Artificial Intelligence (AI) as Impulse for New Work

11.1 Industry 4.0

Production and operations systems are not like they used to be. The twenty-first century will confront enterprises and manufacturing companies with completely novel generations of technologies, services, and products based on computer technologies. In order to meet competition on global markets and to ensure long-term success, the companies need to adapt to shorter delivery times, increasing product variability and high market volatility, by which enterprises are able to sensitively and timely react to continuous and unexpected changes. One of the major cornerstones to meet these challenges is the implementation of digital information and communication technologies into production systems, processes and technologies, which allow novel developments by combining the physical world and fast data access and data processing via the Internet (Industry 4.0).

Industry 4.0 is a name given to the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing. Industry 4.0 is commonly referred to as the fourth industrial revolution. Industry 4.0 fosters what has been called a “smart factory” as shown in Fig. 11.1. Within 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 both internally and across organizational services offered and used by participants of the value chain. There are four design principles in Industry 4.0. These principles support companies in identifying and implementing Industry 4.0 scenarios (Helmold & Samara, 2019):

- **Interconnection:** The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things (IoT) or the Internet of People (IoP)
- **Information transparency:** The transparency afforded by Industry 4.0 technology provides operators with vast amounts of useful information needed to make appropriate decisions. Interconnectivity allows operators to collect immense amounts of data and information from all points in the manufacturing process, thus aiding functionality and identifying key areas that can benefit from innovation and improvement
- **Technical assistance:** First, the ability of assistance systems to support humans by aggregating and visualizing information comprehensively for making informed decisions and solving urgent problems on short notice. Second, the ability of cyber-physical systems to physically support humans by conducting a range of tasks that are unpleasant, too exhausting, or unsafe for their human coworkers
- **Decentralized decisions:** The ability of cyber-physical systems to make decisions on their own and to perform their tasks as autonomously as possible. Only in the case of exceptions, interferences, or conflicting goals, are tasks delegated to a higher level
11.2 Artificial Intelligence (AI) in Lean Management

11.2.1 Lean AI Tools Will Lead to a Competitive Advantage

In the field of computer science, artificial intelligence (AI), sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals. Figure 11.2 depicts nine lean elements of artificial intelligence which can be lead to a competitive advantage across the value chain (Helmold & Samara, 2019).

11.2.2 Autonomous Robots

An autonomous robot is a robot that performs behaviours or tasks with a high degree of autonomy (without external influence). Autonomous robotics is usually

Fig. 11.2 Trends in AI. (Source: Author’s Source)
considered to be a subfield of artificial intelligence, robotics, and information engineering.

11.2.3 Virtual Production and Supply Chains

Virtual production tends to be used to help visualize complex scenes or scenes that simply cannot be filmed for real. In general, though, virtual production can really refer to any techniques that allow filmmakers to plan, imagine, or complete some kind of filmic element, typically with the aid of digital tools.

11.2.4 Lean Simulations

Lean simulations include a set of hands-on experiments to teach employees about systems and process improvement in all areas of the value chain. Lean simulations can focus on design, manufacturing, capacity planning or supply chain design. Purpose of simulations is to understand the implications of input variables and alternatives of the value chain elements.

11.2.5 System Integration

Lean integration is a continuous improvement methodology for bringing disparate data and software systems together. The goal is to maximize customer value. Lean integration is a management system that emphasizes eliminating waste as a sustainable data integration and system integration practice.

11.2.6 Internet of Things

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

11.2.7 Cybersecurity

Cybersecurity is the protection of internet-connected systems, including hardware, software and data, from cyberattacks. In a computing context, security comprises cybersecurity and physical security—both are used by enterprises to protect against unauthorized access to data centres and other computerized systems.
11.2.8 Cloud Computing

Cloud computing is a type of computing that relies on shared computing resources rather than having local servers or personal devices to handle applications. In its most simple description, cloud computing is taking services (“cloud services”) and moving them outside an organization’s IT system and environment.

11.2.9 Additive Manufacturing

Additive manufacturing (AM) is the industrial production name for 3D printing, a computer-controlled process that creates three-dimensional objects by depositing materials, usually in layers. The official industry standard term is the ASTM F2792 for all applications of the 3D technology. It is defined as the process of joining materials to make objects from 3D model data, usually layer upon layer, as opposed to subtractive manufacturing methodologies.

11.2.10 Augmented Reality

Augmented reality (AR) is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information, sometimes across multiple sensory modalities, including visual, auditory, haptic, somatosensory and olfactory.

11.2.11 Big Data

Big Data is a phrase used to mean a massive volume of both structured and unstructured data that is so large it is difficult to process using traditional database and software techniques. In most enterprise scenarios the volume of data is too big or it moves too fast or it exceeds current processing capacity.

11.3 Case Study: Google’s Self-Driving Cars

Research into self-driving cars is not a new phenomenon. In the late 1950s, the first known thoughts on self-driving vehicles were described in Popular Mechanics magazine by a mechanic who argued that altering a roadster to both start itself and back itself into a driveway would be relatively straightforward. Later that year, a GM analyst revealed in Popular Science magazine that the company was already investigating embedding highways with cable and radio-control boxes as a means of developing an infrastructure to support driverless cars. Despite all of the theoretical research into the subject, self-driving cars did not become a reality until 1968. The first physical breakthrough in driverless car technology was the design of a car that
used sonar and gyroscopes to drive, steer, and stop an automobile. In 1968, The Cornell Aeronautical Laboratory created the “Urbmobile”, an electric car that could be driven on the road but could also glide along a subway-style track that utilized roadside guides, magnetometers, magnetic nails, and internal computers. The largest breakthrough came years later, however, with the announcement from Google, Inc. of the Google Car in 2010. With the distinctive sensor and camera nub lodged on top of a Toyota Prius, the Google Car quickly became operational and present on roads across the United States. Shortly thereafter, media coverage of the Google Car became increasingly prevalent in addition to promotional commercials demonstrating the benefits of the car (Google, 2019). While the benefits demonstrated in the videos seemed to be promising, the Google Car’s entrance into the market seemed a far leap away from Google’s core business. Google Inc. specializes in Internet-related services and products, with the mission to organize the world’s information and make it universally accessible and useful. In 1998, Larry Page and Sergey Brin, two Stanford University computer science graduate students, created a search engine that uses back links, or incoming links, to a website or web page, to determine the importance and therefore rank individual web pages during a web query. Existing competitors, like Yahoo and AOL, on the other hand, were directories of other websites, organized in a hierarchy, as opposed to a searchable index of pages. This allows the Google search process to return more relevant results rather than simply a ranked list of preferred sites. In 1999, Google secured funding from Sequoia Capital and Kleiner Perkins Caufield & Byers, Silicon Valley’s two leading venture capital firms (Google, 2019). Only 1 year later, Google became the world’s largest search engine with over a billion pages in its index, surpassing industry giants such as Yahoo. Google’s dominance of the search market continues today as Google maintains a 67% share of global searches. While Google Inc. began as a company specializing in search, it quickly expanded into other product areas. In 2004, Google launched Gmail, an email client which became the world’s largest email provider by 2012 with an estimated 425 million active users. Expanding into the online video domain, Google acquired YouTube in 2006 for $1.65 billion, which reaches over 1 billion unique visitors each month. In 2008, Google launched Chrome, a web browser, and Android, an operating system for mobile devices. In both of these areas as well, Google dominates the market, with a 50% and 68% of the market share, respectively (Miller & Wald, 2013). In 2010, Google announced that the prototype of a driverless car—the Google Car—was completed (Google, 2019). According to Google executives at the time, the goal of the Google Car was to “… help prevent traffic accidents, free up people’s time and reduce carbon emissions by fundamentally changing car use”. With a team assembled consisting of engineers with experience in vehicle technology from the DARPA Challenges, a series of driverless vehicle races sponsored by the US Government, Google was finally able to bring the driverless car phenomenon to reality. The Google Car is a sophisticated system that integrates proprietary hardware and software, using video
cameras, radar sensors, and a laser range finder to visualize traffic and detailed maps taken from Google Maps to enable navigation between destinations. Google’s data centres process the incoming data relayed from the sensors and cameras mounted on the Google Car in order to provide the car with useful information about its environment that is later translated into the physical operation of the vehicle. The key to the Google Car’s technological capabilities is the laser range finder mounted on the roof of the modified Toyota Prius, allowing for real-time environmental analysis. In addition, the Google Car is equipped with four radars and a velodyne 64-beam laser placed strategically around the car to accurately generate a three-dimensional map of its environment. A camera detects traffic lights while a GPS, wheel encoder, and inertial measurement unit control the vehicle’s location and logs car movement. The software system synthesizes laser measurements produced from the laser beam with high-resolution maps of the world, producing dynamic data models then translated into the physical operation of the vehicle by the car’s internal software system. Altogether, the system allows for seamless operation of the vehicle that adjusts to its dynamic environment without the intervention of a driver. In addition to the generic driverless capability, the Google Car’s system also adjusts for local traffic laws and environmental obstacles in real-time. For example, if the Google Car approaches a four-way intersection and senses that the driver with the right of way does not move, the Google Car inches forward slightly to indicate to other drivers the intentions of driving through the intersection (Miller & Wald, 2013).

Altogether, the technology and adaptation to local conditions not only allows for driverless transportation, but also increases safety on the road. Since its introduction, the Google Car has completed 200,000 miles of accident-free computer-led driving, beyond one incident that was arguably caused by another driver. The road test results for the Google Car indicate that the Google Car obeys all of the rules of the road and adjusts to its dynamic environment in real time with no problems. Thus, with this integrated technology, the car has the capability of being safer than a human driver. The Google Car has the potential to have a profound effect on energy consumption, efficiency, and traffic accidents. With subsequent productivity increases, and decreases in costs, the Google Car represents a potentially revolutionizing technology. It is precisely this potential, however, that creates a threat for Google to sustaining a long-term competitive advantage in the driverless car space. As the Google Car may radically shift the structure of affected industries and raises serious privacy concerns, vulnerable industries and consumer groups threaten the viability of the project. Thus, the Google Car faces challenges far greater than competing car manufacturers alone. In squaring off against politically and economically powerful industries that are facing their demise, can the Google Car survive? Can the will to revolutionize driving outweigh the costs of potentially ruined industries and massive unemployment? Who will win the war of the road?
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