustration of the platform economy's market power:

In April 2016, Facebook's market capitalization was 230 billion EUR. Volkswagen's was 58 billion EUR. In terms of turnover, the picture is inverted: Facebook's turnover had a turnover of 12,5 billion $ in 2014, Volkswagen's was 268,9 billion $. The big 4 platforms - Google, Amazon, Facebook and Apple (GAFA) - had together had a market capitalization of almost 1,5 trillion EUR which corresponds to half of Germany's GDP ![638][639]

Platforms (or multi-sided markets) are characterised:

- by « coopetiton » , the term designating a tension between collaboration and competition,

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633 http://thecge.net/wp-content/uploads/2016/01/PDF-WEB-Platform-Survey_01_12.pdf

634 The Rise of thePlatform Enterprise A Global Survey, http://thecge.net/wp-content/uploads/2016/01/PDF-WEB-Platform-Survey_01_12.pdf

635 http://en.wikipedia.org/wiki/Max_Weber

636 4 Things You Should Know About Platforms, http://www.digitaltonto.com/2015/4-things-you-should-know-about-platforms/

637 Platforms Are Eating The World, http://www.forbes.com/sites/gregsatell/2016/09/02/platforms-are-eating-the-world-3/#c903622652b3

638 Facebook und seine Dienste wie WhatsApp oder Instagram sind Beispiele für die hohe Dynamik und Wachstumsgeschwindigkeit erfolgreicher digitaler Plattformen. Facebook wurde 2004 gegründet und hat nach zwölf Jahren rund 1,6 Milliarden Nutzerinnen und Nutzer. 28 Millionen Menschen in Deutschland nutzen Facebook, 21 Millionen davon jeden Tag. Der Messengerdienst WhatsApp wurde erst 2009 gegründet und hat mittlerweile annähernd eine Milliarde Nutzer. Mit dem Au ommen von WhatsApp hat sich die Nutzung von SMS-Diensten drastisch reduziert. Zwischen 2012 und 2015 hat sich das SMS-Volumen in Deutschland um 75 Prozent verringert, während sich die WhatsApp-Nutzung Schätzun- gen zufolge mehr als verdreißigfacht hat. Internetplattformen treten also in erheblichem Maße in Konkurrenz zu den traditionellen Telekommuni- kationsanbietern.

639 GRÜNBUCH Digitale Plattformen, https://www.bmwi.de/BMWi/Redaktion/PDF/G/gruenbuch-digitale-plattformen,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf

- network effects including strong monopoly tendencies (« the winner takes it all »), (« chicken-and-egg-logic)
- And produce integrated solutions that are often cross-industry (and their business models are often transferable from one industry to another - i.e. Uber's declared intention to enter the health care and the travel industry) and their interactions are mostly complex and unpredictable[640].

It turns our that network orchestrators - meaning companies that initiate and control a platform business - create more value[641]

It is not surprising that, given their massive disruptive potential[642], platform ecosystems are currently intensively investigated in microeconomic and business literature[643], [644], [645], [646], [647], [648].

The Data Economy

As we already mentioned, « Data is the new oil » or « Data is the new currency » are economists' new mantras.

In an economic ecosystem where more and more processes, devices and machines are interconnected via all kinds of ubiquitously embedded sensors and computers, the « big data » streams that can be collected, analysed and collated is literally exploding. Data is collected everywhere: in homes, buildings, cars, business functions and value chains, consumers, citizens, governments, science and academia alike. The insights gained open completely new perspectives and possibilities by unveiling behavioural patterns that were completely hidden until recently.

With limping productivity in the « traditional economy », the exploitation of big data combined with digital transformation's other technologies opens up a whole new area of business as well public governance opportunities. But the speed at which organizations can adapt to this new reality in terms of organizational agility, culture and business strategy is lagging behind, apart from the few stars of the digital economy.

Challenges are huge and manifold, indeed. Many more industries and individual firms will be disrupted in the advent of big data.

Economically, data represents a series of interesting characteristics:

- Data is non-rivalrous (but excludable)

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640 Key Innovation Issues for 2016 and Beyond, http://integrative-innovation.net/wp-content/uploads/Co-creation-platform.png

641 What Airbnb, Uber, and Alibaba Have in Common, https://hbr.org/2014/11/what-airbnb-uber-and-alibaba-have-in-common

642 Where Uber and Amazon rule: welcome to the world of the platform - Powerful tech firms are altering not just the way we buy things, but could sweep away an entire economic model, https://www.theguardian.com/technology/2015/jun/07/facebook-uber-amazon-platform-economy

643 Pipelines, Platforms, and the New Rules of Strategy, https://hbr.org/2016/04/pipelines-platforms-and-the-new-rules-of-strategy

644 Everything We Know About Platforms We Learned from Medieval France, https://hbr.org/2016/03/everything-we-know-about-platforms-we-learned-from-medieval-france

645 To Manage a Platform, Think of It as a Micromarket, https://hbr.org/2016/04/to-manage-a-platform-think-of-it-as-a-micromarket

646 Some of the Most Successful Platforms Are Ones You've Never Heard Of, https://hbr.org/2016/03/some-of-the-most-successful-platforms-are-ones-youve-never-heard-of

647 What Platforms Do Differently than Traditional Businesses, https://hbr.org/2016/05/what-platforms-do-differently-than-traditional-businesses

648 Why Platform Disruption Is So Much Bigger than Product Disruption, https://hbr.org/2016/04/why-platform-disruption-is-so-much-bigger-than-product-disruption

    - Data reuse and non-discriminatory access can maximize its value
    - Data enables multi-sided markets
- Data is capital with increasing returns
    - Data can be reused as input for further production
    - Data linkage is a key source for super additive insights
- Data is a general purpose input with no intrinsic value
    - Data are an input for multiple purposes
    - Its value depends on complementary factors related to the capacity to extract information (e.g. skills, software).

It is understandable that the business community claims a proportionate regulation of the data economy between freedom of use for commercial ends, and privacy and security for the individual to ensure a reliable, continuous and affordable access to data[649]. These negotiations, or rather battle fields, are addressed in different ways in the US than in Europe, mainly because of different cultural backgrounds and traditions[650], [651] in both areas. In Europe, things tend to be more challenging as the negotiations for designing the European Digital Single Market[652] at the EU level illustrate[653].

The difference between the European approach to disruptive innovation vs. the US could be summarized, in a slightly provocative way, like this: Europe first develops regulation (which takes a lot of time) and then allows companies to create disruptive innovation within the remaining possibilities left over by that new regulation whereas the US by default allows companies to create disruptive innovation and develops regulation later on, where and when necessary. It is not surprising that within those fundamental differences, the 10 biggest Silicon Valley companies make more profit than the whole German digital industry's turnover taken together [654] !

The Future of Jobs and Work

In the realm of digital transformation, the future of jobs is one of the hottest topics currently discussed. The questions raised mainly are:

- What are the future skills required in a digitally transformed economy?
- What are the current jobs that are threatened in the wave of digitally driven motoric and cognitive automation?
- What are the new job profiles emerging and will we witness a significant labour migration into other sectors of the public and private economy?

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649 A global economy powered by data, https://www.weforum.org/agenda/2016/01/a-global-economy-powered-by-data

650 Europe's obsession with privacy rights hinders growth - This mindset threatens Europe's path to prosperity in the digital age, argues the Ericsson VP, http://www.politico.eu/article/opinion-europes-obsession-with-privacy-rights-hinders-growth/

651 Europe's Other Crisis: A Digital Recession, https://hbr.org/2015/10/europes-other-crisis-a-digital-recession

652 Digital Single Market - Bringing down barriers to unlock online opportunitieshttp://ec.europa.eu/priorities/digital-single-market_en

653 Europe's Digital Wrong Turn, https://www.project-syndicate.org/commentary/eu-data-digital-privacy-protection-by-christopher-engman-2015-07

654 "Deutschlands Konzerne im Umbruch: Gelingt der Strukturwandel?" FORUM WIRTSCHAFT, http://www.phoenix.de/content/1107771

- How will work of entrepreneurs and employed workers develop respectively in the future?
- Will there be more and more multiple simultaneous careers for one person? (The so called « slash careers »[655]

A recent report by the World Economic Forum states the challenge as follows[656]:

> *Disruptive changes to business models and emerging technologies will have a profound impact on the employment landscape over the coming years. Many of the major drivers of transformation currently affecting global industries are expected to have a significant impact on jobs, ranging from significant job creation to job displacement, and from heightened labour productivity to widening skills gaps. In many industries and countries, the most in-demand occupations or specialties did not exist 10 or even five years ago, and the pace of change is set to accelerate. By one popular estimate, 65% of children entering primary school today will ultimately end up working in completely new job types that do not yet exist. In such a rapidly evolving employment landscape, the ability to anticipate and prepare for future skills requirements, job content and the aggregate effect on employment is increasingly critical for businesses, governments and individuals in order to fully seize the opportunities presented by these trends—and to mitigate undesirable outcomes.*

Skills

A possible projected comparison of skills required at the workplace between 2015 and 2020 looks as follows[657], [658], according to the World Economic Forum:

[655] One Person/Multiple Careers: The Truth About Slash Careers, http://www.carpejuvenis.com/2015/03/10/one-personmultiple-careers-the-truth-about-slash-careers/

[656] The Future of Jobs Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution, http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

[657] What skills does the future workforce need?, https://www.weforum.org/agenda/2016/03/what-skills-does-the-future-workforce-need

[658] For a detailed description of results and the methdologies used, including the scope of companies and industries questioned, please refer directly to the study: http://www3.weforum.org/docs/WEF*Future*of*Jobs.pdf*

Top 10 skills

in 2020	in 2015
1. Complex Problem Solving	1. Complex Problem Solving
2. Critical Thinking	2. Coordinating with Others
3. Creativity	3. People Management
4. People Management	4. Critical Thinking
5. Coordinating with Others	5. Negotiation
6. Emotional Intelligence	6. Quality Control
7. Judgment and Decision Making	7. Service Orientation
8. Service Orientation	8. Judgment and Decision Making
9. Negotiation	9. Active Listening
10. Cognitive Flexibility	10. Creativity

Source: Future of Jobs Report, World Economic Forum

Also, employers are increasingly looking for candidates that bring a balanced mix of technical and people skills or, in other words, between their primary professional education and the arts and science in general.

Being empathetic, making sense out of data and phenomena, « connecting the dots » within complex systems together with computational and data science skills and the ability to collaborate with machines[659] are the most searched for skillsets today.

Soft skills are of growing importance[660] too, and mainly consist of

- Goal-centric thinking
- Collaboration skills
- Communication skills
- Multilinguism
- Learning skills
- Troubleshooting skills

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659 Why 2016 Is The Year Of The Hybrid Job - More companies are requiring a mix of technology and people skills—get prepared for the hybrid job, http://www.fastcompany.com/3057619/the-future-of-work/why-2016-is-the-year-of-the-hybrid-job

660 The Soft Skills of Great Digital Organizations, https://hbr.org/2016/02/the-soft-skills-of-great-digital-organizations

- Playfulness

In other words, social skills, asking the right questions (as opposed to giving the right answers), collaboration skills (with machines and people) will be the skills needed to avoid being (quickly) replaced by a robot. As a piece of evidence, it appears that personal services has been the fastest growing job category over the last decade in the US[661], [662].

> ***As the Second Machine Age progresses, will there be any jobs for human beings?***
>
> *McAfee: Yes, because humans are still far superior in three skill areas. One is high-end creativity that generates things like great new business ideas, scientific breakthroughs, novels that grip you, and so on. Technology will only amplify the abilities of people who are good at these things.*
>
> *The second category is emotion, interpersonal relations, caring, nurturing, coaching, motivating, leading, and so on. Through millions of years of evolution, we've gotten good at deciphering other people's body language…*
>
> *Brynjolfsson: …and signals, and finishing people's sentences. Machines are way behind there.*
>
> *The third is dexterity, mobility. It's unbelievably hard to get a robot to walk across a crowded restaurant, bus a table, take the dishes back into the kitchen, put them in the sink without breaking them, and do it all without terrifying the restaurant's patrons. Sensing and manipulation are hard for robots.*
>
> *None of those is sacrosanct, though; machines are beginning to make inroads into each of them.*
>
> *McAfee: We'll continue to see the middle class hollowed out and will see growth at the low and high ends. Really good executives, entrepreneurs, investors, and novelists—they will all reap rewards. Yo-Yo Ma won't be*

661 If You Want To Avoid Being Replaced By A Robot, Here's What You Need To Know, http://www.digitaltonto.com/2014/if-you-want-to-avoid-being-replaced-by-a-robot-heres-what-you-need-to-know/

662 Robots Aren't the Problem: It's Us, http://www.chronicle.com/article/Robots-Arent-the-Problem-/138007/

> *replaced by a robot anytime soon, but financially, I wouldn't want to be the world's 100th-best cellist [663].*

Every business function within companies must adapt its skills to the requirements of digital: from the board down to line workers, including CIOs[664].

In consequence, HR departments and education systems face an unprecedented challenge to follow the trend and deliver[665].

Jobmarket

Until now, we have been extensively describing what intelligent machines and other new digital technologies are already able to do and will be able to do even more in the near future. We have also pointed to the different nature of the current industrial revolution in terms of the aggregated capabilities of cognitive task automation together with more complex mechanistic automation compared to the 1st and the 2nd industrial revolutions. And we also know that labour productivity has almost been stagnating during the last 25 years in modern economies.

The obvious question is: will robots take over our jobs? Or rather, which jobs will be taken over by robots and will there be enough new jobs created for everybody[666] ? And what are those new jobs? Or are we entering a systemic economic and societal shift? What are the challenges for existing and future businesses and for different types of industries[667], [668], [669], [670], [671] as well as on the world economic ecosystem[672], [673] , [674] ? Key developments include:

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663 The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee, https://hbr.org/2015/06/the-great-decoupling

664 Why digital transformation requires CIOs to learn new skills, http://www.information-age.com/it-management/skills-training-and-leadership/123460351/why-digital-transformation-requires-cios-learn-new-skills

665 The new tech talent you need to succeed in digital, http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/the-new-tech-talent-you-need-to-succeed-in-digital

666 Frankly, a Low-Carbon Economy Creates Jobs and Growth, http://sustainabilityadvantage.com/2014/06/30/frankly-a-low-carbon-economy-creates-jobs-and-growth/

667 The Robotics Revolution - The Next Great Leap in Manufacturing https://www.bcgperspectives.com/content/articles/lean-manufacturing-innovation-robotics-revolution-next-great-leap-manufacturing/

668 How Robots Will Redefine Competitiveness, https://www.bcgperspectives.com/content/articles/lean-manufacturing-innovation-robots-redefine-competitiveness/

669 Industries and Economies Leading the Robotics Revolution, https://www.bcgperspectives.com/content/articles/lean-manufacturing-innovation-industries-economies-leading-robotics-revolution/

670 Zahlen per App: Unbemannter Supermarkt in Schweden eröffnet, http://www.heise.de/newsticker/meldung/Zahlen-per-App-Unbemannter-Supermarkt-in-Schweden-eroeffnet-3123489.html

671 WALL-YE, LE PREMIER ROBOT VIGNERON, http://www.anova-plus.com/blog/wall-ye-le-premier-robot-vigneron/

672 Machine Money and People Money — What's The Future of Work?, https://medium.com/the-wtf-economy/machine-money-and-people-money-29b497eeb9d0#.8aglh7lpd

673 ASEAN in transformation: How technology is changing jobs and enterprises, http://www.ilo.org/public/english/dialogue/actemp/whatwedo/aseanpubs/report2016_r1_techn.htm

674 La révolution digitale est-elle intrinsèquement libérale ?, http://www.usine-digitale.fr/editorial/la-revolution-digitale-est-elle-intrinsequement-liberale.N378590

- New generations of manufacturing robots such as Baxter from a company called Rethink Robotics[675] are able to learn new tasks from humans within minutes just by observing them and they also sense the presence of human beings to avoid hurting them (which was not the case with former manufacturing robots).
- Amazon for example already uses an army of 30.000 robots in its warehouses and a large number of Amazon's 220,000 staff are expected to be automated in the coming years[676], [677], [678], [679], [680], [681]. Considering the number and size of warehouses in the world and the number of workers they occupy, the simple equation that comes to mind is dizzying…
- Autopilots in aviation are already landing safely planes for years
- In the coming years, autopilots will probably take over taxi rides[682], [683] (or already are[684] and truck transportation[685]
- Cleaning companies will use robots[686] for toilets and window cleaning (vacuum cleaner robots[687] are already available in retail stores for fewer than 100 EUR)

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675 Rethink-Robotics, http://www.rethinkrobotics.com/

676 Amazon Robotics, https://www.amazonrobotics.com

677 Inside Amazon's Warehouse, Human-Robot Symbiosis: Amazon's newest warehouse is testing the limits of automation and human-machine collaboration., https://www.technologyreview.com/s/538601/inside-amazons-warehouse-human-robot-symbiosis/

678 How Amazon Triggered a Robot Arms Race

In 2012 Jeff Bezos scooped up warehouse automation firm Kiva. Everyone else is still trying to catch up., http://www.bloomberg.com/news/articles/2016-06-29/how-amazon-triggered-a-robot-arms-race

679 Amazon, robots and the near-future rise of the automated warehouse: How warehouse roles carried out by large numbers of Amazon's 220,000 staff are expected to be automated in the coming years., http://www.techrepublic.com/article/amazon-robots-and-the-near-future-rise-of-the-automated-warehouse/

680 Amazon moves one step closer toward army of warehouse robots: Robotics competition prize for best warehouse-working 'picker' machine awarded to robot designed by Dutch team, https://www.theguardian.com/technology/2016/jul/05/amazon-robotics-competition-dutch-team-first-prize

681 30,000 robots now work at Amazon; competing systems emerging, https://www.therobotreport.com/news/amazon-has-30000-kiva-robots-at-work-alternatives-begin-to-compete

682 Uber is testing a driverless taxi on the streets of Pittsburgh, http://www.dezeen.com/2016/05/20/uber-testing-driverless-taxi-self-driving-navigating-car-transport-pittsburgh-pennsylvania-usa/, and it's first self-driving fleet will arrive at the streets of US city Pittsburgh in August 2016, http://www.bloomberg.com/news/features/2016-08-18/uber-s-first-self-driving-fleet-arrives-in-pittsburgh-this-month-is06r7on

683 The race for a driverless taxi service is on, http://uk.businessinsider.com/the-race-for-a-driverless-taxi-service-is-on-2016-8?r=US&IR=T

684 The world's first 'self-driving' cab service hits the streets of Singapore, https://www.weforum.org/agenda/2016/08/the-world-s-first-self-driving-cab-service-hits-road-in-singapore

685 Convoy of self-driving trucks completes first European cross-border trip, https://www.theguardian.com/technology/2016/apr/07/convoy-self-driving-trucks-completes-first-european-cross-border-trip

686 Service Robots for Inspection, Cleaning and Maintenance, http://www.iff.fraunhofer.de/en/business-units/robotic-systems/research/service-robots-inspection-cleaning-maintenance.html

687 Cleaning Robots Hub, http://www.roboticstrends.com/hub/category/cleaning

- Fintech startups use chatbots for customer advice[688] and investment funds are using algorithms to help make investment decisions[689], [690].
- Hospitals use IBM Watson in cancer diagnostic[691] as well surgery robots in surgery[692]
- Chatbots[693] are replacing call-center agents
- And even in the creative industries, machines write songs[694], news articles[695], novels and poetry[696], [697]

It is clear that any kind of job in any kind of industry will be affected and new automation solutions[698] are appearing on the market at an almost daily rhythm which makes precise predictions about the net job market effects rather difficult[699], not to say impossible. Globally, since the 1970s productivity has risen as information technology has advanced, yet real wages have stagnated[700]

Experts' views are divided[701], [702], [703] and predicting the future is, as we know, no exact science. Which is not to say the future should not be envisaged in a foresight type of approach and that the future should be prepared staring today.

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688 Finanztechnik-Start-ups: Die Lümmel von der neuen Bank, http://www.spiegel.de/wirtschaft/fintech-start-ups-bedrohen-banken-branche-a-1052341.html

689 Algorithm appointed board director, http://www.bbc.com/news/technology-27426942

690 Morningstar - Taking the Person Out of Progress Algorithms and automation are upending professions. But do they lead to better outcomes?, http://www.nxtbook.com/nxtbooks/morningstar/magazine_20160809/index.php?elqTrackId=a5aa7c54dbc74263bf6c37eedc850a4b&elq=ffadb6dc99454f80aa4639d8e8976439&elqaid=5333&elqat=1&elqCampaignId=#/0

691 Watson Oncology, https://www.mskcc.org/about/innovative-collaborations/watson-oncology

692 Autonomous Robot Surgeon Bests Humans in World First, http://spectrum.ieee.org/the-human-os/robotics/medical-robots/autonomous-robot-surgeon-bests-human-surgeons-in-world-first

693 Google Plans New, Smarter Messaging App, http://www.wsj.com/articles/google-plans-new-smarter-messaging-app-1450816899

694 Artificial music: The computers that create melodies, http://www.bbc.com/future/story/20140808-music-like-never-heard-before

695 If an Algorithm Wrote This, How Would You Even Know?, http://www.nytimes.com/2015/03/08/opinion/sunday/if-an-algorithm-wrote-this-how-would-you-even-know.html?_r=1

696 Computers Are Writing Novels: Read A Few Samples Here, http://uk.businessinsider.com/novels-written-by-computers-2014-11?IR=T

697 Computer Algorithm Generates Poetry As Good As Shakespeare's, http://www.psfk.com/2014/01/shakespeare-machine-learning-poetry-app.html

698 Les dix innovations technologiques les plus prometteuses du monde en 2016, http://lentreprise.lexpress.fr/high-tech-innovation/les-dix-innovations-technologiques-les-plus-prometteuses-du-monde-en-2016_1757510.html#PMID=eHJpc21hczIwMDBAeWFob28uZnI=

699 Will robots replace humans?, http://www.lse.ac.uk/researchAndExpertise/researchHighlights/societyMediaAndScience/Will-robots-replace-humans.aspx

700 The future of robots in the workplace: The impact on workers, http://journalistsresource.org/studies/economics/jobs/robots-in-the-workplace

701 Will robots take our jobs? Experts can't decide, https://www.theguardian.com/technology/2014/aug/06/robots-jobs-artificial-intelligence-pew

702 Computerization, atomization, crowdsourcing and the new economics of employment, http://journalistsresource.org/studies/international/globalization/computerization-atomization-crowdsourcing-future-work-research-review

703 AI, Robotics, and the Future of Jobs, http://www.pewinternet.org/2014/08/06/future-of-jobs/

There are clearly two schools of thought regarding the coming impact of robots on workers: there are those who warn they will destroy jobs and those who hope new technology will boost the productivity of workers without replacing them[704], [705]. The discussion is a classical utopian-dystopian discourse[706]. Some argue that there is no shortage at things and jobs-to-done[707]. Others claim that completely new jobs will emerge such as for example the anti-aging expert[708], author for virtual reality stories, urban farmer, pet psychologist, all kinds of computer scientists as well as maintenance and cleaning specialists for robots a.o. Also, more people will work freelance or as start-up founders in the future as in many developed countries as huge (open) data pools, computing capacities and maker space capacities will be available in abundance, which will make it easier to develop and execute new business ideas and models. Others predict that in the future, we will be paid according to how good we are at collaborating with robots[709].

A whole series of studies and tools try to establish some guidance and more or less granular assessment grids on which kind of jobs are more or less threatened to be replaced by robots, including white collar expert jobs [710], [711], [712], [713], [714], [715], [716], [717].

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[704] Will Robots in the Workplace Destroy Our Future?, http://time.com/4277517/grappling-with-the-right-role-for-robots-at-work/

[705] Opinion: Robots at work will mean higher pay and more skills for you, http://www.marketwatch.com/story/robots-at-work-will-mean-higher-pay-and-more-skills-for-you-2016-04-21

[706] Robots Aren't the Problem: It's Us, http://www.chronicle.com/article/Robots-Arent-the-Problem-/138007/

[707] The future is brighter than you think, http://edition.cnn.com/2012/05/06/opinion/diamandis-abundance-innovation/

[708] In that context, it's interesting to note the recent AUgust 2016 announcment about « Arianna Huffington To Leave Huffington Post For New Billionaire-Backed Wellness Startup », http://www.forbes.com/sites/clareoconnor/2016/08/11/arianna-huffington-to-leave-huffington-post-for-new-billionaire-backed-wellness-startup/#3001600e5f5c

[709] *A more common job interview question in the near future: "How well do you get along with robots?* - Could you be replaced by a thinking machine?, http://fortune.com/2015/11/01/artificial-intelligence-robots-work/

[710] How Safe Is Your Job From The Robot Takeover? Take This Test, http://www.forbes.com/sites/bernardmarr/2015/09/29/how-safe-is-your-job-from-the-robot-takeover-take-this-test/#5c304af52787

[711] Lawyers are just as likely to lose their jobs to robots as truck drivers and factory workers, http://www.techinsider.io/robots-may-make-legal-workers-obsolete-2015-8

[712] Use this calculator to see if robots will take your job, http://www.techinsider.io/calculator-see-jobs-robots-artificial-intelligence-will-take-2015-9

[713] 5 white-collar jobs robots already have taken, http://fortune.com/2015/02/25/5-jobs-that-robots-already-are-taking/

[714] Four fundamentals of workplace automation, http://www.mckinsey.com/business-functions/business-technology/our-insights/four-fundamentals-of-workplace-automation

[715] Where machines could replace humans—and where they can't (yet), http://www.mckinsey.com/business-functions/business-technology/our-insights/where-machines-could-replace-humans-and-where-they-cant-yet

[716] Nine jobs that humans may loose to robots

[717] Robots at Work, http://cep.lse.ac.uk/pubs/download/dp1335.pdf

But many also predict that more jobs will be killed than new ones created[718], [719], [720], [721], [722]. Workers will have to be ever better qualified to avoid being replaced by machines. More and more jobs will be of a higher cost than the robotic alternative, and machine productivity will surge as a consequence. That will put a heavy burden on training and education systems and their related costs, and nobody knows whether the resources needed will be made available, nor if the ever-shorter innovation cycles will not overstrain workers capacity to follow and adapt. What will be people's reaction in that case? Massive and widespread social unrest[723] ?

In this context, the UK daily newspaper « The Guardian » writes[724]

> *We already have an hourglass economy, with plenty of room at the top for those with existing wealth and access to capital, and a wide, flat base of lower-paid jobs that cannot be automated. There is a hollowing out of the middle – the jobs in retail, or high street banking for example. We are becoming a country of affluent leaders, and struggling workers, with less space in the middle and fewer chances for progression.*
>
> *New technology will exacerbate this trend. Unlike previous waves of industrial progress, it is not just working-class jobs, primarily done with the hands, that automation threatens. Automated systems are diagnosing diseases, writing annual reports, researching criminal cases in court, designing software and pouring our coffee.*

Other relevant studies predict substantial amounts of job destruction in the coming years:

- 47% of jobs in the US (with a detailed look at 702 different job profiles)[725]
- 3 million jobs in France by 2025[726]

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718 Manufacturing hub starts work on first zero-labor factory, http://usa.chinadaily.com.cn/china/2015-05/03/content_20606585.htm

719 How robots are eating the last of America's—and the world's—traditional manufacturing jobs, http://qz.com/53710/robots-are-eating-manufacturing-jobs/

720 How Technology Is Destroying Jobs, https://www.technologyreview.com/s/515926/how-technology-is-destroying-jobs/

721 Who Will Own the Robots?, https://www.technologyreview.com/s/538401/who-will-own-the-robots/

722 Technology and Inequality, https://www.technologyreview.com/s/531726/technology-and-inequality/

723 ***The authors conclude: "Our simple model illustrates the range of things that smart machines can do for us and to us. Its central message is disturbing. Absent appropriate fiscal policy that redistributes from winners to losers, smart machines can mean long-term misery for all.*** - Productivity and information technology: Research on slowdowns, growth and GDP, http://journalistsresource.org/studies/economics/business/information-technology-productivity-gdp-growth

724 When robots do all the work, how will people live?, https://www.theguardian.com/commentisfree/2016/mar/08/robots-technology-industrial-strategy

725 THE FUTURE OF EMPLOYMENT: HOW SUSCEPTIBLE ARE JOBS TO COMPUTERISATION?, http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

726 Les robots vont-ils tuer la classe moyenne?, http://www.lejdd.fr/Economie/Les-robots-vont-ils-tuer-la-classe-moyenne-696622

- 1 of 3 jobs in the UK in the next 30 years[727]
- 45 % - 59 % of jobs in Germany by 2035[728], [729] and only 3% of new jobs would be newly created[730]
- 54,1 % of jobs in Austria by 2035[731]
- a net loss of over 5 million jobs in 15 major developed and emerging economies by 2020[732], [733]

Another likely scenario discussed in the recent and much cited Stanford study on AI[734] is that certain tasks of many jobs will be done by AI in the future, but that the jobs as such won't disappear[735].

> ***Not all types of jobs are disappearing, are they? Why are some affected more than others?***
>
> *McAfee: Technologies such as payroll-processing and inventory-control software, factory automation, computer-controlled machining centers, and scheduling tools have replaced workers on the shop floor and in clerical tasks and rote information processing. By contrast, big data, analytics, and high-speed communications have enhanced the output of people with engineering, creative, and design skills and made them more valuable. The net effect has been to decrease the demand for low-skilled information workers while increasing the demand for highly skilled ones.*

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727 Technology threatens 1 in 3 UK jobs, http://www.ft.com/cms/s/0/ba59685a-6821-11e4-bcd5-00144feabdc0.html#axzz4H2Nivnth

728 45 Prozent der heutigen Jobs durch Roboter bedroht, http://derstandard.at/2000026900097/45-Prozent-der-heutigen-Jobs-durch-Roboter-bedroht

729 Wandel der Beschäftigung - Polarisierungstendenzen auf dem deutschen Arbeitsmarkt, Institut zur Zukunft der Arbeit (IZA),http://www.bertelsmann-stiftung.de/fileadmin/files/user_upload/Wandel_der_Beschaeftigung_NW.pdf?src=asp-cu&typ=pdf&cid=4595

730 Arbeitsmarkt 4.0 – Künstliche Intelligenz: zu 59 % Jobfresser, zu 3 % Jobmotor, https://joblift.de/Presse/Arbeitsmarkt-4.0_K%C3%BCnstliche-Intelligenz-zu-59-Prozent-Jobfresser_zu-3-Prozent-Jobmotor

731 Jeder zweite Job durch Technologie gefährdet, http://kurier.at/wirtschaft/studie-jeder-zweite-job-durch-technologie-gefaehrdet/76.282.506

732 Five Million Jobs by 2020: the Real Challenge of the Fourth Industrial Revolution , http://reports.weforum.org/future-of-jobs-2016/

733 The Future of Jobs, http://reports.weforum.org/future-of-jobs-2016/

734 One Hundred Year Study on Artificial Intelligence (AI100), 2016 Report, https://ai100.stanford.edu/2016-report

735 Der Roboter putzt, der Mensch lebt vom Grundeinkommen, http://www.spiegel.de/netzwelt/web/kuenstliche-intelligenz-noch-wird-die-menschheit-nicht-bedroht-a-1111324.html

> *Brynjolfsson: This trend has been documented in dozens of studies by economists. They call it skill-biased technical change. By definition, it favors people with more education, training, or experience*[736].

But if it happened that there is not enough work for everybody anymore, or at least that the speed of reallocation of work is slower than the crowing-out of jobs by automation, how will society and politics react? By taxing robots who replace the human labour taxation base that should in fact be considered as labour and not as capital in terms of the traditional value chain division? Or will there be unconditional basic income[737], [738] and much stronger social networks where work is done by machines and where people could concentrate on « higher » tasks such as personal achivement and interpersonal activities [739] [740] ? Other authors even already urge civil society to begin building the social institutions to survive it long before the technological obsolescence of human workers actually arrives[741].

Security and Privacy Issues

Security

Digital systems and networks are hackable, and technological development in the IT security industry is an ongoing race between identifying vulnerabilities and closing security wholes and the ingeniousness of hackers with malicious intent.

Also, cybercrimes and cyberwars are no longer science fiction. In other words, private persons, companies as well as governments and states are equally concerned.

According to a recent IBM report, the 5 most cyber-attacked industries in 2015 were[742][743]:

1. Healthcare
2. Manufacturing
3. Financial Services
4. Government

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736 The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee, https://hbr.org/2015/06/the-great-decoupling

737 Grundeinkommen in der Schweiz und Finnland: Gleiches Geld für alle, http://www.spiegel.de/wirtschaft/soziales/grundeinkommen-was-sich-2016-in-der-schweiz-und-finnland-entscheiden-wird-a-1069076.html

738 Yet Another Nobel Laureate Argues for Basic Income, http://www.basicincome.org/news/2016/02/international-christopher-pissarides-a-nobel-economist-argues-for-ubi-at-a-debate-in-davos/

739 Better Than Human: Why Robots Will — And Must — Take Our Jobs, http://www.wired.com/2012/12/ff-robots-will-take-our-jobs/

740 Deep Learning Is Going to Teach Us All the Lesson of Our Lives: Jobs Are for Machines, https://medium.com/basic-income/deep-learning-is-going-to-teach-us-all-the-lesson-of-our-lives-jobs-are-for-machines-7c6442e37a49#.jyokkn3jo

741 A world without work is coming – it could be utopia or it could be hell, https://www.theguardian.com/commentisfree/2016/sep/19/world-without-work-utopia-hell-human-labour-obsolete

742 Top 5 Industries At Risk Of Cyber-Attacks, http://www.forbes.com/sites/stevemorgan/2016/05/13/list-of-the-5-most-cyber-attacked-industries/#18f1d2c63954

743 Cyber Security Intelligence Index, http://www-03.ibm.com/security/data-breach/cyber-security-index.html

5. Transportation

Not surprisingly, the number of cyber-attacks is constantly increasing[744], [745].

The security risks for companies are diverse, including industrial espionage, and risks associated to shadow IT brought in by employees[746] and the costs associated to a cyber-attack can be high[747], [748]. Given the importance of cybersecurity for building resilience of our economies and societies in the future, the market for providing solutions is already tangible and growing[749].

In securing intellectual property, the solution could be much more radical than most traditional companies are culturally able to admit: Tesla's release to the public of their entire patents is a perfect illustration here[750], [751].

With the growing number of connected devices (IoT, smart homes, autonomous vehicles, smart cities…etc.), new type of threats emerge, i.e.:

- Spying (smart homes) through IoT[752], [753], [754], [755],
- Smart car hacking[756],
- Spying robots[757],

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744 HACKMAGEDDON -Information Security Timelines and Statisticshttp://www.hackmageddon.com/category/security/cyber-attacks-timeline/

745 Plus de 62.000 cyber-attaques au Luxembourg en 2015, http://www.itnation.lu/62000-cyberattaques-au-luxembourg/

746 Meeting the Cyber Risk Challenge, http://www.ferma.eu/app/uploads/2013/01/Cyber-risks-report1.pdf

747 The Hidden Costs of a Cyberattack Organizations significantly underestimate the financial and operational consequences of a cyberattack., http://deloitte.wsj.com/cio/2016/07/27/the-hidden-costs-of-a-cyberattack/

748 Measuring the True Impact of a Cyberattack, http://deloitte.wsj.com/cio/2016/06/20/measuring-the-true-impact-of-a-cyberattack/

749 Deals To Cybersecurity Startups Are Increasingly Global With Israel In The Lead, https://www.cbinsights.com/blog/cybersecurity-funding-geographic-trends/

750 All Our Patent Are Belong To You, https://www.tesla.com/blog/all-our-patent-are-belong-you

751 Elon Musk Clarifies That Tesla's Patents Really Are Free; Investor Absolutely Freaks Out, https://www.techdirt.com/articles/20150217/06182930052/elon-musk-clarifies-that-teslas-patents-really-are-free-investor-absolutely-freaks-out.shtml

752 IoT Could Be Used To Spy, Admits James Clapper, http://techcrunch.com/2016/02/10/iot-could-be-used-to-spy-admits-james-clapper/

753 The government just admitted it will use smart home devices for spying , https://www.theguardian.com/commentisfree/2016/feb/09/internet-of-things-smart-devices-spying-surveillance-us-government

754 Hackers Make the First-Ever Ransomware for Smart Thermostats, http://motherboard.vice.com/read/internet-of-things-ransomware-smart-thermostat

755 Smart Home: Bluetooth-Schlösser senden Passwort im Klartext, http://www.heise.de/newsticker/meldung/Smart-Home-Bluetooth-Schloesser-senden-Passwort-im-Klartext-3292041.html

756 http://www.businessinsider.stfi.re/smart-car-hacking-major-problem-for-iot-internet-of-things-2016-3

757 Hackers Don't Have to Be Human Anymore. This Bot Battle Proves It, http://www.wired.com/2016/08/security-bots-show-hacking-isnt-just-humans/

- Artificial intelligence can make phishing attacks more targeted and therefore more difficult to identify for the user[758],
- Cyber-attacks on critical infrastructures including smart connected cities used as a means to destabilize a nation or cause panic, rather than steal money[759]

In is not surprising that, under these circumstances, security concerns are one of the major barriers of digital adoption within companies and governments around the world, although there are differences from country to country in terms of data security capacities[760], [761].

Future conflicts will be, and already are also happening in cyberspace, and governments are well advised to build resilience for themselves and for our societies and economies against these new risks[762].

Privacy

Privacy is closely related to security and is defined as « the state of being free from public attention[763] .»

Privacy is also a cultural question and many experts say that society probably can not guarantee the same level of privacy we were used to in the pre-digital era in the future and that people's attitude towards privacy will change over time as they get more used to the benefits of digitally organizing their life. Studies in the US for example show that privacy concerns vary from person to person and from case to case[764].

But Europe is not the US and many privacy questions have a deeper reaching, almost philosophical component and remain unanswered to date:

- To whom belongs all the data that is currently collected?
- What are commercial firms allowed to do with data that they collect in the public space?
- Under which conditions can commercial firms sell their data and to whom?
- How can commercial firms use the data collected for their own purposes (i.e. personalized advertising, personalized recommendations engines for cross-selling?)
- How far shall governments collect and use data for surveillance, compliance and national security issues?
- How can we control the way governments use their data in general?

It is very difficult for policy makers to follow the pace of technological and associated business process development here.

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758 Künstliche Intelligenz macht Phishing-Versuche zielgenauer und effektiver, http://www.heise.de/newsticker/meldung/Kuenstliche-Intelligenz-macht-Phishing-Versuche-zielgenauer-und-effektiver-3293460.html

759 The emerging cyberthreat on critical infrastructure, http://www.enterpriseinnovation.net/article/emerging-cyberthreat-critical-infrastructure-976548162

760 Top 15 countries for safe data storage, http://www.businessrevieweurope.eu/technology/971/Top-15-countries-for-safe-data-storage

761 Data danger zones, https://www.artmotion.eu/wp-content/uploads/2016/07/DataDangerZones.pdf

762 Sorgfaltsverantwortung im CyberraumLeitlinien für eine deutsche Cyber-Außen- und Sicherheitspolitik, https://www.swp-berlin.org/fileadmin/contents/products/studien/2016S03_bdk.pdf

763 https://www.google.fr/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=privacy+definition

764 Privacy and Information Sharing, http://www.pewinternet.org/2016/01/14/privacy-and-information-sharing/

More generally, how can we achieve a responsible use and free flow of data while minimizing the inherent risks of data to privacy and security? Economies need reliable, continuous and affordable access to data otherwise access to ideas and innovation will be compromised.

But we also know that, in the meantime, Google, Apple, Amazon and Facebook already know almost everything about us, what we do, why we do it, when we do it, where we do it, how often we do it as well as what we feel, and that's just the tip of the iceberg…[765].

Big challenges ahead for regulation and the ethical debate about the future shape of our societies.

Regulatory aspects of Digital Transformation

Up to here, we have been outlining some of the major big shifts that come along with digital transformation and it is easy to recognize the significant regulation challenges that these shifts put on governments and civil society as the new landscape they create is so much different from what we were used to.

Autonomous vehicles[766], the way of using big data, new work forms[767], [768], [769] cybersecurity, to name but a few, are all challenging building sites for intelligent regulation to avoid us entering what could be called a « digital chaos ».

Also, via platforms economics, the digital ecosystem has an inclination towards commercial monopolies. A few, mainly US companies control the lion's share of the emerging platform economy, and almost everybody has grown dependant on them: By using their services, the related companies collect our data, make money out of it and could even influence our opinions. But users are not paid for the usage of the data. They simply implement what is technologically feasible (the « technical imperative ») without asking whether it is compatible with ruling laws. Such a behaviour is possible only because matters are so complex and regulation is often lagging behind. Regulating this new socio-economic unknown terrain where national boundaries have become very blurry is a big challenge[770].

At best, regulation should support innovation, business development and proactively incorporate a business case in itself whilst protecting individual and common interests. In practice however, it is not always clear what the real motivations behind regulation initiatives are: Supporting innovation? Supporting privacy? Supporting consumer rights? Protecting intellectual property? Protecting workers' rights? Or supporting traditional activities that feel threatened by digital transformation and its artefacts and emerging

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765 21 Scary Things Big Data Knows About You, http://www.forbes.com/sites/bernardmarr/2016/03/08/21-scary-things-big-data-knows-about-you/#240e6d5e66a7

766 In Backing Autonomous Cars, U.S. Tells Automakers to Figure It Out, http://www.nytimes.com/2016/09/21/business/in-backing-autonomous-cars-us-tells-automakers-to-figure-it-out.html?_r=2

767 Tout savoir (ou presque) du rapport Mettling en moins d'un quart d'heure, http://www.usine-digitale.fr/article/tout-savoir-ou-presque-du-rapport-mettling-en-moins-d-un-quart-d-heure.N350380

768 Transformation numérique et vie au travail, http://zevillage.net/wp-content/uploads/2015/09/rapport-Mettling.pdf

769 "L'économie collaborative touche désormais tous les secteurs" estime Jean-Eudes du Mesnil (CGPME), http://www.usine-digitale.fr/editorial/l-economie-collaborative-touche-desormais-tous-les-secteurs-estime-jean-eudes-du-mesnil-cgpme.N372989 & http://www.cgpme.fr/upload/ftp/document-economie-collaborative.pdf

770 Wider die Fremdbestimmung Wir brauchen ein Digitalgesetz, http://www.faz.net/aktuell/feuilleton/debatten/digitalisierung-wir-brauchen-ein-digitalgesetz-14391040.html?printPagedArticle=true#pageIndex_2

new business models without necessarily having the capabilities or wanting to adapt adequately? [771], [772]. A recent illustration on how difficult it is for regulators to make that balancing act BEREC's (Body of European Regulators for Electronic Communications[773] recent decision on net neutrality[774] where users and consumers have been favored[775].

Until now, decision makers had time to study a specific issue and develop the necessary response or appropriate and proportionate regulatory framework. It was a linear and mechanistic, top down approach. But given the current pace of change with its broad impacts, this traditional mechanism does not seem appropriate anymore.

Regulators and legislators need to develop an agile approach (inspired from agile management and software development) to continuously adapt to a new, fast-changing environment and reinvent themselves so that they can truly apprehend what it is they are regulating and what the potential effects of regulation might be. To be able to do so, regulation agencies need to embrace an open collaborative culture together with business and civil society.

The Community of Practice, the CoP, as part of the EU's Digital Single Market Initiative is worth mentioning here. It looks at the role of self- and co-regulation in addressing the challenges brought about by new technologies and hyper-connectivity[776]

Cultural dimensions of Digital Transformation

First, the ever-deeper penetration of digital technologies into our everyday lives including the workplace changes our behaviours. Second, to understand the combined effects of digital transformation it has to be considered in the context of all the other social and political realities of our time.

Drawing a consistent picture of every apparent interdependency in that respect would require a detailed report on its own. We therefore chose to limit this section to a series of facts and tendencies that might help to illustrate the deeper meanings at stake.

- Social media and chat apps have become the de facto standard means of communication and coordination amongst many different types of communities

[771] Measures are part of a series of planned European commission changes designed to strengthen rights of creators and publishers, https://www.theguardian.com/technology/2016/aug/25/eu-proposals-could-see-news-publishers-paid-by-google-and-facebook

[772] En obligeant Skype et Whatsapp à devenir opérateur Télécom, l'UE va accélérer la mort d'Orange et SFR, https://www.linkedin.com/pulse/en-obligeant-skype-et-whatsapp-devenir-op%C3%A9rateur-t%C3%A9l%C3%A9com-lo%C3%AFc-texier

[773] http://berec.europa.eu/

[774] Network neutrality is a complex and controversial topic and is an important part of a free and open Internet. Enabling access, choice, and transparency of Internet offerings empowers users to benefit from full access to services, applications, and content available on the Internet. - Policy Brief: Network Neutrality, http://www.internetsociety.org/policybriefs/networkneutrality?gclid=CP2llaKU684CFcgp0wod0KcBZw

[775] Netzneutralität in Europa: "Riesiger Schritt zum Erhalt der Freiheit im Internet », http://www.spiegel.de/netzwelt/netzpolitik/eu-regelt-netzneutralitaet-das-bedeutet-die-regelung-fuer-die-nutzer-a-1109868.html

[776] The Community of Practice for better self- and co-regulation, https://ec.europa.eu/digital-single-market/en/community-practice-better-self-and-co-regulation-0

- Social media allows for activism and mobilization of communities that was not possible before (i.e. Arab Spring, the « Occupy » movement…etc), without having been able to fundamentally change the world[777], [778]

- Social media also supports problem solving and innovation through crowdsourcing at a universal scale and « makes the world smaller »[779], [780].

- But it also makes it easier to misinform, manipulate and spread hate[781] towards, e.g., Different minorities[782]

- Social media amplifies local trends through repetition up to what is called the « echo chamber effect » which creates social polarization through the emergence of separate groups of people that have no mutual understanding and enter in conflict (i.e. US politics or the refugee crisis in Germany)[783], [784], [785]. Some analysts claim that we are sliding too much into an opinion society and not enough into a knowledge society. But sociodiversity is as important as biodiversity for the resilience of the ecosystems we live in.

- Social media has disrupted the news industry which is now dependent on social media as their primary outreach and distribution channel[786]

- Social media plays an increasing crucial role in political activism and campaigning[787]

- In any case, more and more human activity and interaction is transposed into social networks[788], [789].

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777 Pourquoi les médias sociaux ne changent-ils pas le monde ?, http://internetactu.blog.lemonde.fr/2016/04/30/pourquoi-les-medias-sociaux-ne-changent-ils-pas-le-monde/

778 Viewpoint: Beyond Viral- The proliferation of social media usage has not resulted in significant social change.http://web.media.mit.edu/

779 SEARCHING FOR SOMEONE, https://medium.com/mit-media-lab/searching-for-someone-688f6c12ff42#.ardu4dric

780 The Role of Crowdsourcing for Better Governance in International Development, http://fletcher.tufts.edu/Praxis/

781 60 Wohnungen durchsucht: Deutsche Polizei geht gegen Hass-Posts auf Facebook vor, http://www.watson.ch/Digital/International/257523441-60-Wohnungen-durchsucht--Deutsche-Polizei-geht-gegen-Hass-Posts-auf-Facebook-vor

782 LIVING IN THE AGE OF OUTRAGE, https://markmanson.net/outrage

783 Meinung im Netz Soziale Medien: Jeder schnitzt sich sein Weltbild zurecht, http://www.sueddeutsche.de/kultur/meinung-im-netz-soziale-medien-jeder-schnitzt-sich-sein-weltbild-zurecht-1.3118885

784 Networked Sociality/ Vernetzter Individualismus - Netnographie & Digitaler Wandel, http://www.klaus-janowitz.de/wordpress/networked-sociality-vernetzter-individualismus/

785 Von der Pyramide zur Playlist, http://www.klaus-janowitz.de/pdf/Von_der_Pyramide_zuR_Playlist.pdf

786 How social media is reshaping news, http://www.pewresearch.org/fact-tank/2014/09/24/how-social-media-is-reshaping-news/

787 Inside Facebook's (Totally Insane, Unintentionally Gigantic, Hyperpartisan) Political-Media Machine, http://mobile.nytimes.com/2016/08/28/magazine/inside-facebooks-totally-insane-unintentionally-gigantic-hyperpartisan-political-media-machine.html?_r=0

788 Physicist and Star Trek screenwriter Leonard Mlodinow: "In 2035, we'll all be part of one giant social network », http://uk.businessinsider.com/leonard-mlodinow-on-social-networking-climate-change-and-the-future-2015-6

789 How Facebook plans to take over the world, https://www.theguardian.com/technology/2016/apr/23/facebook-global-takeover-f8-conference-messenger-chatbots

- For example, partner websites have revolutionized the wedding and dating behaviour and industry[790]
- Intensity and scope of smartphone, tablet and computer usage has become a central element of conflict and discussion in almost every family, between parents and children, but also between adults
- In Germany, an average smart phone user switches on the screen of his device 88 times a day, spends 2,5 hours using it, but only 7 minutes to make phone conversations, most of the time being spent with Facebook, WhatsApp and gaming, with no really significant difference between children and adults or between social classes, which makes concentrated work more difficult and « accelerates » the pace of our life (i.e. the « always reachable » mantra of workers). 8 % of young smartphone users are considered threatened by addiction. More and more people have difficulties to relax and do nothing[791], [792].
- Paradoxically, Silicon Valley's new tech elites most recent wellness hype is « digital detox[793] » , meaning spending entire days or more without being connected and without their devices (to improve health, posture, human relationships and productivity… ! and fight the many potentially negative effects that technology can have on humans[794], [795], [796], [797]).
- Big data and the Internet affect the psychology of decision making[798], [799].
- Technology will augment human capacities with yet unknown effects[800].
- People will have to develop a « psychological » routine in interacting with robots[801].
- There is a general move towards more collaborative, horizontal, networked, distributed and crowdsourced culture of management, leadership and governance which puts traditional organisations under pressure as their management elite often is not prepared to that

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790 Virtuelle Zwischengeschlechtlichkeit im Kontext relationaler Methodologie. Überlegungen zu einer Soziologie der digitalen Partnerwahlhttp://partnerwahlforschung.de/UserFiles/File/papers/Schmitz_2009_de.pdf

791 Lass doch mal das Ding weg!, Der Speigel, Ausgabe Nr. 32, 2016

792 Digitalisierung belastet Familienleben und Gesundheit, http://www.heise.de/newsticker/meldung/Digitalisierung-belastet-Familienleben-und-Gesundheit-3332752.html

793 https://en.wikipedia.org/wiki/Digital_detox

794 Negative Effects of Technology on Communication, http://www.ehow.com/list*7223067*negative-effects-technology-communication.html

795 25 Negative Effects of Technology, http://roogirl.com/25-negative-effects-of-technology/

796 5 Weird Negative Effects of Social Media on Your Brain, http://www.rd.com/health/wellness/negative-effects-of-social-media/

797 Camp Grounded: Where People Pay $570 To Have Their Smartphones Taken Away From Them, http://www.forbes.com/sites/ellenhuet/2014/06/20/camp-grounded-digital-detox/#6bd21d5c688a

798 Technology, Psychology, and a Coming Revolution in the Study of Decision Making - Association for Psychological Science, http://www.psychologicalscience.org/index.php/publications/observer/2014/february-14/technology-psychology-and-a-coming-revolution-in-the-study-of-decision-making.html

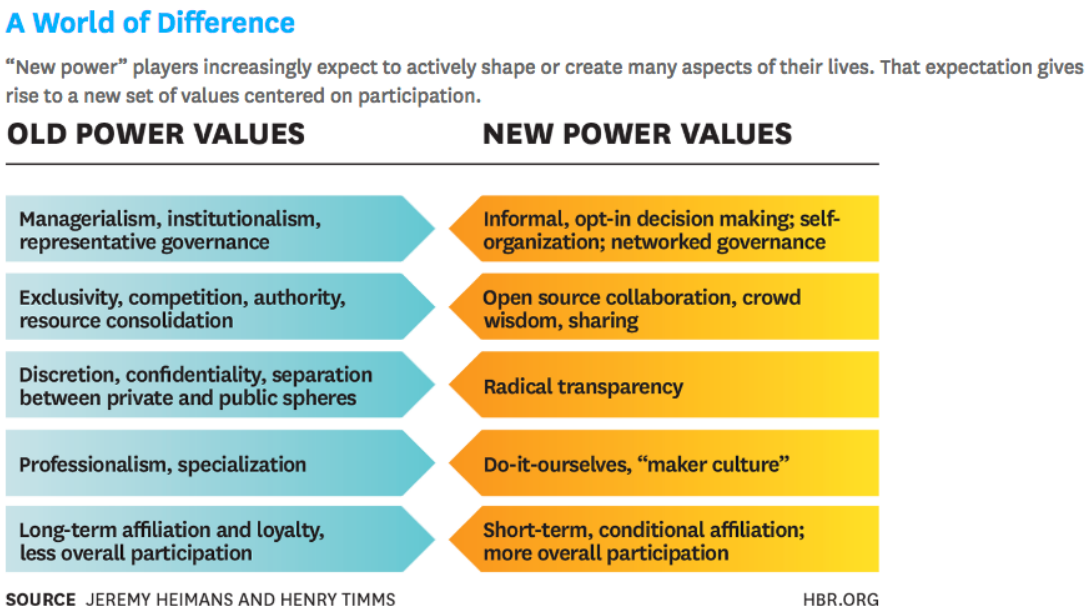
799 Cyberpsychology, a developing field that encompasses all psychological phenomena that are associated with or affected by emerging technology.https://en.m.wikipedia.org/wiki/Cyberpsychology

800 Bio-hacking & neuroprosthetics: Putting a computer in your brain is no longer science fiction, https://www.washingtonpost.com/news/the-switch/wp/2016/08/15/putting-a-computer-in-your-brain-is-no-longer-science-fiction/

801 People favour expressive, communicative robots over efficient and effective ones, https://www.sciencedaily.com/releases/2016/08/160819084651.htm

fundamental shift in power[802]. Understanding new power[803] is essential for survival in the digital world. This process is amplified by the increasing number of generations Y's arriving at the job market with their very different set of values and expectations concerning work purpose and conditions. Organisations which do not adapt will not be able anymore to attract the talent they need[804].

- The following chart shows power values with respect to the old and new perspective:



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- Crowdsourcing[805] and collaboration seem by far superior in generating innovative ideas and solving wicked problems than the traditional, closed, command and control, top down approaches.[806], [807], [808], [809], [810], [811]

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802 Digitale Transformation gestalten, https://www.saatkorn.com/digitale-transformation-gestalten-interview-mit-dr-gerald-fricke/

803 Understanding "New Power" https://hbr.org/2014/12/understanding-new-power,

804 Social impact of exponential technologies, http://dupress.com/articles/social-impact-of-exponential-technologies/

805 Crowdsourcing can be defined as the outsourcing of tasks traditionally performed by specific individuals to an undefined large group of people or a community (crowd) through an open call for collaboration.

806 See for example https://www.kaggle.com/ and https://www.kickstarter.com/

807 The Role of Crowdsourcing for Better Governance in International Development, http://fletcher.tufts.edu/Praxis/

808 CROWDSOURCING SOLUTIONS TO GLOBAL PROBLEMShttp://gsnetworks.org/wp-content/uploads/Williams-Crowdsourcing.pdf

809 Kollaborative Plattformen 4.0, eine neue Hoffnung: Teil 1 - KOMPLEXITÄT, warum wir neue Lösungen mehr denn je für #I40, #ParisAttack, ... brauchen!, https://www.linkedin.com/pulse/kollaborative-plattormen-40-eine-neue-hoffnung-teil-1-winfried-felser

810 Kollaborative Plattformen 4.0, die neue Hoffnung: Teil 2 - KOLLABORATION 4.0 bzw. das neue Erwachen der Macht von Sinn-Netzwerken!, https://www.linkedin.com/pulse/kollaborative-plattformen-40-die-neue-hoffnung-teil-2-winfried-felser

811 Kollaborative Plattformen 4.0, die neue Hoffnung: Teil 3 - PLATTFORMEN - wie jetzt Unternehmen, Märkte und "Everything Else" neu gestaltet werden!, https://www.linkedin.com/pulse/kollaborative-plattformen-40-die-neue-hoffnung-teil-3-winfried-felser?trk=prof-post

- We now live in a world of transparency: Wikileaks, Luxleaks, taxpayer leaks in Germany…etc: Whistleblowers are everywhere

- Developing countries or young states such as post-Soviet Estonia, Singapore or built-from-scratch Chinese or South Korean mega-cities are much quicker and more agile in taking advantage of new technologies and new governance models as they do not have to fight with cultural and infrastructural legacy and thereby develop considerable competitive advantages.

- Access to education has been largely democratized by the possibilities of the Internet. MOOCs (Massive Open Online Courses) [812] are accessible to everybody and the star professors of elite universities[813], [814] can now teach the whole world. This challenges the traditional strategies of many universities[815] worldwide and they have to reinvent themselves to avoid being disrupted the same way Kodak was disrupted by Instagram.

- Secondary education, which in many regions of the world basically is still built upon a mid 19th-century governance model is equally challenged[816], [817]. The many education reform programs following one another in developed countries clearly illustrates the growing nervosity and significant PISA[818] study differences confirm this challenge. Education needs to adapt to the new reality in terms of skills and content[819], programs, methods, technology, organizational and pedagogical forms to make our youth fit for the new world, otherwise they risk being disrupted as well (by the so called « ed-tech » startups)[820], [821], [822], [823], [824]. For the time being, it rather looks like a last fight within the traditional boundaries that are indeed difficult to blast given the heavy identitarian weight they have in modern consciousness. But post-modernity has already arrived.

And the list could go on…

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[812] List of MOOCs offered by the Best Universities and Entities, https://en.wikipedia.org/wiki/Massive_open_online_course

[813] List of MOOCs offered by the Best Universities and Entities, https://www.mooc-list.com/

[814] MOOCs: Top 10 Sites for Free Education With Elite Universities, http://www.bdpa-detroit.org/portal/index.php/comittees/high-school-computer-competition-hscc/29-education/57-moocs-top-10-sites-for-free-education-with-elite-universities.html

[815] Warum sich der Beruf des Rektors wandeln muss, http://derstandard.at/2000043385836/Warum-sich-der-Beruf-des-Rektors-wandeln-muss

[816] Understanding How Our Brains Learn, https://creativesystemsthinking.wordpress.com/2014/02/14/understanding-how-our-brains-learn/

[817] Changing Education Paradigms, http://www.learninginstitute.co.uk/wp-content/uploads/2016/07/rsa-lecture-ken-robinson-transcript.pdf

[818] Programme for International Student Assessment, https://en.wikipedia.org/wiki/Programme_for_International_Student_Assessment

[819] Hacken gehört in den Schulunterricht, http://www.faz.net/aktuell/feuilleton/debatten/die-digital-debatte/samsung-direktor-steffen-ganders-ueber-digitale-bildung-14400856.html?printPagedArticle=true#pageIndex_2

[820] Education Startups Re-shaping the Education World, http://www.insidetrack.com/2016/03/30/education-startups-re-shaping-the-education-world/

[821] Investment in Education Technology on the Rise, https://www.meritalk.com/articles/investment-in-education-technology-on-the-rise/

[822] Meet the fast-growing UK start-ups improving education, http://universitybusiness.co.uk/Article/meet-the-fast-growing-uk-start-ups-improving-education

[823] 16-startups-that-will-disrupt-the-education-market, http://www.inc.com/ilan-mochari/16-startups-that-will-disrupt-the-education-market.html

[824] The End of College: Creating the Future of Learning and the University of Everywhere, https://www.insidehighered.com/news/2015/03/23/kevin-carey-talks-about-his-new-book-end-college

In recent years, and as a response to higher overall complexity and multiple simultaneous challenges of which digital transformation is part of, a large chunk of research has been invested in community resilience science as an attempt to develop frameworks for securing the future of our societies [825], [826].

Governance in the Digital Age

« Code is law » is a famous quote by Lawrence Lessig, the author of the influential and widely cited 1999 book « Code and Other Laws of Cyberspace ».

> *The primary idea of the book, as expressed in the title, is the notion that computer code (or "West Coast Code", referring to Silicon Valley) regulates conduct in much the same way that legal code (or "East Coast Code", referring to Washington, D.C.) does.* [827]

In other words, the new world of Big Data, IoT and autonomous machines are the new laws of society. Under these circumstances, how can governments and legislators continue to guarantee the sovereignty and the legitimacy of their actions in the emerging cyberworld?

Most of today's organizations are built upon Max Weber's bureaucratic and rational model[828], and even more so government administrations. Bureaucracies were once innovations too.

> *Max Weber (1868-1922) clearly sees stability as the primary objective of public bureaucracy, and we can hardly deny that the thick layer of formal rules, the multi-layered hierarchies, the organizational silos, the lack of economic incentives and the divided political leadership in the top of public bureaucracies tend to stifle public innovation*[829]*.*

But as society as a whole is in a transition to networked organizational models, in a fast changing and hardly controllable environment,

> *Governments will increasingly face pressure to change their current approach to public engagement and policymaking, as their central role of conducting policy diminishes owing to new sources of competition and the redistribution and decentralization of power that new technologies make possible.*
>
> *Ultimately, the ability of government systems and public authorities to adapt will determine their survival. If they prove capable of embracing a*

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825 Six Foundations for Building Community Resilience http://www.postcarbon.org/wp-content/uploads/2015/11/Six-Foundations-for-Building-Community-Resilience.pdf

826 Overview of Community Resilience Models and Toolkits, http://thrivingresilience.org/wp-content/uploads/2012/08/Overview-of-Community-Resilience-Models-and-Toolkits.pdf

827 Code and Other Laws of Cyberspace, https://en.wikipedia.org/wiki/Code_and_Other_Laws_of_Cyberspace

828 What Makes an Organization "Networked"?, https://hbr.org/2015/06/what-makes-an-organization-networked

829 Collaborative Innovation in the Public Sector, http://www.innovation.cc/volumes-issues/intro*eva*sorensen*torfing*17v1i1.pdf

> *world of disruptive change, subjecting their structures to the levels of transparency and efficiency that will enable them to maintain their competitive edge, they will endure. If they cannot evolve, they will face increasing trouble*[830].

At times where trust in government is collapsing around the world[831], governments need to embrace agile and lean governance models as well experimentation to policymaking in order to fit into the flow of the new social algorithms, triggered by digital technology, implying a transition towards openness, transparency and engagement with civil society (« citizen science[832] »). In other words, they have to become charismatic new organizations that bring forth disruptive changes in society (those that Max Weber once wanted to be replaced by bureaucratic organizations) and lead to the emergence of new values embodied in new firms and other new types of communities and organizations (« Shumpeterian creative destruction »)[833], [834].

Governments face a set of new very real trends[835]:

- Trend 1: Connectivity: Transparency, Speed, Collaboration
- Trend 2: Disruptive innovation
- Trend 3: Borderlessness, identity politics and 'hollowed out' states
- Trend 4: Individualization, liquid lives & ephemeral community
- Trend 5: Floating & disaffected voters, mediatised politics and the permanent campaign
- Trend 6: A move from parliamentary to monitory democracy
- Trend 7: Shrinking power distance & 'people power'

Public administration also need to dematerialize their processes and automate recurring tasks, in other words, digitize their value chain as much as business organisations need to do. Otherwise, they will not only break out business innovation, but also reduce their own ability to guarantee their role in society. Having sufficient e-skills is equally challenging for governments[836] than for the private sector.

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830 The Fourth Industrial Revolution: what it means, how to respond, http://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond

831 Trust in Government Is Collapsing Around the World, http://www.theatlantic.com/international/archive/2016/07/trust-institutions-trump-brexit/489554/

832 Citizen science (CS) (also known as crowd science, crowd-sourced science, civic science, volunteer monitoring or networked science) is scientific research conducted, in whole or in part, by amateur or nonprofessional scientists. Citizen science is sometimes described as "public participation in scientific research", participatory monitoring and participatory action research., https://en.wikipedia.org/wiki/Citizen_science

833 The rise of innovation labs in the public sector (part 2), http://publicinnovationblog.com/2015/07/03/the-rise-of-innovation-labs-in-the-public-sector-part-2/

834 The landscape of public sector innovation labs, http://designforeurope.eu/news-opinion/landscape-public-sector-innovation-labs

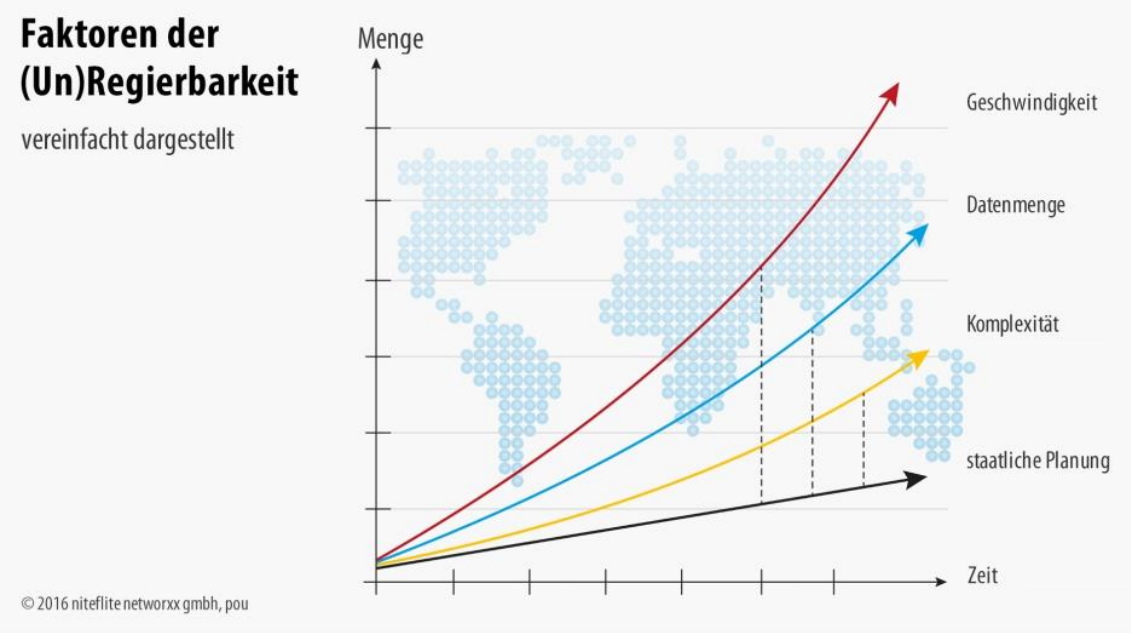
835 The public service in a changing world. *Paul 't Hart, Utrecht University, Netherlands School of Public Administration ANZSOG*

836 Public sector lacks the skills for long-term digital transformation, http://www.information-age.com/it-management/skills-training-and-leadership/123461339/public-sector-lacks-skills-long-term-digital-transformation

> *Some experts think that governments aren't ideologically equipped to address the challenges we will face in this new world, with respect to robots and their effect on society amongst others*[837].

In our western democracies, we witness another recent alarming trend: The middle class is less and less able to identify[838] themselves with globalization[839], value relativism and the cosmopolitan society model because of their fear of the future: They have neither the financial nor the cultural resources anymore to participate in that model and therefore slid almost unnoticed into an identity crisis: The perceived disenfranchisement and the rise of populism and right-wing nationalist politicians and parties in many of the major modern Western democracies continues at an alarming rate and threatens the virtues of enlightenment and democracy.

The following figure illustrates how most current public administrations' planning capacity positions against the combined exponential phenomena in society and obviously calls for action[840]:



837 *There is no minister for this new technology. No special cabinet committee has been set up to come up with solutions. There is no royal commission to look at the economic impact robots will have, or the ethical dilemmas they will pose. Where is the new institution that brings together trades unions, employers and government to establish how the time liberated and wealth created by robots is equitably shared?*, https://www.theguardian.com/commentisfree/2016/mar/08/robots-technology-industrial-strategy

838 Tragische Zeiten: Identitätsfragen dominieren zukünftig den politischen Diskurs, http://diekolumnisten.de/2016/08/08/tragische-zeiten/

839 Digital transformation is at the same time a consequence of globalization and a driver of globalization.

840 Regierungssysteme Leben wir bald alle in gescheiterten Staaten? http://www.faz.net/aktuell/politik/ausland/regierungssysteme-leben-wir-bald-alle-in-gescheiterten-staaten-14368202.html?printPagedArticle=true#pageIndex_2

Ethical and societal challenges

Possibilities within digital transformation seem to be endless and advances in every single field of digital technology goes at a breath-taking speed. New technologies can solve our societies' most wicked problems, dramatically advance healthcare, and enable people to reach a higher state of civilizations. Digital transformation also inspires creative entrepreneurship as illustrated by the world-wide start up boom.

The challenges, however, are real: What will be the net effect on jobs? What about privacy and security? Will our brains be able to follow the pace of change? How will our social and political systems eventually react?

From what we have seen, it is undeniable that digital transformation puts forward a series of ethical questions compared to our value systems as we know them.

- How much power will we attribute to machines, machines that might become more intelligent than ourselves and that no one might fully understand as they come as « black boxes » [841], [842], [843] ?
- Will we tolerate for example autonomous weapons for warfare knowing that well-known AI scientists as well as star tech entrepreneurs (Steve Wozniak, Elon Musk, Steven Hawking a.o) signed an open letter to warn about the pitfalls of AI in general[844], [845] and autonomous weapons in particular[846], [847], [848] ?

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841 Wie viel Macht überlässt man den Maschinen?, http://blogs.faz.net/netzwirtschaft-blog/2016/07/19/wie-viel-macht-ueberlaesst-man-den-maschinen-3950/

842 How can we control intelligent systems no one fully understands?, http://techcrunch.com/2016/05/16/how-can-we-control-intelligent-systems-no-one-fully-understands/

843 Forscherin fordert: KI-Technik stärker kontrollieren, http://www.heise.de/newsticker/meldung/Forscherin-fordert-KI-Technik-staerker-kontrollieren-3343436.html

844 The Top A.I. Breakthroughs of 2015, http://futureoflife.org/2015/12/29/the-top-a-i-breakthroughs-of-2015/

845 An Open Letter - RESEARCH PRIORITIES FOR ROBUST AND BENEFICIAL ARTIFICIAL INTELLIGENCE, http://futureoflife.org/ai-open-letter/

846 AUTONOMOUS WEAPONS: AN OPEN LETTER FROM AI & ROBOTICS RESEARCHERS, http://futureoflife.org/open-letter-autonomous-weapons

847 Robotics: Ethics of artificial intelligence, http://www.nature.com/news/robotics-ethics-of-artificial-intelligence-1.17611

848 The NSA's SKYNET program may be killing thousands of innocent people, http://arstechnica.co.uk/security/2016/02/the-nsas-skynet-program-may-be-killing-thousands-of-innocent-people/

- How much privacy do we accept to sacrifice for security[849], [850], [851], [852], [853] and commercial innovation and profit-making[854], [855] ?
- What is our position towards big nudging applied by governments and public policymaking[856], [857], [858], [859], [860] ?

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849 NSA files decoded Edward Snowden's surveillance revelations explained, https://www.theguardian.com/us-news/the-nsa-files

850 Transmediale: Die Geburt der Datenüberwachung aus dem Geist des Marketings, http://www.heise.de/newsticker/meldung/Transmediale-Die-Geburt-der-Datenueberwachung-aus-dem-Geist-des-Marketings-3096460.html#_jmp0_

851 De Maizière will mit Gesichtserkennung und Cyberfahndung Terroristen jagen, http://www.heise.de/newsticker/meldung/De-Maiziere-will-mit-Gesichtserkennung-und-Cyberfahndung-Terroristen-jagen-3293019.html

852 What Happens When the Surveillance State Becomes an Affordable Gadget?, http://www.bloomberg.com/news/articles/2016-03-10/what-happens-when-the-surveillance-state-becomes-an-affordable-gadget

853 How Spy Tech Firms Let Governments See Everything on a Smartphone, http://www.nytimes.com/2016/09/03/technology/nso-group-how-spy-tech-firms-let-governments-see-everything-on-a-smartphone.html?_r=0

854 This Company Has Built a Profile on Every American Adult, https://www.bloomberg.com/news/articles/2016-08-05/this-company-has-built-a-profile-on-every-american-adult

855 Vermessenes Leben: Soziologe malt ein düsteres Bild des "Lifelogging": Die Jünger der Lifelogging-Bewegung sind meist datenverliebte Ingenieure, denen es vor allem vor einem graust: der Unberechenbarkeit des Menschen, meint der Soziologe Stefan Selke,http://www.3sat.de/mediathek/?mode=play&obj=48546

856 Nudges, "choice architecture," social marketing and other non-rational approaches to government are a pretty significant development. After all, these policies replace explicit arguments ("you should get more exercise for these reasons") with hidden persuasion ("in our next building, let's hide the elevator and make the stairs really prominent?"). That's a major change for any democracy. Government-By-Nudge Is a Global Phenomenon, http://bigthink.com/Mind-Matters/government-by-nudge-is-a-global-phenomenon

857 The combination of nudging with big data created a new form of nudging that can be called « big nudging ».

858 "Big Nudging" - zur Problemlösung wenig geeignet, http://www.spektrum.de/news/big-nudging-zur-problemloesung-wenig-geeignet/1375930

859 Nudge power: Big government's little pushes, https://www.newscientist.com/round-up/nudge/

860 Big Nudging: Der Staat als Herr und Hightech-Hirte, http://diekolumnisten.de/2016/06/16/big-nudging-der-staat-als-herr-und-hightech-hirte/

- How do we think about predictive policing[861] (e.g., see the dystopian future depicted in the movie « Minority report »)[862] » [863], [864], [865], [866], [867] ?
- To whom « belong(s) » the massive amounts of data collected at present and in future [868] ?
- Do we accept human enhancement technologies for those who can afford it but don't need it because of their health condition[869], [870] ?
- Do we accept insurances to collect our behavioural data 24x7 and decide on insurance prices or eligibility consequently[871] ?
- Do we want to give control of our cities in the hands of a few US tech giants that own smart city technologies[872] ?
- Do we accept the widespread adoption of personalized pricing models[873], [874], [875] ?

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861 https://en.wikipedia.org/wiki/Predictive_policing

862 https://en.wikipedia.org/wiki/Minority_Report_(film)

863 The minority report: Chicago's new police computer predicts crimes, but is it racist?,http://www.theverge.com/2014/2/19/5419854/the-minority-report-this-computer-predicts-crime-but-is-it-racist

864 Police data could be labelling 'suspects' for crimes they have not committed, https://www.theguardian.com/technology/2016/feb/04/us-police-data-analytics-smart-cities-crime-likelihood-fresno-chicago-heat-list

865 Kriminalitätsprognose: Berliner Polizei setzt auf Predictive Policing, http://www.heise.de/newsticker/meldung/Kriminalitaetsprognose-Berliner-Polizei-setzt-auf-Predictive-Policing-3291880.html

866 CPD's 'Heat List' and the Dilemma of Predictive Policing, http://www.rand.org/blog/2016/09/cpds-heat-list-and-the-dilemma-of-predictive-policing.html

867 PREDPOL® - The Predictive Policing Company, http://www.predpol.com/

868 What A Neural Network Thinks About Your Neighborhood—And Why It Matters, http://www.fastcodesign.com/3062516/what-a-neural-network-thinks-about-your-neighborhood-and-why-it-matters

869 Human Enhancement Ethics: The State of the Debate, http://www.nickbostrom.com/ethics/human-enhancement-ethics.pdf

870 Ethics Issues Raised by Human Enhancement, https://www.bbvaopenmind.com/en/article/ethics-issues-raised-by-human-enhancement/?fullscreen=true

871 Neue Generali-App Die Veröffentlichung unserer Körper, http://www.faz.net/aktuell/feuilleton/generali-app-preisnachlass-bei-zusenden-der-koerperdaten-13287991.html

872 Vom Global Village zum Feudalstaat, http://www.nzz.ch/feuilleton/zeitgeschehen/evgeny-morozov-ueber-das-internet-vom-global-village-zum-feudalstaat-ld.113600

873 What is price discrimination and is it ethical?, https://econsultancy.com/blog/64068-what-is-price-discrimination-and-is-it-ethical/

874 Big Data and personalised pricing: consider yourself gamed, http://theconversation.com/big-data-and-personalised-pricing-consider-yourself-gamed-25076

875 Web sites change prices based on customers' habits, http://edition.cnn.com/2005/LAW/06/24/ramasastry.website.prices/

- More generally, do we accept to become an automated society steered by algortihms[876], [877], [878], [879], [880], [881] ?

In September 2016, the US tech giants Alphabet (mother company of Google), Amazon, Facebook, IBM and Microsoft have been gathering to discuss more tangible issues of AI, such as the impact on jobs, transportation and even warfare[882]. Their aim is to ensure that AI is focused on benefiting people, not hurting them. The 5 companies are trying to create a framework for a self-policing organization, though it is not clear yet how that will function. A main concern for people in the tech industry would be if regulators jumped in to create rules around their AI work. But who decides what should be done and what not be done? In the same context, researchers from Stanford University recently issued a report financed by a Microsoft Researcher, entitled « One Hundred Year Study on Artificial Intelligence[883] », which lays out a plan to produce a detailed report on the impact of AI on society every five years for the next century[884]. Can we know what the ultimate purpose and power position of that partnership will be?

A recent very interesting (August 2016) interview of US president Barack Obama on the ethical questions related to Artificial Intelligence, Autonomous Cars, and the Future of Humanity is worth mentioning here as it deals with the same questions[885], [886]. He also announced at a recent conference that his successor will govern a country being transformed by AI and that advances like self-driving cars will also come with drawbacks, such as lost jobs[887]

These are all very important, far-reaching and deep ethical questions and the answers we will give to them will inevitably shape the future of humanity. The in-depth debate has yet to be conducted, and we are all well advised to approach it with the humility, serenity and respect it really deserves. Reality is always human shaped.

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876 The rise of data and the death of politics, https://www.theguardian.com/technology/2014/jul/20/rise-of-data-death-of-politics-evgeny-morozov-algorithmic-regulation

877 AI & The Future Of Civilization: A Conversation With Stephen Wolfram, https://www.edge.org/conversation/stephen_wolfram-ai-the-future-of-civilization

878 The dawn of artificial intelligence: Powerful computers will reshape humanity's future. How to ensure the promise outweighs the perils, http://www.economist.com/news/leaders/21650543-powerful-computers-will-reshape-humanitys-future-how-ensure-promise-outweighs

879 Hyperlocal knowledge and facts are important in evaluating a situation in it's context. Algorythms tend to oversee that fact.

880 Das große Rennen um die künstliche Intelligenz, http://www.faz.net/aktuell/wirtschaft/menschen-wirtschaft/zukunft-der-menschheit-das-grosse-rennen-um-die-kuenstliche-intelligenz-14381464.html?printPagedArticle=true#pageIndex_2

881 Künstliche Intelligenz weckt Ängste -

Ein Takeover der Mikrochips?, http://www.nzz.ch/feuilleton/zeitgeschehen/kuenstliche-intelligenz-weckt-aengste-ein-takeover-der-mikrochips-ld.102988

882 How Tech Giants Are Devising Real Ethics for Artificial Intelligence, http://www.nytimes.com/2016/09/02/technology/artificial-intelligence-ethics.html?_r=0

883 https://ai100.stanford.edu/sites/default/files/ai_100_report_0901fnlc_single.pdf

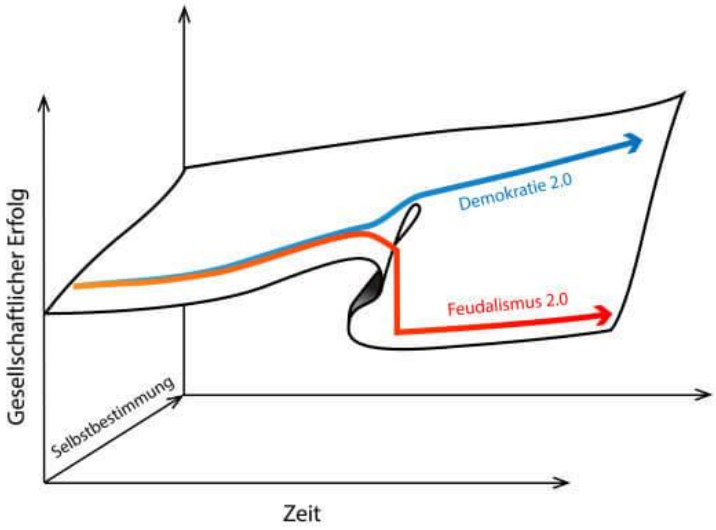
884 Facebook, Amazon, Google, IBM and Microsoft come together to create the Partnership on AI, https://techcrunch.com/2016/09/28/facebook-amazon-google-ibm-and-microsoft-come-together-to-create-historic-partnership-on-ai/

885 Barack Obama on Artificial Intelligence, Autonomous Cars, and the Future of Humanity, https://www.wired.com/2016/10/president-obama-mit-joi-ito-interview/

886 The White House on « Preparing for the future of Artificial Intelligence », https://www.whitehouse.gov/sites/default/files/whitehouse*files/microsites/ostp/NSTC/preparing*for*the*future*of*ai.pdf

887 Obama: My Successor Will Govern a Country Being Transformed by AI, https://www.technologyreview.com/s/602612/obama-my-successor-will-govern-a-country-being-transformed-by-ai/

We are at an inflection point, an inflection where we have to decide whether we enter a world characterized by « Democracy 2.0 », a collaborative, human-centered knowledge society or whether it will be a world characterized by « Feudalism 2.0 », an Orwellian control society [888], [889].



[888] Digitale Demokratie statt Datendiktatur, http://www.spektrum.de/news/wie-algorithmen-und-big-data-unsere-zukunft-bestimmen/1375933

[889] The Age of Ideology, http://www.debaillon.com/

The Situation in Luxembourg

From what we have seen so far, digital transformation is a global phenomenon transcending every level of society. Developments and technological advancements towards the cyber-physical world are inherently dynamic and impossible to centrally control. This is all the more so true as that innovation aims at making life more convenient, increasing process efficiency and improving communication, transportation and energy distribution, together with advancements in fields like medicine.

We have also seen that for many traditional stakeholders, digital transformation pushes them to fundamentally question their current strategies, organisational models and underlying culture in order to persevere in a deep shift that progresses at a sheer exponential rate and implies numerous disruptions in century-old areas of activity.

In other words, **digital transformation will happen, with or without Luxembourg**, with all the consequences highlighted so far in the international socio-economic landscape.

Luxembourg, with its central geopolitical situation in the heart of Western-Europe, its small size, its high standard of living and its dependence on its direct neighbours, Europe and the world as whole as a guarantee for its privileged situation, is well advised to transform into a progressive and exemplary model of the next industrial revolution in order to maintain its position in a more complex, fast-moving and transforming world.

As digital transformation transcends every aspect of the economy and society, we should look at the Luxembourg innovation ecosystem as a whole with a special attention to aspects related to digitisation and its many artefacts, in order to broadly assess the country's current positioning in that area.

In other words, Digital Transformation cannot be apprehended in a siloed-thinking way, as it concerns the basic infrastructure and paradigm on top of which the rest of the ecosystem is built upon. Put differently, capabilities that support the innovation capacity as a whole will also support digital transformation capacity building.

During the following pages we will try to establish a picture of the current Luxembourg ecosystem, and highlight a series of challenges and opportunities in relation to these global developments.

Some general economic facts about Luxembourg

Luxembourg is a very open economy centrally located in Europe. It is ranked 3rd in the International Chamber of Commerce Open Markets Index 2015[890] and 9th in the Heritage's Foundation Index of Economic freedom[891].

It has one of the highest GDP's in the world and GDP growth in 2015 was 4,8 %, with a projection 3,3 % for 2016[892], [893], [894]. Also taking account of the numerous crossborder workers, which do not appear in the traditional GDP per capital figures, standards of living, as measured by indicators such as gross national income, are amongst the highest in the world

Unemployment in 2015 was 6,8 % with a projection of 6,4 % for 2016. Luxembourg has an atypical labor market with 71 % of the workforce not having the Luxembourgish nationality from which 44 % are daily

890 http://www.iccwbo.org/global-influence/g20/reports-and-products/open-markets-index/

891 http://www.heritage.org/index/country/luxembourg

892 Luxembourg | Economic Forecasts | 2016-2020 Outlook, http://www.tradingeconomics.com/luxembourg/forecast

893 OECD: Luxembourg - Economic forecast summary (June 2016), http://www.oecd.org/economy/luxembourg-economic-forecast-summary.htm

894 Europeam Commission - Economic and Finacial Affairs, http://ec.europa.eu/economy_finance/eu/countries/luxembourg_en.htm

commuters coming from the bordering countries, France, Belgium and Germany. Job creation between 2015 Q1 and 2016 Q1 was 3% which means +/- 10.000 new jobs created.

Population growth has also been fairly high during the last decades mounting from almost 400.000 in 1990 to 576.249 at the 1st of January 2016 [895]. The annual population growth rate, largely driven by immigration, is the highest among the EU's 28 member States.

Within a radius of 200 km, 20 of the best European universities and polytechnics have their home.

The Luxembourg economy managed the transition from an industrial economy in 1970 with a total of 44% of industrial production (28 % from steel production) to an important service economy in 2015 with a total share of 87,7 % of services, amongst which 24,7 % stem from its important international financial center.

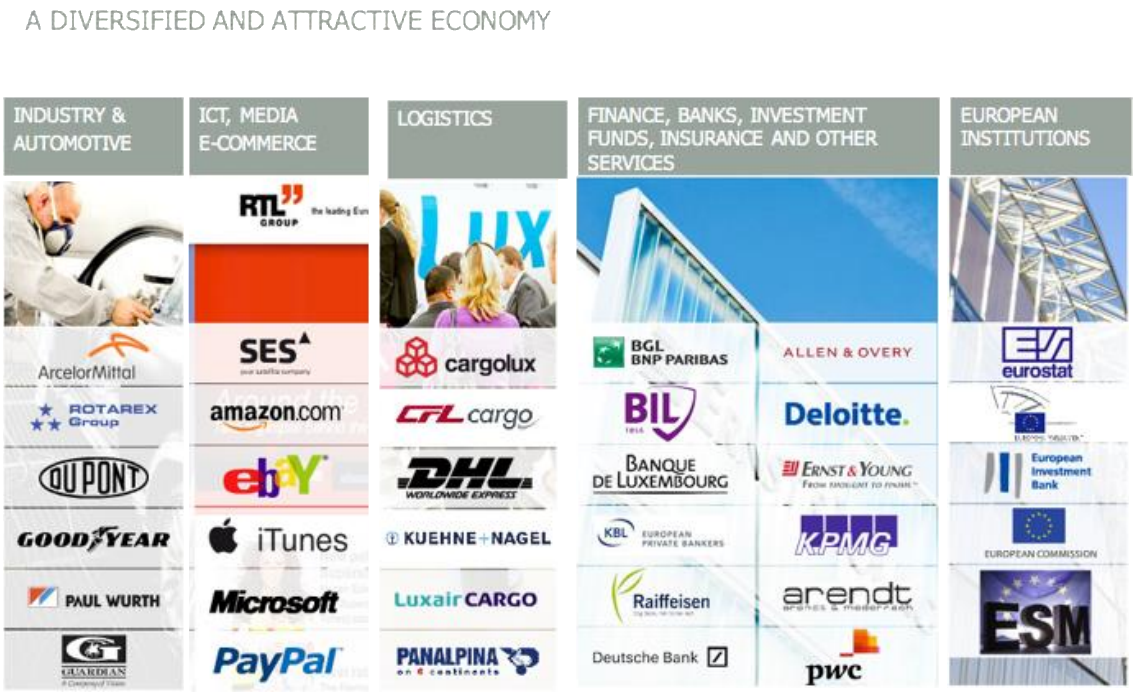
Today, Luxembourg ranks 20th in the World Economic Forums Global Competitiveness Index[896].

According to a 2012 CODEPLAFI study, financial services would even be (directly and indirectly after taking knock-on and spill over effects into account) responsible for 38% of GDP, 30% of tax income and 17 % of employment.

As a small country, the Luxembourg economy is highly dependent on exports.

Economic policy & diversification

Although the Luxembourg economy is still highly reliant on the financial sector, efforts of the recent governments yielded in economic diversification including some promising sectors:



At the same time, together with its private partners, the government pursues an active policy to develop a series of new and already existing promising sectors like

- Clean technologies

[895] Evolution de la population depuis le recensement de 2011-STATEC, http://www.statistiques.public.lu/catalogue-publications/regards/2016/PDF-16-2016.pdf

[896] http://reports.weforum.org/global-competitiveness-report-2015-2016/economies/#economy=LUX

- Health technologies
- Space technologies
- ICT (as a sector on its own right as well as an enabler for all other sectors), media and e-commerce
- Industry 4.0 technologies
- Automotive components industry

(We will see later on that many of these sectors are organized in clusters.)

along with already established hidden champions, such as:

Other relevant sectors and activities include:

- Logistics (Luxembourg being a logistics hub for European transport and distribution)
- Headquarters functions for multinational companies

Digital Infrastructure

Since 2006, the government pursued an active infrastructure development policy in terms of ICT (Information and Communication Technologies).

The result today for instance is the existence of Luxconnect[897], a "multi-Tier (Tier II, III & IV) centre infrastructure as a service" provider relying entirely on renewable energy who has rolled out more than 1000 km of national fibre backbone connecting all professional operators to the major international backbones. Luxconnect has become an important facility provider and business enabler in the Luxembourg ICT market.

In April 2010 the Luxembourg government set targets to provide, by 2015, broadband speeds of 1 Gigabit-per-second (Gbit/s) downstream and 500 Megabits-per second (Mbit/s) upstream to 50% of the population, and 100 Mbit/s downstream and 50 Mbit/s upstream to remaining households. By 2020 the government wants all of its citizen to have a minimum of 1 Gbit/s downstream access[898]. State-owned incumbent, Post Luxembourg[899], is already on track to fulfil the government's plans with its countrywide build-out of a point-to-point FTTH (Fiber-to-the-home) network, considering a 100 % FTTH coverage as key to future economic growth.

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897 https://www.luxconnect.lu

898 P&T Luxembourg Invests in National FTTH Coverage, http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?doc_id=4990

899 http://www.post.lu/

As of today, Luxembourg has 7 of the highest possible standard Tier IV Data centres, which is 30% of the total number of Tier IV Data Centers in Europe (12% worldwide).

Paradoxically, a 2014 STATEC study[900], [901] revealed that only 13 % of local companies were using cloud services compared to a 19% EU average. Insufficient knowledge about contractual, legal and technological aspects as well uncertainty about data localisation were given as the main reasons for the relatively timid adoption.

Luxembourg is also the home of SES, the world-leading satellite operator, founded in Luxembourg on March 1, 1985, as Europe's first private satellite operator. Today, SES[902]is providing reliable and secure satellite communications solutions, and connects and enables broadcast, telecoms, corporate and government customers[903].

The European Digital Economy and Society Index (DESI) 2016

The Digital Economy and Society Index (DESI)[904] is a composite index that summarises relevant indicators on Europe's digital performance and tracks the evolution of EU member states in digital competitiveness. It is edited by the European Commission and updated annually.

The DESI ranks EU member states along 5 dimensions:

1. Connectivity
2. Human Capital
3. Use of the Internet
4. Integration of Digital Technology by business
5. Digital Public Services

Luxembourg ranks 10th (out of 28) in the aggregated 2016[905] index (down from 9th in 2015), which qualifies it as a « lagging ahead » country, in the lower spectrum of the corresponding quadrant:

900 Utlisation payants des services informatiques en nuage, http://www.statistiques.public.lu/catalogue-publications/regards/2016/PDF-13-2016.pdf

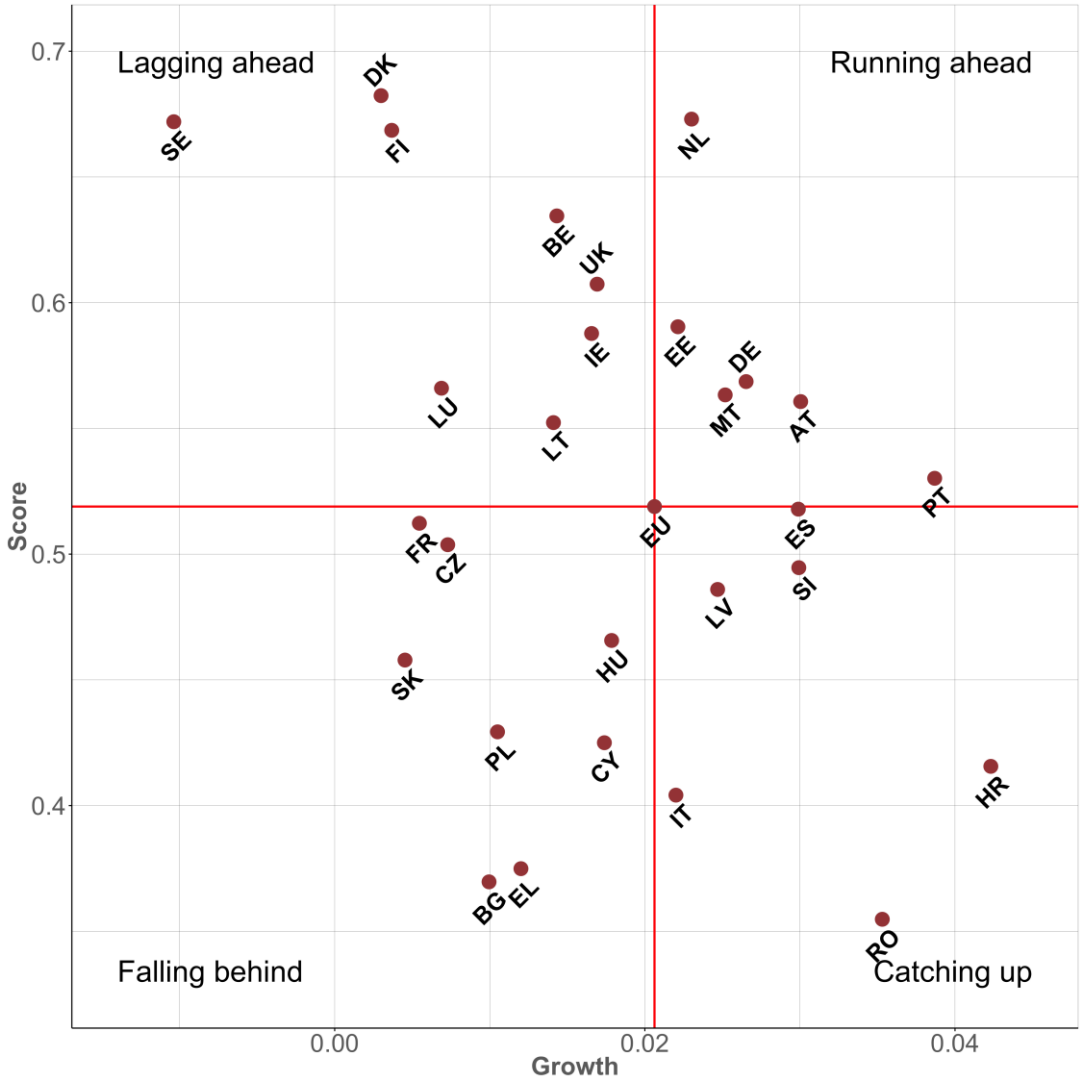
901 Le cloud sous-utilisé au Luxembourg!, http://www.itone.lu/article/le-cloud-sous-utilise-au-luxembourg

902 http://www.ses.com/

903 SES S.A., https://en.wikipedia.org/wiki/SES_S.A.

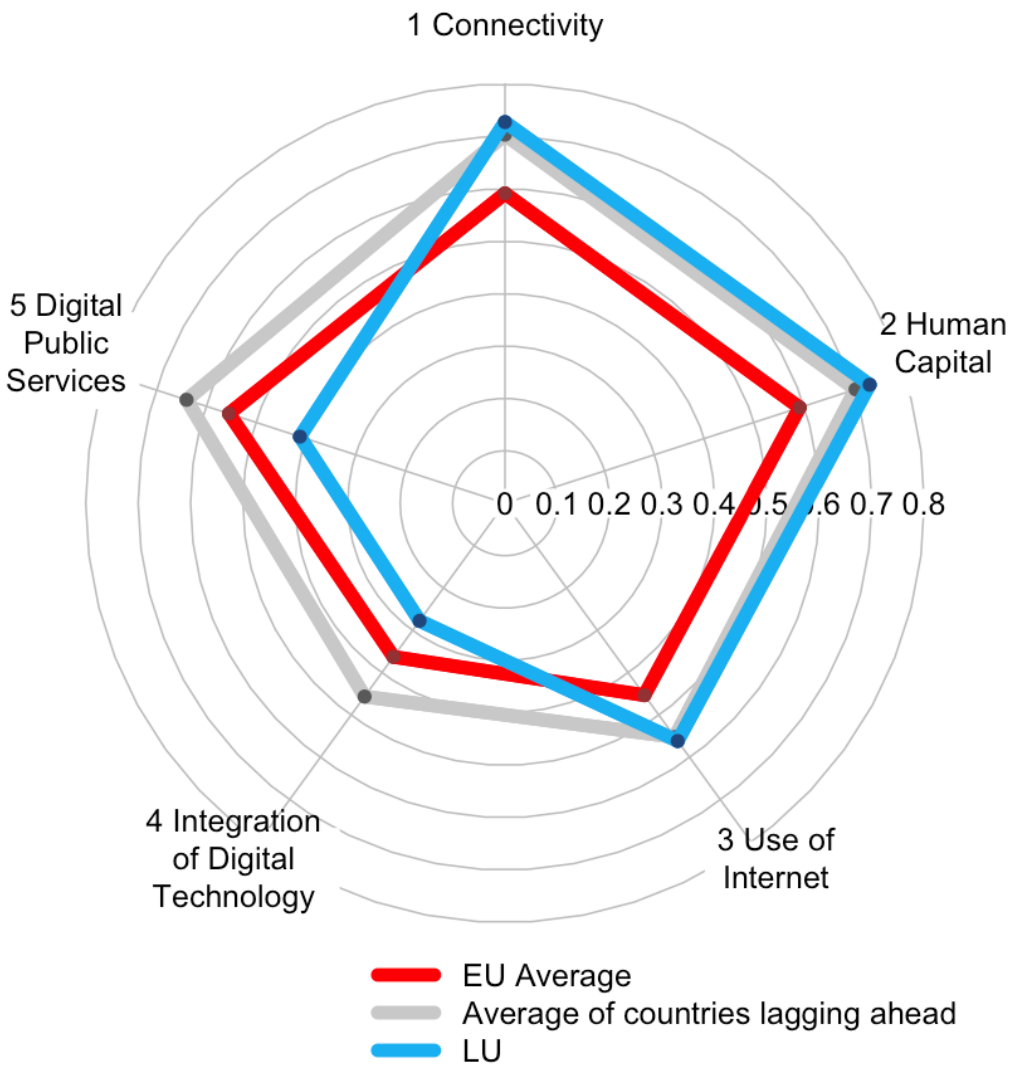
904 The Digital Economy & Society Index (DESI), https://ec.europa.eu/digital-single-market/en/desi

905 DESI 2016 for Luxembourg, https://ec.europa.eu/digital-single-market/en/scoreboard/luxembourg



The picture is however very mitigated with respect to the different dimensions of the index:

While Luxembourg ranks high in connectivity, human capital and use of the Internet (4th place each), it lags behind in Integration of Digital Technology by Business (21st) and in Digital Public Services (22nd).



This picture can be seen as a typical snapshot of Luxembourg: The country performs well in « hard », more financially driven aspects like infrastructure, appliances and employment, but relatively low in « soft » aspects that relate more to organisational culture and agility and to governance aspects.

Aware of the situation, the government has launched a series of initiatives in recent years that we will dig deeper into in the section about the current Luxembourgish ecosystem.

E-skills and the jobmarket

The proportion of ICT specialist in total employment is relatively high at 5,1 %[906] in 2016. The OECD digital economy outlook ranks Luxembourg 3rd in 2014[907]:

The IT intensive financial sector, European institutions as well as international E-commerce players seem to be at the origin of that high demand. At the same time, Luxembourg is considerably lacking skilled ICT professionals. In 2015, 59,1 % of enterprises which recruited or tried to recruit staff for jobs requiring ICT specialist skills reported problems in filling these positions, which is the second-highest figure in the EU after the Czech Republic[908]. Demand is rising rapidly while the supply is not keeping pace.

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906 The Digital Economy & Society Index (DESI), https://ec.europa.eu/digital-single-market/en/scoreboard/luxembourg

907 OECD Digital Economy Outlook 2015, http://ec.europa.eu/eurostat/documents/42577/3222224/Digital+economy+outlook+2015/dbdec3c6-ca38-432c-82f2-1e330d9d6a24

908 Digital Economy and Society Index 2016- Country Profile Luxembourg, EN

The problem might also be related to Luxembourg's low number of STEM (Science, Technology, Engineering and Mathematics) graduates where Luxembourg performs worst in the EU with 3.6 graduates in STEM per 1000 individuals[909],[910].

Many of the employed IT professionals are commuters or expats, as for almost half of the total Luxembourg workforce. That specific situation holds advantages and drawbacks: while it considerably increases diversity by bringing in different points of view, it also takes time for those workers to get used to the Luxembourg ecosystem, they only come at the price of high salaries as every neighbouring country also has a shortage of skilled ICT professionals in times of global Digital Transformation and they are more difficult to retain over time.

Aware of the inherent risks of that disequilibrium on the ICT skill job market, the FDI[911] and the « Digital Lëtzbuerg » Initiative have commissioned an e-skills study[912] on drawing a picture of the current situation and context including recommendations about the creation of a virtual e-skills training centre based on an e-skills framework and a hierarchy of job profiles.

That study also included a SWOT analyses of the Luxembourg ICT sector:

[909] The Digital Economy & Society Index (DESI) , https://ec.europa.eu/digital-single-market/en/scoreboard/luxembourg

[910] It is always difficult to really interprete comparative international rankings with regard to Luxembourg. Luxembourg's atypical socio-demographic environment can create biases in statistics, and it would require to analyse in detail the methodology used by every specific study. In the case of STEM graduates, it is not clear to the author whether they include Luxembourg residents that visit a university abroad, knowing that a large number of Luxembourg residents visits foreign universities.

[911] The Federation of Integrators in Telecommunications, IT, Multimedia and Security represents a group of professionals with interests covering all activities in ICT, multimedia and security systems.

[912] Ant, M., Goetzinger, P., & Binsfeld, N. (2016). E-Skills Study - Strategies for the creation of a virtual e-skills training centre in Luxembourg. Luxembourg.

Strengths	Weaknesses
a. International infrastructures i. Connectivity – golden ring ii. RTT latency values iii. Internet exchange point b. Data centres i. 99.995% availability ii. 13% of the world's Tier IV capacity iii. Redundancy, security, trust c. Nationwide fibre network d. Fiscal policy i. Intellectual property law ii. E-commerce law (until 2015) e. Competitive price for electricity f. PSF Status g. PSDC Status h. Law on "cloud computing" i. Financial sector as main driver j. Simple access to authorities and political decisions makers k. High GDP l. Multilingual workforce	a. Small country – no critical mass i. Market structure – a few large players dominate ii. No single EU market iii. Applied R&D not well developed b. ICT skills underdeveloped i. Limited venture capital available ii. Risk averse iii. High salary costs
Opportunities	**Threats**
a. Development of specialist functional skills to service large ICT suppliers or their customers. b. Development of advanced networking solutions and intelligent networks, social network computing and GPS applications. c. Providing advanced capability in data storage, data processing, data mining and knowledge extraction for any organisation in the world but in particular locally. d. Attraction multinational investment e. Position Luxembourg as secure, trusted HUB f. Redundant electricity grid g. Cyber security h. Pro-active Government (Luxembourg for Business, Luxembourg for ICT) i. Small country – innovation lab	a. Failure to invest in infrastructure on a constant basis b. Competing in a local market where international brands are most trusted c. Competing on a world wide scale d. Innovating and producing in fragmented markets e. Intensive Competition from neighbouring countries f. New VAT and tax regimes g. EU and G20 pressures h. Political pressure on international companies i. Dependant on electricity grids of neighbours j. ICT workforce and skills missing k. Limited creativity j. Increasing public debt, limited investment capacity

Source:[913]

An e-skills job profile hierachy is especially relevant in the context of the new types of ICT skills that are required to build the cyber physical world (i.e. web application builders, data analysts and data scientists, corporate community managers…etc) than the more traditional ICT job profiles like systems administrator or integrator required by the existing financial sector, for example.

[913] http://www.digital-luxembourg.public.lu

Globally, Luxembourg has a very high attractiveness for talents[914], [915], but falling from the 2nd place in 2014 and 2015 to the 9th place in 2016 and ranks 3rd in IMD World Talent Report 2015[916].

E-commerce

Whilst 93 % of Luxembourg residents are active Internet users and 78% shop online[917] and 78% of shops in Luxembourg have an Internet presence, only 7 % of the country's SMEs actively sell online, the EU average being at 14 % [918].

In view of these figures, Luxembourg is dangerously lagging behind in digital transformation of its local commercial industry knowing that 87 % of Luxembourg's companies are micro-enterprises[919]. It's those enterprises that « make » the Luxembourg economy and create most jobs in the private sector.

Different reasons may explain that lagging:

- Security concerns
- Lack of affordable online payment systems
- Lack of affordable, transparent and automated e-commerce logistics offers, a market dominated mostly by German and Belgian companies that have a low sensitivity for the needs of the local market [920]
- Lack of skills and talents
- Penalising EU regulation on territorial restrictions for goods procurement
- High administrative burden due to VAT regulations (As a small territory, Luxembourg e-commerce operators proportionally tend to export a higher part of their products than other countries)

Furthermore, the biggest local Supermarket chain « Cactus » closed down their online-shop at the beginning of February 2016 after only 3 years of operation, stating the low profitability of the venture. Other supermarkets continue to sell online (Cora, Delhaize, Auchan, and Luxcaddy).

There might be other hidden reasons for low e-commerce adoption of local SMEs. Qualitative reasons (not yet underpinned by representative statistical finds) might include elements such as:

- An insufficient knowledge of the strategic challenges at stake
- Cultural legacy of doing it « the old and traditional way » and resisting to change and maybe in some cases a low motivation and passion for innovation by some retailers

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914 Le Luxembourg reste dans le top 10 pour les expatriés, http://paperjam.lu/news/le-luxembourg-reste-dans-le-top-10-pour-les-expatries

915 The World Through Expat Eyes - Expat Insiders, The International Survey, http://tab.news.paperjam.lu/sites/default/files/expat*insider*2016*the*internations*survey*0.pdf

916 http://www.imd.org/uupload/IMD.WebSite/Wcc/NewTalentReport/Talent*2015*web.pdf

917 L'e-commerce cherche encore sa voie, http://paperjam.lu/news/le-commerce-cherche-encore-sa-voie

918 Pousser les PME à vendre en ligne, http://paperjam.lu/news/pousser-les-pme-a-vendre-en-ligne

919 Pousser les PME à vendre en ligne, http://paperjam.lu/news/pousser-les-pme-a-vendre-en-ligne

920 E-commerce recherche logistique, http://paperjam.lu/news/e-commerce-recherche-logistique

- An insufficient understanding of how digital transformation changes customer expectations and a corresponding lack of skills in omnichannel customer experience management, service design and customer jobs-to-be-done mapping techniques[921].
- A dependency of many Luxembourg companies to headquarters abroad, hampering local investment decision making.
- Lack of qualified personnel

Aware of the situation, two main initiatives have been taken by the community:

- The House of Training proposesd a professional training program on e-commerce in collaboration with Google[922], [923] and offers multiple courses dealing with the challenges of digital transformation.[924]
- The CLC (Luxembourg Confederation of Commerce) has created a branch for e-commerce to better represent the interests of e-commerce operators in Luxembourg [925], [926], [927], [928], [929].

Paradoxically, many major international players in e-commerce are present in Luxembourg (Amazon, Skype, iTunes, Paypal, Rakuten a.o) but these are operating world-wide and rather use Luxembourg as hub without really focusing on the local market.

To help better understand the elements of a country's innovation and renewal capacity, we describe a typical innovation ecosystem in Box 11 hereafter.

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921 Know Your Customers' "Jobs to Be Done", https://hbr.org/2016/09/know-your-customers-jobs-to-be-done

922 https://www.houseoftraining.lu/training/module-1-votre-entreprise-en-ligne-1902

923 Pousser les PME à vendre en ligne, http://paperjam.lu/news/pousser-les-pme-a-vendre-en-ligne

924 Digital transformation courses at the House of Training : https://www.houseoftraining.lu/search?categories=155&subcategories=219&search_term=

925 Fédération luxembourgeoise du e-commerce, http://www.ecom.lu/

926 Consommation sans frontières, http://paperjam.lu/news/consommation-sans-frontieres

927 Au-delà des frontières, http://paperjam.lu/news/au-dela-des-frontieres-0

928 Constitution et élection du conseil d'administration de ecom.lu, http://paperjam.lu/communique/constitution-et-election-du-conseil-dadministration-de-ecomlu

929 Ecom.lu représente le Luxembourg au Global E-commerce Summit 2016 à Barcelone, http://paperjam.lu/communique/ecomlu-represente-le-luxembourg-au-global-e-commerce-summit-2016-a-barcelone

BOX 11: What is an Innovation Ecosystem?

The elements of an innovation ecosystem[930] are: The innovation subsystems, system dynamics, and innovation policy.

Innovation subsystems

An innovation ecosystem usually comprises different innovation subsystems:

The National Innovation System (NIS): 'The network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies' (Freeman, 1987). Another word that is used on a regular basis for NIS is "Institutional Environment" – which describes the institutionalisation of innovation policy in governments, research institutes, advisory boards and educational institutes.

Regional Innovation Systems (RIS): 'The regional innovation system can be thought of as the institutional infrastructure supporting innovation within the productive system of a region.' (Asheim & Gertler, 2005). While NIS focuses more on the institutional environment of innovation, RIS usually focuses more on soft factors, such as network characteristics, trust, identity, cosmopolitism, quality of life and culture.

Sectorial Innovation Systems (SIS): In contrary to NIS and RIS, SIS focus on globally active sectors that function more or less independently of the institutional environment. NIS and RIS are usually supportive to SIS. SIS can be seen as the top priority sectors for a government's economic development policy. The Top Sectors defined are Agri-Food, Chemicals, Creative Industry, Energy, High-Tech, Logistics, Life Sciences & Health, Agriculture and Water. Another institute, the EIT, is also focusing on these sectors (Climate, Digital, Health, Raw Materials and Energy).

Education Systems: these are the ecosystems that surround educational institutes, such as universities. This group is often referred to as the economics of education. A well-performing education system usually increases expenses because of increased income, increases in return on investments because of higher (company) incomes and increases in productivity. It enables academic inflation.

Macro-economic Systems: this system refers to basic economics: output and income (GDP, GRP), unemployment and inflation and deflation.

Start-up Systems: a start-up ecosystem is a small-scale system that enables start-ups to arise. It involves aspects such as ideas, inventions, research, education, start-ups, entrepreneurs, angel investors, seed investors, mentors, advisors and events and is supported by universities, incubators, accelerators, facilitators, investors, co-working spaces and venture capitalists.

Innovation Management Systems: these refer to a cyclical view of turning ideas into innovation.

Cluster or Science Park Systems: In 2000 Michael Porter already wrote: 'Geographic, cultural, and institutional proximity provides companies with special access, closer relationships, better information, powerful incentives, and other advantages that are difficult to tap from a distance. Competitive advantage lies increasingly in local things – knowledge, relationships, and motivation – that distant rivals cannot replicate.' (Porter, 2000). Clusters usually go the four phases: emergence, growth, maturity and renewal. The reason why clusters seem to work well is proximity. Cooke et al. (2011) suggest 7 types of proximity, ***1) Geographic proximity*** – referring to the physical distance between actors, ***2) cognitive proximity*** – referring to the closeness in ways of thinking between the actors, ***3) communicative proximity*** – referring to the closeness professional language between the actors, ***4) organisational proximity*** – referring to the arrangements that organizations make to coordinate interactions and collaborate with each other, ***5) functional proximity*** – referring to closeness in expertise in different industries/clusters, ***6) cultural proximity*** – referring to closeness of cultural habits and virtues and ***7) social proximity*** – referring to the intensity of trust-based social relations, such as friendship.

[930] The Innovation Ecosystem, http://www.openinnovation.eu/27-07-2015/schematic-overview-to-understand-the-complexity-of-the-innovation-ecosystem-infographic/

System dynamics

As every system, innovation ecosystems have dynamics that are not always controllable. In systems theory, the difference is made by positive loops, that reinforce the system's aim and negative loops that can break the systems' positive flow and even render it chaotic.

The Innovation subsystems described in the previous section are all positive loops. Negative loops in the innovation subsystem can be:

Labour market depletion: innovation not only creates new firms which in turn increase employment, innovation also creates more automated, efficient processes that in turn might lead to less employment: labour market depletion.

Other new (disruptive) technologies: from an industry perspective, other new technologies can cause the whole sector to be superfluous, known as disruptive innovation.

Imitation: rising profits within a sector also attracts new companies to the sector that will try to copy the products – at lower costs and without the initial investment. Especially sectors with low entrance barriers are receptive to this, such as software, app development and low-tech products.

Policy failures: a various number of reasons can cause policy to fail. The most common ones are bureaucracy, corruption and short-term thinking.

Innovation policy

The innovation subsystems in one way or another, try to positively influence an economy's innovation capacity. A few of the soft factors that play an increasing role in capacity building are:

Smart infrastructure: this characteristic is about all kinds of infrastructure that the region has to offer. This includes hard infrastructure, soft infrastructure and technological infrastructure.

Quality of life: according to Sternberg and Arndt (2001) the quality of life is created by: labour quality, housing amenities, and leisure amenities. All of these factors attract highly qualified people to the region, but moreover, they also make people stay in the region.

Cosmopolitanism: this aspect refers to any form of feeling that is evoked by the region. The characteristics of this factor are for example attractiveness for highly educated personnel, a world-wide reputation, a good atmosphere, a shared purpose, and highly motivated people (Whitley, 2002).

Talented human capital: Micheals et al. (2001) describe that attracting talent, educating talent, and keeping talent is of high importance to the region. They focus on managerial talent, but they explain that technological, engineering and business talent must also be part of a regional strategy to win the war for talent.

Creative cultural environment: a well-developed entrepreneurial climate is attracting and benefitting from personal talent and is reinforcing the strong culture of the community. Hofstede, more than 25 years ago, received worldwide praise for constructing four – although years later a fifth one was added – dimensions to characterize cultures of different nations: power distance, uncertainty avoidance, individualism, and femininity (Hofstede, 1980).

Trust: there is considerable evidence that a trusting relationship creates greater knowledge sharing. In a trust-based relationship, people are more willing to share useful knowledge. Trust promotes social and emotional ties, on the one hand, and promotes professional collaboration, on the other hand, both facilitators of knowledge sharing (Chowdhury, 2005; Tsai & Ghoshal, 1998; Mayer, Davis, & Schoorman, 1995).

Identity: scientists claim that knowledge is more effectively generated, combined and transferred by individuals who identify with a larger collective goal. The individual members then share a sense of purpose with the collective. Ultimately, this will lead to lower network costs, and more trust and commitment (Kogut & Zander, 2003; Dyer & Nobeoka, 2000; Orr, 1990)

Diversity: this characteristic of knowledge refers to the extent to which a variety of knowledge, know-how, and expertise is available in a network. New opportunities and resources will be discovered more quickly with access to diverse knowledge and knowledge diversity therefore directly stimulates creativity and

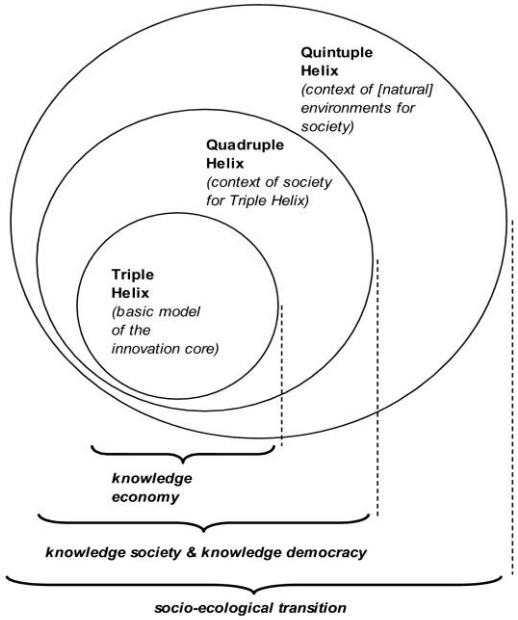
innovativeness of the actor in the network. (Galunic & Rodan, 2004; Galunic & Rodan, 2002; Rodan, 2002).

Open Innovation

Over the last decade, and as consequence of rising complexity and global development speed, the concept of open innovation has gained considerable prominence. More open collaboration and co-creation between different types of stakeholders unleash collective intelligence and increase system resilience.

Simply said: deep integration between governments and industry could result in quicker innovation. As does deep integration between education and industry; or different industries with each other, et cetera.

The concept itself has evolved from what is called the triple helix, through the quadruple to the quintuple hélix[931], [932]:



Digital transformation can be considered as a case of disruptive innovation applying to the whole society and economy. In turn, as we have seen, there will be hardly any strategically viable innovations without a consistent digital strategy embedded.

The above framework will therefore help to evaluate Luxembourg's position with regard to Digital Transformation without making a detailed assessment of every aspect of the framework as a whole which leads beyond the scope of the present paper. We will rather distil certain aspects that we consider of particular importance.

> ***What kind of economic environment would make the best use of the new digital technologies?***

[931] Governing Quintuple Helix Innovation: Urban Living Labs and Socio-Ecological Entrepreneurship, http://timreview.ca/article/972

[932] Triple Helix, Quadruple Helix and Quintuple Helix and How Do Knowledge, Innovation and the Environment Relate To Each Other?, https://www.researchgate.net/publication/273268696_Triple_Helix_Quadruple_Helix_and_Quintuple_Helix_and_How_Do_Knowledge_Innovation_and_the_Environment_Relate_To_Each_Other

McAfee: One that's conducive to innovation, new business formation, and economic growth. To create it, we need to focus on five things:

The first is ***education****. Primary and secondary education systems should be teaching relevant and valuable skills, which means things computers are not good at. These include creativity, interpersonal skills, and problem solving.*

The second is ***infrastructure****. World-class roads, airports, and networks are investments in the future and the foundations of growth.*

Third, we need ***more entrepreneurship****. Young businesses, especially fast-growing ones, are a prime source of new jobs. But most industries and regions are seeing fewer new companies than they did three decades ago.*

A fourth focus is ***immigration****. Many of the world's most talented people come to America to build lives and careers, and there's clear evidence that immigrant-founded companies have been great job-creation engines. The current policies in this area are far too restrictive, and our procedures are nightmarishly bureaucratic.*

The fifth thing is ***basic research****. Companies tend to concentrate on applied research, which means that the government has a role to play in supporting original early-stage research. Most of today's tech marvels, from the internet to the smartphone, have a government program somewhere in their family tree. Funding for basic research in America, though, is on the decline: Both total and nondefense federal R&D spending, as percentages of GDP, have declined by more than a third since 1980. That must change.*

Brynjolfsson: Our one confident prediction is that digital technologies will bring the world into an era of more wealth and abundance and less drudgery and toil. But there's no guarantee that everyone will share in the bounty, and that leaves many people justifiably apprehensive. The outcome—shared prosperity or increasing inequality—will be determined not by technologies but by the choices we make as individuals, organizations, and societies. If we fumble that future—if we build economies and societies that exclude many people from the cycle of prosperity—shame on us.

> *Technological progress is an extraordinarily powerful force, but it's not destiny. It won't lift us into utopia or carry us into an unwanted future. The power to do that rests with us human beings. Technologies are merely our tools*[933].

The Luxembourg ecosystem

As we have been outlining in Box 11, an Innovation Ecosystem consists of different elements. In view of Luxembourg's small size, there is no different between the NIS and a RIS. They are one and the same entity in the case of Luxembourg.

In terms of international benchmarks, Luxembourg ranks 9th out of 141 countries for global innovation in the INSEAD Global Innovation Index 2015, 6th in the Innovation Union Scoreboard 2015 of the European Commission and 1st in the World Economic Forum Global Competitiveness Report 2015[934] and 11th in the IMD World Competitiveness Scoreboard 2016[935].

In the following paragraphs, we will give a short description of the main actors and initiatives that are part of the Luxembourg innovation ecosystem.

Research and Development

The following institutions are part of the public Luxembourg R&D landscape:

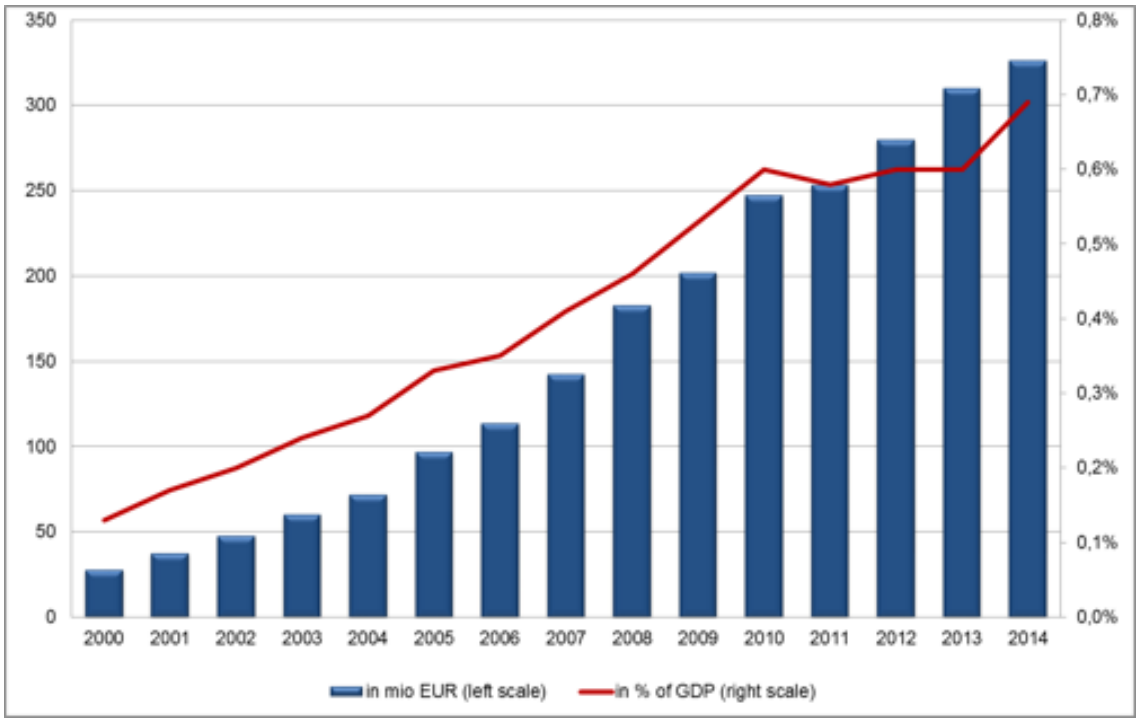
UNI.LU	LIST	LIH	LISER	CVCE	MPI
Université du Luxembourg	Luxembourg Institute of Science and Technology (LIST)	Luxembourg Institute of Health	Luxembourg Institute of Socio-Economic Research (CEPS)	Centre Virtuel de la Connaissance sur l'Europe	Institut Max Planck de droit procédural réglementaire international et européen du Luxembourg

Public spending in R&D has been steadily increasing over the last years:

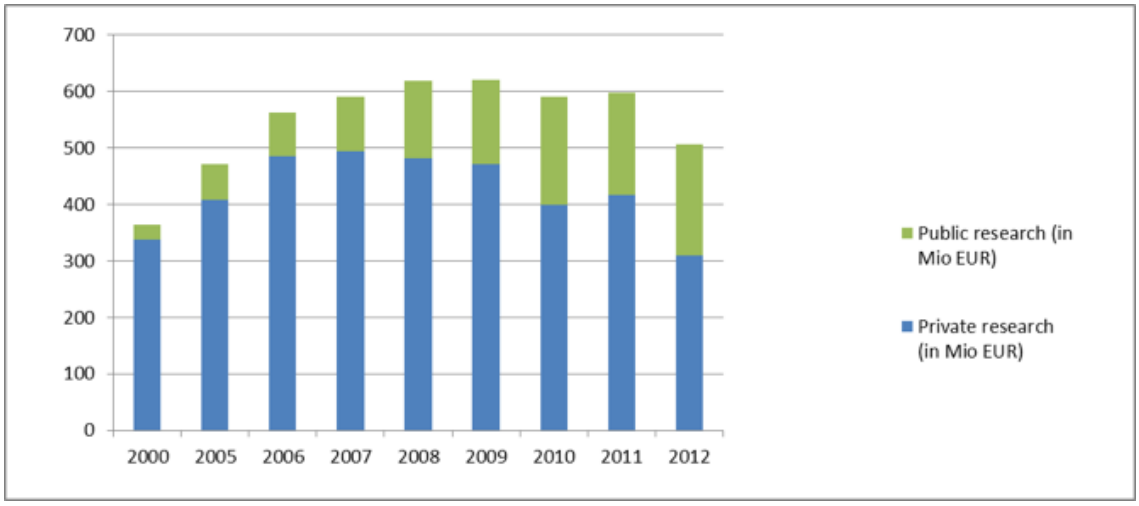
933 The Great Decoupling: An Interview with Erik Brynjolfsson and Andrew McAfee, https://hbr.org/2015/06/the-great-decoupling

934 http://reports.weforum.org/global-competitiveness-report-2015-2016/competitiveness-rankings/#indicatorId=GCI.B.09

935 http://www.imd.org/uupload/imd.website/wcc/scoreboard.pdf



In 2012, 40% of the total R&D expenditure was done by the private sector.



As a public institution, the National Research Fund (FNR)[936] is the main funder of research activities in Luxembourg.

[936] http://fnr.lu/

The Luxembourg Cluster Initiative

The Luxembourg Cluster Initiative[937] is coordinated by Luxinnovation[938], [939], the national innovation agency.

Currently, there are 6 active clusters in the following sectors :

- automotive components[940]
- life sciences[941]
- eco-technologies[942]
- information and communication technologies[943]
- materials and production technologies[944]
- space technologies[945]

Within the framework of its economic development policy, the Luxembourg Government has also decided to stimulate other value-adding sectors with a strong growth potential, such as ***logistics***[946] and ***maritime***[947] ***activities***, both sectors being organised in clusters too.

The cluster's main objectives are to:

- foster communication and the exchange of knowledge and know-how among cluster and innovation network members
- stimulate the development and implementation of collaborative projects at national, European and international level
- enhance the visibility of the technological excellence and of the innovation potential of cluster and innovation network members
- encourage the uptake of new technologies and the identification of potential business opportunities.

The government also supports the project for the creation of a « Creative Industries Cluster[948] ».

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937 http://en.luxinnovation.lu/Services/Luxembourg-Cluster-Initiative & http://www.automotivecomponents.lu/clusters/

938 http://www.en.luxinnovation.lu/

939 Annual report 2014, http://en.luxinnovation.lu/content/download/20658/190061/version/3/file/LUX_074_Rapport+Annuel+2014_EN_web.pdf

940 Luxembourg Automotive Compnets, http://www.automotivecomponents.lu/

941 Luxembourg Biohealth CLuster, http://www.biohealthcluster.lu/

942 Eco Innovation Cluster, http://www.ecoinnovationcluster.lu/

943 Luxembourg ICT cluster, http://www.ictcluster.lu/

944 Luxembourg Materials & Production Technologies Cluster, http://www.materialscluster.lu/

945 Space Technologies Cluster, http://www.spacecluster.lu/

946 Cluster for Logistics, http://www.clusterforlogistics.lu/

947 Cluster Maritime, http://cluster-maritime.lu/

948 Vers un cluster pour les «industries créatives», http://paperjam.lu/news/vers-un-cluster-pour-les-industries-creatives

Luxinnovation also manages a Web portal[949] that syndicates information about innovation activities and offers on Luxembourg. Detailed information about Luxinnovation's activities can be found in their annual report[950].

Initiatives & programs

The main initiatives and programs within the Luxembourg ecosystem are:

Fit for Innovation

"Fit for Innovation" is a subsidised programme aimed at supporting SMEs and SMIs. It is managed by Luxinnovation, the national agency for innovation and research and has been developed in partnership with the Ministry of the Economy[951].

Fit for digital

Luxinnovation has created the Fit for Digital programme to support the digitalisation of small enterprises[952].

Fit for circularity

The Fit for Circularity programme has been designed to facilitate and accelerate companies' transition to the circular economy

Club Innovation

Launched by the « Chambre des Métiers[953] » and Luxinnovation in 2006, the Club Innovation[954] is primarily a meeting place and a forum for entrepreneurs mainly associated with the crafts sector.

Luxembourg Open Innovation Club (LOIC)

LOIC[955] is an initiative dedicated to the development of business relations between large accounts, intermediate-sized enterprises and innovative start-ups through open innovation.

Fit for start

« Fit for Start[956] » offers early-stage funding and coaching to ICT start-ups in Luxembourg. The program is built upon the lean start-up methodology[957]. « Fit for Start » is a specific program within Luxinnovation's support for innovative start-ups[958].

Fit4Entrepreneurship

« Fit4Entrepreneurship » is an initiative which supports job seekers willing to start a business project. The project provides adequate support to project developers through an assessment of their entrepreneurial skills, a training program and individual coaching by entrepreneurs. The program is managed by the Chambre de Commerce in collaboration with Adem and the Chambre des Métiers and with support from

949 http://www.innovation.public.lu/en/index.html

950 http://www.luxinnovation.lu/Publications/Luxinnovation/Luxinnovation-Annual-Report-2015

951 http://www.innovation.public.lu/en/innover/pme-artisanat/fit-for-inno/index.html

952 http://www.innovation.public.lu/en/innover/pme-artisanat/fit-for-digital/index.html

953 http://www.cdm.lu/

954 http://www.innovation.public.lu/en/innover/pme-artisanat/club-innovation/index.html

955 http://loic.lu/

956 http://en.luxinnovation.lu/Services/Support-for-innovative-start-ups/Fit-for-Start

957 http://en.luxinnovation.lu/Services/Support-for-innovative-start-ups/Fit-for-Start/Lean-Start-Up-methodology

958 http://en.luxinnovation.lu/Services/Support-for-innovative-start-ups

the European Social Fund. It complements the entrepreneurial ecosystem by creating linkages to other initiatives in entrepreneurship.

House of Entrepreneurship

The House of Entrepreneurship (HoE) is the single physical "One-stop shop" which gathers all the main private and public actors of entrepreneurship in Luxembourg under one roof. The HoE is the single entry point for any project manager or entrepreneur - regardless of the nature of his activity (craft, commercial, industrial, innovative social purpose) - in search of support and personal advice, and at each stage of its entrepreneurial journey: administration, initiation, development, recovery, extension, rationalisation, internationalisation, transfer or termination of activities.

Hello Future

Fedil, in partnership with the Chamber of Commerce, Luxinnovation and the government have launched the « Hello Future » campaign aiming at promoting (STEM) jobs in industry[959], [960].

Digital(4)Education

The Digital(4)Education[961] strategy is designed to prepare young people for a complex working environment that is undergoing permanent change, to promote new apprenticeship programmes and innovative educational projects based on the use of digital technology at school and in the world around school, to train future ICT experts and to promote entrepreneurship in this sector. It also aims to reduce the digital divide by providing all young people with access to quality educational resources, regardless of their social background[962].

Funding opportunities

The Luxembourg ecosystem also offers different funding opportunities and initiatives.

Luxinnovation also advices interested companies and startups on national and European funding opportunities[963], such as the Horizon 2020 programme[964].

National funding

National public funding[965] offers include:

- R&D and innovation projects financing in a companies[966]
- Eco-technologies and sustainable development financing[967]

[959] http://www.hellofuture.lu/

[960] Hello Future: Promotion des métiers de l'industrie au Luxembourg, http://www.innovation.public.lu/fr/actualites/2016/03/fedil-hello-future/index.html

[961] http://portal.education.lu/digital4education/

[962] http://www.digital-luxembourg.public.lu/en/actualites/e-skills/2015/Digital-4-Education/index.html

[963] http://en.luxinnovation.lu/Services/Advice-on-national-and-European-funding-opportunities

[964] The EU Framework Programme for Research and Innovation, https://ec.europa.eu/programmes/horizon2020/

[965] http://en.luxinnovation.lu/Services/Advice-on-national-and-European-funding-opportunities/National-funding

[966] http://en.luxinnovation.lu/Services/Advice-on-national-and-European-funding-opportunities/National-funding/Financing-R-D-and-innovation-projects-in-a-company

[967] http://en.luxinnovation.lu/Services/Advice-on-national-and-European-funding-opportunities/National-funding/Financing-eco-technologies-and-sustainable-development

Digital Tech Fund

In 2016, The Luxembourg Government also launched a seed fund (Digital Tech Fund[968]) created jointly with a group of private investors to support the financing and development of start-ups operating in the field of information and communication technologies (ICT), considered as a key sector for the diversification of the national economy[969].

Luxembourg Future Fund

The Luxembourg Future Fund is a EUR 150 million fund which aims to stimulate the diversification and sustainable development of the Luxembourgish economy. It will invest and co-invest in early and growth innovative European technology SMEs as well as in Venture Capital funds[970].

Financial Centre

The proximity of Luxembourg's major international financial centre also offers opportunities for funding of innovative companies although the sector has not been known as a high-risk venture capital investor in the past, with some notable exceptions like Mangrove Capital Partners, a major VC operating in the digital economy worldwide[971].

Start-up accelerators, incubators and co-working spaces

A growing number of start-up incubators and accelerators are also part of the Luxembourg ecosystem:

- Technoport[972]
- Future Lab[973]
- PWC accelerator[974]
- Nyuko[975]
- 1535[976]
- Luxembourg House of Financial Technology (Lhoft)[977]
- Finnolux[978]
- The House of Biohealth[979]
- The Green House[980]

968 http://www.exponcapital.com/funds/digital-tech-fund

969 Luxembourg's new digital tech fun to finance ICT startups, http://www.digital-luxembourg.public.lu/en/actualites/innovation/2016/digital-tech-fund1/index.html

970 Le Luxembourg Future Fund prêt à booster l'innovation, http://paperjam.lu/rendez-vous/le-luxembourg-future-fund-pret-a-booster-linnovation

971 http://www.mangrove.vc/

972 http://technoport.lu

973 http://www.luxfuturelab.lu/

974 https://www.pwcaccelerator.com/pwcsaccelerator/index.html

975 https://nyuko.lu/

976 http://www.1535.lu/

977 http://www.luxembourgforfinance.com/en/products-services/fintech/luxembourg-house-financial-technology

978 http://finnolux.com/

979 http://www.houseofbiohealth.lu/

980 http://www.thegreenhouse.lu

- 6zero1 for social entrepreneurs[981]
- Shaker[982]

These institutions are either privately held, private-public partnerships or publicly held. Some are generalists while others focus on specific sectors or specific type of activities. There are positive signs that the startup scene in Luxembourg slowly gains traction[983],[984] as compared to international trends.

Makerspaces

Makerspaces[985], sometimes also referred to as hackerspaces, hackspaces, and fablabs are creative, Do-It-Yourself spaces where people can gather to create, invent, and learn.

The makerspace movement has also reached Luxembourg with the creation of a first Fablab[986], [987] in 2013, and a second space has been inaugurated in 2016[988].

Also, « Bee Creative[989] », a digital tool Fablab targeted at students and youngsters has been created in 2016. Bee Creative is present in 6 schools across the country and more schools have expressed their interest.

The Learning Factory[990] is a maker space type training centre for the manufacturing industry targeted at empowering resource efficiency and operational excellence.

Representative bodies

The main representative body more specifically dedicated to the digital industry is Luxembourg ICT Luxembourg[991] which works as a « meta-federation » for the trade associations representing the ICT sector in Luxembourg, with the aim to enhance synergies, exchange of information and best practices between all the players of the sector. It supports and fosters ICT related projects and initiatives throughout the country for a strong national positioning and a more effective international reach[992].

The main member organisations of ICT Luxembourg are:

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981 http://www.6zero1.lu/

982 ALD Automotive drives mobility innovation with launch of incubator for startups Shaker, http://www.siliconluxembourg.lu/ald-automotive-drives-mobility-innovation-with-launch-of-incubator-for-startups-shaker/

983 50 start-up «made in Luxembourg» à suivre, http://paperjam.lu/news/50-start-made-luxembourg-a-suivre

984 Vers une « start-up nation » au Luxembourg, http://www.lequotidien.lu/economie/vers-une-start-up-nation-au-luxembourg/

985 Defining Makerspaces: What the Research Says, http://renovatedlearning.com/2015/04/02/defining-makerspaces-part-1/

986 A Fab Lab (Fabrication Laboratory) is an open prototyping platform where knowledge sharing is essential. Tools such as 3D printers, laser cutter, CNC milling machines or a vinyl cutter as well as technical and logistical assistance are available to facilitate invention but equal emphasis is put on fostering a multidisciplinary and intergenerational dynamic between start-ups, artists, designers, architects, engineers, hobbyists, researchers, students and so on.

987 http://www.technoport.lu/online/www/content/fablab/188/ENG/index.html

988 Un deuxième FabLab pour le Technoport,http://paperjam.lu/news/un-deuxieme-fablab-pour-le-technoport

989 http://www.bee-creative.lu/

990 http://www.learningfactory.lu/?lang=en

991 http://ictluxembourg.lu/

992 Entrevue du gouvernement avec ICTLuxembourg, http://paperjam.lu/communique/entrevue-du-gouvernement-avec-ictluxembourg

- **FEDIL ICT**[993], which represents the leading players of the Luxembourg Information and Communications Technology sector. It acts as the voice and the principal interest group of the digital technology industry. The member companies range from innovative SMEs to major ICT companies[994].

- **APSI** (Association des Professionnels de la Société de l'Information)[995] , is a business federation focusing on the ICT industry in general. Its mission is to inform, represent and defend the interests of member companies and participate in the promotion of the ICT sector information in Luxembourg.

- **FDI**, the Federation of Integrators in Telecommunications, IT, Multimedia and Security represents a group of professionals with interests covering all activities in ICT, multimedia and security systems.

Associate members are:

- **ALFI** - The Association of the Luxembourg Fund Industry[996] is the official representative body for the Luxembourg investment fund industry and was set up in November 1988 to promote its development. ALFI has initiated the "ALFI FinTech Forum" to analyse the impact of fintech on the investment fund industry.

- **APSFS**[997] is the association informing, helping and encouraging synergies between member companies and the proactive treatment of subjects directly linked to the development of the Support PSF industry[998].

- **AAC**[999], the association of collective antennas operators

- **ABBL**, the Luxembourg Bankers' Association is the professional organisation representing the majority of banks and other financial intermediaries established in Luxembourg. Its purpose lies in defending and fostering the professional interests of its members. As such, it acts as the voice of the whole sector on various matters in both national and international organisations[1000].

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993 The Business Federation Luxembourg (Fedil) was founded in 1918 and is representing companies in the sectors of industry, construction and business services. FEDIL's main objectives are to defend the professional interests of its members and analyse all economic, social and industrial issues relating thereto, to develop the spirit and solidarity among Luxembourg employers. Maintaining regular contact with the national and European levels with politicians, public authorities, the business community and trade unions, the FEDIL strives to influence political and administrative decisions in the interests of free enterprise. In order to promote the Luxembourg economy, the FEDIL also participates in numerous trade missions abroad. Its subsidiary Fedil ICT represents the platform for ICT companies that are also member of Fedil Business Federation. Since 1983, Fedil has been handing out the Innovation Award of Fedil as a way to encourage creativity and innovation. This award is handed out every 2 years.

994 http://www.fedil.lu/fr/fedil-ict-asbl/about-fedil-ict-asbl/

995 http://www.apsi.lu/

996 http://www.alfi.lu/

997 http://www.supportpsf.lu/

998 All natural or legal persons who exercise a professional activity within the financial sector are subject by law to authorisation and ongoing regulation by the financial services supervisory authority (Commission de surveillance du secteur financier - CSSF). In addition to banks, the law targets a vast range of "financial sector professionals" known as PSF (to use the French acronym). It distinguishes between three types of activity: the PFS investment firm, "specialised" PSF and "support" PSF., http://www.luxembourgforfinance.com/en/products-services/psf

999 http://aac.lu/

1000 http://www.abbl.lu

- **OPAL** is the association of alternative Telco operators[1001]

- **EUROCLOUD** Luxembourg[1002] was founded in December 2009 with the support of Fedil - Business Federation and the ABBL, in an impulse to position Luxembourg on the European map for Cloud Computing and SAAS, and encourage the adoption of such technologies at the national level. It is also part of the larger pan-European network, EuroCloud Europe.

Regulators and governance bodies

Media and Communication Service (Service des Médias et des Communications - **SMC**) was established in 1991. Its missions are media regulation, protection of data and the digital economy. The current Prime Minister Mr. Xavier Bettel is also Minister for Communication and Media.

The Luxembourg Institute of Standardisation, Accreditation, Safety and Quality of Products and Services (Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services - **ILNAS**[1003]) is a public service under the authority of the Minister in charge of the Economy. ILNAS is a competency network at the service of competitiveness and consumer protection. ILNAS represents Luxembourg's interests in the European and the international standardization organizations.

ILNAS's terms of reference in the field of standardization are:

- to organize, coordinate and develop the wording, dissemination and implementation of normative documents at national level;
- to ensure the participation of the various economic sectors in the development of European and International standards;
- to implement European standards at national level;
- to set up a standards watch;
- to promote the use of standards.

The Luxembourg Institute for Regulation (Institut Luxembourgeois de Régulation - **ILR**[1004]) regulates the telecommunications, energy sector and postal services. It is an independent regulator which is financed by the operators of the sector. The ILR competence is to stimulate and guarantee competitiveness, to determine the fees and conditions at which communication networks are operated, to prepare statistics, annual reports and regulations. ILR can also lead sanctions against operators, which infracted laws or regulations. The ILR sets rules in accordance with European directives and national laws.

The National Commission for Data Protection (Commission Nationale pour la Protection des Données – **CNPD**[1005]) is an independent authority created by the Act of 2 August 2002 on the protection of individuals with regard to the processing of personal data. It verifies the legality of the processing of personal data and ensures the respect of personal freedoms and fundamental rights with regard to data protection and privacy.

The Surveillance Commission of the Financial Sector (Commission de Surveillance du Secteur Financier - **CSSF**[1006] is a public institution which supervises the professionals and products of the Luxembourg financial sector. It supervises, regulates, authorizes, informs, and carries out on-site inspections and issues sanctions. Moreover, it is in charge of promoting transparency, simplicity and fairness in the markets of financial products and services and is responsible for the enforcement of laws on financial

1001 http://opal.lu

1002 http://www.eurocloud.lu/

1003 https://portail-qualite.public.lu/fr/index.html

1004 http://www.ilr.public.lu/

1005 http://www.cnpd.public.lu

1006 https://www.cssf.lu/

consumer protection and on the fight against money laundering and terrorist financing. It responds to the following objectives:

- to promote a prudent business policy in compliance with the regulatory requirements,
- to protect the financial stability of the supervised companies and of the financial sector as a whole,
- to supervise the quality of the organization and internal control systems,
- to strengthen the quality of risk management.

The « Haut-Commissariat à la Protection nationale - **HCPN**[1007] **»** also acts a regulatory authority in Luxembourg.

The initiative « Security made in Luxembourg » (**SMILE**[1008]) launched in February 2015 is the online source for cyber security in Luxembourg. Its goal is to provide news, relevant information as well as a toolbox with useful cyber security solutions for private users, organizations and the ICT community. It centralizes, all news and other valuable material from its three fields of activity (CASES, AWARE and CIRCL). It builds on the integration of the pre-existing services, infrastructure, platforms, experience and competence of partners, and thus represents a central place for information security awareness-raising, information, support and problem solving material. SMILE also initiates new markets with high added value to deliver high-quality services accessible to municipalities, SMEs and companies of every size, by developing new solutions and competent services for the Luxembourg economy.

Cyberworld Awareness and Security Enhancement Services (**CASES**) and Cyber Emergency Response Community Luxembourg (**CERT**) are institutions whose objectives it is to create a community gathering of all security professionals under one label and platform and to represent the sector on all national and international levels.

The Computer Incident Response Centre Luxembourg (**CIRCL**) is an initiative designed to provide a systematic response facility to computer security threats and incidents. CIRCL provides a reliable and trusted point of contact for any users, companies and organizations based in Luxembourg, for the handling of attacks and incidents. CIRCL's aim is to gather, review, report and respond to cyber threats in a systematic and prompt manner[1009].

LU-CIX stands for Luxembourg Commercial Internet exchange. LU-CIX was founded in 2009 based on a cross-industries initiative set up by major national and international Internet players, with the aim of developing the Internet in Luxembourg.

INCERT GIE is a national economic interest group managing IT critical infrastructures from the State of Luxembourg, personalizing smart cards, and representing the country at international technical committees. INCERT GIE has been founded in 2012 by the State of Luxembourg and the Luxembourg Chamber of Commerce, both having identified the need to centralize some IT critical infrastructures. Within the aim to constantly improve its information security and operational activities, INCERT GIE has initiated end of 2013 a certification process against ISO/IEC 27001 standard and that includes all its business and internal services. This process has been successfully completed and INCERT GIE has been certified in January 2014

Finally, there is **Luxtrust**[1010], a public limited company that provides IT services, created and supported by State, institutional and private partners. Its mission is to guarantee the digital identity and security of the electronic data of companies and citizens. LuxTrust's ambition is to increase trust in the digital economy in

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1007 http://www.gouvernement.lu/hcpn

1008 "security made in Lëtzebuerg" (SMILE) g.i.e.'s public service (including CIRCL, CASES and AWARE) its partner initiatives and other activities are henceforth promoted under the name SECURITYMADEIN.LU., https://securitymadein.lu

1009 These descriptions are taken from « E-Skills Study - Strategies for the creation of a virtual e-skills training centre in Luxembourg. Luxembourg », Ant, M., Goetzinger, P., & Binsfeld, N. (2016)

1010 https://www.luxtrust.lu

order to make life simpler for citizens and encourage cost reductions for businesses. LuxTrust deploys a large range of solutions to be integrated in the process of securing electronic documents or online transactions, authentication of their authors and of application users online. They also make it possible to sign electronic documents and operations conducted online, as well as to time-stamp them.

The media

IT One[1011], the ICT Community of Luxembourg, was created in 2007. IT One strives for the recognition of Luxembourg's ICT community, the development of the entire sector and the promotion of its professionals as well as for the diffusion of best practices, innovative solutions and valuable services. IT One's Luxembourg-based leading web portal deals with ICT trends and topical issues at national and international scales. In order to promote the sector, IT One organizes awards and events, such as the IT One Gala where the best national practices are rewarded with the Luxembourg ICT Awards, the ICT Spring Europe[1012], a two-day event that brings together more than 4000 ICT key decision makers from all over the world and IT Days Luxembourg, and the Information Security Days, a two-day event focused on security, gathering in one venue security specialists, CIOs and key decision makers from different Europeans countries.

ITnation[1013] is a magazine specialized in B2B communication, news and event organization for ICT professionals.

Paperjam[1014] is the leading magazine for the business world in Luxembourg and strongest media brand in the country founded in 2000. The Paperjam Club is an essential platform in Luxembourg which was launched in 2008. The club consists of over 600 member companies and over 4,000 executive members. It offers its members a variety of events, allowing exchange of knowledge and ideas through networking. The Club is approved by the Ministry of Economy.

Founded in 2013, **Silicon Luxembourg**[1015] is a media channel designed to profile start-ups and promote entrepreneurial activity in Luxembourg[1016].

Other activities

Startup-days[1017], hackathons[1018] and jams complete the innovation ecosystem landscape in Luxembourg.

Some of these initiatives directly target digital transformation whilst other are more general initiatives in R&D, innovation and entrepreneurship. But as we have seen, digital transformation is a horizontal phenomenon and thus has to transgress every initiative in order for them being strategically relevant and real value creators in the long term.

A more comprehensive list of stakeholders and initiatives can be on Digital Lëtzebuerg's website[1019].

Bold projects

Beyond this whole series of initiatives that altogether support innovation, entrepreneurship and digital transformation in a way or another, the current government has also set up a series of bold projects that,

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1011 http://www.itone.lu/

1012 http://www.ictspring.com/

1013 http://www.itnation.lu/

1014 http://paperjam.lu/

1015 http://www.siliconluxembourg.lu/

1016 These descriptions are taken from « E-Skills Study - Strategies for the creation of a virtual e-skills training centre in Luxembourg. Luxembourg », Ant, M., Goetzinger, P., & Binsfeld, N. (2016)

1017 Build an amazing startup in Luxembourg, all over the course of one weekend., http://www.up.co/communities/luxembourg/luxembourg/startup-weekend

1018 FIRST HACKATHON A GREAT SUCCESS, http://www.digital-luxembourg.public.lu/en/actualites/e-administration/2016/20160413_hackathon/index.html

1019 http://www.digital-luxembourg.public.lu/en/acteurs/index.php

apart from supporting national innovation in the digital economy, also put Luxembourg on the international agenda.

Digital Lëtzebuerg

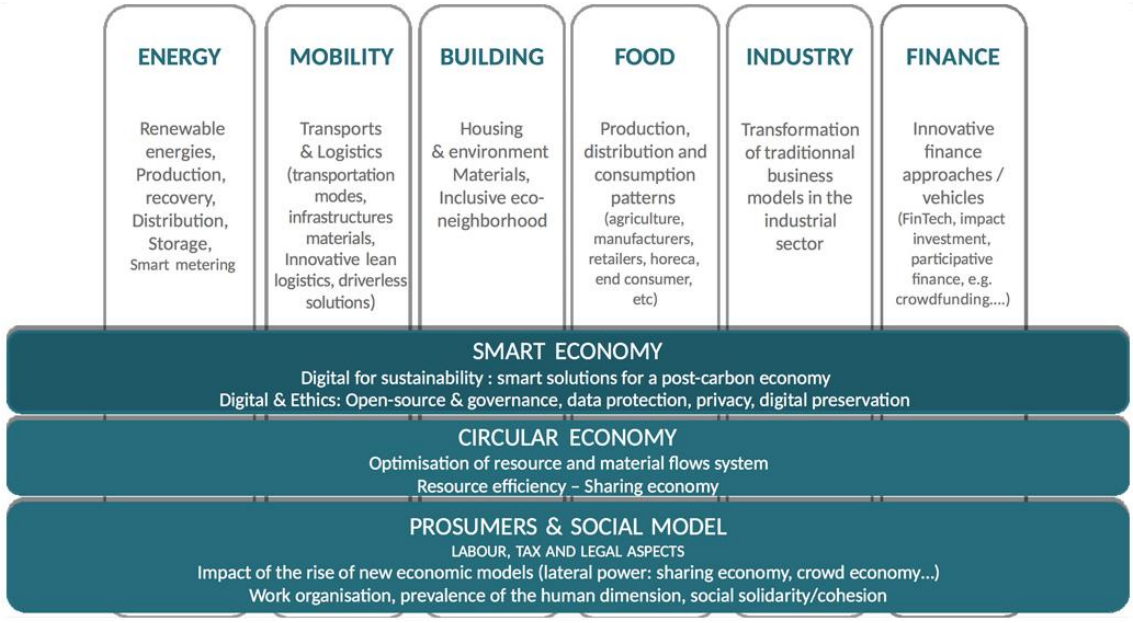
The current government of Luxembourg sought to provide a common umbrella for the numerous public and private initiatives that make up the country's digital economy and society. Thus, in autumn 2014, the Digital Lëtzebuerg initiative was launched.

Digital Lëtzebuerg acts as a coordinator and synergy seeker for all existing initiatives as well as an initiator in areas where action is still necessary.

The Digital Lëtzebuerg website [1020] regularly publishes news and blog posts to all digital transformation related activities in the country.

The Third Industrial Revolution (Rifkin-process)

The Ministry of the Economy together with the Chamber of Commerce and IMS Luxembourg hired US expert Jeremy Rifkin to advise the government on a transition plan towards the so called 3rd Industrial Revolution (see first chapter). The process is a highly participative bottom-up process with 319 people from different backgrounds (civil society and topical experts) participating, and has been split in 6 vertical and 3 horizontal working groups, and the civil and professional society has been invited to co-create a possible master plan. A significant number of ideas have been generated, and most of the working group coordinators are more than happy with the quality and quantity of useful proposals that the process has been able to generate. The first final results of the process are expected for late fall 2016. The challenge will then be to continue to tap into the 319 particpants' (and beyond) collective intelligence for designing and implementing the outcomes so as to make this highly strategic project a true end-to-end participative process, a necessary condition for a large adoption by all stakeholders of society and the economy.



High Performance Computing (HPC)

Luxembourg has managed to get the lead of a 6 billion € European IPCEI project (Important Project of Common European Interest) for the implementation of a super-computing project (High Performance Computing - HPC), which is a project of common European interest together with partner countries

[1020] http://www.digital-luxembourg.public.lu

France, Spain and Italy[1021]. It is the second time ever that such a project has been created. The first time was with Airbus, 17 years ago.

On a global level, Europe is falling behind in both HPC and Big Data. Only one European supercomputing facility ranks among the world top 10 supercomputers, whereas China holds the first position and the U.S. hosts 5 of the top 10 facilities. The risk that Europe becomes technologically locked, delayed or deprived of strategic know-how is very real. There is an increasing recognition of the strategic security and economic impact of HPC enabled applications.[1022], [1023], [1024].

Space Mining

Space Resources[1025] is another bold project in which the government of Luxembourg engaged in 2016. Luxembourg is thus pionnering investment in asteroid mining, with a pledge of €200m in funding for the space-mining industry. So far, US-based Planetary Resources[1026] and Deep Space Industries[1027] have agreed to open offices there.

Luxembourg is thus the first European country to set out a formal legal framework which ensures that private operators working in space can be confident about their rights to the resources they extract, i.e. valuable resources from asteroids. Such a legal framework will be worked out in full consideration of international law. The Grand-Duchy aims to participate with other nations in all relevant fora in order to agree on a mutually beneficial international framework. According to a recent declaration by the Minister of The Economy, Mr. Etienne Schneider, the project would advance rather quickly and that the government will probably also create a « National Space Agency »[1028].

Luxembourg's current involvement is not the first time it has played an important role in the space industry. In 1985, the government helped fund the commercial satellite start-up SES, which initially had only one customer. Today, SES is the largest commercial satellite operator in the space industry.

Digital technologies including optical vision and autonomous robots are essential for this visionary project to become reality.

The University of Luxembourg's Interdisciplinary Centre for Security, Reliability, and Trust (SnT)[1029] will develop an optical vision system for the Deep Space Industries' experimental Prospector-X spacecraft.

1021 IPCEI project: Luxembourg, France, Italy and Spain signed the agreement, http://hpc.cineca.it/news/ipcei-project-luxembourg-france-italy-and-spain-signed-agreement

1022 Luxembourg launches Supercomputing Project, http://ec.europa.eu/commission/2014-2019/oettinger/blog/luxembourg-launches-supercomputing-project_en

1023 What's the deal with Luxembourg's supercomputer?, http://www.wort.lu/en/business/luxembourg-leads-europe-in-supercomputer-race-what-s-the-deal-with-luxembourg-s-supercomputer-56a64feb0da165c55dc51d84

1024 "HPC", une idée à six milliards d'euros, http://www.wort.lu/fr/economie/le-luxembourg-aux-manettes-hpc-une-idee-a-six-milliards-d-euros-56a5f0050da165c55dc51d2d

1025 http://www.spaceresources.public.lu

1026 http://www.planetaryresources.com

1027 http://deepspaceindustries.com/

1028 «Nous avons été plus malins que les Américains», http://paperjam.lu/news/nous-avons-ete-plus-malins-que-les-americains

1029 The Interdisciplinary Centre for Security, Reliability and Trust (SnT) at the University of Luxembourg contributes to establishing Luxembourg as the European centre of excellence and innovation for secure, reliable and trustworthy ICT systems and services. The interdisciplinary approach brings together expertise from engineering, natural, law, and human/social sciences to address common challenges. SnT fosters interaction and collaboration with industrial, international and government partners, http://wwwen.uni.lu/snt

The research group at the University of Luxembourg's Automation and Robotics Research Group, which is part of the university's SnT Centre, has built up expertise in robotic automation and unmanned aerial vehicle vision systems[1030], [1031].

Luxembourg Automotive Campus

With an already well-established leading edge automotive components industry in Luxembourg[1032], [1033] and in the light of tremendous opportunities in the future of the automotive and mobility industries, the government of Luxembourg unveiled its plan for a future industrial site specialising in automotive component R&D in 2016. The future "Luxembourg Automotive Campus" will house the research and development departments of several automotive sector companies. The project includes plans for shared infrastructure, such as research labs and buildings, conference rooms, catering areas and exhibition spaces.

Challenges & Opportunities

In view of the Innovation Ecosystem described in Box 11, it looks like Luxembourg's ecosystem is well set-up in view of the listings and descriptions of the previous chapter. At the same time, we have also seen that Luxembourg is performing insufficiently well in terms of digital adoption by local business and by public services.

The picture is somehow mitigated and it is not straightforward what that means for Luxembourg's real capacity to manage digital transformation successfully at a systemic level[1034].

Luxembourg also faces some more general economic, social and sustainability challenges that might interfere with its digital transformation capacity[1035].

In this chapter, we will mention those general challenges, depict some specific opportunities for Luxembourg and make some recommendations for the specific digital transformation challenges.

General challenges

General economic challenges that are well identified by decision makers:

- The open, export-oriented economy is highly dependent on international demand and external decisions
- High dependency on the financial sector and some other big corporations (economic diversification must stay a top priority)
- High dependency on foreign workforce and capital
- High volatility of some fiscal incomes

1030 Deep space mine: Luxembourg's robot experts have their sights on asteroid mining, http://www.zdnet.com/article/deep-space-mine-luxembourgs-robot-experts-have-their-sights-on-asteroid-mining/

1031 Luxembourg takes first steps to 'asteroid mining' law, http://phys.org/news/2016-06-luxembourg-asteroid-law.html

1032 http://www.automotivecomponents.lu

1033 Almost all cars worldwide rely on at least 1 key component developed in Luxembourg.

1034 In A Globalized World, Fixing Problems Means Fixing Systems, https://www.fastcoexist.com/3025056/in-a-globalized-world-fixing-problems-means-fixing-systems

1035 Actualité & tendances N° 10- Bulletin économique de la Chambre de Commerce: Le développement durable au Luxembourg – Pour une économie durablement compétitive et au service du bien-être, http://www.cc.lu/uploads/media/Actualit%C3%A9***Tendances*n*10-brochure*pdf.pdf**

- Under these conditions, difficulties to make reliable economic forecasts and thus long term planning
- Pressure for structural reforms in pensions and healthcare to ensure future financial viability and social cohesion
- High and increasing housing and office rent prices
- Sub optimal energy efficiency and renewable energy share
- The IMD World Competitiveness Yearbook 2016 also ranks Luxembourg only at position 49 for start-up opportunities.
- Sustainability issues in terms of infrastructure due to the high afflux of new workforces every year that are already affecting quality of life

Innovation efficiency

Public spending in R&D and innovation are relatively high and have been steadily increasing in recent years. But there is a general questioning about the efficiency and the real socio-economic impact of this spending. It appears that applied R&D is not well developed, that collaboration between the research and academic community and the society and the economy must be further improved, and that the innovation value creation continuum « invent-execute-adopt » is often stuck at the stage of invention. This might be linked to how the funding programs are shaped but also to the fact that innovation has become more diverse and complex in recent years[1036]. It's not about mere technological innovation anymore. But it also appears that these phenomena are quite difficult to depict with existing traditional microeconomic and macroeconomic accounting techniques. The phenomenum is generally know as « the valley of death in innovation »[1037], [1038]

New approaches such as,

- Intellectual Capital reporting[1039], [1040]
- Dynamic mapping using big data[1041], [1042], [1043]

1036 It's Time To Build A National Innovation Infrastructure, http://www.forbes.com/sites/henrydoss/2016/06/01/its-time-to-build-a-national-innovation-infrastructure/#6c1688e17072

1037 A Valley of Death in the Innovation Sequence: An Economic Investigationhttp://www.phoenix-center.org/FordVoDAEA2008.pdf

1038 Bridging the valley of death: improving the commercialisation of research http://www.publications.parliament.uk/pa/cm201213/cmselect/cmsctech/348/348.pdf

1039 Intellectual Capital Reporting for Regional Cluster and Network Initiatives, http://www.rkk.hu/rkk/nyuti/pages/kiadvany*2007*RICARDA*Manual*eng.pdf

1040 Intellectual Capital as a Key Factor of Socio-economic Development of Regions and Countries, http://www.sciencedirect.com/science/article/pii/S2212567113001421

1041 Innovation Analytics: A guide to new data and measurement in innovation policy , http://www.nesta.org.uk/blog/innovation-analytics-guide-new-data-and-measurement-innovation-policy

1042 http://www.nesta.org.uk/publications/innovation-analytics-guide-new-data-and-measurement-innovation-policy

1043 "The volume of data – both public and private – that can be employed in principle in measuring the economy, together with the technological capacity for handling it, has exploded as a result of the digital revolution" - Independent review of UK economic statistics: final report, https://www.gov.uk/government/publications/independent-review-of-uk-economic-statistics-final-report

- Social Impact Assessments[1044], [1045], [1046] based on Logic models[1047], [1048]

might be paths to explore in order to get a clearer picture about the country's real innovation efficiency, an evidence- based understanding that is necessary if adjustments have to be made.

As a related issue, scholars also start to question whether existing GDP and productivity measures are up to the challenges of the digital economy characterised by disintermediation, new types of service provision and consumption, shifting value chains[1049] and radical internationalisation[1050], [1051].

Financial incentives for entrepreneurship and business investment

Like other countries (Germany, France, Belgium, UK), the government should vote a new type of « Loi Rau », meaning a financial incentive for private persons to invest in startups and innovative SME ventures. Luxembourg residents are traditionally risk averse, investing mainly in real estate, and such incentives could help to reorient part of resident savings into investing in the country's future[1052].

The government should also consider creating new types of financial instruments in terms of stock options and phantom stock options[1053] for startups. Salaries are high in Luxembourg, which puts a considerable barrier on startups and their founders. This kind of financial instrument could help to counterbalance that barrier effect.

Luxembourg also has a high density of family offices. Those family offices do not tend to consider the internal Luxembourgish market for investment, another area where the government could take some action in terms of incentives.

Last but not least, many digital businesses can be relocated within a week if they judge the conditions in which they operate no more attractive enough. The low barrier to delocalisation for digital businesses literally asks for attractive financial instruments implemented in an agile way.

SMEs

In overall terms, Luxembourg SME's are lagging behind in digital transformation according to the annual EU DESI index and we've seen that only 7% of them sell online at a 14% EU average.

There is probably more than one reason for that situation, and cultural aspects may play an important role and barrier, along with the more economic reasons we have already been outlining.

1044 Measure Your Social Impact, http://www.sametrica.com

1045 The solution for impact management, http://www.sinzer.org/

1046 Why measuring social impact has become just as important for companies as doing the 'right things', http://business.financialpost.com/entrepreneur/companies-are-realizing-that-measurement-of-the-right-things-is-as-central-to-business-practice-as-engaging-in-them

1047 Using a Logic Model, http://toolkit.pellinstitute.org/evaluation-guide/plan-budget/using-a-logic-model/

1048 Logic Models, http://fyi.uwex.edu/programdevelopment/logic-models/

1049 The second economy, http://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/the-second-economy

1050 Are GDP and Productivity Measures Up to the Challenges of the Digital Economy?, http://www.csls.ca/ipm/30/ahmadandschreyer.pdf

1051 How Well Does GDP Measure The Digital Economy?, http://seekingalpha.com/article/3989913-well-gdp-measure-digital-economy

1052 Chacun peut devenir business angel, http://paperjam.lu/rendez-vous/chacun-peut-devenir-business-angel

1053 https://en.wikipedia.org/wiki/Phantom_stock

What is missing is a thorough understanding of this lagging behind, an understanding that is necessary for a possible evidence-based action plan. In practice, there are opportunities for innovation through digital transformation in every sector and for companies of all sizes[1054].

In view of the strategic importance, a widespread study based on a digital maturity model would be helpful to get a clear picture of the current digital transformation capacity of Luxembourg's SMEs. A subsequent action plan including incentives to participate could help to trigger a trend reversal here. In such an action plan, digital transformation should not only be approached from a technological point of view, but should also include customer experience management concepts, innovation management frameworks, as well new forms of organizational design, as they are all aspects of the same coin. As change management will the most important activity for ensuring the transition of Luxembourg SMEs to digital enterprises with an end-to-end digitization of their value chains and business models, a new governmental program « Fit-for-change » would make sense. Such a program could embrace other existing programs like fit-for-digital and fit-for-innovation, but would semantically better illustrate the challenges at stake.

The action plan should also aim at incorporating SMEs needs in terms of professional (initial training and vocational training related to digital transformation. Strengths and weaknesses of the related ecosystem, also including the public education system, must be addressed as well, in synergy with other exiting initiatives in order to avoid redundancies by embracing a lean approach.

Multinational corporations that are based in Luxembourg are much less concerned, as they usually get their strategies defined by their headquarters abroad. Also, they are exposed to globalised international markets where competition is much fiercer and pushes them more quickly to adopt new management models and business strategies.

Public services

Public services are also lagers in digital transformation, according to the DESI index. Although a lot of efforts have been made in recent years in the area of e-government at the frontend, it appears that back office dematerialization is much less developed in Luxembourg compared to front running jurisdictions. Again, cultural reasons might be at the origin here, but also a lack of understanding by decision makers of the tight intertwining of today's technologies and management models.

Recent announcements of the « once only[1055], [1056] » and « digital-by-default[1057] » strategies are well consistent with the EU e-government strategy but do not seem to address the root of the challenge, and are rather features of a system than a strategy.

In general government agencies need much more disruptive innovation - not only in Luxembourg -, outside organizational silos, as incremental innovation tends to improve isolate parts of the system at the expense of ever-rising total costs.

We have also seen that government organisations face big challenges on many levels to keep pace with digital transformation under all its aspects and artefacts which can become a considerable risk. But governments should be enablers of the digital economy.

1054 Fleischerhandwerk will Chancen der digitalen Welt nutzen (Das Fleischerhandwerk hat Nachwuchssorgen. Gleichzeitig bemüht die Branche sich, den Anschluss an das digitale Zeitalter zu finden – etwa mit Online-Bestellkonzepten und Smartphone-gesteuerten Abhol-Kühlfächern), http://www.heise.de/newsticker/meldung/Fleischerhandwerk-will-Chancen-der-digitalen-Welt-nutzen-3343357.html

1055 The "once-only" principle means that citizens and businesses should supply the same information only once to a public administration. - EU e-Government Action Plan 2016-2020. Accelerating the digital transformation of government, http://thegovlab.org/eu-e-government-action-plan/

1056 European eGovernment Action Plan 2016-2020, https://ec.europa.eu/digital-single-market/en/european-egovernment-action-plan-2016-2020

1057 Digital-by-default requires that each public service and procedure is digitized including a digital interface with users.

And with an ever-growing population, changing citizen expectations and needs and rising complexity, pressure on public services won't decrease. That's why more and more governments put in place so called public innovation labs as they all share the same challenges[1058], [1059], [1060], [1061].

With a growing digital divide between the private and the public sector, and at the speed digital transformation currently moves on, the risk is that public services become decelerators of an ever more digitized and speedy economic process, not running smoothly enough in the interconnected global socio-economic system.

For example, instead of only positioning digital readiness of public agencies in the context of an EU average, bilateral benchmarks with digital champion countries like Estonia or Singapore could act as an accelerator in public service digital transformation.

Regulation

We have seen that Luxembourg has 5 different regulation authorities, each covering a different type of activity. That means that according to the type of activity of a specific company, it may need compliance clearing from one or more of them (for an example an IT provider that also is a telco operator and has financial institutions as well sensible government agencies as their clients). As each regulation authorities is only charged to take care of its « silo of competence », obtaining a compliance clearing can become a heavy or even prohibitive administrative burden.

Knowing that in global international competitiveness agility and experimental attitudes help companies to speed up their innovation processes, Luxembourg's regulation authorities should embrace a collaborative approach between themselves but also with business, in order to support sustainable economic value creation. Regulation authorities need to embrace the big picture of economic development and the ethical challenges of Digital Transformation. They should act as a coach for companies, as co-creators of opportunities.

In other words, regulation should be considered as a business case, and not merely as control and compromising act. Other countries also understood these challenges[1062], [1063]. Future sustainable growth in a globalised, complex and speedy environment is a shared community objective.

Fintech & Regtech

Luxembourg is the leading financial centre of the Eurozone and the second in the EU after London (Z/Yen London[1064]) and the sector accounts for more than 30 % of national tax income. Over the years, the place has been able to accumulate and attract a lot of highly valuable skills.

1058 http://www.theiteams.org/

1059 The landscape of public sector innovation labs, http://www.designforeurope.eu/news-opinion/landscape-public-sector-innovation-labs

1060 The rise of innovation labs in the public sector (part 1), http://www.lipse.org/blogpost/item/11

1061 The rise of innovation labs in the public sector (part 2), http://www.lipse.org/blogpost/item/12

1062 See for example the September 2016 updated « AKTIONSPROGRAMM DIGITALISIERUNG - 12 Punkte für die Digitale Zukunft » by the German Ministry of the Economy and Energy, also including other highly relevant digital transformation policy action points, https://www.bmwi.de/DE/Mediathek/publikationen,did=780630.html

1063 Gabriel will Verschlüsselung, Uber und Breitbandnetze beflügeln, http://www.heise.de/newsticker/meldung/Gabriel-will-Verschluesselung-Uber-und-Breitbandnetze-befluegeln-3331282.html

1064 Luxembourg Confirmed as Leading Eurozone Financial Centre, http://www.luxembourgforfinance.com/en/news/luxembourg-confirmed-leading-eurozone-financial-centre

In view of the **Fintech** [1065] , [1066], [1067] hype, and the disruptive forces[1068], [1069], [1070] that analysts predict that Fintech will have on traditional banks and other financial service providers, Luxembourg should be very vigilant and have a proactive plan to defend its economic position.

Luxembourg has a well-developed IT sector that has been providing IT solutions for the financial sector for many years. But those providers were providing the legacy systems for operating a traditional bank. Fintech, however, is about disrupting the traditional bank's business model in many ways, and note merely to provide IT support systems for the existing. Fintech thus follows a different state of mind that has to enter the banker's DNA.

Figure 2

Customer and partner ecosystems are emerging

The ecosystem around customers will be built to cater to a range of customer-needs beyond traditional banking services

The ecosystem of partners, such as fintechs, will extend bank capabilities and support operational scalability

Source: IBM Institute for Business Value analysis.

1065 Financial technology, also known as FinTech, is a line of business based on using software to provide financial services. Financial technology companies are generally startups founded with the purpose of disrupting incumbent financial systems and corporations that rely less on software. - Fintech definition, https://www.fintechweekly.com/fintech-definition

1066 What is 'Fintech'? , http://www.investopedia.com/terms/f/fintech.asp

1067 What is FinTech and where does it Live?, https://www.finextra.com/blogposting/12890/what-is-fintech-and-where-does-it-live

1068 Finanztechnik-Start-ups: Die Lümmel von der neuen Bank, http://www.spiegel.de/wirtschaft/fintech-start-ups-bedrohen-banken-branche-a-1052341.html

1069 Fintech Startups Face Dilemma on Banks: Are They Friend or Foe?, http://blogs.wsj.com/moneybeat/2016/09/02/fintech-startups-face-dilemma-on-banks-are-they-friend-or-foe/

1070 Fintech and the Evolving Landscape - Landing points for the industry structure, http://www.fintechinnovationlablondon.co.uk/fintech-evolving-landscape.aspx

(Source[1071])

The illustrations above show the many disruptive forces at work in Fintech.

With the creation of LHoFT (Luxembourg House for Fintech)[1072], a strong collective platform where all fintech stakeholders can meet and connect, ask for advice, share knowledge and learn from each other has been established. The financial sector and the rest of the business world are expecting the LHoFT to feed the ecosystem. LHoFT's first and foremost mission is to help entrepreneurs translate their innovative and sophisticated ideas into operational products. LHoFT will have one peculiar characteristic: It will not only parent, support and look after young start-ups, it will also advise long-established financial incumbents who are looking for new business opportunities. Fintech companies, as well as financial industry actors, need a strong partner who is able to identify interfaces.

In September 8th 2016, another Fintech incubator opened its doors in Luxembourg, called Fintech Zone. The FinTech Zone, is an independent FinTech centre and a place where local, as well as international

[1071] Banking redefined: Disruption transformation and the next-generation bank, https://www.linkedin.com/pulse/banking-redefined-disruption-transformation-bank-peter-j-korsten

[1072] http://paperjam.lu/news/la-lhoft-prend-un-peu-plus-de-substance

Fintech start-ups, who want to create a presence in Luxembourg, can call home[1073], [1074]. Fintech is definetely on the Luxembourg agenda now[1075], [1076], [1077], [1078].

Some other countries and financial centres have been quicker in embracing the opportunities that Fintech[1079], [1080] offers[1081]. Thus, the competition is not sleeping, and Luxembourg has to make efforts to catch up with the dynamics and creativity of other Fintech hubs around the world.

Together with the financial sector, Luxembourg also hosts an important legal industry including compliance reporting required by regulation. The Finance Industry underlies a series of strict regulation rules and the presence of many EU institutions in Luxembourg also boots local demand for compliance know how. **Regtech** is the term used for innovative digital solutions to regulation. Luxembourg certainly has a role to play in that area as well[1082], [1083], [1084], [1085], [1086], [1087].

Reinforcing existing economic priorities and other assets

The Luxembourg government supports, apart from the important financial sector, a series of other sectors that are organised in clusters as we have seen.

Sectors like logistics, ecotechnologies, health technologies, automotive components industry, maritime activities and materials and production technologies are all potentially disrupted by digital transformation, on the one side, and are already today intensive users of digital technologies within their production function on the other side.

Economic policy should therefore intensify the search for synergies between the existing clusters and disruptive innovation through AI, the Internet of Things, Robotics, 3D Printing and Big Data.

1073 The FinTech Zone: Luxembourg's first Independent FinTech Centre, http://finnolux.com/tag/fintech-zone/

1074 Connecter fin et tech, http://paperjam.lu/news/connecter-fin-et-tech

1075 Le Luxembourg sur la carte des fintech avec ses atouts, http://paperjam.lu/dossier/2016/07/technologies/#/page-119916

1076 « Fin » & « tech » – un mariage qui promet ! (1/3), http://www.carlothelenblog.lu/2016/09/08/fin-tech-un-mariage-qui-promet/

1077 « Fin » et « tech » – une révolution culturelle dans la finance (2/3), http://www.carlothelenblog.lu/2016/09/23/fin-et-tech-une-revolution-culturelle-dans-la-finance-23/

1078 «Fin» & «tech»: l'union fera la force de l'industrie au Luxembourg (3/3), http://www.carlothelenblog.lu/2016/10/13/fin-tech-lunion-fera-la-force-de-lindustrie-au-luxembourg-33/

1079 Top 10 Fintech News Sites and Blogs, http://fintechnews.sg/581/fintech/top-fintech-sites-and-blogs/

1080 Everything You Wanted to Know About FinTech in Europe, https://letstalkpayments.com/everything-you-wanted-to-know-about-fintech-in-europe/

1081 7 FinTech hubs worth looking at, https://www.untapt.com/blog/2015/08/17/7-fintech-hubs-worth-looking-at/

1082 Is RegTech the new FinTech?, http://www2.deloitte.com/ie/en/pages/financial-services/articles/RegTech-is-the-new-FinTech.html

1083 What is Regtech? And Why is it Becoming the Next Big Thing? https://complyadvantage.com/what-is-regtech/

1084 21 Hottest RegTech Startups That Are Defining the Industry, https://letstalkpayments.com/21-hottest-regtech-startups-that-are-defining-the-industry/

1085 10 keys to understand what regtech is all about, https://info.bbva.com/en/news/general/10-keys-understand-regtech/

1086 RegTech in Financial Services: Technology Solutions for Compliance and Reporting,https://www.iif.com/file/14970/download?token=vx29uy05

1087 Ces start-up qui « ubérisent » le droit, http://www.lesechos.fr/politique-societe/societe/0211219136234-ces-start-up-qui-uberisent-le-droit-2024004.php

On the infrastructure side, Luxembourg is well advised not to rest on its achievements and top ranking in terms of high quality connectivity, equipment penetration and data centres, as the speed of development of the digital economy is expected to continue exponentially. Infrastructure should be continuously expanded and further developed ahead of immediate needs, as it has been the case until now, if Luxembourg wants to keep its competitive advantage in that area.

Luxembourg is a highly mobile society and so are its citizens and its business people, travelling in and out the country literally every day. Globally, mobile business applications are a growing market. Given the Luxembourg data centre infrastructure and reputation in trust and reliability, developing and hosting innovative mobile business applications could be a business sector opportunity to be developed.

Big Data

As we have seen, data is considered as the new currency in the cyber-physical world (or the new oil, the metaphor being basically identical). Luxembourg is a data-intensive economy because of its existing IT infrastructure and because of the financial sector and the EU institutions located there.

The HPC project is a real asset as it potentially allows for Big Data application that are not possible everywhere. Roboadvising in banking as well as a driverless car infrastructure[1088] or innovative smart city applications are just a few obvious opportunities. But in order to be exploited, Luxembourg needs the right skills and attitude and we have seen that e-skills and also creativity in applications is a weak point and thus an area that has to be worked on with high priority. Deep learning experts as well as data scientists are probable the rarest resource in the current job market landscapes worldwide, and we know that hardware is useless without skilled and creative programmers.

How to make Luxembourg a mecca for these profiles ?

Security and trust

Luxembourg has a top reputation for security, trust, confidentiality and privacy largely due to its stable international financial sector. As these concepts also apply to data, it is obvious that these key advantages shall be translated into business cases in the digital economy as well[1089]. There are many possible scenarios here, ranging from secure data centres for critical data to storing digital identities, blockchain applications and digital payment solutions.

Again, skills, creativity and innovation capacity will be the determining factors for business opportunities that build upon security and trust.

E-identity

A common mistake by policy makers and commentators is the ssumption that a “more digital” economy will equal economic growth. But digitalization does not necessarily translate into growth but can act as a powerful enabler. A new technology is never a disruption on its own. It’s an enabling condition, arguably even a necessary one, but it is not a sufficient condition. For a new digital technology to deliver a disruptive innovation, a new technology must leverage two things:

> - *A new route to market. All disruptive innovators in business have capitalized on a channel of commercialization where the leading firms are not present. For instance, Dell sold directly to consumers, as did Salesforce, Skype, and eBay.*

[1088] François Bausch, Francine Closener and Camille Gira on a working visit to Silicon Valley: focus on driverless self-driving vehicles, http://www.digital-luxembourg.public.lu/en/actualites/e-mobility/2016/bauschsiliconvalley/index.html

[1089] Luxembourg ranks 4th in a recent country report on safe data storage: http://www.businessrevieweurope.eu/technology/971/Top-15-countries-for-safe-data-storage

- *A new business model. Disruptive innovators usually change the revenue architecture — how you hire a car or plan a trip, for example. It's really hard for incumbents already deeply invested in an existing business model to follow suit, which explains the success of free newspapers, Zipcar, TripAdvisor, and Lending Club*[1090].

If the public sector is to realize the full potential of digital technology to transform public management and even kick-start national economic growth, governments will have to move beyond streamlining services and cutting red-tape for entrepreneurs.

One example comes from Estonia. The small European nation has made it possible for entrepreneurs to become "e-residents[1091], [1092]." Anyone in the world who wants to operate out of Estonia can become a "resident" of the country without living there. While e-residents don't have full rights as citizens (they don't vote, for example), the government will grant them, for a flat subscription rate, a digital identity that grants you full rights to do business in Estonia and in most European countries, depending on the industry. This enables the Estonian government not only to foster entrepreneurship in their economy but to generate revenue through the e-card subscriptions. Even better for public finances, e-residents are not physically in the country (they just pay taxes there), which means they do not generate the expenses that normal citizens impose on a country, e.g. in terms of infrastructure or social security spending[1093]. It will attract investment: once an e-resident has an Estonian ID, setting up a company there takes only a few minutes.

This initiative is not about using digitalization to make the process of entrepreneurship more efficient or faster, which is one of the key metrics on how countries are measured worldwide, but instead leverages a new model (in this case, a new model of citizenship) to capture new net growth.

> *On a more general level, Estonia's approach makes life efficient: taxes take less than an hour to file, and refunds are paid within 48 hours. By law, the state may not ask for any piece of information more than once, people have the right to know what data are held on them and all government databases must be compatible, a system known as the X-road. In all, the Estonian state offers 600 e-services to its citizens and 2,400 to businesses*[1094].

Luxembourg, with its reputation as a trust centre and secure data centres, and as a major international business platform, can potentially do even better. It only has to embrace the Estonian lesson of innovative thinking and culture of execution, including the understanding of how to make people's lives easier.

Luxembourg as a laboratory

Luxembourg is also a perfect playground for testing innovations of all sorts. Its small size, geopolitical location, heterogeneous international consumer an entrepreneur base as well as the good infrastructure

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1090 Why Estonia Is Letting Entrepreneurs Become "E-Residents", https://hbr.org/2016/03/why-estonia-is-letting-entrepreneurs-become-e-residents

1091 Benefit from e-residency and start your company in Estonia, https://1office.co/estonia/

1092 Estonia claims the Panama Papers and British vote to leave the EU have boosted its recruitment drive for digital residents, https://www.theguardian.com/world/2016/sep/15/estonia-e-residency-european-union-brexit-eu-referendum

1093 Estonian e-residency: A success story in the making, http://www.thedigitalpost.eu/2015/channel-digital-single-market/estonian-eresidency-a-success-story-in-the-making

1094 Estonia takes the plunge,http://www.economist.com/news/international/21605923-national-identity-scheme-goes-global-estonia-takes-plunge

makes it a perfect laboratory for testing new solutions. Consumer product companies from the food industry like the Italian chocolate producer Ferrero have done this for years in Luxembourg. It would straight forward to extent this practice to innovations with digital as an enabler, like smart mobility, self-driving cars, smart grids, e-health, smart cities, etc.

Again, delight in experimentation is a cultural feature, but is also a driver of success and new value creation in a complex world as expressed by new economic thinking[1095].

Sustainable development

Luxembourg faces some unsolved sustainability problems in terms of system dynamics:

- To finance the existing social system in the future, Luxembourg needs a continuous economic growth of 4% per year
- This means many new jobs created per year
- A high proportion of these jobs will be taken by commuters and immigrants who further charge transport infrastructure, the education system and other amenities
- The higher demand on the real estate market might further fuel already expensive housing pricing which might exacerbate social divide and inequality
- On top, as of today, Luxembourg's energy efficiency is only average as is the percentage of renewable energy use. Despite ambitious future projects such as those suggested by the Rifkin study.

Taken together, these evolutions can bring chaos to the system with unforeseen negative consequences (see box 11 on Innovation Ecosystems). In other words, Luxembourg faces the challenge of avoiding to become a victim of its own success[1096].

Driverless cars, that some experts predict to be largely adopted sooner than expected, might also contribute to solving Luxembourg's soaring traffic and transport problem[1097], [1098].

A solution could be to go for a more intensive rather than extensive gowth model, i.e. create fewer jobs, but with high added value and productivity, and to intelligently use digital as an enabler for solving those sustainability issues and break out of a vicious circle. More systems thinking is needed to guarantee a

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1095 How the Profound Changes in Economics Make Left Versus Right Debates Irrelevant, https://evonomics.com/the-deep-and-profound-changes-in-economics-thinking/

1096 Dossier Luxemburger Wort: Der 1,1-Millionen-Einwohnerstaat - Wie viel Wachstum verkraftet Luxemburg?, http://www.wort.lu/de/politik/der-1-1-millionen-einwohnerstaat-wie-viel-wachstum-verkraftet-luxemburg-57ced20aac730ff4e7f66047

1097 We've built our communities entirely around cars. And for the most part, we've built them for cars that aren't even moving. The average vehicle is used only 4% of the time and parked the other 96%. Imagine "what our world could look like if we found a way to take most of these cars off the road. It would be a world with less traffic and less pollution. A world where we need less parking – where streets can be narrowed and sidewalks widened. It's a world where we can construct new housing and small businesses on parking lots across the country – or turn them into green spaces and parks. That's a world built around people, not cars. - How driverless cars could change our whole future, https://www.theguardian.com/commentisfree/2016/sep/25/uber-self-driving-cars-pittsburgh-how-driverless-cars-could-change-our-future-lyft-john-zimmer

1098 The Third Transportation Revolution, https://shift.newco.co/the-third-transportation-revolution-27860f05fa91#.9q99tnkb0

sustainable future for Luxembourg[1099], [1100], [1101], [1102], [1103] . Box 12 on building community resilience makes the perfect case here.

Culture & identity

Luxembourg has a highly atypical demographic situation: Luxembourg nationals, on the one hand, with a low percentage of entrepreneurs and becoming a minority in their own country, and non-nationals coming from very diverse backgrounds on the other hand: top skilled bankers, IT people and business consultants, EU civil servants all coming from different nations together with a historically important Portuguese immigrant community.

While Luxembourg is benefiting from this high diversity in terms of economic development and opportunities, openness and intense connectedness with the rest of the world, it also appears that from a sociological point of the Luxembourg society feels rather fragmented with many sub-communities based on professions and nationalities that might not fully interact on a shared identity building level. Also, many immigrants do not necessarily plan to stay in Luxembourg forever, but rather consider it for a time-limited accelerator of their professional careers[1104].

We have seen that individuals who identify with a larger collective goal are an important soft element of a performing innovation ecosystem as well as a condition for building community resilience. Luxembourg might still lack visions and strategies that are discussed, co-created and shared by every part of its population. Luxembourg should, along with its rather successful economic policy, care more about social innovation projects that tie its diverse communities closer together to build and maintain community resilience on a general level.

In addition, Luxembourg does not necessarely have a historic culture of creativity and co-creation making it less attractive for the creative class[1105], a creative class that is needed as a driver for digital transformation.

And risk-taking in finance (such as Venture Capital Investing) and entrepreneurship is also traditionally low[1106].

We have also seen that, in the wake of digital transformation, management models move away from hierarchies to networks of enabled and self-organizing swarms of individuals, and strategy is more and more replaced by agility and speed, two areas where Luxembourg hasn't been an innovator in the past.

We therefore think that the biggest challenge Luxembourg is facing in terms of digital transformation is a cultural upgrade, a sort of « Luxembourg Culture 3.0 ».

(Smart) Governance

Governance models are an artefact of the ruling culture.

1099 https://en.wikipedia.org/wiki/Systems_thinking

1100 Basic principles of systems thinking as applied to management and leadership, http://www.systemicleadershipinstitute.org/systemic-leadership/theories/basic-principles-of-systems-thinking-as-applied-to-management-and-leadership-2/

1101 Overview of systems thinking, http://www.thinking.net/Systems*Thinking/OverviewSTarticle.pdf*

1102 Bird feeder dilemma, https://www.youtube.com/watch?v=jh5xtlGlFUA

1103 Making the jump into systems thinking, https://thesystemsthinker.com/making-the-jump-to-systems-thinking/

1104 Luxembourg : 204 000 arrivées et… 111 000 départs !, http://www.fondation-idea.lu/2016/07/29/luxembourg-204-000-arrivees-et-111-000-departs/

1105 The Rise of the Creative Class, Revisited, http://www.citylab.com/work/2012/06/rise-creative-class-revisited/2220/

1106 Global Entrepreneurship Monitor - 2015/16 GLOBAL REPORT, http://www.gemconsortium.org/report/49480

More open networks, more collaboration, more co-creation, more transparency and permeability, more agility[1107], more lean thinking, more systems thinking, more courage, more trust-building integrity and more roles instead of individuals are needed if Luxembourg has to succeed in the cyber-physical world the same way it succeeded in the traditional economy. The rules of the game have changed. And you cannot continue to win if you don't respect the new rules[1108], [1109].

Governance and management models in digital era have to be in line with and reflect the characteristics of the "digital economy and society system" that is in the course of being created, namely transparency, hyper connectivity, speed, fluidity and immediacy.

In times of global and exponential changes, dinosaurs must get out of the garage.

"The world as we have created it is a process of our thinking. It cannot be changed without changing our thinking."[1110]

[1107] The Future of Corporate Agility, http://www.startuplessonslearned.com/2016/10/the-future-of-corporate-agility.html

[1108] In terms of social network analyses, Luxembourg has too many nodes compared to the number and relative length and distance of connectors between the nodes. In such an overcrowded social network setting, signal flow get stuck and risks suffocating. http://www.kstoolkit.org/Social+Network+Analysis

[1109] The smart economy working group of the Rifkin TIR working group also expressed reccommendations on smart governance in the digital era.

[1110] Albert Einstein, https://www.goodreads.com/author/quotes/9810.Albert_Einstein

BOX 12: Building community resilience

In today's times of high complexity and uncertainty - with digital transformation being one of the important artefacts here -, building community resilience has become a scientific area of high interest.

The US-based Post Carbon Institute[1111] [1112] (and a low-carbon economy can only be achieved with the help digital technologies including smart grids a.o.), has recently published a concept paper entitled « Six Foundations for Building Community Resilience[1113] ».

The report draws on some of the most compelling recent thinking about resilience from academia, sustainability advocacy, and grassroots activism, as well as Post Carbon Institute's prior work.

The report's main conclusions are:

> *There are two requirements for building community resilience if it is indeed to be organized at the local level:*
>
> 1. *The responsibility for resilience building and the power to decide how it is done must rest with community members.*
> 2. *The process of resilience building must equitably address both the particular situation of the community and the broader challenges facing society.*

> ***The Six Foundations***
>
> *Although many resilience frameworks and tools for building community resilience are now available, no single approach will likely work for all communities and their varied social and economic contexts. Therefore we have identified six foundations that, in our view, are essential—no matter where or how resilience-building efforts are undertaken, or which challenges are of most concern locally. The foundations support building community resilience, rather than achieving resilience as a fixed goal, so as to emphasize resilience building as an ongoing process.*
>
> *The six foundations are:*

1111 http://www.postcarbon.org/

1112 Post Carbon Institute's mission is to lead the transition to a more resilient, equitable, and sustainable world by providing individuals and communities with the resources needed to understand and respond to the interrelated economic, energy, ecological, and equity crises of the 21st century.

1113 http://sixfoundations.org

1. *People. The power to envision the future of the community and build its resilience resides with community members.*

2. *Systems thinking. Systems thinking is essential for understanding the complex, interrelated crises now unfolding and what they mean for our similarly complex communities.*

3. *Adaptability. A community that adapts to change is resilient. But because communities and the challenges we face are dynamic, adaptation is an ongoing process.*

4. *Transformability. Some challenges are so big that it's not possible for the community to simply adapt; fundamental, transformative changes may be necessary.*

5. *Sustainability. Community resilience is not sustainable if it serves only us, and only now; it needs to work for other communities, future generations, and the ecosystems on which we all depend.*

6. *Courage. As individuals and as a community, we need courage to confront challenging issues and take responsibility for our collective future.*

As resilience science is not limited to environmental challenges, but is rather applicable at a general level, we think that the six foundations are an inspirational framework when thinking about Luxembourg's transition into the future in general and into the cyber-physical world in particular.

Final remarks

As we have seen, digital transformation affects many aspects of our lives in more or less radical ways.

We have seen how new technologies like the everything smart, IoT, Big Data, AI, robotization, 3D-Printing, Augmented and Virtual Reality affect the systems we live in. We have also analysed their impact on business and the economy in terms of new market structures and forces, business models, management practices and organisational designs as well as their likely impact on jobs and the labour market. And we have been digging into the related security and privacy issues, regulation challenges and governance models as well as cultural and ethical dimensions of digital transformation.

At the same time, we live in turbulent times, politically, economically, socially and ecologically with an uncertain outcome. Within this context, economic and social actors face multiple challenges - societal, economical, ethical and cultural ones - and the rules of the game in competition between nations and their creative economies are already affected.

Luxembourg, a small nation in the heart of Western Europe with its very open economy and its fast-changing demographics and cosmopolitan character including many skilled workers is literally the ideal playground for experimentation in this emerging future, if it succeeds to « unlearn » some of its own cultural and institutional legacies that might hinder that vision.

Already, the government's recent bold projects show a more visionary approach to the upcoming transformation processes and their cumulative potential. But execution has yet to be mastered and the transformation process must go deeper into the cultural codes and make them compatible with the flows and processes of the cyber-physical world.

We have seen how effective innovation ecosystems should be built and how community resilience can be strengthened. And we have new types of promising social and economic change frameworks at our fingertips [1114] for unlearning the old and co-creating the new from the perspective of the emerging future and for agile and distributed change management[1115].

It is always difficult and at the same time trivial to make policy and strategy recommendations as they often feel reductionist and smart alec.

But it is not forbidden to ask inspiring questions:

- What if Luxembourg would become an example of a flourishing democracy 2.0 society, thereby setting the trend?
- What if Luxembourg would solve its transport and other sustainability challenges through intelligent technologies, smart communities and creative solutions?
- What if Luxembourg's public service would become an exemplary adopter of digital and deliverer of first class integrated omnichannel experiences?
- What if Luxembourg's different communities would all be connected via an intelligently orchestrated network platform for co-creation and solving real problems, in an OpenIdeo[1116] fashion, at home and abroad?
- What if Luxembourg's healthcare and cities would become smart in a way to increase efficiency and at the same time produce richer citizen experiences, thereby increasing individual and collective knowledge and well-being?
- What if Luxembourg would crowdfund (digitally driven) social innovation?

[1114] Such as Otto Scharmer's Theory-U, https://www.presencing.com/theoryu

[1115] Such as John P. Kotter's dual operating system - Accelerate!, https://hbr.org/2012/11/accelerate

[1116] OpenIDEO is a global community working together to design solutions for the world's biggest challenges, https://openideo.com/

- What if Luxembourg would use its « laboratory » character for lean-startuping about anything?
- What if Luxembourg would become a number one start-up nation or even better, a number one “platform nation”?
- And what if the Chamber of Commerce would lead the ongoing shifts by example and act as catalyst for digital transformation and the transformation of the underlying governance models at a more global scale?
- And the list could go on…

Taking the « right » opportunities has a lot to do with courage, attitude and beliefs. Thus, it is in our own hands to design our desirable future as a country and its communities of people.

Appendice I: Ressources on Organization Design in Transition

- « Il est plus rapide de changer une technologie que les pratiques de collaboration », http://www.usine-digitale.fr/article/il-est-plus-rapide-de-changer-une-technologie-que-les-pratiques-de-collaboration.N377717
- 2b AHEAD ThinkTank: TrendINDEX 2016.1: Trendklima steigt! Jeder dritte Innovationschef verhindert Innovation aus ANGST, http://www.2bahead.com/de/studien/trendstudie/detail/trendindex-20161-trendklima-steigt-aber-jeder-dritte-innovationschef-verhindert-innovation-au/
- 7 Gründe für gutes UX Design in der Softwareentwicklung - Smarter Service,http://www.smarter-service.com/2016/03/02/7-gruende-fuer-gutes-user-experience-design-in-der-softwareentwicklung/
- A New Manifesto for the Tech Industry — Medium,https://medium.com/@idraves/a-new-manifesto-for-the-tech-industry-8eaccbe1d2d3#.onvj2fwnr
- How Boards of Directors Can Prepare for Digital Transformation – Adjuvi, http://adjuvi.com/how-boards-of-directors-can-prepare-for-digital-transformation/
- Autodiagnostic de l'innovation par le numérique, http://www.cefrio.qc.ca/media/uploader/Autodiagnostic-Rsultats-version_finale.pdf
- bcg.perspectives - Most Innovative Companies, https://www.bcgperspectives.com/most_innovative_companies
- Build a change platform, not a change program | McKinsey & Company, http://www.mckinsey.com/business-functions/organization/our-insights/build-a-change-platform-not-a-change-program
- Collaboration Flows from a Strong Business Mission, http://www.cmswire.com/digital-workplace/collaboration-flows-from-a-strong-business-mission/
- Digital transformation in 2016: how far have we come, and how far have we left to go? | Information Age, http://www.information-age.com/it-management/strategy-and-innovation/123460706/digital-transformation-2016-how-far-have-we-come-and-how-far-have-we-left-go
- Digital Transformation Requires Total Organizational Commitment | TechCrunch, https://techcrunch.com/2016/01/31/digital-transformation-requires-total-organizational-commitment/
- Don't Replace People. Augment Them. — What's The Future of Work? — Medium, https://medium.com/the-wtf-economy/dont-replace-people-augment-them-8bea60cb80ac#.gznxq2y4m
- Establishing a new mentality for innovation | Paul4innovating's Innovation Views, https://paul4innovating.com/2016/04/28/establishing-a-new-mentality-for-innovation/
- Evolv | Cornerstone OnDemand, https://www.cornerstoneondemand.com/evolv
- Knack, https://www.knack.it/
- Born to be digital - How leading CIOs are preparing for a digital transformation, http://www.ey.com/Publication/vwLUAssets/EY_CIO_-_Born_to_be_digital/$File/EY-CIOs-Born-to-be-digital.pdf
- Gamification - Förderung der Kollaboration in Netzwerken | Roman Rackwitz | LinkedIn, https://www.linkedin.com/pulse/gamification-f%C3%B6rderung-der-kollaboration-netzwerken-roman-rackwitz
- How social tools can reshape the organization, http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/how-social-tools-can-reshape-the-organization
- How to overcome organizational silos? I Zhecho Dobrev, https://beyondphilosophy.com/how-to-overcome-organizational-silos/

- Ideo's CEO On How To Lead An Organization Creatively | Co.Design | business + design, http://www.fastcodesign.com/3059787/ideos-ceo-on-how-to-lead-an-organization-creatively
- Massive platforms for cocreation: the new normal? by Peter Hesseldahl (1/2), https://nbry.wordpress.com/2014/06/23/massive-platforms-for-cocreation-the-new-normal-12/
- Massive platforms for cocreation: the new normal? by Peter Hesseldahl (2/2), https://nbry.wordpress.com/2014/06/27/massive-platforms-for-cocreation-the-new-normal-22/
- Irving Wladawsky-Berger: The Puzzling Technology Adoption Discrepancy Between Individuals and Institutions, http://blog.irvingwb.com/blog/2013/12/discrepancy-in-technology-adoption-between-individuals-and-institutions.html
- La transformation numérique implique un changement de modèle managérial, http://mobile.lemondeinformatique.fr/lire.php?id=64986
- Et si l'innovation RH était la clef pour transformer nos entreprises ?, http://m.lesechos.fr/redirect_article.php?id=cercle_142909&fw=1#
- Machines Gauging Your Star Potential Automate HR Hiring - Bloomberg, http://www.bloomberg.com/news/articles/2013-10-11/machines-gauging-your-star-potential-automate-hr-hiring
- Medium Gastbeitrag von Günter Koch: "Keine Digital- und Disruptionskomptenz im Aufsichtsrat" , http://directorschannel.tv/dcMedia/detail/mid/2051
- More Evidence Online Community is Central to the Future of Work - Enterprise Irregulars, https://www.enterpriseirregulars.com/107330/evidence-online-community-central-future-work/
- Optimising Digital Collaboration from the Inside Out,http://poncier.org/blog/?p=7084
- The Organization in the Digital Age, http://www.netjmc.com/wp-content/uploads/2015/11/ORGANIZATION-DIGITAL-AGE-2015-EXEC.pdf
- Organizations and the Asperger Syndrome - Sonnez en cas d'absence, http://www.debaillon.com/2016/04/organizations-and-asperger-syndrome/
- Organizing for the future, http://www.mckinsey.com/business-functions/organization/our-insights/organizing-for-the-future
- Oscar Berg: What Is Wrong With The Hierarchy?,http://www.oscarberg.net/2014/02/what-is-wrong-with-hierarchy.html
- People analytics reveals three things HR may be getting wrong | McKinsey & Company, http://www.mckinsey.com/business-functions/organization/our-insights/people-analytics-reveals-three-things-hr-may-be-getting-wrong?cid=other-eml-nsl-mkq-mck-oth-1608
- Transformation numérique et vie au travail, http://zevillage.net/wp-content/uploads/2015/09/rapport-Mettling.pdf
- 19 Recruiting Strategies to Make Hiring Work For You In 2016, https://www.betterteam.com/blog/recruiting-strategies
- Sensemaking in Organizations: Reflections on Karl Weick and Social Theory | EPIC, https://www.epicpeople.org/sensemaking-in-organizations/
- The Case for Dual Innovation | Integrative Innovation, http://integrative-innovation.net/?p=1288
- The critical success factors for digital transformation programmes and how to meet them | Information Age, http://www.information-age.com/it-management/strategy-and-innovation/123460348/critical-success-factors-digital-transformation-programmes-and-how-meet-them

- Tracking the Trends in Bringing Our Own Devices to Work, https://hbr.org/2016/05/tracking-the-trends-in-bringing-our-own-devices-to-work
- Transformation is organizational more than digital | Jane McConnell | LinkedIn, https://www.linkedin.com/pulse/transformation-organizational-more-than-digital-jane-mcconnell
- Two Routes to Resilience, https://hbr.org/2012/12/two-routes-to-resilience
- Understanding “New Power”, https://hbr.org/2014/12/understanding-new-power
- Until You Have Productivity Skills, Productivity Tools Are Useless, https://hbr.org/2016/08/until-you-have-productivity-skills-productivity-tools-are-useless
- Using Artificial Intelligence to Humanize Management and Set Information Free, http://sloanreview.mit.edu/article/using-artificial-intelligence-to-humanize-management-and-set-information-free/
- Wenn Müller nur Müllerchen rekrutiert - Smarter Service, http://www.smarter-service.com/2015/11/18/thomas-sattelberger-wenn-mueller-nur-muellerchen-rekrutiert/
- What Do You Really Mean by Business “Transformation”?, https://hbr.org/2016/02/what-do-you-really-mean-by-business-transformation
- Why agility pays | McKinsey & Company, http://www.mckinsey.com/business-functions/organization/our-insights/why-agility-pays
- Your Employees’ User Experience Should Be a Strategic Priority, http://www.strategy-business.com/article/Your-Employees-User-Experience-Should-Be-a-Strategic-Priority
- Zappos Founder Says His Self-Management Experiment Only Cost Him A Tenth Of His Staff - ReadWrite, http://readwrite.com/2016/01/19/zappos-holacracy-buyouts/