INNOVATION MANAGEMENT AND ARTIFICIAL INTELLIGENCE: THE IMPACT OF DIGITALISATION ON MANAGEMENT PROCESSES

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DOI: 10.19062/1842-9238.2018.16.1.12

Abstract: *We stand on the brink of a technological revolution that will fundamentally change many current practices, from the way we work to how we live, innovate management and work processes. In its scope and complexity, this transformation will be a huge step forward focused on: routing decisions in accurate information, fraud detection (transactions, data prediction), diagnosis and recommendation systems, real time data analysis and security forecasts.*

This coincides with the beginning of the fourth industrial revolution, which allows products, equipment and people to communicate via the Internet or different interfaces – but for this to improve and work, an involvement from the public and private sectors of both civilian and military environments is necessary, in order to make the switch from classical to innovation thinking.

Keywords: *innovation, AI (Artificial Intelligence), industry, innovation, management, digitalization*

1. INTRODUCTION

The term innovation etymologically originates in the Latin words *"novus"* = new and *"innovare"* = renewing. From this developed the word *"innovatio"* – which means renewal, change. Anyone who creates something new today – be it in companies, universities, or other organizations – is "innovative". The vague and inflationary use of the term has meanwhile also led to the labelling of anything that is issued or even slightly modified as "innovative" [1].

The world is considered a mature industry where the introduction of new processes and functions is necessary due to product complexity. Those changes require high investments and careful preparation and the right decisions – innovation through technical, social or economic change.

The operational technology and innovation process has to face the challenges of structured development of new technologies, products and processes. Research and advance development are designing new thinking and methodologies for a decade, to be implemented on a central information and communication platform to continually improve the technology and innovation process, leveraging enterprise-wide skills and creativity.

Faster and more powerful supercomputers are being build and are beginning to analyze the data volumes the world generates. They are helpful in finding better solutions, answering challenges such as research or data privacy more quickly. Digital technologies were combined with Artificial Intelligence (AI) to become more efficient and innovative – by working closely with people. Ultimately, human beings are always the focus of new developments, ideas and continuous progress – to be responsible, well-informed and to play a part in shaping the future.

2. FROM 1.0 TO 4.0

Nothing is more constant than change and it is also becoming faster and faster in industries, schools, corporations, institutions – in every corner or aspect of the world. In recent years, the industry is in an exciting phase, comparable to a strategic and technological change, thus inaugurating a new era. Politicians came up with the idea to name this 4th revolution of industrial development, in short, Industry 4.0.

First of all, several hundred years ago there was no such thing as an agenda for Industry 1.0, Industry 2.0, Industry 3.0 and now Industry 4.0. Looking back, however, it is appropriate for the individual development stages before Industry 4.0 to be versioned in order, for simplification. Thus, industrial change can be divided into four roughly subdivided phases – from Industry 1.0 to Industry 4.0 – with focus on development phases, progress that can be assigned to the respective version (Industry 1.0, Industry 2.0, Industry 3.0 and Industry 4.0), processes and also innovation in all sectors (from mechanical or technological ones to human capital) [2].

Development to Industry 1.0 – The first mass production by machines started around 1800, so if we look backwards in history, this is when the Industry 1.0 phase started. The first machines, such as the looms, were operated by human power. Mechanical production facilities were built and motorized by water and steam power.

Hydropower was the first primary energy. After that, steam engines were used. In this phase of development, the earliest successes of early industrialization included the first railways, coal mining, heavy industry, steamship, cloth manufacture, transport and textile printing. People just started to realize what *investment* and *progress* meant.

The first foundations for the later following Industry 3.0 were developed as soon as the 19th century, such as what we call today computer work, but realized on a mechanical level. British mathematician *Ada Lovelace* is considered the first programmer ever to have done such work in her program for *Charles Babbage's Analytical Engine* (in which she developed key aspects of later programming languages).

Development to Industry 2.0 – The introduction of electricity as a driving force at the end of the 19th century was the starting signal for the 2nd industrial revolution (Industry 2.0). From the first, early 20th century automobiles onwards, work in the production halls continuously evolved towards automation. The factory halls produced on-line in record time, and engines continued to work.

During this development phase, bureaucratic workplaces such as offices also experienced a further development in communication. Telephone calls and telegrams simplified communication, which accelerated work processes. But efforts to simplify correspondence began as early as 1714 with Henry Mill's description of a typewriter for which a patent was granted. The first typewriter was probably a device manufactured in 1808 by *Pelligrino Turri*, for the blind *Countess Carolina Fantoni da Fivizzone*. As people dared give way to their ingenuity more and more freely, other devices followed, such as the writing piano by *Karl Drais (1821)*, the typewriter models made of wood by the Tyrolean *Peter Mitterhofer (1864)* or the writing ball by *Malling Hansen (1865)* [3].

Success factors in the second revolution were the first steps of globalization. The production of automobiles, clothing, raw materials and food were automated.

Traffic also continued to develop for the first time across continents. Aviation began its operations and ships crossed the world's oceans.

Development to Industry 3.0 – This phase had already been masterminded in the 18th century: together with the already mentioned *Ada Lovelace*, *Charles Babbage* is considered to be the prime mover of the individually programmable computer, with his Analytical Engine.

The developments worked out by the thought leaders eventually resulted in the first functional devices. The German civil engineer *Konrad Ernst Otto Zuse* developed the functioning computer of the world with the *Z3* in 1941. It was program-controlled, freely programmable and fully automatic. In 1950, the *Z4* model was the first commercial computer, followed by others. Rapid development followed and the development cycles became shorter and shorter.

In the 1970s, the 3rd industrial revolution started. Here, the focus was on further automation through electronics and IT. After the big calculating machines, the personal computer for offices and households established a whole new branch of industry.

Development to Industry 4.0 – We are in the middle of the 4th industrial revolution when it comes to the theories and insights of tangible developments, possibly even at the end. In this phase, the focus will be on the increasing digitization of earlier analogue techniques and the integration of cyber-physical systems. For many years now, many companies have stopped producing in-stock, producing many products on demand or according to actual needs. Just-in-time strategies could be implemented thanks to the constant development in information processing and technology. In addition to the ever faster manufacturing, progress was also made in the field of environmental protection and occupational safety [4].

Industry 4.0 is the term for modern technology and production in the age of the digital revolution. This not only describes the industrial development of other technologies, as in the past two centuries, but the changed world of production and work in the global age as well.

"Computerization" is taking on more concrete forms in Industry 4.0. Traditional industries such as the construction industry are being digitized further and new forms of communication created – even commodities and packaging are connected to the Internet via barcodes.

Industry 4.0 can also respond faster and more precisely to trends, tastes and the needs of the sales market. A wider range of models and product designs will be produced as quickly as responding to the rapid developments in the marketplace. And new, digital factories can produce affordable individual pieces without sacrificing what they need.

Development of computing (supercomputers are creating a stir as lighting fast virtual analyzers and it is planned that quantum computers take the corresponding leap to their assistance in the future) [5]:

-1941: Konrad Zuse's Z3, Germany – the world's first functioning computer;

-1946: ENIAC, USA – the first electronic universal computer;

-1964: CDC 6600, USA – the first super computer;

-1984: M-13, Soviet Union – the first computer in gigaflop (floating point operations per second) range;

-2017: Sunway TaihuLight, China – the fastest computer to date.

From a global perspective, there is a growing emphasis on globalization and digitization. Developed countries have an interest in maintaining their international competitiveness and are actively looking for ways to respond as effectively as possible to consumers' needs and requirements, analyze real-time data, identify and respond to the demands of the ever-growing market by being as innovating as possible.

Emerging markets are looking for international networks or are developing their own solutions to ease their access to the international scene. All this leads to changes from management methodologies, business models, digital solutions to new processes and innovative ideas.

Innovation or digitalization has a similar effect in the military sector – flying drones, robots, cybersecurity, automated processes or weapons, data control are receiving more and more attention.

Governments around the world are investing huge sums of money in their defense apparatuses, whose arms race is increasingly turning towards digitization and virtualization. Warfare in cyberspace costs. According to the Swedish Peace Research Institute SIPRI, global military spending in 2015 totaled $ 1,760 billion. Cybersecurity becomes the new key market for the defense industry. And major arms companies such as BAE Systems, Lockheed Martin Corporation and Raytheon Company are increasingly turning to the civil sector. The innovative technologies that they develop affect society as a whole.

Today, a number of both publicly known and secret research institutions operate on behalf of the armies. These may be small initiatives, such as the "Athena Project", in which the crew of a ship of the U.S. Navy brainstorming on technical and organizational issues. Or large organizations like the U.S. Army Research Laboratory (ARL), which conducts research into Nano-aircraft drones with in-house specialists and in cooperation with private companies and universities.

Some innovations of military origin have shaped our civilian lives so profoundly that we almost forget where they came from. This is true for the Internet, which started as the US Department of Defense Arpanet in the 1960s. This also applies to the American positioning system GPS, which today everyone uses for navigation while driving and as tracking technology while jogging. The public funds for research and development in the army can today also promote basic research that could greatly change the everyday life of civil society in the future. Special attention is currently focused on drones and exoskeletons.

The U.S. Army has been using drones for years, and developed European countries such as Germany, Italy, France and Spain are also investing to have their own ones by 2025 – a common goal for increasing safety in Europe.

Exoskeleton is the term borrowed from the animal world for a hydraulic robotic suit that anticipates and amplifies the movements of its user. In France, the model *Hercule* was introduced in 2014, which is specifically designed for military use – to strengthen the physical strength of soldiers – as well as for civil use, for medical purposes.

On the one hand, this is nothing new: Man and technology have always been in a relationship of co-evolution. And since time immemorial, man tends to humanize technology. The military has always been a fertile ground for innovation. "Power" is a key driver in technologisation, the evolution of technical innovation.

3. ARTIFICAL INTELLIGENCE

"Artificial intelligence" (hereafter referred to as "AI") represents a threat (according to some experts) and a chance to a new evolution (according to others). For some it is a figment of the imagination and for others it is only a matter of time. As a result, it becomes clear that this topic is playing a crucial role today.

What is intelligence? There are different understandings of the term and it is usually assumed that intelligent behavior is tied to the controlled use of the mind. Under the scientific definition of mind, one understands the ability to think in terms and draw logical conclusions as in the processing of symbols and the use of logical operations (for example: solution of a three-sentence task).

Another approach, according to the literal meaning of intelligence, which translates to insight, reason, perception, is the ability to solve problematic and insightful behaviors. Actually it has a different definition for each individual, as we are not the same – and the same applies to AI.

Human vs. Artificial Intelligence – So far, in our society, intelligence has always had a biological form, and it is hard to imagine translating that principle into something entirely different or transferring the complexity of thinking processes that lead to the present evolution of the world – to a non-living system. A computer does not have the ability to recognize emotions and to situate them in real situations. Thus, it seems almost impossible to convert some subcomponents that make up human intelligence into a system. However, AI is more of a field of research, a branch of computer science that deals with the replication of certain aspects of human intelligence on computer systems such as speech recognition, deduction, interference, creative behavior, the ability to learn from personal experience, and the ability to draw conclusions from incomplete information - *AI will support people not replace them.*

The road to super-intelligence:

-1951: *Marvin Minsky* builds the first neurocomputer, *SNARC* (Stochastic Neural Analog Reinforcement Calculator);

-1956: Scientists present the first AI program, *Logic Theorist*;

-1972: Introduction of *Mycin* expert system for the diagnosis and treatment of infectious diseases;

-1994: First test of autonomous automobiles on German roads;

-1997: The *Deep Blue* computer beats the world champion Garry Kasparov at chess;

-2011: IBM brings the powerful AI computer *WATSON* onto the market;

-2017: The *Libratus* software beats four world-class players at poker.

Generally, the ultimate goal is to develop machines that behave as if they had human intelligence. They should act and think like a human being, but also rationally, and try to imitate the thinking and working of a person to solve a task. The computer stores repetitive operations, addressing or information as so-called empirical values and searches out of well-known behavioral structures the one that does justice to the situation. Another task is to analyze raw data in order to draw possible conclusions or offer possible solutions [6].

Intelligence types of AI – The goals that this new discipline seeks to achieve can be assigned to different subfields. *Visual intelligence* focuses on perception – image recognition, especially. The systems are capable of recognizing images or shapes, such as crime fighting. Fingerprints, handwriting recognition and the detection of the human iris are the tasks of the AI. In *linguistic intelligence*, the goal is to recognize natural language, to translate an input text into speech, and vice versa.

Programs such as SHRDLU or ELIZA are among the best-known language systems. ELIZA is a computer program developed by Joseph Weizenbaum in 1966 to show the possibilities of communication between a human and a computer through natural language. *Robotics* as a third sub-area seems to dominate the future.

The number of programmable robots is increasing, as they are often used in manufacturing technology for dangerous work or perform monotonous operations. A fourth subsection is made up of *computers* used in the field of *rational intelligence* called expert systems. These are based on a database in which expertise is stored and are often used in medical computer diagnostics.

The future of human-machine cooperation – It's not about simply replacing humans with machines, but about redeploying activities - an ideal distribution of work in terms of individual competences. This benefits individuals and computers on a case-by-case basis: a person builds relationships with other people, is intuitive and creative. Computers, on the other hand, calculate faster, they analyze vast amounts of data in a shorter time than any human. The fact is that there will be much closer cooperation with intelligent machines in the future. In the future, only those who join in this digital transformation will still be a wheel in the gear of the working society [7].

AI systems are already capable of doing things that we achieve through learning experiences and intuition. They do this just with great computing power and sophisticated mathematics. It is, undoubtedly, a significant innovation, and we should make use of it. Sooner, the existing algorithms will evolve and also be used in decision making situations in business, study or politics [8].

4. INNOVATION MANAGEMENT IN IT PROCESSES

Innovation management mediates between the operational implementation and the strategic decision-making levels. It supports the work of both levels by providing suitable framework conditions. These support services include, for example, leadership, processes, resources, methods, mediation, communication, tools, information, and preparation of decisions. The aim is to combine the right information in the right form with the right competence at the right time.

Strategic and methodological approaches are implemented on a central information and communication platform to permanently improve the technology and innovation process, leveraging enterprise-wide skills and creativity. The motivation here is to increase collaboration, information transparency, networking density and improving decision-making.

Strategic innovation management plays a key role in the early stages of the product development process. The task of innovation management is the identification, prioritization and control of innovation projects as well as the qualification of technologies and competences. Decisions of this kind have a long-term and strategic significance. To decide, for example, in which technologies should be invested, which projects must be funded or stopped and what expertise is necessary for this. However, shorter development and technology cycles mean faster and faster decisions. On the other hand, this requirement is counteracted by the increasing complexity of performing such action, due to the amount and haziness of existing information [9].

Innovation methodology is advancing at an even quicker pace, allowing individuals, companies or institutions to learn and grow four times faster than they were able to in the past. The huge amount of data available is opening borders never imagined before: data prediction, digitalization, research, development, network to communications and no limits.

Countries like Germany are already investing in this direction. The Army's Cyber Innovation Hub (CIHCyber Innovation Hub) is the interface between the startup scene and the army. His job is to drive digital innovation within the army.

The hub identifies innovative technologies in the international startup scene and develops and validates these for the German Armed Forces. A special focus is on disruptive technologies in the fields of cyber/IT information technology and digital products and services.

The Cyber Innovation Hub acts in the field of tension between startup culture and army tradition and is intended to deliberately introduce mindset and working methods as an ability in the army. At the same time, new ways should be deliberately tried out.

The team consists of soldiers, civilians and serial entrepreneurs who want to contribute to a successful digital transformation of the armed forces. The Cyber Innovation Hub also sees itself as a platform to specifically attract and integrate innovators and talents from the public sector.

Army management processes and innovation all come closer and closer together, having the same scope – to discover the unknown.

5. CONCLUSIONS AND FURTHER DEVELOPMENT

In summary, the use of modern IT technologies in the business, institutional or private environment is becoming increasingly important due to the high dynamics and limited information processing capacities. Virtual methods can assist people in answering specific questions and analyzing complex issues by processing data and making it understandable. Man continues to be responsible for the interpretation of the results and the final decision. At present, the gap between a strategic decision and its decision-making basis is still very large and depends heavily on the experience of the decision-maker. Humans can make wrong decisions within this scope of interpretation. With the gradual improvement of technology in the fields of innovation and artificial intelligence, as well as the related ability to process large amounts of data – this gap can be gradually closed. This applies in particular to the integration of data from the Internet, the potential of which is still underutilized. The Internet as a rich knowledge resource offers opportunities to develop new technological insights, more accurate trend detection, market changes, customer expectations and inspirations for new products and business areas.

However, in addition to the advancing technical possibilities, it should not be forgotten that human beings continue to be at the core of creativity, knowledge and thus added value within any company. Most of the necessary information for methodological processing is provided by humans. In order to further improve the acceptance between man and machine, a continuous investment in innovative management processes, revolutionary technologies and human capital has to be made.

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