INTRO 4.0 PROJECT

REPORT (IO1) CURRENT STATUS OF THE INDUSTRY 4.0

This report aims to come up with an overview about what has been done in the European Industry in terms of Industry 4.0. Named as *The Forth Industrial Revolution*, the Industry 4.0 has been described as *the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms*.

INTRO 4.0 PROJECT

REPORT (IO1) CURRENT STATUS OF THE INDUSTRY 4.0

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OUTPUT 1: THE 1ST REPORT ABOUT THE CURRENT STATUS OF THE INDUSTRY 4.0

Step by step we'll build a standardized non-academic knowledge base with the learning material to spread out the information about 4th industrial revolution within the EU.

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M0. THE 4TH INDUSTRIAL REVOLUTION

1. Definition, Development and Legal Framework

The evolution of technologies linked to Industry 4.0 is triggering rapid social and economic changes in an unprecedented context of global competitiveness and demographic change. The forth industrial revolution, commonly referred to as Industry 4.0, is characterized by the decentralized intelligence which helps to create intelligent object networking and independent process management, with the interaction of the real and virtual worlds representing a crucial new aspect of the manufacturing and production processes.

For most people, the term "industrial revolution" refers to the changes that took place after the introduction of steam and water powered production methods. Indeed, the industrialization of the world began in the late 18th century with the first industrial revolution and it was defined by the introduction of mechanical production facilities with the help of water and steam power. Hand production methods were replaced by machinery and small workshops evolved into the factory system that allowed the production on a more massive scale. It wasn't until a century later, in the beginning of the 20th century that the second industrial revolution started, with electricity and assembly lines making mass production possible. The period between the second and the third revolution lasted only a few decades. In the 1970s the third industrial revolution began when advances in computing-powered automation enabled us to program machines and networks. By this time it was created the first programmable logic control system through the application of electronics and IT to further automate production.

Now, we are witnessing the forth industrial revolution, which is characterized by the digital transformation with the development of cyber-physical technologies that allow disruptive changes in production and business models. The Industry 4.0 is a natural outgrowth of the third industrial revolution which fully transformed the nature of commerce in the second half of the 20th century with an array of computerization and IT advances. It was a period of big changes for retail and consumer goods companies, marked by the emergence of credit cards, back-office and warehouse automation, just-in-time supply chains, and the first online business models.

Industry 4.0 is focused on the digitalization of processes and in system integration, with application to the traditional industry, with the multiple partners in the value chain. As a matter of fact, the concept of Industry 4.0 is relatively recent and, has grown in importance during the last few years within the different companies.

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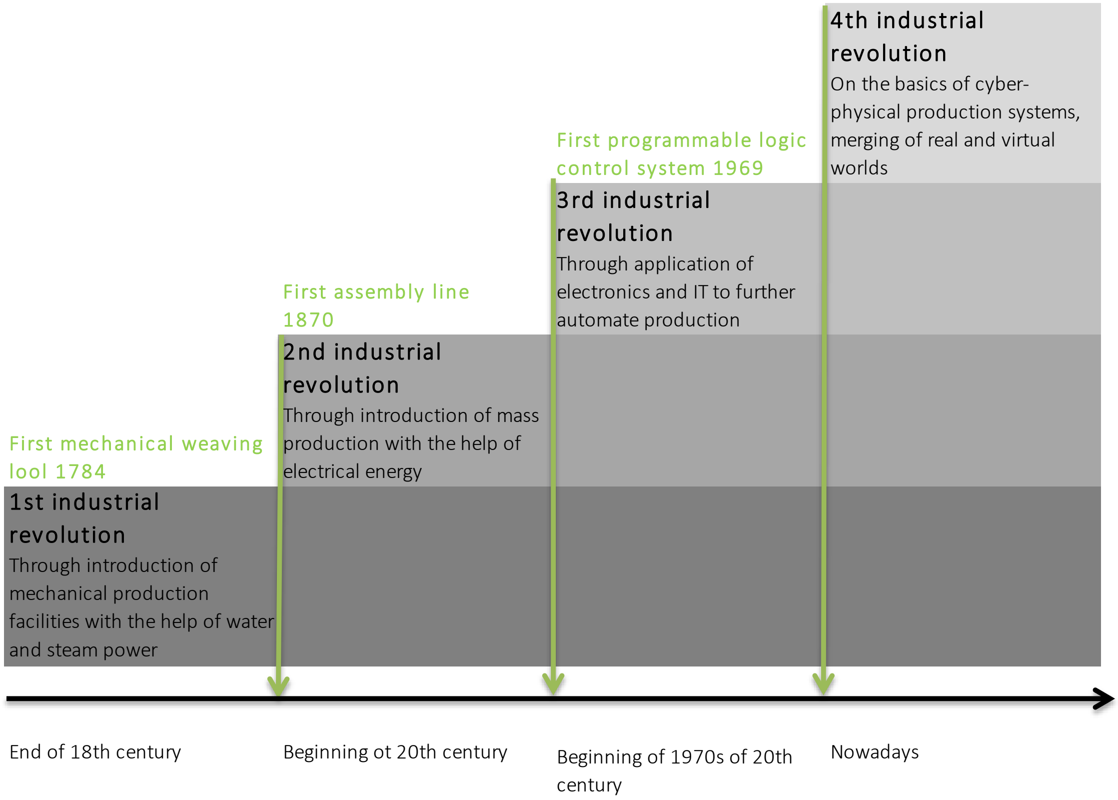

FIGURE 1- THE FOUR INDUSTRIAL REVOLUTIONS

The term "Industry 4.0" was initially coined by the German government and, it aims at describing and encapsulating a set of technological changes in manufacturing and sets out priorities of a coherent policy framework, whose goal was to maintain the global competitiveness of the German industry. Nowadays, Industry 4.0 describes the organisation of production processes based on technology and devices autonomously communicating with each other along the value chain: a model of the 'smart' factory of the future where computer-driven systems monitor physical processes, create a virtual copy of the physical world and make decentralised decisions based on self-organisation mechanisms.

The concept takes into consideration the increased computerisation of the manufacturing industries where physical objects are seamlessly integrated into the information network. As a result, manufacturing systems are vertically networked with business processes within factories and enterprises and horizontally connected to spatially dispersed value networks that can be managed in real time – from the moment an order is placed right through to outbound logistics.

At the moment Industry 4.0 is referred as the forth industrial revolution and, it consists of merging production methods with the latest developments in information and communication technology. This development is driven by the digitalizing trend in the economy and in society. The technological support of this development is made possible by intelligent and interconnected "cyber-physical systems" (CPS) that will enable people,

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machines, equipment, logistics systems and products to communicate and cooperate directly with one another.

In order not to miss the opportunity that represents the so called Industry 4.0 the industrial enterprises have to accept that a dynamic and modern industrial sector is an essential factor for the economic growth and, that digitalization is also an undeniable reality. To recognize that people, consumers, suppliers or other stakeholders have been changing also indicates us that the challenge doesn't resides only in the technological aspect but also, it relies on identifying which platforms and processes are important to have in the different companies to integrate all the mentioned interlocutors.

2. Main characteristics

We have witnessed a paradigm shift in the industry and, broadly, extending to the whole economy. This is essentially characterised by the introduction of digital technologies in the most diversified fields of economics and society.

In light of the above, it is crucial that the different businesses are capable of following this movement and engage in the effort to be in the cutting edge of technological developments, thus ensuring that companies are able to take advantage of the multiple benefits associated with Industry 4.0 and, simultaneously, neutralizing the challenges and obstacles which are also associated with it.

Industry 4.0 is a combination of several novel technological advancements:

- ✓ Information and communication technology: Digitalization and the widespread application of ICT allow the integration of all systems throughout the supply and value chains and enables data aggregation on all levels. information is digitized and the corresponding systems inside and across companies are integrated at all stages of both product creation and use lifecycles;
- ✓ Cyber-physical systems: Cyber-physical systems improve the capability of controlling and monitoring physical processes, with the help of sensors, intelligent robots, drones, 3D printing devices (some of which will be more detailed further into this report). In cyber-physical systems the physical components are aggregated into a network of interacting elements. While the initial inputs and final outputs are customarily physical, information often transposes between physical and digital states during manufacturing process;
- ✓ Network communication: All these devices, both within the manufacturing plant and across suppliers and distributors, are connected through different wireless and Internet technologies. Reliable high-quality communication networks are a crucial requirement Industry 4.0 and therefore it is important to expand the Broadband Internet infrastructure where needed. This high level of networking of

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interconnected components allows for a decentralized and self-organized operating of the cyber-physical systems;

- ✓ Big data and cloud computing: With the use of big data and cloud computing, the information retrieved through these networks can be used to model, virtualize and simulate products and manufacturing processes;
- ✓ Modelling, virtualization and simulation: Simulation is a core functionality of systems by means of seamless assistance along the entire life cycle, for example, by supporting operation and service with direct linkage to operation data;
- ✓ Improved tools for human-computer interaction and cooperation: To control these processes, human workforce is supplied with state-of-the-art ICT tools that make use of advancements in augmented reality and intelligent robotics. The cyber-physical systems of Industry 4.0 have the primary aim of assisting humans in their everyday jobs. The key features of such systems are non-intrusiveness, context-adaptiveness, personalized, location-based and mobility.

The central aspect of Industry 4.0 is its interface with other smart infrastructures, for example, smart buildings, logistics, mobility connectivity to business and social web. Therefore, it is important that these key areas are also considered when implement the Industry 4.0 elements. Thus, it can be said that the effect of Industry 4.0 is not limited to manufacturing but it also influences many aspects of human life.

3. Enabling Industry 4.0 opportunities

Although the term Industry 4.0 was initially only connected to manufacturing, its application is now going beyond industries. The benefits of the Industry 4.0 can be found in intelligent transportation, smart buildings and even smart cities. The main goal of Industry 4.0 is to transform the reality not only of factories but of the entire industrial ecosystem, making it faster, autonomous, and efficient and customer centric. At the same time, it aims to go beyond automation and actually contributing to finding new opportunities and new business models.

That being said, we identify below some of the opportunities associated with this industrial revolution, both for the macro and micro perspective:

- **Business models:** Industry 4.0 has a significant impact on current business models, which results mostly from the use of smart data and, by the offer of new services that would not be feasible if these technological developments did not exist. Effectively, nowadays a Smart Factory containing hundreds or even thousands of smart devices that are able to self-optimize production will lead to an almost zero down time in production. This is extremely important for industries that use high and expensive

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manufacturing equipment such as the semi-conductors industry. Being able to utilize production constantly and consistently will benefit significantly the company.

- **Value creation networks:** The existence of value creation networks offers new opportunities for realizing closed-loop product life cycles and industrial symbiosis. Regarding the industrial symbiosis we constantly witness the cooperation amongst different manufacturers, which allows them to create a competitive advantage by trading and exchanging products, materials, energy, water and also smart data on a local level.

  Also, companies will be able to find new ways for value creation and adapt their business models accordingly. In addition to prices, companies will be able to compete on quality, customization level and prototyping speed, which in turn will provoke changes in the business paradigm.
- **Customization:** Creating a flexible market that is costumer oriented will help meet the population's demand faster and smoothly. Countering the widespread mass production, mass customization will allow production on an extremely small scale (even down to a single product) to still be profitable. Small last minute changes to the products or prototypes will be possible, thanks to the high configurability of the automated production systems. This way, it will also destroy the gap between the manufacturer and the costumer, given that communication will take place between both directly. Thus, customization will allow the companies to adopt new business models for value creation and compete not only with price but with other aspect such us the quickness at prototyping.
- **Equipment:** Naturally the equipment's used in most factories are incorporating some aspects of Industry 4.0. In fact, it is increasingly significant the use of automated tools and equipment's, which are more flexible to change rather than the equipment's used a few years ago. At this level it is also important to highlight the increasingly cooperation between the workers and the machines, which translates into a more efficient productive process.
- **Workforce:** Related to the topic mentioned above, the requirements of the workforce have also evolved. As the current jobs in manufacturing are facing a high risk for being automated, the number of workers will thus decrease. The tasks assigned to the workers are often related to the monitoring of the automated equipment and, are being integrated in decentralized decision-marking processes. On the other hand, it is important to mention that a new industry will require a new set of skills. Consequently, education and training will take a new shape that provides such an industry with the required skilled labour.
- **Product and Process:** The development of new technologies will be increasingly deployed in the value chain processes, since the costs of additive manufacturing have been rapidly dropping during the last few years by simultaneously increasing in terms of speed and precision. Although higher speed has previously been associated with lower quality, in the case of data-driven manufacturing, product

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quality will increase and error rates reduce, as sampling methods for error detection are replaced with real-time data from sensors.
This data can simultaneously be used to enhance productivity and efficiency, and optimize decision-making – advanced analytics, predictive maintenance and data-driven simulations will help avoid machinery failures and plan shop-floor changes.

In short, the purpose of this movement is to automate any and all kinds of repetitive processes. In addition, the referred movement seeks to connect different data sources so that these crossings provide valuable insights for new decision making and thus contributing to the emergence of different opportunities for innovation in the multiple business models. The future is in the exploration of data that has never been explored before, in it lays a huge potential for the industries.

4. Managing Industry 4.0' changes

The 4^{th} industrial revolution brings digital tools for an easy and automated analysis of the large amount of operational data circulating in an organization which, because of its large volume, hides relevant knowledge about the operational management of its activity. Scanning the business is the ultimate step to take, in order to raise any business to the next level.

Although this trend provides clear business advantages there are still some people reluctant to embrace and implement theses changes. As a matter of fact, the changes in the value chain require companies to embrace new business models and to establish partnerships between each other (including suppliers, technology companies and infrastructure suppliers). In addition, companies will have to invest large sums into new machinery, software, business model development, employee training, among other aspects.

Therefore, it is important to be aware that there are also some important challenges associated with Industry 4.0, such as:

- **Security:** Perhaps the most challenging aspect of implementing Industry 4.0 techniques is the IT security risk. This online integration will give room to security breaches, data leaks and might even involve cyber theft. As data is collected throughout the supply chain questions of ownership will arise and, it is important for companies to make sure that their data won't end up in the hands of a competitor.
  On the other hand, it must be ensured that the production facilities themselves do not pose a threat to humans or the surrounding environment, and that the workers receive continuous safety trainings.
- **Capital:** Such transformation will require a huge investment in new technology, which will represent a significant cost for the companies who want to adapt their business model to this new reality. The

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decision to make such transformation will have to be on CEO level. Even then, the risks must be calculated and taken seriously.

In addition, the need for a huge investment might also be a barrier for the smaller companies (because they might not have the needed resources available), which can also cost them their market share in the future.

- **Workplace:** With the implementation of Industry 4.0 it is expected that the human workforce will focus on less repetitive and more challenging tasks. Such developments will affect the essence of certain jobs and skills profiles. This new organizational structures will require a socio-technical approach for decision making, coordination, control and support across both virtual and physical machinery and factories.
- **Employment:** While it is still early to speculate on the impact of Industry 4.0 on employment conditions, it is safe to say that workers will need to acquire different or an all new set of skills. This may help employment rates go up but it will also alienate a big sector of workers. The sector of workers whose work is perhaps repetitive will face a challenge in keeping up with the industry. On the other hand, different forms of education must be introduced, but it still doesn't solve the problem for the elder portion of workers. This is an issue that might take longer to solve and will be further analysed later in this report.
- **Privacy:** This issue concerns not only the customers, but also the producers. In one hand, the customer needs to collect and analyse data which is relevant for the development of his business. On the other hand, the costumer might feel that his privacy is being threatened. Also, small and large companies who haven't shared their data in the past will have to work their way to a more transparent environment. Bridging the gap between the consumer and the producer will be a huge challenge for both parties.

5. Conclusion of M0

Despite the enormous economic potential of Industry 4.0 most people remain relatively cautious about it. It is not easy for small and medium-sized enterprises, due to lack of resources, to assess the technological maturity of the relevant solutions and their business uses. Simultaneously, management still lacks a methodical approach to implementation, thus there are still a big number of SMEs that do not have a comprehensive Industry 4.0 strategy.

Nevertheless, it should be recalled that the fourth industrial revolution is defined by digital transformation and has a significant impact on current business models, which results from the use of intelligent data and the provision of new services that would not be useful if technological developments did not exist.

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These developments are driven by a digitalization trend in the economy and society. The combinations of the new technologies that represent industry 4.0 enable the integration of all systems along the supply and value chains and the aggregation of data. The central aspect of industry 4.0 is its interface with other intelligent infrastructures, so it is important that in these infrastructures the fundamental elements of industry 4.0 are implemented.

Also, the creation of different data sources provides important information for new decision making, which contributes to the emergence of different innovation opportunities in the various business models. It should be noted that changes in the value chain require companies to adopt new business models and to create new partnerships with other companies. In addition, companies will have to make large investments in software, new machines and human resources.

In conclusion, for a company to realize the full potential of Industry 4.0 it is often necessary to reorganize its entire internal structure. The decision to carry out a digital transformation in the company must be taken into account with leadership, commitment and vision by the management team and, shall be clearly communicated to all stakeholders. Likewise, in order to adopt a digital culture all employees must be aligned with this goal, the way they think and act, experimenting with new technologies and learning new ways of performing. In fact, the move towards industry 4.0 can't be made just at once; it requires that the company is constantly reinventing its skills and competencies at a faster pace than in the past, so that they can remain competitive in the market.

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M1. TECHNOLOGY

1. Technological Scope within Industry 4.0

In the last few years we have witness the happening of the 4th industrial revolution, the so called Industry 4.0, in which computers and automation will come together in an entirely new way, with robotics connected remotely to computer systems equipped with machine learning algorithms that can learn and control the robotics with very little input from human operators.

By definition, revolutions are disruptive and the fourth industrial revolution is no exception. Yet, whereas historical developments brought forward by steam power, electricity and digital machinery were all based solely on new technologies, Industry 4.0 is different, focusing instead on how new and existing tools can be used in innovative ways.

Industry 4.0 has seen the rise of robots working alongside factory workers, and autonomous vehicles replenishing production line supplies. Sensor networks and communications technologies have been used to connect designers with factory workers, with intelligent machines and software interacting autonomously through the cloud, and facilities connected in real time to suppliers and customers.

Smart technologies, or rather, smart technological utilisation, offers the manufacturing industry so much potential. Engineers can get instant feedback on costs and performance predictions. Factory machines and logistics equipment can automatically assign factory processes. Cloud-based AI systems can compare parts and processes to optimise performance and computer systems equipped with machine based learning algorithms enable robotic systems to learn and operate with limited input from human operators.

Technological advances have driven dramatic increases in industrial productivity since the dawn of Industrial Revolution. Now, we are in the midst of a forth wave of technological advancement: the rise of a new industrial technology known as Industry 4.0, which is powered by a lot of key technologies. Effectively, there are several digital technologies as enablers of Industry 4.0, nevertheless, a company can't implement all technologies at once, nor should try to do it.

Many of the advances in technology that are the base of this Industry 4.0 already exist in the manufacturing industries, but they are used isolated and, therefore, their output is not optimised. However, with Industry 4.0 these technologies will be optimised and will come together as a fully integrated, automated and optimized production flow, leading to greater efficiencies and changing traditional production relationships among suppliers, producers and customers, as well as between human and machines.

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3D printing, sensor technology, artificial intelligent, robotics, drones and nanotechnology are just a few examples of exponentially growing technologies that are radically changing industrial processes, accelerating them and making them more flexible. Many of these technologies are not new and were, in fact, "invented" some 20 or 30 years ago. However, the recent massive boost in computing power and the reduction in cost along with miniaturisation now make them suitable for industrial use.

2. Disruptive technology trends

The basic rationale behind Industry 4.0 is that, through the connection of machines, production systems and equipment, companies will have the ability to create intelligent networks along the entire value chain, thus controlling and commanding the production processes independently.

The Industry 4.0 aggregates technologies and disruptive methods which are described below.

Disruptive Technologies
Mobile Internet
Automation of Knowledge Work
The Internet of Thing (IoT)
Cloud Technology
Advanced Robotics
Autonomous and near – autonomous vehicles
Next generation genomics
Energy store
Advanced material
Advanced oil and gas exploitation and recovery
Renewable energy

FIGURE 2- DISRUPTIVE TECHNOLOGIES

- ✓ Mobile Internet

In just a few years, Internet-enabled portable devices have gone from a luxury for a few to a way of life for more than one billion people who own smartphones and tablets. In a remarkably short time, millions of people have developed a stronger attachment to their smartphones and tablets than to any previous computer technology.

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These mobile devices enable users to go on about their daily routines with new ways of knowing, perceiving, and even interacting with the physical world. Commonly, mobile Internet is defined as a combination of mobile computing devices, high-speed wireless connectivity, and applications.

Nevertheless, the full potential of the mobile Internet is yet to be realized. In fact, it is expected that in the coming years, mobile Internet devices could potentially be smaller, far more powerful, more intuitive, wearable, and packed with many types of sensors.

New mobile software and apps offer a wide range of abilities, effectively placing the capabilities of an array of gadgets (including PCs) in a mobile package that provides voice calling, Internet access, navigation, gaming, health monitoring, payment processing, and cloud access. Thus, a crucial element in the success of mobile Internet use is the related to the use of software applications (apps) that deliver innovative capabilities and services on devices. These apps help make mobile Internet use very different from using other conventional phones or computers, providing location-based services; personalized feeds of information and entertainment content; and constant online contact with friends, colleagues, and customers.

The prospect of up to three billion more consumers joining the digital economy could represent an unprecedented growth opportunity. Entrepreneurs in developing economies might be able to compete globally in online commerce, and global players will have a new channel to reach the fastest-growing markets.

- ✓ Automation of Knowledge Work

It is undeniable that new technologies have contributed significantly to an increase in the productivity of companies and simultaneously to the maintenance of their competitiveness in the market. In fact, the automation of some phases of the production process have led not only to an increase in productivity and production capacity, but also, is has allowed the improvement in the way companies deal with their costumers. This last topic is reflected by the availability of higher quality goods, a simplified access to those goods and greater margins for businesses.

The automation of knowledge work can be defined as the use of computers to perform tasks that rely on complex analyses, subtle judgments, and creative problem solving. This is only possible due to advances in three areas: computing technology, machine learning and natural user interfaces such as speech recognition technology. These advances are making it possible to automate many tasks that were previously carried out by workers and, that for a long period of time were seen as impossible or impractical for machines to perform. This opens up possibilities for sweeping change in how knowledge work is organized and performed.

Also, with the development of these capabilities we witnessed the appearance of a new relation between workers and machines, this means that nowadays it is increasingly possible to interact with a machine the way one would with a co-worker.

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As a result, these days to pull all the information on the performance of a certain product in a specific market, a manager or executive could simply ask a computer to provide the required information. This has the potential to provide more timely access to information and raise the quality and pace of decision making and, consequently, improving the performance indicators.

Advances in software, especially machine learning techniques such as deep learning and neutral networks, are key enablers of the automation of knowledge work. These techniques give computers the ability to draw conclusions from patterns they discern within massive data sets, enabling them to "see" relationships or links that a human might overlook. Moreover, these machines can "learn" more and get smarter as they go along; the more they process big data, the more refined their algorithms become.

Finally, advances in user interfaces, such as speech and gesture recognition technology, give computers the ability to respond directly to human commands and requests (for example, Apple's Siri and Google now use such natural user interfaces to recognize spoken words, interpret their meanings, and act in accordance). The commercialization of computers with this level of intelligence over the coming decade could have massive implications for how knowledge work is conducted.

- ✓ The Internet of Things (IoT)

The Internet of Things consists of objects with embedded or attached technologies that enable them to sense data, collect them and send them for a specific purpose. Depending on the object and goal this could be capturing data regarding movement, location, presence of gasses, temperature, 'health' conditions of devices, among other aspects. It is envisaged that this form of digital connection will stimulate the emergence of new products and differentiated services.

It is important to keep in mind that nowadays only some of a manufacturer's sensors and machines are networked and make use of embedded computing. They are typically organized in a vertical automation pyramid in which sensors and field devices with limited intelligence and automation controllers feed into an overarching manufacturing-process control system. But with the Internet of Things, more devices will be enriched with embedded computing and connected using standard technologies. This allows field devices to communicate and interact both with one another and with more centralized controllers, as necessary. It also decentralizes analytics and decision making, enabling real-time responses.

- ✓ Cloud Technology

The cloud computing is a computer system in which storage of data is carried out on specialized servers and regarding to which the access to information, services and programs is accomplished remotely via the internet.

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The use of the cloud is now widespread in software and data management, given that it allows a greater interconnection between production sites and other departments within the enterprise.

As previously mentioned, companies are already using the cloud, but with Industry 4.0 more production-related undertakings will require increased data sharing across sites and company boundaries. At the same time, it is expected that the performance of cloud technologies will improve, achieving reaction times of just several milliseconds. As a result, machine data and functionality will increasingly be deployed to the cloud, enabling more data-driven services for production systems.

Effectively, the cloud creates tremendous value for consumers and businesses by making the digital world simpler, faster, more powerful and more efficient. In addition to delivering valuable Internet-based services and applications, the cloud can provide a more productive and flexible way for companies to manage their IT.

With cloud technology, any computer application or service can be delivered over a network or the Internet. In order to do this, IT resources (such as computation and storage) are made available on an as-needed-basis, which means that when extra capacity is needed it is seamlessly added. The cloud is enabling the explosive growth of Internet-based services, from search to streaming media to offline storage of personal data (photos, books, music), as well as the background processing capabilities.

With cloud resources, the bulk of computational work can be done remotely and delivered online, potentially reducing the need for storage and processing power on local computers and devices. The cloud enable network access (from computer or mobile Internet device) to a shared pool of computing resources such as servers, storage and applications that can be used as needed. This requires a complex system of servers and storage systems that can allocate computing resources to serve multiple customers simultaneously and keep track of what each user needs.

Cloud technology can be implemented as a third-party service or by companies that pool their computing resources on their own private clouds. Clouds setups are also more reliable (since they are capable of shifting processing form one machine to another if one becomes overloaded or fails), eliminating productivity-draining outages.

- ✓ Advanced robotics

The concept of robotic technology as an inherent part of production is not new, but it is nonetheless challenging. In fact, over the past few years robots have become more autonomous, flexible and cooperative, and can be used in different phases of the production processes. Nevertheless, there is still a long way to go in terms of cooperation between them and the human workforce.

Indeed, expectations rely in the fact that future robots will be able to interact and work side by side with humans, safely and in a way that both parties can learn from each other. Also, it is anticipated that the cost of

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these robots will decrease (which will make them available for a wider range of companies) and that they will consistently increase the range of capabilities they have.

For the past several decades, industrial robots have taken on physically difficult, dangerous, repetitive or dirty jobs, such as welding and spray painting. But now, a new generation of more sophisticated robots is becoming available and, they have greater mobility, dexterity, flexibility, and adaptability, as well as the ability to learn from and interact with humans, greatly expanding their range of potential applications. Effectively, we are walking towards a world with limited need for physical labour in which robot workers and robotic human augmentation could lead to massive increases in productivity (which could translate into change in prices and quantities available).

Robotics is now seeing major advances and, importantly, in extremely valuable uses such as robotic surgery and human augmentation. Advances in artificial intelligence, combined with improved sensors, are making it possible for robots to make complex judgements and learn how to execute tasks on their own, enabling them to manage well in uncertain or fluid situations.

Advanced robotics also holds a great deal of promise for businesses and economies. Early adopters could gain important quality, cost, and speed advantages over competitors, while some companies could find that advanced robotics lowers the barriers for new competitors.

- ✓ Autonomous and near-autonomous vehicles

In the past few years we have witnessed the creation of cars, trucks, aircraft, and boats that are completely or partly autonomous, this means that nowadays there are autonomous vehicles that can be manoeuvred with reduced or no human intervention. From drone aircraft on the battlefield to Google's self-driving car, the technologies of machine vision, artificial intelligence, sensors, and actuators are making the development of these machines possible and rapidly improving.

However, it is important to state that for year almost all commercial aircraft have had the ability to operate on autopilot and, also, the tankers and cargo ships that transport most of the goods for the global economy are highly automated. Only more recently we have watched this technology be extended to regular vehicles.

In fact, machine vision is a key enabling technology for autonomous vehicles. Is has become increasingly common the user of cameras and other sensors that allow a more autonomous driving, just as well as the use of a computer that constantly monitors the road and the surrounding environment, acquiring an image and then extracting relevant information on which to base actions. Pattern recognition software, including optical character recognition programs, can interpret symbols, numbers, and the edges of objects in an image.

The way this new technology works is by using a control engineering software that does the "driving," giving instructions to the actors that perform the task needed for the desired action, such as accelerating, braking, or

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turning. With these capabilities, a fully autonomous vehicle can navigate to a specified destination, moving safely among other vehicles, obstacles, and pedestrians. These vehicles' computers can also optimize fuel economy by accelerating and braking smoothly, remaining within the speed limit, and never taking a wrong turn.

Partly autonomous driving features are already being offered or will soon be offered on production vehicles. Some examples are steering assistance, braking and accelerating to maintain distance from vehicles ahead, and automatic braking when obstacles appear ahead. Within the next decade, we can expect autonomous driving to be offered as an option on new automobiles, initially on high-end models and later on mid-priced vehicles.

- ✓ Next generation genomics

The science of genomics is at the beginning of a new era of innovation. The rapidly declining cost of gene sequencing is making huge amounts of genetic data available, and the full power of information technology is being applied to vastly speed up the process of analysing these data to discover how genes determine traits or mutate to cause different diseases.

Armed with this information, scientists and companies are developing new techniques to directly write DNA and insert it into cells, building custom organisms and developing new drugs to treat cancer and other diseases.

Next-generation genomics can be described as the combination of next- generation sequencing technologies, big data analytics, and technologies with the ability to modify organisms, which include both recombinant techniques and DNA synthesis (that is, synthetic biology). Next-generation sequencing represents newer, lower-cost methods for sequencing or decoding DNA. It encompasses the second and third generation sequencing systems now coming into widespread use, both of which can sequence many different parts of a genome in parallel.

- ✓ Energy storage

Energy storage systems convert electricity into a form that can be stored and converted back into electrical energy for later use, providing energy on demand.

This enables utilities, for example, to generate extra electricity during times of low demand and use it to augment capacity at times of high demand.

Today, about 3 to 4 percent of the electricity that is produced by utilities worldwide is stored, almost all of it through a technique called pumped hydro-electric storage (PHES), which involves pumping water uphill during

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times of low demand or low cost and releasing it downhill to turn power-generating turbines during times of high demand and high cost. PHES currently accounts for approximately 120 gigawatts of storage capacity.

- ✓ Advanced materials

Science is improving new ways to manipulate matter for the production of advanced materials that could produce innovations in different fields (infrastructure, construction, medicine, etc.). These advances include ‘smart materials’ that are self-healing or self-cleaning, memory metals that can revert to their original shapes, piezoelectric ceramics and crystals that turn pressure into energy, and nanomaterials.

Nanomaterials are made possible by manipulating matter at nanoscale (less than 100 nanometers, or approximately molecular scale). At nanoscale, ordinary substances like carbon and clay take on surprising properties —including greater reactivity, unusual electrical properties, and enormous strength per unit of weight— that can enable the creation of new types of medicine, super-slick coatings, and stronger composites.

Nanoscale objects and machines can be created in a variety of ways, including direct manipulation of molecule-sized nanoparticles using tools such as atomic-force microscopes, or electron beam or laser lithography capable of printing two- or three-dimensional structures with nanoscale features. Invisible to the naked eye, nanomaterials have already found their way into products as varied as pharmaceuticals, sunscreens, bacteria-killing socks, and composite bicycle frames.

Nanotechnology is predicted to have four distinct generations of advancement, and we are currently experiencing the first or maybe second generation of nanomaterials. The first generation is all about material science with enhancement of properties that are achieved by the incorporating "passive nanostructures". This can be in the form of coatings and/or the use of carbon nanotubes to strengthen plastics. The second generation makes use of active nanostructures, for example, by being bioactive to provide a drug at a specific target cell or organ. This could be done by coating the nanoparticle with specific proteins.

The complexity advances further in the third and fourth generations. Starting with an advance nanosystem for e.g. nanorobotics and moving on to a molecular nanosystem to control growth of artificial organs in the fourth generation of nanomaterials.

- ✓ Advance oil and gas exploitation and recovery

After the first global oil shock during the 1970s, nations and energy companies around the world were forced to consider what a future with dwindling fossil fuel supplies might look like. One response was to look for new types of fossil fuel reserves and develop ways to reach them. Forty years later, these efforts are finally beginning to pay off. Horizontal drilling and hydraulic fracturing, the technologies for reaching

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“unconventional” reserves such as the natural gas and “light tight” (LTO) oil trapped in rock formations (often shale) are now at the point of widespread adoption.

These extraction techniques have the ability to unlock both newly discovered reserves and previously known deposits that could not be economically extracted using conventional methods.

Unconventional oil and gas reserves are defined as reserves that cannot be extracted by conventional drilling methods. In these reserves, oil or gas is trapped in natural fractures in rock (often shale) or adsorbed by nearby organic material.

- ✓ Renewable energy

Renewable energy is energy that is derived from a source that is continuously replenished, such as the sun, a river, wind, or the thermal power of the world’s oceans. These renewable sources of energy have the potential to be transformative if technological development and adoption accelerate

Renewable energy holds a simple but tantalizing promise: an endless source of power to drive the machinery of modern life without stripping resources from the earth; contributing to pollution and climate change; or incurring the economic, social, and political toll associated with the competition for fossil fuels.

This promise has been elusive because of the relatively high cost of renewable energy sources such as solar and wind compared with fossil fuels such as coal, oil, and gas.

5. Conclusion of M1

In light of the above we can see that Industry 4.0 is driven by disruptive technologies and can impact a company in many ways, mostly by providing operational effectiveness and challenging established business models. Realizing the benefits in these areas, however, requires that companies build a digital foundation, which is a far reaching task that poses managerial challenges at all levels of the organization. Not just processes, strategy and capabilities will have to change, but also mindsets. Companies need to act now, launching short term initiatives immediately and start preparing the medium – to long term initiatives that aim at transformation rather than augmentation.

Using Industry 4.0 as the path to the future of manufacturing will allow companies to do more than just upgrade their equipment and eliminate inefficiencies, but also increasing their operational effectiveness. It will also give them the freedom to make the right strategic decisions and reinvent their business model, preparing them to maintain a competitive edge in the global manufacturing market of the future.

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In summary, one of the main goals of Industry 4.0 is to develop the capacity of cyber-physical systems to make simple decisions on their own and to become as autonomous as possible. Only then will the agility and flexibility necessary to deal with uncertainties, respond to personalization demands, the concept of the intelligent factory and its place in an interconnected ecosystem, the required data analytics, and the various logistics can be improved.

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M2. MARKET AND MANUFACTURING

1. Industry 4.0 Design Principles

Manufacturing in Europe is undergoing a transformation through the integration of digital technology, robotics and artificial intelligence into advanced manufacturing from the factory floor to networked factories. This is important because manufacturing in Europe represents a significant part of the economy; it provides high skilled jobs and enables us to produce technologies that meet our societal and environmental needs.

Accordingly to the European Commission, nowadays manufacturing provides thirty million direct jobs and sixty million indirect jobs in Europe and, it is responsible for eighty percent of the Union's exports and generates a turnover of approximately € 7 trillion. The digitalisation of manufacturing will increase this impact as industry creates new types of jobs, manufactures in dynamic ways and provides stat-of-the-arte goods and services.

Nevertheless, this transformation goes beyond installing new ICT or high speed connectivity, it is a complete transformation of how and why we manufacture. This is why Industry 4.0 is often resumed in five design principles, essentially serving as part of the Industry 4.0 vision and to make the guidelines clearer for companies who want to make sure that their companies evolve in order to still be competitive in the market.

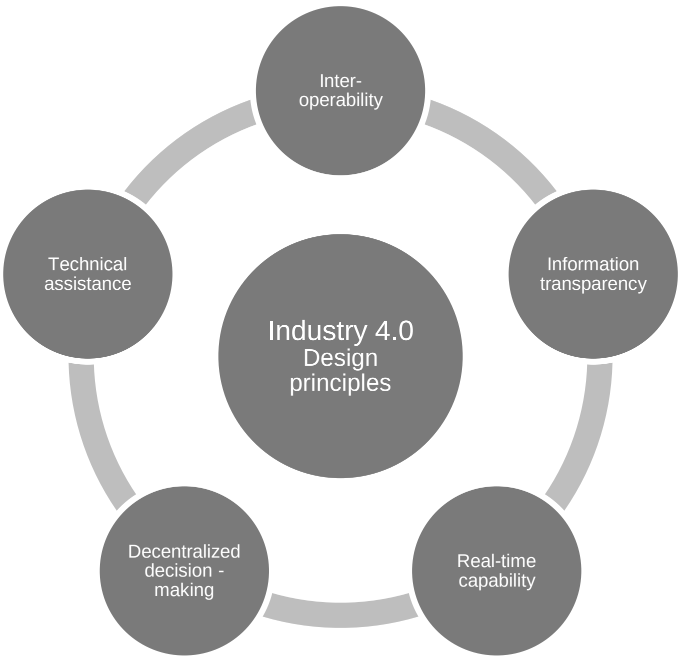

FIGURE 3- MAIN DESIGN PRINCIPLES OF INDUSTRY 4.0

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Interoperability — Interoperability is closed related to the concept of collaboration, the ability to have many standards talk to each other so data from various sources can be leveraged. Interoperability means connected machines, devices, sensors and people that communicate with one another. Without interoperability, information transparency and virtualization are not possible as the information needs to be put in context and systems are context-aware, combining information from other sources too.

Information transparency — Information transparency is essentially the capability of information systems and cyber-physical systems to simulate and create virtual copies of physical world elements through the creation of digital models that are fostered by all the data collected through the sensors and inter-operating and inter-operable "things". Briefly, the systems create a virtual copy of the physical world through sensor data in order to contextualize information.

Technical assistance — the service orientation is related to the fact that manufacturing needs to be more tailored to the demand of costumers for services and products with value added instead of what the company decides to produce; this will imply a transformation of manufacturing in a scope of customer centricity and, also, will mean that the costumer will have to be more involved in the production process contributing with his own opinion and requirements.

Therefore, technical assistance and more specifically maintenance, is a core principle as Internet of Things and data analytics simply allow the transformation of services and maintenance. Assistance systems must also serve all workers who need to be able to make decisions supported by several systems that enable them to do so. In short, the technical assistance is critical because it implies both the ability of the systems to support humans in making decisions and solving problems and the ability to assist humans with tasks that are too difficult or unsafe for humans.

Decentralized decision-making — as mentioned before one of the main goals of Industry 4.0 is to give the ability of cyber-physical systems to make simple decisions on their own and become as autonomous as possible. Only then the agility and flexibility needed to be able to deal with uncertainties, respond to demands of personalization, the concept of the smart factory and its place in an inter-connected ecosystem, the required data analytics and the various logistics can be enhanced, meeting the need for speed. Decentralized and autonomous decisions are not just key in the technologies and cyber-physical systems of Industry 4.0 but also in the human aspects as not all decisions can be fully automated and human planning, interpretation and decisions are still key and in many cases as there is a mix of semi-autonomous capabilities in collaboration with people.

Real-time capability — advanced analytics, the Internet of Things and production systems in a smart manufacturing environment in its broader context of collaboration and ecosystems already are all about the development of real-time capabilities. Thus, it is crucial that regarding data, turning it into actionable intelligence and on the level of the processes and functioning of the overall manufacturing, logistics and 'smart

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factory' operations there is a need for a real-time capability. Flexibility, predictive maintenance, being able to quickly replace assets in case of failures and the Internet of Things all are important in this perspective which also touches the previously mentioned design principles and the data to decision aspects tackled previously.

2. Market opportunities of Industry 4.0

The diffusion of the fourth industrial revolution has been having a progressively more significant impact on various aspects of human life. In fact, we have witnessed a break with many of the paradigms and production models, which affects the production levels and the value chain of the different areas. This new reality promises many positive changes in today's manufacturing, including mass customization, flexible production, faster production speed, higher product quality, reduced error rates, optimized efficiency, data-driven decision making, new value creation methods and lifetime improvement.

Regarding the evolution of **internal processes**, it is important to state that the work environment is quickly changing due to the technological advancements, which translates into the transformation of jobs and the required skills for employees to fit into the emerging business models. The most significant change regards human-machine interface, which embraces the interaction between workers and a set of new ways of collaborative work.

The number of robots and smart machines is increasing and the physical and virtual worlds are merging, which means that a significant transformation is being lunched in the current work environment. The increasing relevance of human-machines interfaces will promote the interaction between both production elements and the required communication between smart machines, smart products and employees, enhanced by the vision of Internet of Things.

The integration of Industry 4.0 in manufacturing systems and the increasing implementation of new technologies will have an impact on job profiles, as well as on work management, organization and planning. The main challenge in this context is to avoid what is known as technological unemployment, redefining current jobs and taking measures to adapt the work force for the new jobs that will be created.

In respect to **supplier and customer interface exchange**, the products and services are being highly influenced by the new industrial paradigm. In fact, over the past few years fast changes in economic landscape and dynamic market requirements have resulted in an increased demand for the development of more complex and smarter products. The products will become more modular and configurable, promoting mass customization in order to meet specific customer requirements. That is why Industry 4.0 is characterized by innovation and the introduction of new products and services that become responsive and interactive. Also,

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their activity can be managed and tracked in real-time, optimizing the whole value chain and providing relevant information about their status during their own lifecycle.

At this level it is also important to state that this new industrial paradigm will bring a new manufacturing vision that is characterized by decentralized and digitalized production, where the production elements are able to autonomously control themselves, trigger actions and respond to changes in their environment. Moreover, the emerging paradigm proposes to fully integrate products and processes, shifting the production vision from mass production to mass customization, which brings a higher level of complexity. Therefore, the production processes and operations will be deeply affected by the technological developments and the establishment of smart factories, allowing a greater flexibility in operations and a more efficient resource allocation.

Finally, in the last few years we have witnessed a significant change in the existing business models, which lead to the arise of **new innovative business models**. The emergence of disruptive technologies in the context of Industry 4.0 have changed the way products and services are sold and provided, affecting technological businesses and bringing new business opportunities and models.

Therefore, value chains are becoming more responsive,since Industry 4.0 promotes the integration between manufacturers and customers, allowing a closer interation with costumers and the adaptation of business models to market requirements, which are in constant evolution. The systems integration and complexity alongside the increasing digitization of industrial production will led to the creation of more complex and digital market models, increasing competitiveness through the elimination of barriers between information and physical structures.

Industry 4.0 is the designation given to the process that aims to computerize the manufacturing world. This means the technical integration of cyber-physical systems into production and logistics and the use of the Internet in industrial processes. The goal of having machines, storage systems and equipment networked is the "smart industry", in which intelligent machines exchange information between themselves autonomously without, however, constantly adapting to current production requirements. As a result, the expectation of the specialists if that there will be a quick increase in productivity and important savings in the matter of energy and materials.

The benefits of an Industry 4.0 could outweigh the concerns for many production facilities. For example, in very dangerous working environments, the health and safety of human workers could be improved dramatically. Supply chains could be very readily controlled when there is data at every level of the manufacturing and delivery process. Computer control could produce much more reliable and consistent productivity and output. And the results for many businesses could be increased revenues, market share and profits.

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3. Risks and Challenges

The Industry 4.0 or the 4th industrial revolution is driven by the innovative technologies which have profound impacts not only in the production systems but also in the business models. Since we are breaking with the existing paradigm in the various sectors and implementing profound structural changes, some companies still show a high resistance to implementing changes that ensure the correct implementation of the principles of Industry 4.0 in their activity.

In fact, some people are still wondering whether the benefits outweigh the challenges associated to this new reality. Some of the most relevance issues are associated with:

- Data security

A lack of standards and norms with regard to interface technologies is another reason why investments in integration of IT systems are either not carried out or delayed. Small and medium-sized enterprises worry not only about opting for the wrong standard but also about data security. Also, the principles inherent to the Industry 4.0 imply integrating new systems and with the generalization of the access to them, which increases the likelihood of data theft, industrial espionage and attacks by hackers.

- Skilled employees

Digitization also increases the importance of new technical skills, notably in case of operating activities and mechanical working processes in production, purchasing, warehousing and logistics. New Process-dependent systems making greater use of technology may prove to be a major challenge for existing employees.

Another concern that companies have regarding this subject is the systemic lack of experience and manpower available to create and implement these systems – not to mention a general reluctance from stakeholders and investors to invest heavily in new technologies.

- IT Infrastructure

Industry 4.0 requires existing installations to be adapted and, in some cases, entirely new types of IT infrastructure. Diverse systems need to be networked and to learn to communicate with each other, and new communication networks need to be developed from scratch. Simultaneously, the companies are worried about avoiding technical problems that could cause expensive production outages. It is important to keep in mind that in some industries we are talking about a dramatic decrease of the number of tasks to be performed by humans.

Finally, it is a concern the ability of smart systems to communicate across factories and with suppliers and customers that have different systems.

- Changes in the world of work

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In this matter it is important to address the issue of automation leading to major job losses. Industry 4.0 can unfold its potential only by means of the practical knowledge and adaptability of employees. While it's true that simple repetitive work is increasingly being replaced, it is also true that new jobs are emerging elsewhere due to new business models. The challenge for small and medium-enterprises is to create flexible organisational structures and to boost their employees' interdisciplinary thinking.

Thus, employees' existing qualifications and experience have to be deployed in the introduction of Industry 4.0 and enabled to reflect on production processes and to bring about continuous improvements.

- Other aspects

A high degree of reliability and stability are needed for successful cyber-physical communication that can be difficult to achieve and maintain. Maintaining the integrity of the production process with less human oversight could become a barrier.

Lastly, Industry 4.0 comprises the digitization of horizontal and vertical value chains but will also revolutionize the company's product and service portfolios and lead to the implementation of new, often disruptive digital business models transforms the entire company and requires the widespread support by policy-makers.

4. Manufacturing Industry Tech Trends

As already mentioned, the world is moving quickly and manufacturers are finding the speed of their business is increasing consistently. Product life cycles are shrinking, political and trade realities are putting pressure on businesses and the winners are the ones who can react quickly. Manufacturers need to innovate in their business processes and embrace digital technologies to stay ahead of the curve.

That being said, we detail below some of the most important tech trends that we are witnessing in the manufacturing industry.

Tech Trends
3D Printing
The Internet of Thing (IoT)
Nanotechnology
Cloud computing
Augmented Reality
CO2 Snow Cleaning

FIGURE 4- MANUFACTURING INDUSTRY TECH TRENDS

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✓ 3D Printing

3D printing belongs to a class of techniques known as additive manufacturing, this process consists of building objects layer-by-layer rather than through moulding or subtractive techniques (such as machining). Today, 3D printing can create objects from a variety of materials, including plastic, metal, ceramics, glass, paper, and even living cells. These materials can come in the form of powders, filaments, liquids, or sheets. With some techniques, a single object can be printed in multiple materials and colours, and a single print job can even produce interconnected moving parts (such as hinges, chain links, or mesh).

A variety of 3D printing techniques are in use today, each with its own advantages and drawbacks. Major techniques include selective laser sintering, direct metal laser sintering, fused deposition modelling, stereolithographic, and inkjet bio printing. With some techniques this is accomplished by melting material and depositing it in layers, while other techniques solidify material in each layer using lasers. In the case of inkjet bio printing, a combination of scaffolding material and live cells is sprayed or deposited one tiny dot at a time.

3D printing has several advantages over conventional construction methods. With 3D printing, an idea can go directly from a file on a designer's computer to a finished part or product, potentially skipping many traditional manufacturing steps, including procurement of individual parts, creation of parts using moulds, machining to carve parts from blocks of material, welding metal parts together, and assembly.

On the other hand, 3D printing can reduce the amount of material wasted in manufacturing and create objects that are difficult or impossible to produce with traditional techniques, including objects with complex internal structures that add strength, reduce weight, or increase functionality. In metal manufacturing, for example, 3D printing can create objects with an internal honeycomb structure, while bio printing can create organs with an internal network of blood vessels. Current limitations of 3D printing, which vary by printing technique, include relatively slow build speed, limited object size, limited object detail or resolution, high materials cost, and, in some cases, limited object strength. However, in recent years rapid progress has been made in reducing these limitations.

✓ The Internet of Things (IoT)

The Internet of Things refers to the use of sensors, actuators, and data communications technology built into physical objects—from roadways to pacemakers—that enable those objects to be tracked, coordinated, or controlled across a data network or the Internet. There are three steps in Internet of Things applications: capturing data from the object (for example, simple location data or more complex information), aggregating that information across a data network, and acting on that information—taking immediate action or collecting data over time to design process improvements.

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Internet of Things technology ranges from simple identification tags to complex sensors and actuators. Radio Frequency Identification (RFID) tags can be attached to almost any object. Sophisticated multisensor devices and actuators that communicate data regarding location, performance, environment, and condition are becoming more common. With newer technologies such as micro electromechanical systems (MEMS), it is becoming possible to place very sophisticated sensors in virtually any object (and even in people). And, because they are manufactured using a semiconductor-like fabrication process, MEMS are rapidly falling in price.

With increasingly sophisticated Internet of Things technologies becoming available, companies can not only track the flow of products or keep track of physical assets, but they can also manage the performance of individual machines and systems. Sensors can also be embedded in infrastructure; for example, magnetic sensors in roads can count vehicles passing by, enabling real-time adjustments in traffic signal timing. Equally important as these sensors and actuators are the data communications links that transmit this data and the programming—including big data analytics—that make sense of it all.

Increasingly, Internet of Things applications include closed-loop setups in which actions can be triggered automatically based on data picked up by sensors. For example, in process industries, sensor-based systems can automatically react to incoming signals and adjust process flow accordingly. They can change a traffic light to green when a sensor in the pavement signals that cars are backed up at the intersection, or alert a doctor when the heart rate of a patient with a remote monitor spikes.

Basic uses of the Internet of Things are already well under way, in fact one of the biggest applications so far employs RFID to track the flow of raw materials, parts, and goods through production and distribution. These tags emit a radio signal that can be used to pinpoint their location. So, for example, as a tagged product moves through a factory, computers can track where it is at any given moment. Using that information, the company can spot bottlenecks, managing the timing of the release of more parts into the system, or schedule trucks to pick up finished goods. RFID tags on containers and boxes are used to track products as they make their way through warehouses and transportation hubs to store shelves and (in cases where tags are used on packaging) even all the way to the consumer.

- ✓ Nanotechnology

Any use or manipulation of materials with features at a scale of less than 100 nanometers (roughly molecular scale) can qualify as nanotechnology. Nanoscale objects and machines can be created in a variety of ways, including direct manipulation of molecule-sized nanoparticles using tools such as atomic-force microscopes, or electron beam or laser lithography capable of printing two-or-three dimensional structures with nanoscale features. Since complex nanoscale structures such as nanomachines (including nano electromechanical machines, or NEMS) are currently experimental and very difficult to construct, and methods for large-scale

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production may not be developed for another decade, we focus in this chapter on nearer-term applications of advanced nanomaterials.

Nanomaterials can have amazing properties. At nanoscale, science enters the strange realm of quantum mechanics. Nanoparticles, for example, generally have far greater surface area per unit of volume (up to 2,000 square meters per gram) than other materials and are thus highly reactive (and bio-reactive), making them useful in medicine. Nanoscale materials can also have unusual electromagnetic, thermal, and optical characteristics, which could enable advances across many of the technologies described in other chapters of this report, including the next- generation sensors and actuators use in advanced robotics and in Internet of Things applications. The properties of nanomaterials could make them useful in creating a variety of other advanced materials.

After many years of delivering more promise than visible progress, nanotechnology is often viewed as overhyped. The truth is that nanotechnology, although in its more basic, invisible forms, is already a reality today and will have a growing role in industry, medicine, and the lives of consumers in years to come. Over the coming decade, the full potential of advanced nanomaterials may only begin to be felt, but these materials will likely continue to attract considerable interest and Research and Development (R&D) investment. Nanomaterials could begin to open up major opportunities for health-care technology companies, pharmaceutical companies, and health-care providers. Business leaders, particularly in health care, manufacturing, and electronics, should consider now how these materials could be used to create new products or make existing products better, and invest accordingly. Meanwhile, policy makers will need to address unanswered questions regarding the safety of nanomaterials.

- ✓ Cloud Computing

Increasing the sharing of network information for the development of a product implies the use of applications and data sharing in addition to the company’s server. The cloud feature provides a great deal of time reduction providing important gains in cost and efficiency.

The first cloud computing services are only a decade old, but a variety of organizations, such as small startups to global corporations, government agencies, and nonprofits, are embracing technology for a variety of reasons. There are big reasons why organizations are turning to cloud computing services:

1. In terms of cost, cloud computing eliminates the capital costs of buying hardware and software and setting up and running local data centers;
2. Cloud computing services are delivered by self service and on-demand, meaning that large amounts of computing resources can be provisioned in minutes, giving companies a lot of flexibility and eliminating the pressure of capacity planning;

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3. Cloud computing services also include ability to scale elastically, that is, provide the right amount of IT resources;
4. Cloud computing allows local datacenters a lot of "racking and stacking," that is, hardware configuration, software patch, and other time-consuming IT management tasks.
5. Most cloud computing services run on a worldwide network of secure datacenters, being regularly updated to the latest generation of fast and efficient computing hardware, leading to greater economies of scale.
6. Finally, cloud computing makes data backup, disaster recovery, and business continuity easier and less costly, since data can be mirrored across multiple redundant sites on the cloud provider's network.

However, there are also some disadvantages in using cloud service providers. Once they enable better security standards and industry certifications, storing important data and files in external service providers always has some risks.

First of all, to use cloud computing a company needs to give the service provider access to important company data, which means that this information is more vulnerable, because the company automatically loses the control over who has this information. Also, the ease of getting and accessing cloud services can also give “harmful” users the ability to verify, identify, and exploit gaps and vulnerabilities within a system.

Finally, the company becomes dependent on a vendor for these services, the so called vendor lock-in, which means that the company won’t be able to use another vendor without substantial switching costs.

✓ Augmented Reality

A direct use of this "augmented reality" technology aims at providing immediate information regarding the maintenance and repair techniques of components and equipment. This technology can also be useful for training or to design and make project stages less abstract, promoting a greater involvement of all stakeholders, as well as in the field of communication and marketing, namely in tourism.

Augmented-reality-based systems support a variety of services, such as selecting parts in a warehouse and sending repair instructions over mobile devices. At the moment these systems are still in their early stages, but in the future it is expected that companies will make a wider use of this reality to provide workers with real-time information and, this way, improving decision making and work procedures.

For example, workers may receive repair instructions on how to replace a particular part whilst they are looking at the actual system needing repair. This information may be displayed directly in workers’ field of sight using devices such as augmented reality glasses.

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training or to design and make project stages less abstract, promoting a greater involvement of all stakeholders, as well as in the field of communication and marketing, namely in tourism.

Boeing researcher Thomas Caudell coined the term augmented reality in 1990, to describe how the head-mounted displays that electrician used when assembling complicated wiring harnesses worked. One of the first commercial applications of AR technology was the yellow "first down" line that began appearing in televised football games sometime in 1998. Today, Google glass and heads-up displays in car windshields are perhaps the most well-known consumer AR products, but the technology is used in many industries including healthcare, public safety, gas and oil, tourism and marketing.

Augmented reality apps are written in special 3D programs that allow the developer to tie animation or contextual digital information in the computer program to an augmented reality "marker" in the real world. When a computing device's AR app or browser plug-in receives digital information from a known marker, it begins to execute the marker's code and layer the correct image or images.

Nowadays, distance learning goes through the redefinition of concepts, among other reasons by the rise that the so-called emerging technologies are acquiring, thus expanding the technologies with which the students can interact and the experiences that can be provided.

The traditional and current format blended learning which dominates the university education generally formed by a combination of non-presence, flexibility and easy access, is demanding a new view and form of usage. Together with it, the Augmented Reality, catalogued by the Horizon Report as a technology which must be present in the educational system about the year 2020, is presented as a resource which can improve the previous one, given the closeness between the content and the context reality presented, thanks to its possibility of being used at a distance.

- ✓ CO2 Snow Cleaning

In the manufacturing process, cleaning is required in several steps – unfortunately, most methods of cleaning are messy, hazardous, inefficient, and far too rough for many delicate parts. Nevertheless, the CO2 snow cleaning is a method that is becoming increasingly popular. This is a waterless cleaning method that successfully eliminates those issues that complicate precision manufacturing in industries like data storage, automotive, and medical device. Recycled liquid dry CO2 drawn from a source expands to form “snow” particles that are forced through a nozzle to clean by precisely impacting the surface.

And just as robotics are streamlining the assembly line, so is dry CO2 cleaning – systems can be automated for improved efficiency and have recently taken the automotive plastics industry by storm. BMW and VW are the first European automotive manufacturers to implement these practices, but it is expected that more other manufacturers will follow this tendency.

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Another huge shift in the manufacturing is that towards environmentally-friendly practices, and where recycled CO2 succeeds is in preventing water and chemical waste from entering and harming the environment. Manufacturing, like almost all industries, is steadily moving away from physical, muscle-powered work to digital, brain-powered work.

5. Conclusion of M2

It is expected that the work environment will rapidly change due to technological advances, which translated into job transformation and the change in the required skills for employees to fit into emerging business models. The increasing relevance of man-machine interfaces will promote the interaction between the two production elements and the necessary communication between intelligent machines, intelligent products and employees. Systems integration and complexity, together with the increasing digitalization of industrial production, will lead to the creation of more complex and digital market models, increasing competitiveness and removing the existing barriers between information and physical structures.

Some of the principles inherent in Industry 4.0 imply the integration of new systems and the widespread access to them, which increases the likelihood of data theft, industrial espionage and hacker attacks. The challenge for small and medium-sized enterprises is to create flexible organizational structures and boost the interdisciplinary thinking of their employees. Thus, existing employee qualifications and experience must be implemented in the introduction of Industry 4.0 and made possible to reflect on production processes and to achieve continuous improvement. The basic rationale behind Industry 4.0 is that by connecting machines, production systems and equipment, companies will have the ability to create intelligent networks along the entire value chain, controlling and commanding production processes independent.

Lastly, a factory that is characterized by Industry 4.0, has connected machines, devices, sensors and people communicating with each other, without this happening, information transparency and virtualization are not possible. It should be noted that technical assistance is also indispensable because it involves both the capacity of systems to support human beings in decision-making and problem solving and the ability to assist human beings with tasks that are very difficult or uncertain. Industry 4.0 is driven by disruptive technologies and can impact a business in many ways, primarily by providing operational effectiveness and challenging established business models. Realizing the benefits in these areas requires companies to build a digital base, which is a far-reaching task that poses managerial challenges at all levels of the organization.

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M3. EDUCATION

1. Work organization and work design in the digital industrial age

The development of Industry 4.0 will be accompanied by a change in the tasks and demands aimed for the human workforce. Being the most flexible element in cyber-physical production systems, workers will be faced with a large variety of jobs ranging from specification and monitoring to verification of production strategies. Through technological support it is guaranteed that workers can realize their full potential and adopt a role as strategic decision-makers and flexible problem-solvers. The use of established interaction technologies from the consumer goods market seems to be promising.

The social challenge in industry 4.0 contemplates three different sustainable approaches:

1. Increasing the training efficiency of workers by combining new ICT technologies, e.g. virtual reality head-mounted displays with learn instruments;
2. Increasing the intrinsic motivation and fostering creativity by establishing new CPS-based approaches of work organization and design, e.g. by implementing the concepts of flow theory or using new ICT technologies for implementing concepts of gamification in order to support decentralized decision-making;
3. Increasing the extrinsic motivation by implementing individual incentive systems for the worker, e.g. by taking into account the smart data within the product life cycle for providing individual feedback mechanisms.

As manufacturing processes are becoming more and more flexible, both in terms of their activities and in terms of their physical spaces, different forms of work organisation are emerging, this can affect worker-enterprise relationships.

The SatisFactory Project developed a toolkit that allows supervisors to manage machinery and human resources in real-time. It takes into account the workers' skills, in order to match each task to the required expertise of worker and experience. It also provides statistics that help evaluating the workload, the workers' experience, and the condition of assets (The 4th Industrial Revolution, European Commission 2018).

It is expected that the 4th Industrial Revolution will change the future job profiles, but it will also affect the way work on the shop-floor can be organised and how "human centred manufacturing "could empower workers. The change from a mass production model to a mass customisation model also implies challenges to the way the work and resources are organised within a factory. New ways of working using new tools, processes and approaches will be needed in factories of the future (FoF) in order to better assess the machinery, skills and workforce resources needed to increase flexibility, agility and competitiveness.

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2. Training and continuing professional development of Industry 4.0

The actual educational profile of a typical Industry 4.0 worker it's not so well developed. Workers should be mostly trained in a STEM (Science, Technology, Engineering and Mathematics) but in addition to strong domain-specific skills, they also need to excel in general competencies such as managerial skills, understanding of specific industries, and the interrelationship of different industries in value chains, supply chains, and processes.

There is also a greater demand for excellent communication skills to promote teamwork and customer relationships. All of these new competency requirements advocate the development of entirely new qualifications that address the interdisciplinary nature of the work. New learning content and teaching methods need to be better established and included in vocational education and lifelong learning. To support continuing education of workers, the development of new standards to assess formal and informal learning is critical.

However, the current developments are inducting job growth, if the concurrent high skills instability is not dealt with in time, industries will be led to massive recruitment challenges and talent shortage, already happening now and expanding rapidly over the next five years (Kusmin, 2017).

3. Latest educational technologies trends

- Learning Technologies Types:

  - Adaptive Learning Technologies

As emerging technologies and methodologies reshape corporate training, one phrase "adaptive learning" is among the biggest of the buzzwords. The concept of adaptive learning is related to the need of adapting the course plan to the individual needs of the students. Therefore, the teachers / trainers must be able to adjust the taught contents in order to provide an adequate answer to the needs of the different students. Currently, the available technology plays an important part in helping to make these adjustments easier and more efficient.

The adaptive learning technology plays and important part at two levels:

(i) Assist teachers/students to adapt their course plans. The adaptive technology can help teachers/trainers to monitor the evolution of their students and, thus, better understand which subject they already master and, in which they need more guidance;

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(ii) Provide information that better qualifies the teacher/trainer. The adaptive learning technologies keep track of the progress of the students and, they are able to provide on time information regarding their learning status. This way, the teachers/trainers don't have to spend hours of their time with the students assessing which competencies require more training (they'll have on-demand data aggregating that information).

Adaptive learning is an educational method based on the analysis of data (learning analytics) that generate the learning process of students; allows modifying the educational proposal in a personalized way and in real time taking into account the performance of each student.

Adaptive learning began to develop in the 1980s with the expansion of computers and digital tools that obtain, manage and process a large amount of information to adapt the proposal to users. It is currently reaching its highest level of extension and improvement thanks to the advancement of new technologies, the Internet and big data, that is, the development of algorithms to process and relate a large amount of massive data and generate specific proposals for each user.

It offers direct benefits for the improvement of learning and very clear advantages for both the student and the teacher. Students improve the results because the intelligent system adapts the learning itinerary according to their needs, difficulties or strengths; knows the results immediately and helps them detect and understand errors. In this way they learn better and more effectively and quickly. In addition, at the same time the process motivates them because they see how they advance in their learning and gain confidence in themselves. Teachers, on the other hand, improve their knowledge of students and their abilities, weaknesses and strengths in learning, and they can address them in a more individualized way and appropriate to their objectives. Thus, they can focus their attention on the less consolidated aspects, address the difficulties in a personalized way or pose new challenges to more advanced students so that they do not lose interest.

First, the system requires gathering information about students, their ways of learning, their weaknesses and their strengths. Taking into account the data collected, the digital educational tool establishes a work plan adapted and differentiated for each student, so that emphasis is placed on areas where the student needs more work or takes advantage to generate more challenges and motivate them, or adapt the most appropriate learning approaches in each case. In addition, it is a system that is committed to permanent interaction, with which feedback is constant and adaptation is ongoing. However, for this it is necessary -and not all the tools on the market offer it- that the system provides detailed information to the teacher so that he can, thanks to the greater personal knowledge of the needs of the student, adjust the itinerary and address the difficulties in a personal way to each student.

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- Microlearning Technologies

With the forth industrial revolution we have witnessed the appearance of a new learning paradigm - a digital approach that can effectively and quickly close knowledge gaps. This new approach appeared in a point of time in which it is no longer enough to rely in the knowledge previously acquired by the employees, alternatively it is crucial to make sure they are continuously learning new methods and techniques and, therefore, making sure they are able to follow market trends.

That being said, microlearning means disaggregate content into small parts or units (making the learning materials more compact) and, using time flexibility with short activities when and as the learners needs them. Some of the advantages of using microlearning are that it is avoided the information overload, it is promoted a learning experience step by step and, by incorporating short and logically structured lessons, microlearning helps to close any skill gaps employees have.

Finally, it important to keep in mind that has this technology provides on demand information completely adapted to the workers' needs, it will also play an important role in increasing the workers' motivation and learning outcomes. With future staff training methods, content will no longer be prescribed for each individual employee. Instead, employees and their managers will construct individualized programs based on career plans and performance goals.

- Mobile Learning.

Mobile learning involves the use of mobile technology, either alone or in combination with other information and communication technology (ICT), to enable learning anytime and anywhere. Learning can unfold in a variety of ways: people can use mobile devices to access educational resources, connect with others, or create content, both inside and outside classrooms.

This way of learning enables the reduction of time reserved for learning only, allows a faster updating of content when compared to more traditional methods of teaching and, thus, gives a better qualification to the professionals that the institutions form.

One of the advantages of these technologies is that it allows taking learning to places where it is harder to get. For example, in some companies due to the nature of their activities or to the schedule of their workers it may be hard to enrol in a training course. Therefore mobile learning may just be the perfect alternative, given that it provides knowledge at distance and, contents are up to date.

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At last, it is important to take into consideration that mobile learning doesn't aim at replacing the conventional learning approaches; instead, this technology is a complementary tool, being a mean of interaction and helping the students in their activities.

- Next-Generation LMS.

Learning Management Systems (LMS) have been evolving over the past few years and, nowadays, they have become a critical tool for nearly all institutions of higher education and a driving force in online learning. Moreover, various organizations are starting to understand the importance of ensuring a continuous training and development of their workers, as this is a vital contributor to organizational growth, hence they should also consider investing in good LMS.

In order for this systems to be efficient it is important that they can easily track learners progress and performance, to provide unlimited and uniform access to eLearning materials, that they have the eLearning content gathered in one location and, finally, to be a cost savings alternative.

Along with the above mentioned features, the next gen learning management systems should also incorporate features such as:

- Software-as-a-Service (SaaS): These platforms provide reliability, on-demand scalability and, therefore driving organizational efficiency and cutting down on operational expenses.
- Online assessment: this will allow employers/tutors to assess the progress of the worker/student. It may consist of questions and based on the responses the application would suggest certain courses.
- Course management: The option of adding courses is usually available for the administrators of the application, but in the future it may be of interest to extend these permissions to the workers. They may be interested in adding their own courses or additional information.
- Goal management: This will allow an individual to set certain goals and specify the period of time in which they anticipate to achieve them. For a specific goal they should be able to create different tasks and set dates to complete them, the application would track goals achieved and mark complete accordingly.

A learning management system (LMS) is a software environment that enables the management and delivery of learning content and resources to students. It provides an opportunity to maintain interaction between the instructor and students and to assess the students by providing immediate feedback on the online quizzes. Most LMS are web-based to facilitate "anytime, anywhere" access to learning content and administration. Common LMS in higher education fall under two broad categories: Commercial systems such as Blackboard, WebCT, eCollege, and Desire2Learn; Open source code products such as Moodle, Sakai, Segue, and Coursework.

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These learning environments may be used to totally replace face-to-face (F2F) teaching in a physical classroom, partially replace F2F teaching ("blended") or only supplement existing F2F teaching (Arbaugh & Duray, 2002).

The LMS can enhance learning through efficient access to learning materials, by the provision of immediate feedback to students through on-line assessment (Breen, Cohen, & Chang, 2003), and by improved communication between students and instructors through discussion forums and email (Beard and Harper, 2002).

However, some opinion leaders believe that the current LMS have limited capacity, because they focus too much on the learning management instead of learning itself. The next generation of LMS, also called digital learning environment next generation (NGDLE), it refers to the development of more flexible spaces to attend customization, meet the standards of universal design and play a more important role in formative learning assessment. Instead of being unique applications, are a set of IT systems and application components that adhere to common standards that would allow diversity while would promote consistency.

As we have said the current space LMS is dominated by several brands including Canvas, Blackboard, Moodle, Edmodo, Desire2Learn and Sakai, which are generally used at the level of the entire institution. Beyond these large platforms, only a small percentage of the market share belongs to the alternative learning and development platforms courses, although the arrival of the MOOC in 2011 created new possibilities with open source platform OpenEdX, or Helix LMS that caters to new and growing online approaches such as open education and competency-based learning. The way for the next generation of LMS is being paved by the desire to allow educators to separate all components of a learning experience to remixing open content and educational applications unique and compelling way.

Although technological advances have enabled LMS sophisticated analysis of learning, adaptive learning and dynamic social exchanges, challenges for the design of new models remain. LMS are owned by companies that strictly control their platforms, making it difficult to expand feature sets and integration of external resources so that better suit the needs and evolving institutional pedagogies. Increasingly teachers and students use tools like Google Apps, WordPress, Slack and iTunes U, but generally access these applications outside the LMS. In addition, the gamification, adaptive learning and OER are just a few examples of technological advances that institutions are taking to strengthen student success and increase affordability, although these elements are not always integrated into the LMS. Ecosystems that not only incorporate learning approaches emerging today, but also be agile enough to support future evidence-based practices are needed.

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- Virtual & Remote Laboratories

Laboratory experiences are essential in any educational field as they provide practical training in addition to the fundamental theories taught in lectures. Simultaneously, with the recent technological developments students have been able to use existing online labs, created independently, as a tool in which users can perform tailored experiments.

However, the limited resources and restricted budgets of universities and of some companies and the large amount of students and/or workers sometimes make the available resources at the laboratories insufficient, which complicate the task of providing quality experimental training.

Taking advantage of new communication technologies such as the Internet and computing tools such as virtual instrumentation, the available resources can be shared, developing and implementing collaborative schemes and e-learning environments that allow the access to practical training to a larger amount of students/workers, regardless their location.

- Virtual Lab: It is a website or a software for interactive learning based on the simulation of a real problem or phenomena. It allows students to explore a topic by comparing and contrasting different scenarios, to pause and restart the application for reflection and note taking, and to get practical experimentation experience online.

  The common case for all virtual labs is that real experiments are virtualised or simulated using software, in most cases dealing with a challenge close to reality. The actor is performing his actions from a distance by using an ordinary computer system sending his input over a network (in most cases involving Internet transmission) to a receiver system which will be in most cases linked directly to the virtual lab. In specific cases a virtual lab may involve different virtual machines (as in a network experiment, where students have to set-up a network infrastructure from a distance) or additional server systems (database systems among others) which are necessary for the virtual lab. The system itself directly sends the feedback over the communication channel back to the actor's personal computer.
- Remote Lab: A remote lab (or online lab) enables actors (such as students or employees) to carry out experiments over the Internet which are normally performed in real-time physical studies in educational laboratories. In a remote lab, the actor is connected by a personal computer (or any other device, like a smart phone or tablet pc) to the Internet. The actor is performing by utilising specific software or just by accessing a web application running in any common web browser. The user's actions are transmitted to a receiver system (in most cases a computer system) with a public IP address.

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Virtual and remote laboratories reflect a movement among education institutions to make the equipment and elements of a physical science laboratory more easily available to learners from any location, via the web.

Virtual laboratories are web applications that emulate the operation of real laboratories and enable students to practice in a “safe” environment before using real, physical components. Students can typically access virtual labs 24/7, from wherever they are, and run the same experiments over and over again.

Some emerging virtual lab platforms also incorporate reporting templates that populate with the results of the experiments so that students and teachers can easily review the outcomes. Remote laboratories, on the other hand, provide a virtual interface to a real, physical laboratory.

Institutions that do not have access to high-calibre lab equipment can run experiments and perform lab work online, accessing the tools from a central location.

Users are able to manipulate the equipment and watch the activities unfold via a webcam on a computer or mobile device. This provides students with a realistic view of system behaviour and allows them access to professional laboratory tools from anywhere, whenever they need.

Additionally, remote labs alleviate some financial burden for institutions as they can forgo purchasing specific equipment and use the remote tools that are at their disposal.

- Internet Technologies Types:
    - Internet of Things

It is undeniable the impact of the Internet in the state of education, over the past few years. Actually, one of the very smart aspects of modern schools and classrooms is that the IoT improves the education itself and brings advanced value to the physical environment and structures.

The Internet of Things helps to create smarted lessons plans, keep track of important resources and learning centres, improves access to information, design safer campuses and many other aspects.

Next we will talk about some of the advanced tools that have changed the education sector.

Interactive learning: Currently the learning process is not limited to a set of books that combine text and images. Alternatively, most manual are already used in combination with other online materials that contain additional information on given subject; videos, animations, and other resources that support and complement the learning process. This reality gives students a broader perspective that allows them to learn new contents and encourages their interaction with teachers and their colleagues.

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Additionally, teaching professionals are increasingly bringing real problems to the classrooms and thus working together with the students in order to identify potential solutions.

Mobile devices and tablets educational apps: Mobile devices have revolutionized the educational context. In fact, the use of devices such as mobile phones and tablets allows instilling new forms of learning and even stimulating the creativity of students, for example, trough the use of 3D graphics. Additionally, it provides several educational games and makes the learning process more engaging and interactive.

It is also important to highlight the role of e-books that have gained greater relevance over the past few years. The main advantage associated with this kind of books is that students can carry hundreds of books without difficulty.

Mobile devices can hold hundreds of textbooks, plus quizzes, homework and other related files thus eliminating the need for physical storage of books. For all the students who are very excited to watch the videos, diagrams or Infographics, eBooks provide richer experiences and expands learning opportunities to students.

Different learning sources: In a context of constant technological evolution, new forms and methods of learning are emerging, some of which have a significant impact on the way students and teachers share information and also on how the institutional objectives of the learning process are defined.

Tools like Google Apps allow students and teachers to share documents online and even make correction and changes to them on the screen in the classroom. In addition, there are already some applications that help teachers organize all the resources they will make available for students, enabling a more adequate structuring of the need of each individual.

Finally, we can not fail to mention that in these days' students and teachers can have all the information they need at a distance from a click. Effectively, nowadays it is possible to find a high volume of information on the broadest topics, available online and easily accessible to all users.

Distinct ways of communication: As for the methods of communication, these have also changed considerably in recent years. Technology has played an important role in fostering communication between students and teachers/trainers, as well as allowed the use of different communication methods.

On the one hand, this evolution helps the teachers/trainers to keep a proper track on each of the students and assign them with home works through different online tools and track their performance. This way,

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teachers/trainers can keep in touch with their students any moment they wish to and thus eliminate any communication barrier that exists between them.

On the other hand, communicative use of technology helps the students to take on several roles and bear their own responsibility for learning. It also gives them freedom of speech and action in a modern and safe environment.

Advanced Security measures: Implementing more technologically advanced security solutions can be very useful for the education sector. These technologies may include emergency alert systems, audio enhancement, wireless clocks and hearing impaired notifications that provide the students and staff with a sense of security.

Schools and different education centres are adopting different security measures that can play a crucial role in maintaining campus safety.

The communications console can also be utilized for different emergency tones, live announcements, multiple bell schedules and pre-recorded instructional messages that will direct the staff and students during emergency.

New teaching materials: Formerly one of the most widely used solutions in classrooms was chalkboards, however, more and more this alternative has fallen into disuse. In fact, students and teachers increasingly favour the used of Smart Boards, which have become more useful as they make it easier to display presentations online and allow the display of videos.

Web-based tools and programs help to teach the students more effectively that was once paper or chalkboard based. Smart technology let teachers and students surf the web and even edit video and share assignments.

Attendance tracking systems

We can anticipate that a strong school attendance system ensures the security of an educational organisation and can help schools and education centres in many ways. For example, it will help the teachers to input the necessary information directly into the system. This will minimize the time spent submitting attendance data and, will allow school officials to send an electronic message to parents, every time the absence numbers are too high. It can also help to track the number of times a student has reported to the doctor and keep a check on student’s medical needs and medication they may be taking.

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➢ Syndication Tools

Content syndication is a process in which it is allowed that other websites republish the content existing in a determined website, never forgetting to make a reference regarding who is the author of the content.

This process is rather importance hence it enables the content of a website to appear on other websites and, thus, gives a better change to drive more engagement, boost traffic to the base website and increases the exposure of the brand or product. Also, it has been growing the idea that the next evolution of content is not the creation of more content but a better distribution of it.

Following please find a brief description of the most used syndication tools.

1. RSS feeds – Rich Site Summary

RSS stands for Really Simple Syndication, it is a tool specially designed to help syndicate content, over a variety of convenient platforms. It may be helpful in the process to help broaden syndication opportunities and will help making content available to a wider potential audience.

2. Social Media Marketing

It is undeniable that social media has become an essential element of today's marketing mix. However, without the right tools to access and deliver timely, relevant and nearly continuous new content, the social media efforts can fall flat.

Also, by effectively using social media sites such as Facebook, Twitter and LinkedIn to communicate with potential buyers, channel partners gain the power to build their brand and boots brand awareness.

3. Email Marketing

E-mail marketing can be used to promote a companies products and services and, it plays an important part in building a subscriber base. The usual process is to create a "SignUp" form in a prominent area of the website.

4. Video syndication

A solid video distribution is essential for digital video publishers, and the best distribution strategies use a video syndication platform to interact with distribution partners. In fact, pairing a smart online video distribution plan with the right content syndication tools may be the best way to monetize the video.

5. Audio syndication

The content syndication rates with audio are quite high. For example, we can frame here iTunes which is a platform that allow content marketers to share their content in the form of podcasts. In the case companies are targeting an audience that prefers to listen to the information rather than read it.

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6. Slideshare

The website of slideshare allows anybody to upload a slideshow that visitors can download and use. This enables the distribution of content to a wide audience of users.

One of the possible disadvantages of this tool is that it requires the adaption of the content into a slideshow. Also, the slideshow audience is looking for quality, well-researched content that can be used in professional presentations.

7. Linkedin

Linkedin has become one of the most important social media pages aimed at the development of career networks. In addition, it is also a great avenue for syndication, as it's filled with regularly posted articles that are written by members of the community. Also, this tool is particularly useful because its audience is very specific, so the companies can evaluate if it makes sense to share their content there.

Enabling Technologies Types:

- Big Data (E-learning Analytics)

Today, almost any interaction made over the internet or through the consumption of goods and services is being tracked, stored, and used in targeted ways. This has led to the notion of big data massive amounts of data that reflect the behaviour and actions of various populations. Data scientists and data collection platforms are now able to computationally organize petabytes and exabytes of data so that it is easy to analyse and identify patterns that may have otherwise gone undetected. With the complexity surrounding such large, diverse sets of data, displaying the information is crucial to its success. Visual data analysis blends highly advanced computational methods with sophisticated graphics engines to illuminate patterns and structure even the most complex visual presentations. Information visualization uses infographics; the graphical representation of technical data designed to be quickly and easily understood. In education, data mining is already underway to target at-risk students, personalize learning, and create flexible pathways to success. As education institutions become more adept at working with and interpreting big data, they can make more informed decisions that reflect real learner needs.

5. Conclusion of M3

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In synthesis, new learning content and teaching methods should be better established and included in vocational education and lifelong learning in order to support the continuing education of workers, the development of new standards for assessment of formal and informal learning. With the fourth industrial revolution, the emergence of a new learning paradigm can effectively and quickly close knowledge gaps.

This new approach has emerged at a time when it is no longer sufficient to rely on the knowledge previously acquired by employees, so it is vital to ensure that they are continuously learning new methods and techniques and thus ensuring that they are able to keep up with market trends. In fact, one of the most intelligent aspects of modern schools and classrooms is that IoT improves one's education and adds advanced value to the physical environment and structures. The Internet of Things (IoT) helps people to create smart lesson plans, track important resources and learning centers, improve access to information, design safer campuses, and many other things. Currently, the learning process is not limited to a set of books that combine text and images; alternatively, most manuals are already used in combination with other online materials that contain additional information. This reality gives students a broader perspective that allows them to learn new content and encourages their interaction with teachers and peers.

In a context of constant technological change, new forms and methods of learning are emerging, some of which have a significant impact on how students and teachers share information and also on how the institutional objectives of the learning process are defined. Visual data analysis combines highly advanced computational methods with sophisticated graphing mechanisms to illuminate patterns and structure even the most complex visual presentations. In education, data exploration is already in progress to target at-risk students, customize learning, and create flexible paths to success. As educational institutions become more adept at working and interpreting the big data, they can make more informed decisions that reflect the real needs of students.

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M4. NATIONAL AND EU POLICIES

1. Implications of EU Education Systems for Industry 4.0

I. Improving digital literacy

New technologies are transforming the world by redefining customer expectations and enabling companies to meet these new expectations and change the way people live and work. Digital transformation has immense potential to change the lives of consumers, create value for business and liberate broader social benefits.

In collaboration with Accenture, the World Economic Forum launched the Digital Transformation Initiative in 2015 to serve as a focal point for new opportunities and issues arising from the latest developments in the digitization of business and society. It supported the broader activity of the Forum related to the Fourth Industrial Revolution.

Since its inception, the Initiative has analyzed the impact of digital transformation in 13 sectors and five intersectoral themes to identify the key issues that allow the value generated by digitization to be captured for business and society at large. Based on these themes, they have developed a series of imperatives for business leaders and politicians who seek to maximize the benefits of digitization. They have engaged more than 300 executives (both global leading companies and new technology deregulators), government leaders and politicians, and academics.

Europe may be at the beginning of a new industrial revolution, considered the fourth innovation and therefore labeled Industry 4.0. The omnipresent use of sensors, the expansion of communication and wireless networks, the deployment of increasingly intelligent robots and machines, as well as the increase of computational capacity at low cost and the development of "big data" analysis, have the potential to be manufactured in Europe.

This new digital industrial revolution promises greater flexibility in manufacturing, mass customization, higher speed, better quality and greater productivity. However, in order to capture these benefits, companies will need to invest in equipment, information and communication technologies (ICTs) and data analysis, as well as in the integration of data flows across the entire value chain.

The EU supports industrial change through its industrial policy and through research and infrastructure funding. Member States are also sponsoring national initiatives such as Industry 4.0 in Germany, the Factory of the Future in France and Italy, and Catapult centres in the UK. The need for investment, changing business models, data issues, legal questions of liability and intellectual property, standards, and skills mismatches are

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among the challenges that must be met if benefits are to be gained from new manufacturing and industrial technologies. If these obstacles can be overcome, Industry 4.0 may help to reverse the past decline in industrialization and increase total value added from manufacturing to a targeted 20% of all value added by 2020.

The digitization initiative of European industry is an important component of the digital single market strategy, which aims to make the EU single market appropriate to the digital age. Complementing the various national initiatives for the digitization of the industry, the DEI strategy is structured in five main aspects:

- European platform of national initiatives on digitising industry;
- Digital innovations for all- Digital Innovation Hubs;
- Strengthening leadership through partnership and industrial platforms;
- A regulatory framework fit for the digital age;
- Preparing Europeans for digital future.

The state of industry digitization varies from sector to sector, particularly in the high technology and more traditional areas, and between Member States and regions. There are also large disparities between large companies and SMEs. Industrial value chains are interconnected across borders and the digital revolution brings challenges that can only be resolved through a coordinated effort at EU level (Digitizing European Industry, European Commission, 2018).

Only about 1 in 5 companies across the EU are highly digitized, with about 60% of large industries and more than 90% of SMEs feeling "behind" in terms of digital innovation. The digital revolution brings opportunities for large and small businesses, but many of them find it difficult to know which technologies to invest in and how to secure funding for their digital transformation.

With the advent of the digital revolution, products and services increasingly combine different digital technologies. For instance, connected and automated cars integrate vision systems, robotics, artificial intelligence, mobile communication, and more. To build such products, one needs both the digital technology building blocks like smart sensors, robotics components, artificial intelligence modules and mobile communication systems, and at the same time the means to integrate those building blocks into applications.

Digital industrial platforms integrate the different digital technologies into real-world applications, processes, products, and services; while new business models re-shuffle value chains and blur boundaries between products and services.

To reinforce the EU's competitiveness in digital technologies, the Digitising European Industry strategy (DEI) supports Public-Private Partnerships (PPPs) that develop future digital technology building blocks.

Digital transformation is structurally changing the job market and its nature. These changes may affect employment levels, the types of work available and the distribution of income. To make the most of the digital

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transformation and ensure all Europeans are ready for these changes, major investments in reskilling citizens are needed.

The New Skills Agenda has supported a shared commitment and worked towards a common vision on the strategic importance of skills to sustain employment, growth and competitiveness. This Skills Agenda strengthens and, in some cases, streamlines existing initiatives to better assist Member States in their national reforms as well as to trigger a change of mindsets in both individuals and organizations. It seeks a shared commitment to reform in a number of areas where Union action brings most added value. It focuses on the following three areas of work:

- Improving the quality and relevance of skills formation;
- Making skills and qualifications more visible and comparable;
- Improving skills intelligence and information for better career choices.

Success depends on the EU and the commitment and competence of many actors, such as national governments, regions, local authorities, business and employers, workers and civil society and the people themselves, taking advantage of opportunities to make the most of their talents.

People need a minimum level of basic skills, including numeracy skills, literacy and basic digital skills, to gain access to good jobs and to participate fully in society. These are also the building blocks for further learning and career development. Around a quarter of the European adult population struggles with reading and writing, and has poor numeracy and digital skills. More than 65 million people in the EU have not achieved a qualification corresponding to upper secondary level. This rate varies significantly across EU countries, reaching 50% or more in some.

The rapid digital transformation of the economy means that almost all jobs currently require some level of digital skills as well as participation in society at large. Collaborative economics is shifting business models, opening up opportunities and new routes to work, requiring different sets of skills and bringing challenges, such as access to advanced qualification opportunities. Robotization and artificial intelligence are replacing routine jobs, not just on the shop floor, but also in the office. Access to services, including electronic services, is changing and requires that both users and providers and public administrations have sufficient digital skills.

II. Integrating formal and non formal learning

The European guidelines for validating non-formal and informal learning are written for individuals and institutions responsible for initiation, development, implementation and operation of validation. These stakeholders operate at different levels (European, national, sectoral and local) and in different contexts in public, private and voluntary sectors; in education and training and in labor market services (European guidelines for validating non-formal and informal learning, 2015).

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Non-formal and informal learning aims to become more visible in the labour market or in the education system through its identification, documentation, evaluation and certification. It has the potential to contribute to achieving the goals set by the Europe 2020 Strategy (European Commission, 2010) as a tool for better matching skills and labor demand, supporting mobility between sectors and countries and combating social exclusion.

The European inventory on validation 2014 shows that education and training are the main promoters of validation of non-formal and informal learning in Europe and that ministries of education usually play a key promotion and coordinating role. Validation is seen as linked to education and training, potentially limiting its role, for example, in business and the voluntary sector. The VET sector has been one of the main proponents of validation of non-formal and informal learning in Europe. Its close relationship to the labor market and strong traditions in work-based learning has aided validation. Widespread use of learning outcomes and competence-based standards has also supported that are easier to relate to previous work experience. It is reasonable to expect that the VET sector will continue to play an important role in validation.

Validation is particularly important to adult education and training and as a way to support lifelong learning. In many countries, adult education providers play a key role in implementation. Validation is far less common in relation to higher education qualifications than VET. Higher educations institutions are normally more autonomous and determine the scope and possibilities for validation on their own (European inventory on validation of non-formal and informal learning, 2016).

III. Rethinking the roles of educators

Rethinking Education was established in 2012 to reform education systems across the EU in order to meet the growing demand for higher levels of skills and reduce unemployment. The initiative focuses on three areas in need of reform: quality; accessibility and funding. The reforms should be designed to, raise basic skills levels; promote apprenticeship; promote entrepreneurial skills and improve foreign language skills.

With labor markets and the demand for new skills, education systems need to adapt so that they can cope with the rising demand anticipated over the next decade. Despite the widespread investment among the different countries, education systems in several EU countries are still unable to meet these challenges, and EU countries still fall well short of the target of fluency in two foreign languages for all school-leavers.

Each EU country is responsible for its own education and training systems. European policy aims to support national measures and help address common challenges such as the aging of society, the lack of skilled workers, technological developments and global competition. Cooperation in this area will take place in the strategic framework for education and training for 2020 (Education and Training 2020).

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ET 2020 provides a forum for the exchange of good practices and mutual learning, which allows the collection and dissemination of information and factual information on effective measures and providing advice and support for policy reforms. The policy objective of increasing the number of young people with higher education qualifications has been translated into a number of large-scale initiatives to widen participation in general and in particular among under-represented groups. Most countries are doing this by providing targeted support to disadvantaged groups, improving access routes to higher education and reforming their systems of student support.

Literacy, numeracy, basic maths and science are key foundations for further learning (Education and Training Monitor 2012), and are a gateway to employment and social inclusion. These skills are nonetheless being redefined by the ongoing digital revolution, as new forms of reading and writing are evolving and, the diversity of information sources are changing their very nature.

The reforms have introduced national standardised tests; established an infrastructure of literacy, maths and science centres; created teacher networks and continuing professional development; and stepped up action to improve digital and media literacy. Nevertheless, underperformance remains and addressing low achievement is now urgent. Member States need to introduce new systemic reforms to strengthen early screening and intervention for learning difficulties and to replace repetition or ability grouping with increased learning support. These efforts within compulsory schooling need to be preceded by high-quality, accessible and affordable early childhood education and care. They should be complemented with family literacy and numeracy programmes as well as high quality adult basic skills programmes, particularly through workplace learning (Rethinking Education, 2012).

Language learning is important for jobs and also needs a particularly attention. In a world of international exchanges, the ability to speak foreign languages is a factor for competitiveness. Languages are more and more important to increase levels of employability and mobility of young people, and poor language skills are a major obstacle to free movement of workers. Business also requires the language skills needed to function in the global marketplace.

The European Commission will continue to take action and pursue discussions designed to ensure that education systems introduce new teaching and learning methods by 2020 that will enable them to equip students with the right skills for employment.

2. Implications of EU Industrial for Industry 4.0

EU economies are being transformed by the emergence of “ new manufacturing models” driven by a wave of technological changes: the pervasive diffusion of digital technology; new business models; new forms of demand and access; and a sustainable innovation agenda. Advanced technologies are currently fueling the

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so-called "fourth industrial revolution", with the potential of transforming EU industries and creating a big growth of the European economy. Rather than creating new industries, the greatest digital opportunity for Europe lies in the transformation of existing industry and enterprises.

Answering to the challenges, most of the EU governments have made I4.0 a priority adopting large-scale I4.0 policies to increase productivity and competitiveness and improve the high-tech skills of their workforce. I4.0 policies differ in their policy design, funding approaches and implementation strategies. However, the national authorities are aware of the policies of their peers, lacking more systematic cooperation and exchange of good practices.

Industry 4.0 policies are all part of an overarching framework or strategy, reflecting the priority status I4.0 enjoys in Europe. In particular, these wider frameworks or strategies lay out the overall vision and approach of the research, innovation and industrial policies. Member States' I4.0 policies show great overlaps in the objectives and targets they follow. The majority of policies aim at strengthening the respective country's industrial competitiveness and modernization and better ensuring the sustainable growth of the manufacturing sector. Regularly, economic objectives are combined with social and environmental objectives.

Regarding the barriers facing I4.0 policies there are some aspects to take into account. Resource deficiencies and effective engagement of SMEs have challenged the implementation of some initiatives. Like any other large-scale policy project, initial public funding is crucial for I4.0 policies to pick up speed and build up the capacities needed for effective program operations (Digital Transformation Monitor, 2017).

Due to the enormous potential of Industry 4.0 policies, it is essential that Europe leverages its combined know-how to fully exploit the benefits of advanced technologies. While EU funding on topics of 4.0 is provided through several research programs, better coordination at EU level of national policy efforts allowing for effective knowledge and best practice sharing seems indispensable. The Digital Transformation Monitor (2017), suggest a need for coordination at EU-level, a first step in this direction would be to create a forum to ensure that valuable policy lessons are identified, collected and disseminated across Member States and industries. In a second step, an online inventory of available Industry 4.0 and digital transformation policies could help ensure that targeted beneficiaries are aware of the entire set of measures and funding instruments available in Europe, beyond the national flagship initiatives.

To summarize, Europe needs digitally intelligent people who can not only use, but also innovate and lead the use of new technologies. Without it, Europe will not be able to embrace this digital transformation. The acquisition of new skills is vital to accompany technological development and the industry is already introducing innovative training methods. Research and innovation centers can also help develop and transfer such skills, acting as catalysts for investment and for creating business and jobs (A new skills agenda for Europe, European Commission, 2016). The rapid digital transformation of the economy means that most jobs currently require a high level of digital skills as well as participation in society at large. Collaborative economics

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is changing business models, opening up opportunities and new paths to work, requiring different sets of skills and bringing challenges, such as access to advanced qualification opportunities.

3. EU & National Framework

- **EU Framework**

According to Stefan Zimmermann (2017) in an Atos publication, Industry 4.0 (I4.0) is the most disruptive concept for most industries, affecting revenue and cost structures, key indicators in different businesses and operating models. Legal issues will have a major impact on the success of I4.0 as they will affect the whole digital transformation.

A UK-based law firm in Pinsent Masons has identified a study focusing on preparing medium-sized German companies for I4.0 and legal issues published in 2016, with 66% of companies noticing a growing demand for support legal in the future. In this study only 28% of these companies consider that legal risks, for example related to data protection, will hinder the digital transformation of their company, there are large deficits in identifying relevant legal risks. The implementation of the I4.0 principles is based on the following areas: Liability (product liability, contractual liability and distribution of risk); Data Protection and IT Security; Labour Law and Intellectual Property.

Regarding liability, it is crucial for a company to use digital transformation in its business processes, examining all the legal challenges it may be facing. Legal challenges include risks arising from the integration of external partners in a company's supply chain, in relation to data protection and security.

Data protection and IT security should be the responsibility of a company's management when I4.0 emerged. In addition to organizational and technical impacts, the legal aspects of digital process transformation and the introduction of new business models must be taken into account from the outset. The question of personal data being protected will generate new challenges, since the analysis of the data will allow the identification of individual profiles for each individual.

Every automotive OEM that companies want to collect, for example, customer's car data will first need to get their approval, given that IT security and data protection laws differ from country to country. Therefore, the task of adhering to the various laws that are being addressed in markets will be complicated.

In relation to labor law, the new technologies such as Artificial Intelligence (AI) when introduced, for example, in the manufacturing process, bring potential conflicts with existing labor laws and employee representative groups. The implementation of assembling thefts makes employee functions unproductive.

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The I4.0 will allow for increasingly flexible and useful working time models, thus requiring management, employees and representative groups to agree on a more flexible working schedule.

Digital transformation will bring new work profiles and make existing ones obsolete. In this way, existing workforce skills in relation to the requirements of the new digital world will be crucial, both management and employees need to adapt to this change.

I4.0 will also have an impact on the protection of intellectual property. Companies and employees must recognize that the legal protection of R&D, production and company data is insufficient. Existing legal frameworks will not suffice for the impact that scanning will have on the protection of intellectual property. Industry 4.0 will require companies seeking digital transformation to make substantial efforts to master legal changes in data protection, IT security, labor laws and accountability.

The advances made by industry 4.0 create new legal challenges that will have to be addressed by legislators, judges and legal advisers. Legal discussions about these challenges are just beginning, and jurisdiction is still a bit rare. While Industry 4.0 can have a major impact in many fields of law, it remains to be seen when and to what extent national or EU lawmakers will take action, especially as regards regulatory and liability issues, as well as property issues of data.

- **Portuguese Framework**

According with the *Digital Economy & Society Index 2016* from European Commission, Portugal has a great position in terms of digital competitiveness. Nonetheless, there is no a specific law regarding the industry 4.0 already.

In the beginning of 2017 the Portuguese government worked together with different companies in order to develop a strategy and a set of measures aimed at helping the Portuguese companies to start their adaptation processes towards the Industry 4.0. The Portuguese Ministry of Economy intending to generate the conditions for the industry and national services in the digital era, decided to launch an initiative (named *Portugal i4.0*) to identify the needs of the Portuguese industry and elaborate measures (public and private) aiming at achieving three central objectives:

- Accelerate the adoption of technologies and concepts of the Industry 4.0 among the Portuguese industry;
- Promote technological Portuguese companies at international level;
- Making Portugal an attractive hub for investment in the context of the Industry 4.0.

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Portugal i4.0 was launched in association with companies already operating in the market and it was added a space for the various entities that aren't businesses and, finally there was consulted a Strategic Committee that included some international entities with proven experience in the field of Industry 4.0.

The developed methodology for this initiative involved the realization of individual interviews, the study of other European initiatives and sessions of group discussion which materialized in a package of recommendations for the development of more than 60 measures (which implementation will be gradual over the 4 years) organized in 6 priority areas of action that branch from national human capital to the legal and normative adaptation to support the process of digitalization of the economy.

The defined areas of action were:

- Human Qualification

  Adapting the contents of the national educational system to the new technologies and promote measures of requalification and training of professionals. This means adapting the education system in order to match industry future needs by integrating digital skills in the education curriculum. Also there is a need to encourage employees training and enhance continuous training through extra-curricular activities. The measures created in this area were designed to fill the gaps identified by the *Digital Economy & Society Index 2016* from European Commission. In spite of Portugal has the infrastructures and the innovation capacity needed, digital skills have been identified as one of its weaknesses.

- Technological Cooperation

  Promote the cooperation between companies, universities, technological centers, business associations and other stakeholders are crucial for the development and subsequent implementation of innovative solutions and technologies in framework of the 4th industrial revolution. To achieve this, 24 measures were created to be implemented in order to stimulate industry innovation and encouraging the development of partnerships.

- Start-up i4.0

  According with the current National Strategy for Entrepreneurship (named *StartUP Portugal*), a set of measures were designed to support and enhance the role of Start-ups in terms of innovation and also in the implementation of new business models. The aim is to create favourable conditions for the development of i4.0 start-ups as well as, national technological solutions in an international context and finally ensuring that the required conditions to position Portugal as an attractive hub are met. The tourism sector assumed a particular relevance in the national field, so the range of measures created in this Start-up i4.0 area had a special focus on this sector of the Portuguese industry.

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- Financing and Investment Support

  Develop a set of financing mechanisms aimed for projects in the context of the Industry 4.0 in order to accelerate investment and stimulate the convergence of Portuguese companies with this new reality. "Vale Indústria 4.0" is a financial instrument already created in the scope of this action area. Portuguese government invested over 12 million euros distributed in vouchers of 7.500€ each to support SME's digital transformation. Furthermore, a credit line will also be launched in order to support export activities.

- Internationalization

  Foster the Portuguese technology in the external market, boosting the internationalization of these companies and attracting investment for the country. In order to trying to attract financial investment and human resources to the national economy, some initiatives are planned to be implemented like International Showcase "Portugal 4.0 Day" or the "Digital Champions" Meeting.

- Legal and Standards Regulation

  Ensure legal adaptability and technical standardization in the face of the challenges of the new industrial revolution, creating an environment conducive to technological development and investment.

  In addiction, following the EU guidelines Portugal will be able to implement the General Data Protection Regulation (GDPR) from the 25th May 2018. There are several national guidelines as well as a set number of fines for those who do not follow the rules, including businesses and individuals (General Regulation of data Protection of Portugal, 2018). It should be noted that the strategy includes the involvement of private sectors as a means to ensure the success of their implementation, and that the initiative depends on an equal distribution of public and private measures. However, part of the private investment affected is eligible for public co-investment through the Portugal 2020 strategy.

In sum, although Portugal has a great position in terms of digital competitiveness, there is no specific law on the sector 4.0. Nevertheless, while Portugal has its infrastructure and capacity for innovation, digital skills have been identified as one of its weaknesses. The goal of i4.0 start-ups is to create favorable conditions for its development as well as national technological solutions in an international context and ensure that the necessary conditions to position Portugal as an attractive center are met. The International Showcase "Portugal 4.0 Day" aims to attract financial investments and human resources to the national economy, in order to grow all this initiative.

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- **Spanish Framework**

The "Connected Industry 4.0" is the Spanish initiative for the digitising and improvement of the competitiveness of the Spanish industrial sector since 2014. It consists on supporting companies in their digital transformation in order to strengthen their position against the challenges produced by the globalization of the market. The Spanish Government strategy was to create a partnership between the private and public sectors. This initiative was boosted by the support of three main private partners: Santander bank (providing financial experience), Indra Systems (technological) and Telefónica (telecommunication).

At the beginning, the collaboration of this partnership consisted in a consultation process opened by the Spanish Government to draw the action lines of a strategy with different actors (private institutions, trade unions, Scientifics, political parties, etc.) which quickly turned into a national model to reach the digitalisation of the industrial sector. The partnership is leaded by the Ministry of Industry, more specifically by its General Secretary of Industry and SME (with participation of the Secretary of Telecommunications), and the result of the collaboration between these four actors was the "Connected Industry 4.0", which is not the first Industry 4.0 initiative in Europe, but is an holistic model (inspired by other European initiatives) whose originality lays on the participation of different stakeholders with different backgrounds. The main aim of "Connected Industry 4.0" is developing skills and sharing knowledge with the industry sector companies, with a special focus on guiding SMEs and micro enterprises (what makes the Spanish case different from other European related programmes or actions). It creates multidisciplinary environments to develop collaboration tools and specific solutions for the industrial sector.

The initiative started with coordinated actions with the financial support of the private sector, which contributed to the creation of specific call for proposals aimed to improve the competitiveness of Spanish companies (97.5 million € in loans by 2016). These calls were integrated in the financial support and policies provided by the Spanish Government through the "Agenda for Strengthening the Industrial Sector in Spain", whose aim is to help industrial sector to face the current challenges of the market. This report aimed to reinforce the Spanish industry during the global crisis as an important factor to fight for growth and employment by increasing exports to offset the lack of internal demand.

While the Spanish Connected Industry 4.0 is neither the first nor the only Industry 4.0 initiative of its kind, special efforts were dedicated to creating a Spanish model addressing the industry specific challenges of the country. The decision was inspired by the initiatives of other EU countries as well as the EU's public-private-partnerships, in particular with regard to their global and integral approach to cover industry digitisation and stakeholders from different backgrounds.

- **Austria Framework**

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In 2015 the Austrian Ministry of Transport, Innovation and Technology initiated the foundation of an association called "Plattform Industrie 4.0" with a multi-stakeholder approach containing firms, labour unions and special interest groups of various societal fields. On a national level "Plattform Industrie 4.0" is due to its constitution and its constellation the most relevant body in Austria's policy framework setting the political and research agenda.

The main idea behind the association can be defined with fostering the collaboration of the relevant stakeholders and the facilitation of technological developments and innovations in the context of digitization in order to contribute to meeting the challenges with sustainable solutions companies, research institutions and society face. The diverse backgrounds are considered to be especially fruitful since Industry 4.0 is seen as societal challenge which necessarily needs not only industry, science, regional and national policy makers, but also trade unions and NGOs. The status by March 2018 of the association shows the involvement of about 44 organizations with a good share of companies, research organizations and various NGOs and further institutions. Since the 2016 there is a continuous growth in membership numbers.

What is worth to mention for Plattform Industrie 4.0 is that it managed to create an ecosystem in which also employee associations found their place. This is an interesting aspect because employee's concerns on digitization and the new working environment play a substantial role in the association's research agenda. Thus, the Plattform Industrie 4.0 manages to create a credible picture of leveraging interests and accompanying the change process driven by digitalisation. Its mission is not only to provide knowledge and services on Industry 4.0 to companies, academia and the general public, but also to be an advisory institution for policy makers defining fields of action with joint strategies. Since its founding the association initiated regional, national and international activities enabling the exchange of experience, best practices, data and studies.

Operatively the association formed expert groups with overall 200 experts who cover relevant and current themes on Industry 4.0, delivering roadmaps, guidelines, strategies, analytical documents and events. Since its embeddedness into the wider policy framework Plattform Industrie 4.0 influences the research agenda and also influences the national and regional agencies on their subsidy policies. The technologically oriented expert groups take over themes as I) Pilot Factories, II) Smart Logistics, III) Norms and Standards and IV) Research, Development and Innovation, the more human or societal oriented expert groups focus on the V) The Human in the Digital Factory, VI) Security and Safety and VII) Qualifications and Skills. With a business or economic focus there are expert groups on VIII) New Business Models and IX) Regional Strategies.

With the Executive Lounge there is a format for increasing awareness of possibilities and exchange of expertise for its member's decision makers, thus fulfilling the pillar of information. For the pillar of identification the association developed the Industry 4.0 maturity model helping companies to evaluate their digitization

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strategies in order to become digital champions. As a concrete support component a Tool Box was setup to strengthen the development aspect by providing concrete solutions.

The pillar with networking contains the Expert Groups with the major targets of disseminating best practices and studies as well as the collaborative development of relevant content. Last but not least the validation pillar allows trying out new business models in a secure framework, generating market feedback and the acquisition of pilot customers with the so called L.ab. Pretty much related to the Industry 4.0 discourse in Austria the ministerial initiative "Production of the Future" together with other programmes like "Silicon Austria" and "ICT for the future" inject approximately € 120 million in direct funding on digitisation topics in science and industry since 2014 until 2020.

Due to the platform, several research cooperation has started between companies and research organisations. One of the primary outputs of PI4.0 is the numerous publications developed in the Working Groups, for example the Normungskompass ("standardisation compass") which is used by the Swiss authorities and the Austrian Social Insurance for Occupational Risks (AUVA) ("Allgemeine Unfallversicherungsanstalt"). Moreover, the platform created an online database with more than 300 standards and norms in the context of I4.0. In this way, Plattform Industrie 4.0 manages to create a credible image of leveraging interests and tracking the change process driven by scanning. Its mission is not only to provide Industry 4.0 knowledge and services for business, academia and the general public, but also to be a consultative institution for policymakers defining areas of action with joint strategies.

- **Czech Republic Framework**

In the Czech Republic, the INDUSTRY 4.0 is not directly supported by any law. Průmysl 4.0 (Industry 4.0) is a national initiative aiming to maintain and enhance the competitiveness of the Czech Republic in the wake of the Fourth Industrial Revolution. The concept was firstly presented during the 57th International Engineering Fair in Brno, September 2015 and approved by the Government of the Czech Republic on 24th August 2016. The Ministry of Industry and Trade plays a key role in the implementation process, however, there is a strong interdisciplinary cooperation between the ministries, social and industrial partners and academia. The long—term goal of the Initiative is to maintain and enhance the competitiveness of the Czech Republic at the time of in—mass onset of the so—called Fourth Industrial Revolution in the world.

The Initiative includes measures to promote investment and standardization as well as applied research, and deals with issues related to the cybersecurity, logistics, and normalization. The Czech Republic is a country with one of the longest industrial traditions, and it is an ambition for its future to remain tied to the industry. The Fourth Industrial Revolution brings with it a number of challenges, but above all, it provides a unique opportunity to ensure the long-term competitiveness of the Czech Republic in the global competitive

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environment. The Czech Republic has one of the highest shares of industrial production per GDP among EU countries (approximately 32% GDP). Furthermore, the country has strong industrial ties to Germany, which is its strategic business partner1. Czech companies mainly supply industrial components to its neighboring country, thus integrating into the German industrial supply chain. Next, to be a reaction to the German 'Industrie 4.0' initiative Průmysl 4.0 also seeks to counteract the often fragmented and misleading portrayal of I40 by correctly describing the concept as well as its impact on society.

The initiative is based on the state-of-art analysis carried out by a team of experts from industry, academic and research communities called the Core Team Průmysl 4.0. The team is led by professor Mařík from the Czech Institute of Informatics, Robotics and Cybernetics. The document analyses the 4th industrial revolution, in particular regarding the technological perquisites and vision of Průmysl 4.0, its requirements concerning applied research and standardization. It also investigates the impact on the labor market, education system and regulatory framework.

Fact is that the Czech INDUSTRY 4.0 was not just influenced, but is sourced from INDUSTRIE 4.0 (Germany), INDUSTRIE DU FUTUR (France), and technological cluster FABRICA INTELLIGENCE (Italy). Also as a good example INDUSTRY 4.0 learned and focused on the same initiative in the USA (INDUSTRIAL INTERNET). Asian countries (China, Japan, and South Korea) know well about the 4^{th} industrial revolution very well, and they focus on the potential plus for their companies.

The Ministry of Industry and Trade established a coordination platform Alliance Society 4.0 bringing together experts and policymakers to prepare an action plan for the implementation of Průmysl 4.0 taking into consideration the current Czech Action Plan on Digital Market Development.

The main goal of the initiative is to create a social and business environment that allows all Czech companies to adapt sooner or later to changes and to take advantage of the new business opportunities arising from the fourth industrial revolution.

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M5.CONCLUSIONS

Although the concept of Industry 4.0 is not yet widespread, it has potential to penetrate and improve many aspects of human life. Starting from changes in business paradigms and manufacturing process models, it will affect all levels of production and supply chains, including business and production managers, factory workers, cyber-physical system designers, among others.

The increased attention received by this new industrial paradigm commonly know as Industry 4.0 has raised many questions about the meaning of the concept and its real impact, as well as the technological developments to be accomplished and the impacts that are related to the effective adoption of these advancements.

In this research report we have made a review of the state of the art for the current industrial development known as Industry 4.0. Our aim was to better understand the concept, its main characteristics and, the impact it already had (and that will be increased) in society. All this level it is important to keep in mind that Industry 4.0 has an impact not only on the production systems, but also, on management, economics and society in general.

Industry 4.0 is driven by disruptive technologies and can impact a business in many ways, primarily by providing operational effectiveness and challenging established business models. So realizing the benefits in these areas requires companies to build a digital base, which is a far-reaching task that poses managerial challenges at all levels of the organization. The work environment is also expected to change rapidly due to technological advancements, which translate into the transformation of work and skills needed for employees to fit into emerging business models.

The increasing relevance of man-machine interfaces will promote the interaction between the two production elements and the necessary communication between intelligent machines, intelligent products and employees. With the fourth industrial revolution, the emergence of a new learning paradigm can effectively and quickly close knowledge gaps. Currently, the learning process is not limited to a set of books that combine text and images; alternatively, most manuals are already used in combination with other online materials that contain additional information. This reality gives students a broader perspective that allows them to learn new content and encourages their interaction with teachers and peers. New forms and methods of learning are emerging, some of which have a significant impact on how students and teachers share information and also on how the institutional objectives of the learning process are defined. Europe needs digitally intelligent people who can not only use but also innovate and lead the use of new technologies. Without it, Europe will not be able to embrace this digital transformation. The acquisition of new skills is vital to accompany technological development and the industry is already introducing innovative training methods.

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Regarding legal issues, Industry 4.0 can have a large impact in many fields of law and it remains to be seen to what extent national or EU lawmakers will take action, especially with regard to regulatory and liability issues as well as issues of data ownership.

We are witnessing a transformation characterized by disruptive technological advancements that are eliminating boundaries between the virtual and physical world, integrating workers, smart machines, smart products, production systems and processes. This means that companies will be affected in many ways, and they will have to adapt in order to maintain their competitiveness. In order to do this, companies will have to build a digital foundation, which is a far reaching task that poses managerial challenges at all levels of the organization. Not just processes, strategy and capabilities will have to change, but also mindsets. Companies need to act now, launching short term initiatives immediately and start preparing the medium – to long term initiatives that aim at transformation rather than augmentation.

Using Industry 4.0 as the path to the future of manufacturing will allow companies to do more than just upgrade their equipment and eliminate inefficiencies to increase their operational effectiveness. It will also give them the freedom to make the right strategic decisions and reinvent their business model, preparing them to maintain a competitive edge in the global manufacturing market of the future.

In addition, it is important to be aware that as Industry 4.0 further develops, there will also be greater challenges regarding the tasks and demands aimed for the human workforce. Being the most flexible element in cyber-physical production systems, workers will be faced with a large variety of jobs ranging from specification and monitoring to verification of production strategies. For this, a wide range of employees will need to get further education in order to develop new skills, suitable for the new requirements associated with Industry 4.0.

In conclusion, even though the 4th industrial revolution as associated plenty of advantages and a huge potential for the development of our society, there are still a lot of challenges that come with it as well. As a matter of fact, the changes in the value chain require companies to embrace new business models and partner with other companies (including suppliers, technology companies and infrastructure suppliers). In addition, companies will have to invest large sums into new machinery, software, business model development, employee training, among other aspects. Therefore, companies in cooperation with the responsible parties in the different countries have a long way ahead in which they need to develop strategies that are enough to tackle this new reality.

Co-funded by the Erasmus+ Programme of the European Union

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Co-funded by the Erasmus+ Programme of the European Union

This project has been funded with the support from the European Commission. This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use, which may be made of the information contained therein.

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