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INDUSTRY 4.0

THE NEW INDUSTRIAL REVOLUTION FOR EUROPE

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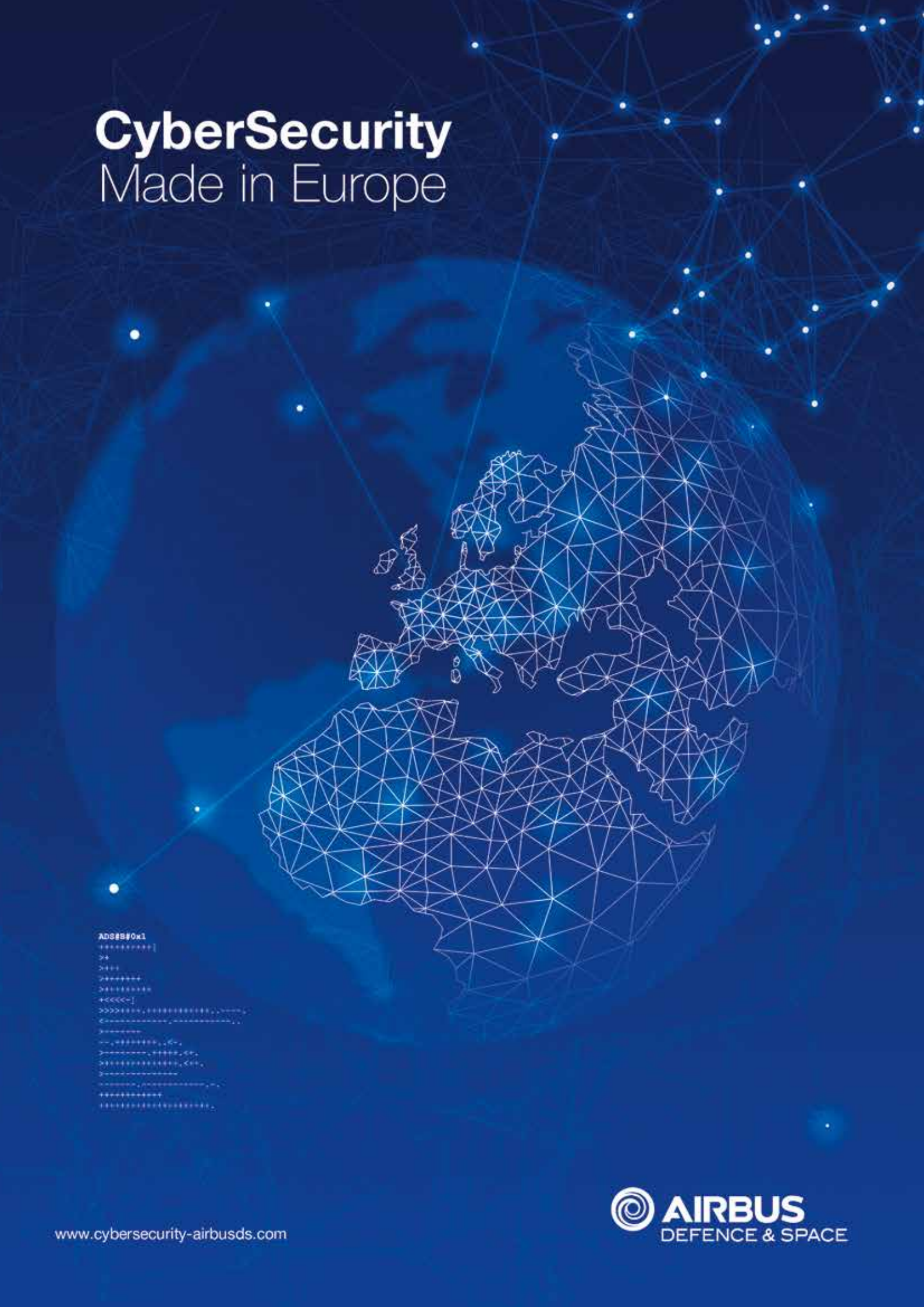

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EDITORIAL

Industry 4.0: The New Industrial Revolution for Europe

Industry 4.0 is the combination of new technologies and organization of labor to push manufacturing into a new realm of optimization. It is a trend that focuses on creating smart factories through innovative communication and design between machines and humans. As a leader in high-tech manufacturing, Europe is well placed to promote this transition to Industry 4.0. The European Commission is actively involved in outlining areas of cooperation and investment in this transition. However there still a lot of potential that is not exploited. As the economy continues to digitalize, it is important that firms transform to integrate the digital world into their functioning. Through the support of the European Union (EU), the adoption and adaptation of new industry should benefit all citizens and provide a more sustainable and optimized model for economic growth.

At the forefront of this issue is the ability to adopt new key enabling technologies. These technologies are often pioneered by start-ups headquartered in different parts of Europe, making wider adoption and faster innovation more difficult for some sectors of industry. A key facet of a unified Europe is to provide a platform for the private sector to reach its market potential throughout the continent. Therefore, many proposals should be considered to connect businesses of all sizes to innovate around specific issues. Whether the solution is to promote innovation hubs or connect industry stakeholders through regional and issue-based platforms, the important point is that these options are made available and easy to integrate.

Firms should also encourage digitalization within their organizations as a motor for improved dialogue and interactions for its employees. An organization that is better integrated is more efficient and provides its employees with better opportunities to perform. These changes should reflect the flexibility acquired through intelligent manufacturing networks. When machines are optimized, and human communication is too, productivity improves. A "Smart Factory" is one that synthesizes "cyber-physical" components that manage production across a virtual network.

Just as Industry 4.0 revolves around improving communication within the factory, the EU should promote transparency and cooperation between nations and industry sectors. If this is truly a solution for improved productivity and competitiveness, the EU's main role is that of a facilitator. This means creating policies that enable adoption and regulatory frameworks that support the well being of all of Europe. The EU must consider the greater impact of automation on the rights and security of workers across Europe. What models of labor ensure quality contracts for future employees? The answer necessitates careful consideration and projection of the needs of future employees in Europe. These needs are dynamic and Industry 4.0 should provide a solution to the volatility of labor in the long-term.

Currently, the EU is gathering major stakeholders in the private sector, research and academia as well as business associations and trade unions to discuss what matters to them regarding education, security, and regulatory frameworks. It is imperative to present a positive image of Industry 4.0. This is done by highlighting the opportunities this approach to industry provides for SMEs just as it does for the larger public. A more integrated network of industry relies on strong infrastructure and high-quality education, all of which should be high priorities for European nations. This should facilitate improved technology as the fundamental driver of an advanced economy. Industries such as space, energy, and defense, depend on cutting-edge research to grow. They represent a large playing field to promote an EU-wide approach to Industry 4.0, with benefits felt through Europe.

Ultimately, the objective of this initiative is to take Europe's industry to a more advanced future. This means improved quality and efficiency with reduced production costs and delays. A framework for a liberated labor market should complement this in a way that mimics the gains of an integrated manufacturing network. This issue of the European Files carefully considers the approach necessary for a successful transition to a new industrial revolution.

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Elżbieta BIEŃKOWSKA

Commissioner for Internal Market, Industry, Entrepreneurship and SMEs

The transformation promised by Industry 4.0 is an enormous opportunity in terms of jobs, growth and improving people's lives. New and emerging technologies are key drivers for the development of innovative products, processes and services and offer opportunities for both small and large enterprises. However, at present European businesses are not moving fast enough to embrace these opportunities. There is scope for more action to modernise European industry and to take advantage of the increasing inter-linkages between goods and services. Europe is well placed to achieve this as it still has a leading position in many manufacturing and services industries and in both digital and key enabling technologies.

The Commission has already built a strong industrial dimension into its major initiatives. The Single Market Strategy and the Digital Single Market Strategy are designed to establish a truly single market to further encourage innovation and industrial modernisation. However, more needs to be done in order to help our industry and our society prepare for the future. Most of all, the actions proposed by the Commission need the support of the Member States, regions and industry itself to make it all happen on the ground.

The Commission's industrial initiatives address the needs of specific sectors where new technologies can have the biggest impact, as well as the general business environment. Current major initiatives target the automotive, space, defence and energy industries.

Connected cars and autonomous driving require automotive digitalisation. The Commission recognised the urgent need for an EU strategy and it launched the GEAR 2030 high-level group gathering relevant stakeholders, ministers and Commissioners which will make first recommendations on the roll out of automated and connected vehicles by the end of this year.

The emergence of new competitive actors in the space sector stimulated Europe to create a more agile and dynamic environment able to match businesses' needs. The Commission's Space Strategy launched in October aims at fostering the take-up of space data by innovative businesses, promoting the emergence of new space-based applications and services, and creating a predictable investment environment for industry and start-ups to flourish. This will enable Europe to benefit from its space investments and help the EU space industry to remain a world leader.

Innovation-related technologies also have a great impact in the defence sector. European industry must meet Europe's mid-to-long term strategic defence needs. The Commission's European Defence Action Plan will identify ways EU programmes and funds can be used to support projects related to European defence needs. Moreover, a European Defence Fund, will for the first time fund research in this particular area.

New technologies, such as smart grids, second and third-generation biofuels and tidal turbines, are reshaping the energy industry. However, Europe needs to predict when these technologies will be viable. To this aim, the High-Level Expert Group on Energy Intensive Industries might provide the Commission with expertise and insight, helping in the development of solid policies in this field.

On top of sector specific actions, Commission's initiatives with a horizontal focus address the major framework conditions for stimulating European economic growth. A skilled European workforce and dynamic and strong start-ups are two of the major areas where the Commission has concentrated its initiatives.

The so-called fourth industrial revolution will drastically change the nature of labour markets. Therefore, it is imperative to enable the existing European workforce and rising generations to acquire the right skills that industry needs now and in the future. The initiative "Blueprint for Sectoral Cooperation on Skills", launched this year under the "New EU Skills Agenda", will help mobilise and coordinate key players, encourage private investment and promote more strategic use of relevant EU and national funding programmes.

Nowadays, start-ups contribute to the economy as much as to the marketplace for ideas and talent. Moreover, start-ups scaling up into bigger firms increase innovation and competitiveness, strengthening the entire European economy. However, too often these promising start-ups fizzle out rather than turn into European and global winners. The Commission's Start-up and Scale-up initiative aims to remove existing barriers, create the right opportunities and ensure access to finance across the EU.

These initiatives can reinforce each other. To make sure this happens, the Smart Specialisation Platform on Industrial Modernisation will provide the right instruments to combine, not only Commission's actions, but also actions at the national or regional level. By channelling technical and financial advisory services, this platform will support European regions and Member States as they work together, developing a pipeline of investment projects connected to their smart specialisation priority areas related to industrial modernisation.

Like every important challenge, this new industrial revolution creates new uncertainties as well as new opportunities. The Commission has assumed the role of enabler and its range of initiatives are evidence of the way it has adjusted its policy-making to the smart industry of the future. In my view, only by joining forces with all relevant players and working in partnership with businesses, will we make sure that the opportunities of this fourth industrial revolution are seized by all European industry.

Industry 4.0: An opportunity to re-industrialize Europe

Christophe SIRUGUE
French Secretary of State for Industry

European industry stands at crossroads. For the last decades, it has been weakened by the lack of long-term investment in innovation and digital technologies, whilst the competition from low labor costs countries intensified. Between 2007 and 2014, the share of the EU in the global industrial production dropped from 23% to 19%. During the same period, the share of industrial employment regarding total employment in the EU decreased from 28% to 24%.

Industry however represents a strategic component of our economy, much more important than its share in GDP may suggest: industry accounts for 64% of European R&D, and economists estimate that each additional job in the industry creates between 0,5 and 2 jobs in other sectors. Therefore, reindustrialize Europe must stand at the top of EU leaders' agenda.

The new industrial revolution: a necessity and a challenge for EU Industry to strengthen its position as a world leader

In this context, Industry 4.0 is both a challenge we cannot afford to miss and an opportunity to ensure Europe's place in a globalized world.

- First, I believe that the digital transformation and modernization of production facilities is an imperative of prime importance to increase the competitiveness of our industrial companies. On this matter, narrowing the productive gap with US or Japanese leaders requires first to raise digital awareness, and of course investments. However our ambition must not be limited to catch up with our competitors.
- New technologies will trigger new products more linked with services, smarter and more efficient production models and disruptive business paradigms. Anticipating this changes and taking strong market shares in the new markets that emerge represent the main opportunity for our industrial sector for the next decade.
- Finally, EU industry has the potential to be a major provider of the technologies at the core this new industrial revolution. In fields such as additive manufacturing, contactless technologies or energy efficiency, European research centers and companies are at the cutting-edge. Ensuring EU's leader position calls for unprecedented efforts in terms of research and investment.

Far from the prevailing negativity, our aim should be to apprehend with confidence and seize the opportunities created by this new industrial revolution. Many European countries have pertinently already implemented government-sponsored programs dedicated to promote the spread of new technologies in industry.

Supporting SMEs and helping employees develop new skills are 2 critical issues, identified by the French program "Industrie du Futur" (Industry of the future)

The French government launched the *Industrie du Futur* program in 2015. It aims at accelerating the transformation of French Industry, thanks to innovation, digitalization and new advanced manufacturing technologies. The program is mainly implemented, with a strong coordination with the public authorities (state and regions), by the *Alliance Industry of the Future*, a non-profit organization that gathers industrial federations and research and education institutions. After a year of implementation, I identify 2 main challenges that apply, I believe, to most European countries.

One strong issue is to support Small and Medium-sized Enterprises in their digital transformation. Too often, they lack access to technological and methodological experts or resource centers that can help them better understand the emerging available technologies, identify the human or organizational roadblocks to implement them and reinvent their business model. Very important human and financial resources are allocated by the *Industrie du Futur* program to address this particular issue : more than 500 experts have been identified across the country, and more than 2000 SMEs will have received a customized assessment by the end of 2016. €2.2 billion (complemented by further €2 billion after 2017) are already available in the form of loans for SMEs to invest in their digital transformation.

Another critical issue is to help industrial employees improve their skillsets to tackle new jobs. Training upcoming generations to perform new tasks is the cornerstone to the success of the Industry of the Future. Training goes hand-in-hand with the heightened presence of digital technology and robotics in industry, which are vital to creating jobs in Europe and ensuring that businesses in many sectors remain competitive. A new vision of training must be based on a collective approach, in particular with the social partners and local stakeholders.

The stakes are particularly high for our industry. EU integrated market and the mutual dependency between our industries call for a strong cooperation between European programs. On this matter, the set of measures announced by the European Commission on April, 19th 2016 is a major step. Bilateral cooperation is also needed to better coordinate our respective programs and promote joint approaches abroad. The successful cooperation between the German platform "Industrie 4.0" and the French "Alliance Industrie du Futur" perfectly illustrates what can be achieved: significant progress have been made to promote interoperability between testbed platforms and in the field of standardization. These achievements could serve as a basis for a European approach on such topics.

Industrie 4.0 and the future of manufacturing

© Michael Voigt

Matthias MACHNIG

Secretary of State in the German Ministry for Economics

Two things are necessary in order to harness the potential of digitisation and Industrie 4.0. First, we need to arrive at a shared understanding of what is happening, of what is possible, and of what we need. Digitisation is changing the rules – and it is doing so at breath-taking speed. Digitisation is changing every aspect of our lives: the ways in which we do business and live together as a society, the way we work, act as consumers, cooperate and communicate with one another.

Second, we need to engage in joint initiatives, that is in cooperation. Digitisation is not limited to decision-making at national level. Digitisation does not stop at national borders. We must therefore join forces internationally to create growth and well-being across the globe. That does not mean that all countries ought to do the same. Far from it. Everyone ought to play to their strengths and do so in their own way.

Sometimes, we'll find that the various approaches complement each other. We in Europe can certainly learn a few tricks from countries in America or Asia. And they can learn from us. We'll find that each country and each region in the world has its own industrial tradition, its own way of doing business, its own notion of data privacy, of what a good regulatory framework should look like, and of labour standards, for example. This is why there are many different approaches to making the transition into the digital age: Some will rely on platforms. Others will focus on the industrial sector.

We in Germany have made it very clear that we want *transformation* rather than *disruption*. We want to create real products, real jobs, real innovation, and real economic output. By 2030, an estimated 500 billion devices will be connected, which is 25 times more than the number today. This figure adds up to 60 connected objects, machines and sensors per person. These developments cut across all areas of our lives. And of course, the industrial sector is no exception. This opens up massive potential. For Germany, projections say that we may well see 435 billion euros being added to our economic output by 2025 thanks to digitisation. Our productivity is set to rise by up to 30 per cent, our efficiency is to improve by 3.3 per cent every year, and our costs could fall at an annual rate of 2.6 per cent.

We now need to lay the basis for successful digital transformation, which also means that we need to build trust within the public. For instance, we need to ensure that labour rights continue to be protected in the digital age. This means that intermediaries and platforms must be held to account when it comes to wages, labour standards, and social security. We need a regulatory framework for investments and innovation. It's about creating a level playing field, a competitive environment without monopolies or similar forms of power and data concentration. We need to take account of the fact that economic success depends no longer just on physical products, but also on data. We need new rules that level out the playing field for analogue, digital, and hybrid business models.

Parallel to this, we must also address several other issues. But the most important thing we need is powerful digital infrastructure. We must not allow ourselves to end up in a situation whereby a lack of infrastructure is holding us back on digitisation and Industrie 4.0. This is why Germany has decided to upgrade its broadband network into a gigabit optical fibre network. Industrie 4.0 will only

work if there's control in real time. Only then will it be universally applied. We must also make sure that all our small and medium-sized firms based in rural areas have access to broadband.

So what exactly do we mean by Industrie 4.0?

Industrie 4.0 brings together manufacturing and state-of-the-art information and communication technology. Following the invention of the steam engine, the production line, electronics and IT, smart factories are what defines the fourth industrial revolution. Industrie 4.0 will completely change the way in which global value chains are organised. International cooperation will be more crucial than ever before.

German companies are extremely well prepared for Industrie 4.0. They have a global distribution network and are much valued for their expertise. Let me point out three major steps that we have taken in Germany:

1. First, we have recognised that Industrie 4.0 has the potential to completely change the way in which our society, politics, and businesses are organised. This is why we have made sure to build our Industrie 4.0 platform on a broad basis and made sure to get society and policy-makers on board. About 300 stakeholders representing more than 150 organisations have joined the platform so far. This includes companies from all over the world. The platform is one of the largest global networks. There are five working groups staffed with experts from the private sector, science and academia, business associations and trade unions who are supporting the German government in its efforts to develop practical and workable solutions. These five working groups are looking at: standardisation, research and innovation, security, the right regulatory framework, jobs and skills management.

2. Second, we have succeeded in giving Industrie 4.0 a positive image. Industrie 4.0 is now being debated in terms of the opportunities it opens up.

3. Third, we have succeeded in steering the debate towards the facts. The focus is on developing solutions that work for companies. Of course, our Industrie 4.0 platform has a leading role to play in this. And other countries are also listening closely to what is being said there. Let us take standardisation as an example. The platform established its RAMI 4.0 model [Referenc architecture model Industrie 4.0], which now serves as a key basis for discussions within the international standardisation bodies.

For Germany as an export-driven country with export-driven SMEs, particularly engineering companies, international cooperation is of utmost importance. It is important to point out that engaging in this cooperation must always be the companies' task. However, government can act as a door-opener and create a suitable regulatory framework. We are therefore also in close contact with the European Commission and welcome the Action Plan on accelerating the digital transformation of industry at European level. We will host the first European Stakeholder Forum together with the Commission on January 31st to Februry 1st in Essen, Germany to provide for the exchange between the national initiatives in the field of Industrie 4.0. Industrie 4.0 will also be high up on our agenda for the German G20 presidency. We are planning to host a conference in mid-March that will bring together all of the Industrie 4.0 initiatives undertaken by the G20 states.

All this shows that Germany, in its capacity as a leading industrialised country, is also a sought-after partner for cooperation on Industrie 4.0. We will do our utmost to strengthen international cooperation in this field. If we are to remain globally competitive, we need modern infrastructure, a strong industrial sector, a highly capable ICT sector, and international cooperation.

INDUSTRY 4.0

Digital Transformation of Industry: Challenges and opportunities for Europe

Khalil ROUHANA

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Digital innovations are changing the way we design, produce, commercialise and generate value from products and related services. Advances in technologies such as the Internet of Things (IoT), 5G, cloud computing, data analytics and robotics are transforming products, processes and business models and ultimately reshuffling global value chains in all sectors.

To maintain their competitive edge companies in any field have to fully embrace digitisation not only by making the best use of latest digital technologies but by integrating digital innovations as key elements of their development strategies. Next digital champions can emerge in any sector of the economy from construction and textile to health or energy equipment. In Europe, many companies, especially in the high-tech sector, are already grasping the opportunities of this new industrial revolution, and studies show that digitisation of products and services could increase EU industry revenues by €110 billion a year.

However, many traditional sectors and small and medium-sized enterprises (SMEs) are lagging behind: less than 2% of them use advanced digital technologies to innovate in products and processes. In addition, a large disparity exists between Member States and regions creating a new "digital divide" which can ultimately hurt all economies in Europe.

To tackle these challenges, the European Commission launched the Digitising European Industry initiative in April 2016. Its overall objective is to put in place the necessary mechanisms to ensure that every industry in Europe, in whichever sector, wherever situated, and no matter of which size can fully benefit from digital innovations.

The initiative focuses on actions with a clear European value-added. It builds on, complements and ensures the scaling up of national initiatives. Of particular importance are four action lines: the European platform of national initiatives, Digital Innovation Hubs, Digital Industrial Platforms, and Digital Skills.

The European platform of national initiatives is a governance structure to ensure a continuous EU-wide dialogue with all stakeholders from the public and private sector, academia and civil society. Its main objective is the coordination of different initiatives and exchange of best practices of EU and national initiatives on digitisation.

More than 30 national and regional initiatives for digitising industry have already been launched across Europe in recent years. Examples at national level are *Plattform Industrie 4.0* in Germany, *Industrie du Futur* in France, *Smart Industry* in the Netherlands, and *Produktion der Zukunft* in Austria. Each Member State implements its national initiative in a different way. Therefore, national and regional initiatives can learn from each other's experiences by exchanging best practices at EU level.

The second line of actions concern Digital Innovation Hubs. Digitisation of industry needs to be comprehensive across Europe. After all, economies in Europe are closely connected, and industry has built strong cross-border value chains. The use of digital technologies in industry, however, varies across sectors and Member States.

To bring the benefits of digital innovation to every industry, the EU will invest €500 million in Digital Innovation Hubs which consist of beefed-up competence centres that offer access to the latest expertise and technology for testing and experimenting of digital innovations.

An example of what such hubs can offer is a small Swedish company designer and manufacturer of sports cars, that has successfully managed its digital transition. During the design process of one of its recent cars, the company was faced with new aerodynamics challenges that could not be mastered with the means it had available.

With the help of a Digital Innovation Hub, the company teamed up with an SME with advanced simulation software, a centre with High Performance Computing facilities, and expert advisors. Working together and

using simulation software on the cloud, the necessary aerodynamic capabilities could be achieved at affordable cost and in a short time. It saved the company 30% in design costs, 60% in prototyping costs, and 50% in wind tunnel and physical testing.

Digital Industrial Platforms are the third main line of actions. These platforms act as a link between different technologies and application sectors. They open up data and make it accessible, enabling third-party innovation and connecting different stakeholders such as users and application developers. Various platform development activities, including experimental environments where they can be tested, exist at EU or national level. However, to develop the next-generation digital industrial platforms and to validate them via large-scale pilots, we need to bring various initiatives together.

Public-private partnerships have a key role to play in this context as the main mobilisation and coordination mechanisms. The European Commission plans to launch a number of projects in from 2017 on that will support the development of the next-generation digital industrial platforms in key sectors such as 5G, the smart connected factory, smart agriculture, or health and care. Building on the successful experience in the areas of electronic components and embedded software, it will also invest in developing and rolling out latest high performance computing and big data technologies. Investments in these digital public private partnerships is planned to reach close to 30 Billion Euro with including 6 Billion Euro from the EU, 1.2 Billion Euro from Member States and the rest from industry.

Equipping today's workforce with the necessary digital skills to compete in tomorrow's work environment is another crucial element of our strategy. People need to feel that they can cope with the challenges ahead. To this end, we have recently launched the Digital Skills and Jobs Coalition to develop a large digital talent pool and to ensure that individuals and the labour force in general in Europe are equipped with adequate digital skills.

Our overarching strategic goal is to make digitisation of industry a European success story. Global competition is fiercer than ever and we cannot rest, just because today's situation is comfortable. Digitisation, based on our strengths and on our will to collaborate, is our approach to keep high-quality industrial activities in Europe and to ensure our continuous relevance in the global economy. There is a lot of work ahead of us, but the potential benefits are worthwhile, for industry, for employees, and all citizens.

Improving the european labour market and european industries Through the digital economy

Dominique RIQUET

MEP (ALDE), President of the European Parliament Intergroup on long-term investment and reindustrialisation

Artificial Intelligence, Internet of things, Big Data and online intermediation platforms are among the new technologies that are radically changing our production methods and consequently the outlook of our job market.

On this topic, it is commonly believed that technological change is favourable to high skilled workers and unfavourable to unskilled ones. More specifically, the term "polarization" is used to describe the decline of share of intermediate jobs favouring the share of highly qualified jobs (which cannot be automated) together with an increase in demand for certain low-skilled jobs (where automation would not yet be of economic interest).

In fact, machines automation eventually replace repetitive tasks (manual or cognitive) rather than replacing jobs properly spoken. The criterion here is more functional than organic, all levels of qualification being concerned by the ICT (information and communication technologies) revolution's effects. This process thus advantage jobs with non-routine tasks that requires a high degree of creativity or personal interactions.

This polarization phenomenon isn't homogenous in the European Union. But it is worth noticing that the countries with the most developed robot systems are those with the lowest unemployment rates. Automation and robotization generates increase of productivity, as well as quality gains, and not necessarily result in workforce cuts in fine. For instance the German automotive industry, that is one of the most automated in the world, employs more than 800 thousands workers that is as much as ten years ago and 100 thousand more than 20 years ago.

There are diverging views trying to estimates how many professional activities will disappear at some point in the future, the most commonly acknowledged ones show that only an average of 9% of all jobs have a high risk of automation, whereas for 25% of the other jobs half of their tasks will be significantly modified by automation. We could be discussing the exact number of jobs that these developments will destroy taking Keynes' idea of "technological unemployment", but it is far more useful to focus on the current transformation and creation of a great number of job activities. There is a continuous adaptation of the tasks along with technological developments to enhance the worker's productivity. In some cases, tasks that were previously very demanding in terms of personal skills could be entrusted to people equipped with the appropriate technology. This complementarity between men and machines will multiply the services associated with goods and will favor middle and intermediate qualifications.

In parallel, new "ICT-enabled" jobs are created like coders, developers, maintenance managers. Besides, indirectly ICT is also a job creator by the emergence of new consumption needs and business models like the platform economy.

Most certainly the individual prospect of a whole career spent in the same company is coming to an end. Our legislation must take it into consideration and be adjusted. It needs to be more flexible in order to enable and enhance self-employment as well as multiple jobholding. Moreover, it must be able to encourage entrepreneurship by accompanying business risk-taking.

One can easily say that the digital era poses a number of other challenges for the legislator. To name only a couple, how to bring new skills to the traditional sectors and how to ensure social protection for the digital economy.

Education and lifelong learning needs to better prepare and adapt workers to the "Industry 4.0". The rebound of our industry and related services greatly depends on SMEs, yet somehow the entrepreneurs and employees of SMEs aren't eventually the one benefiting from lifelong training programs. In France for instance we should consider entrusting the responsibility for training policy to the Ministry of Industry, rather than the Ministry of Education, to ensure that these policies reflects the needs of the labor market. In Germany training policies have already been tackling this issue for a few years now by offering new courses such as coding.

Digitalization also enables the development of platforms that provide new job opportunities facilitating the match between supply and demand between stakeholders. However, this new model calls for a legal framework that can ensure the service providers social protection (remuneration, social security, insurance, access to training) without jeopardizing its concept.

The European Union has to invest in this important transition. Funding for research and development is absolutely strategic in the context of a fierce global competition to increase our future industry's growth potential. It is also its mission to support and coordinate the action of the Member States in this field for the benefit of today's and tomorrow's European citizens.

Industry 4.0: an opportunity for SMEs

Slawomir TOKARSKI

Director of innovation and advanced Manufacturing, DG GROW
European Commission

Manufacturing is among the key driving forces of the European economy. It provides about 20% of all jobs in Europe (above 30 million) and generates a turnover of about €7 000 billion in 25 industrial sectors and over 2 million companies, dominated by SMEs. Against a background of trends such as globalisation, resource scarcity and digitalisation, European manufacturing sectors need to undergo innovation-driven transformations towards more competitive, sustainable and modern production. Industrial modernisation is thus of crucial relevance for economic dynamism in Europe and the lasting creation of growth and jobs in the EU.

Europe still has a dominant position in advanced manufacturing technologies in terms of share of patents (40%) and share in total exports (44%). We also have numerous examples of SMEs having successfully transformed their business by adopting digital and key enabling technologies and business models. These companies boosted their growth or strongly recovered after difficult times. Improved quality of products and services, reduced production lead time, improved resource efficiency and employees' productivity are important drivers for companies to invest and transform their business.

But many SMEs struggle to embrace the Industry 4.0 revolution. The uptake of advanced manufacturing solutions by them remains a challenge: only one in five manufacturing companies have already used advanced manufacturing solutions[1] and some reports even claim that the age of installed process technology in Europe increases rather than decreases.

A recent study[2] shows that for nearly three quarters of the firms, the most important barrier is the high cost of investments in advanced manufacturing acquisition and the lack of financial resources. About half of all firms indicate difficulties in assessing the performance and the potential business return of such technologies and/or the lack of skilled personnel required to adopt relevant technologies and business models.

Therefore, we are providing targeted support to help SMEs to move towards smart and sustainable production.

First, we aim to ensure that SMEs have easy access to state-of-the art facilities and can make informed investment decisions.

Technology centres sharing their equipment and expertise with SMEs are important to accelerate innovation and to bridge the gap between the laboratory and industrial application. However, our mapping of technology centres active in key enabling technologies shows that in 60% of EU Member States, SMEs are not likely to find the technology services they need. The solution lies in collaboration between centres with regional access points. As part of the Digitising European Industry initiative, the Commission is focusing 500M€ investment from Horizon 2020 on digital innovation hubs. This is an important step. As a pilot, the Commission will also support a network of technology centres to provide services to SMEs in advanced manufacturing for clean production. More networks and innovation hubs in advanced technologies will follow.

In addition, we will set up a pan-European Advanced Manufacturing Support Centre to help SMEs assess the possibility of adopting advanced manufacturing solutions and transforming their business towards a factory of the future. The centre will also help to launch new innovation advisory services for manufacturing SMEs at national and/or regional level on the basis of a coherent EU methodology.

Second, we stimulate joint investments into industrial modernisation. To help creating regional partnerships for investment between public and private actors, we have set up a Smart Specialisation Platform on Industrial Modernisation. The objective is to create an investment pipeline of mature projects in new growth areas across the EU and along the value chain - such as digital and key enabling technologies, resource efficiency or creative industries for example. To achieve this we will provide tailored advice and help regions willing to collaborate in these areas to reach out to the business and research communities. The platform will help regions develop or share infrastructure such as testing facilities, pilot plants, data centres, and Fab-Labs. The Commission will support networking and matchmaking and provide access for the partnerships to expert, IPR and financial advice. In addition, the action 'Transforming regions and cities into launch-pads of digital transformation and industrial modernisation' will support cities and regions to build up innovative and digital ecosystems and reinforce pan-European networking with the view to developing cross-regional partnerships in digital transformation.

Third, initiatives have been launched to support skills development. The modern economy - and modern industry - calls for a very wide range of new skills. As part of the New Skills Agenda adopted in June 2016, the Commission will design specific skills solutions for some industrial sectors. The so-called 'Blueprint for sectoral cooperation' will provide a new strategic approach seeking to mobilise industry, training and education stakeholders, to stimulate private investment and to ensure a more coordinated and strategic use of EU and national funding programmes. In 2017, also other initiatives will be launched to support the development of new skills for digital and key enabling technologies (KETs) and to increase the European talent pool of technology professionals, managers and entrepreneurs.

Finally, we want to make SMEs better aware of the opportunities offered by the 4.0 revolution and of the support provided at different levels to help them. We are currently launching a new phase of the WATIFY campaign, which will raise SMEs' awareness about the benefits of technological transformation for their business and which will also connect SMEs with the stakeholders who can help. The campaign will organise 240 awareness events all around Europe and communicate on success stories of technological transformation. Such learning examples will inspire other great ideas for industrial transformation!

1 Innobarometer 2016 results

2 An analysis of drivers, barriers and readiness factors of EU companies for adopting advanced manufacturing products and technologies

Digital Transformation, the challenges and importance of the Industrial Internet Consortium (IIC) & Industrie 4.0 in Europe

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There is so much in the press, Twitter, LinkedIn about the importance of Digital Transformation and how critical it is to businesses today, if they are to survive and ideally lead this new digital age. But is it going to be another short-lived trend? Or is it just another one of those marketing buzz phrases?

No it is here to stay, and it has become a strategic driver for company success, and is a topic that appears regularly on board agenda's and if it doesn't, it should! Businesses of all sizes are asking the same questions, what is Industry 4.0? The Internet of Things? and, more importantly, how will my business model change? This is less a discussion around technology but rather how technology can challenge the status quo, and how to make the seemingly impossible things possible.

For this the entrepreneurs and employees have to change their mindset, they have to look at new ways of managing their business and performing the day to day task. This might not be easy, after all, if what they are doing today, and the effort it takes, is working just fine, then why look to change it? In addition, if the perception is that the new possibilities of an autonomous systems or artificial intelligence are a threat instead of an opportunity, it can be a difficult conversation to have, and for companies to see how they can actually be beneficial.

We know that the first steps toward a truly digital business models is when companies consider new billing and service models, based on so-called remote-service-business models in the sense of "predictive maintenance and services" of machines and devices. This is where businesses are able to gain a competitive edge and be successful with their products and services in the future. This is especially true for smaller and medium-sized enterprises where handling and exchanging data can be a huge overhead, as today there are no omnipresent standards.

But to be clear, it is not just a matter of agreeing on a small set of standards, it is about carefully organizing complex and partially competing protocols and standards on multiple levels. This cannot be done by one organization alone, it has to be done in partnership. Global standards have to be in place if companies are going to be able to operate their business models. This is an ongoing process and needs to be consensus-based with international standard committees like the IEC or OPC foundation.

Most large companies today already rely heavily on standards to connect sensors, machines, moving assets and facilities in a heterogeneous environment. This is why it is so important for businesses to be actively engaged in various standardization and pre-standardization organizations like Industrial Internet Consortium (IIC) the Platform Industrie 4.0, the OPC or the World Wide Web Consortium (W3C).

These Integration standards which permeate all layers of the Industrial Internet stack, for instance, are necessary to integrate devices, platforms and business applications in an efficient way. At the same time, different partners in the ecosystem need to agree on certain interoperability standards to allow interaction among various assets. What is also extremely important is ensuring a high level of security and trust, which is crucial for Internet of Things.

Without doubt, digital transformation requires a lot of joint effort from enterprises. It needs strong collaboration from institutions across all industries, national borders, and organizations working together.

As an example, the collaboration between the Alliance Industrie du Future and the platform Industrie 4.0 (a conference took place last year in Paris) has shown that there are lots of activities on both sides, but it is absolutely necessary to continue to collaborate with each other. For, in both countries, there may be diverging approaches and priorities, but they complement each other perfectly. Both sides have participated actively in this collaboration, for example with the Competence Centers, the Labs Network Industrie 4.0 and the Standardization Council 4.0.

The collaboration with the alliance has provided new opportunities:

- Additional views on the reference architecture which - combined with RAMI 4.0 - serves as a basis for a database for industry standards
- New application scenarios complementing the existing Platform Industrie 4.0 scenarios
- The concrete collaboration between leading academic institutions of both countries to create new education profiles which we need urgently

One goal for Europe must be that it raises its voice to get more attention with regards to international standardization setting, and to avoid extensive bilateral discussions. In the future we need to look at better ways to co-ordinate this. The process should be supported by government and pushed by France and Germany within the European Union and Europe. Other European countries, especially those with a strong industrial base, should also be closely involved, like Italy and the Netherlands. We don't need e.g. a separate Reference Architecture by countries in Europe.

As a final comment, the U.S .is still leading the digitization of business models in the B2C world and is a great example of how things can be done. We shouldn't hesitate to cooperate with the United States, but we need to ensure that Europe also has a strong voice. The industry is moving rapidly and Silicon Valley will not wait for us. We need to work together, to build on existing concepts like RAMI 4.0 and the "Facettes" of the French Reference Model Industry of the Future', and create a global model, together with the US, Japan, Korea, China and other countries.

Industry 4.0: Rethink Energy

Patrizia TOIA

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By now everybody acknowledges that the industry sector is undergoing a revolution that will radically change the way we produce and hence the way we work and live: it the fourth revolution or Industry 4.0. What is still not completely recognised is that the energy sector is also going through the same revolution based on digitalization. The energy industry in particular may not have fully realised how much the current industrial revolution will be transforming it. That should come as no surprise considering that energy has been key to all industrial revolutions so far. It's the invention of the steam-powered mechanical manufacturing that triggered the first industrial revolution in 1784. One century later the second industry revolution revolved around another energy revolution: the electrical power that allowed the production line based on the division of labour. The third industrial revolution, around 1970, is based on electronics and IT, but the control of energy, this time on a micro dimension scale of microchip, is still fundamental. Today the fourth industrial revolution is based on the digitalization of production, products and consumption: Internet of things, 3D printing, innovation, modular production and crossing and blurring of borders between manufacturing and services, hardware and software and producers and consumers. How is this going to affect the energy sector? Before looking at the big picture let's consider a couple of everyday examples that show how the fourth energy revolution is already happening. Home automation, or domotics, is the residential extension of building automation and involves the control and automation of lighting, heating ventilation, air conditioning, and security and home appliances. Today you can have lights that switch off automatically when nobody is in a room, saving energy, or you can program your washing machine to wash during the night, when energy prices are lower. Or we can look at hybrid cars, more and more common on our roads. There you have a battery that can recuperate the kinetic energy that would be lost in breaking or slowing down in order to re-use it later through an electrical engine. A computer and a software can manage the fluxes of energy determining when recuperating and when re-using. That's energy 4.0! Systems composed of physical entities and controlled or monitored by computer-based algorithms. That is at the same time cause and consequence of a revolution in energy production. Phasing out of nuclear plants and of fossil fuels is giving way to intermittent renewables. Energy efficiency is more and more fundamental. That implies new ways of energy production, new transmission and distribution grids, a central role for storage and a lot of change on the commercial side of energy sector: unbundling, trading, home production. At the core of the revolution is the increased need to collect and exchange data at all levels. The rising share of renewable energy results in greater volatility in the amount of power available over the day and across the year. This means that we also need more energy flexibility on the consumer side. An energy-flexible factory is built on three pillars: building technology including energy storage, production planning and production control systems, and the machinery proper. Energy efficiency means avoiding peaks in consumption. We are seeing an increase in recovering braking energy from machines and feeding it to other using units. In the future, this approach will be applied to entire factories. Do all the spindles in a manufacturing line have to start at exactly the same moment or wouldn't it be more sensible to offset their starts and in this way to smooth power consumption? Networking beyond the boundaries of individual companies is an essential prerequisite for greater energy flexibility. In the future, production planning and production control systems will also be charged with energy management. They will exchange data on upcoming power requirements. The Smart Factory and the Smart Grid, i.e. intelligent power grids, will merge.

Industry is one of the pillars of our European economy. The manufacturing sector in the European Union accounts for 2 million enterprises, 33 million jobs and 60% of productivity growth. We set the 20% target of industry's share in Europe's GDP by 2020 and we are working on several initiatives such as Industry 4.0 and Digital Single Market to support and boost innovation and technology change. However all these efforts will not succeed if they are not matched with an energy revolution within the EU. That's why we welcomed the energy package presented the 30th of November by the European Commission. The push for clean energy and a binding 30% energy efficiency target can be the boost we need to bring change in the energy sector. We need also huge investments to use the full potential of IT in the energy production and consumption and we need to make sure that we put in place a legal framework that allows a big technological change based on flexibility and interaction among multiple players, from the single household that sells energy produced by solar panels in the electric grid to companies of very different sizes. Finally, the fourth industrial and energy revolution offers a lot of potential benefits at the economic, social and environmental level but we have to make sure that every single European citizen is in the condition to reap them.

Smart Products: the Consumer's Perspective

Asha-Maria SHARMA

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Germany has, for two years now, been running a campaign entitled: 'Germany. Smart up your business'. The country is pushing to be the pioneer of an industrial scene in which intelligent machines are inter-connected, in which energy use is optimized by intelligent power distribution grids, and in which generic basic products can all be tailored to individual consumer requirements yet come from the same production line. Businesses will reap efficiencies from aspects such as automated production, intelligent machines which monitor themselves, improved performance to customers, artificial intelligence and big data service. The collective term for this is Industrie 4.0 – or as it was termed at the World Economic Forum in 2016: the fourth industrial revolution.

Europe's largest economy has created a strong position for itself as both an end-user market and a producer market. While the larger companies in Germany – such as BMW for cars or Siemens for electronic equipment – are increasingly implementing Industrie 4.0 practices, it is the huge number of smaller companies who are both adopting and innovating within the sphere.

But the real beneficiaries are set to be the consumers. It is becoming entirely conceivable that within a decade, the average individual will be able to wake up to a ready morning coffee in an intelligently-controlled house, put on clothes which have been tailored to exactly his size, leave the house to switch itself off, and climb into a car which drives him to his office.

The Smart Home concept is gathering just as much attention in Germany at the moment as the Smart Factory. Industrie 4.0 is a concept wider-reaching than previous industrial concepts in this way.

A study by the Federal Association for Information Technology (BITKOM) in Germany suggests there will be more than a million Smart Homes in Germany by the end of 2020, while globally, more than 50 billion products and devices will be linked up to the web. Such developments are likely to have a heavy impact on consumer behavior, with a strong move towards on-demand purchasing. Developments such as speech-controlled devices or augmented or virtual reality solutions make such purchasing processes easier, while the continued development of 3D and additive manufacturing ensures that all specifications can be realized faster.

The increasing importance of mobile devices, such as smartphones, wearables and tablets is also affecting the way consumers use things and the competitive field. The multi-functionality of connected devices makes them effective substitutes for others – the smartphone is rapidly driving the Mp3 player into history, for example – and the more such devices are networked with others, such as those in the home, the more they become market drivers.

For business consumers, the effects are similar. Industry 4.0 takes manufacturers into a world of automated manufacturing and digital operations, incorporating inter-connectivity between machines and the lessons learned from analysing big data sets into manufacturing technologies. The ultimate goal is for a factory to be 'smart', in that it operates autonomously, maintains itself, processes orders and delivers products autonomously. It is an enticing prospect for any manufacturing operation, not least in terms of efficiency.

It is also daunting. It requires investment in new resources and change in the culture of the way organisations operate. But that creates opportunities for competitive advantage if done right. To achieve this competitive advantage companies need to challenge some of the long-held assumptions holding them back. This includes a belief that moving to smart manufacturing will initially involve a complete overhaul with huge premature investment in new machinery and additional employee training. But you can start with a host of small changes that enhance existing systems and processes.

Small investments can enable real-time tracking on the production lines, for example, which has allowed a digital replication of manufacturing processes, providing full visibility of what's happening on the factory floor via an iPad and thus a digital overview of all the orders in all the stages of production at all times.

Such information is a major help in all areas of a business. For instance, it allows the sales team to keep customers updated at all times and allows managers to isolate any abnormalities in real time. Supplementary technologies are also adding detail to that real-time data. Using location trackers such as beacons, for example, management can see that everything is where it should be at any given time. Used in conjunction with QR codes affixed to each run, producers can also locate any errant material quickly.

Deploying technology does cost money, there is no escaping that. But it doesn't have to be a big bang investment. Smart manufacturing is not about picking one miracle solution that does everything. Nor does it mean having to make massive changes that destabilize an entire workforce. Instead, by investing shrewdly in affordable solutions that work in harmony with each other, a company can start to evolve the factory floor, enabling everyone's work, from technical managers to sales staff to operators, to be leaner, smarter and more enjoyable.

The logical next step is the move towards smart services, connecting physical services with internet ones. Smart services will become more successful the better the consumer perspective is woven into the service design and the easier they are for the consumer to use. Big data platforms, gathering data from countless sources, are already building the bases for these services.

It is these solutions that Germany is enabling its small-to-medium business landscape to find, develop and implement, through creation of a benign investment landscape and the fostering of these small companies, encouraged to investigate ever-smaller niches and more and more accurate solutions. My company, Germany's economic development agency Germany Trade & Invest, is here to guide prospective investors through this landscape and help potential settlers here land in the correct place and with the correct government support.

Shaping the Digital Transformation – Industrie 4.0

Thomas HAHN
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Siemens AG
Corporate Technology

A trend that will fade as quickly as it appeared, or a pie-in-the-sky idea not yet representative of market realities and especially not the reality of manufacturing companies? In the past, people often used these characterizations to dismiss the idea of Industrie 4.0. Nonetheless, what was supposed to be the "future" has already begun: Industrie 4.0 has been a reality for some time now. The key question for manufacturers and service providers therefore starts not with "whether" but with "how." And the question is, "How can we shape the forward march of digitalization?"

Application Scenarios Describing the Future of Manufacturing

In order to find a common basis to integrate the different viewpoints involved in digitalization discussions, the Plattform Industrie 4.0 has developed so called application scenarios. Application scenarios are top-down archetypical stories based on new manufacturing processes and digital technologies; they illustrate how digitalization may influence manufacturing industries, and thus describe the future of manufacturing. In addition, the application scenarios start by addressing customer needs, thereby helping to evaluate how users might benefit from the implementation of different situations.

Thus, the application scenarios help to promote a common understanding between stakeholders, especially between providers and users of digitalization concepts, solutions, and technologies. The application scenarios thereby serve to structure the complex discussion about the influence of the digital transformation on manufacturing.

Management of Value-Added Processes in Manufacturing

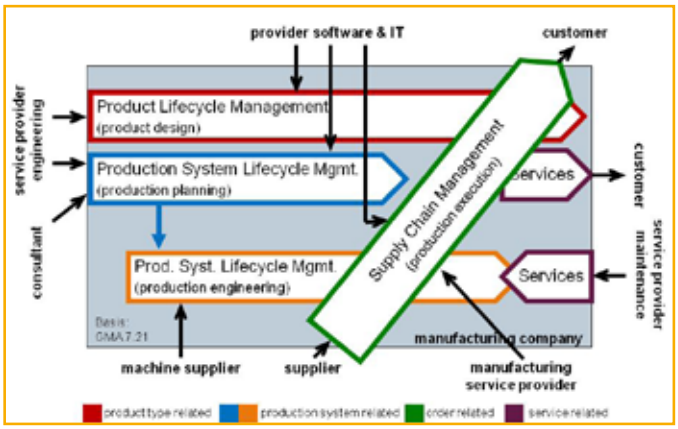
Industrie 4.0 signifies the 4th industrial revolution, a new stage of organization and management for the entire product lifecycle value chain. This cycle is increasingly being determined by growing customer demand for individualized solutions; it ranges from idea, development, order, production, and delivery of the product to the customer all the way to recycling and associated services.

In order to shape this transformation, a common understanding of the core value-added processes in manufacturing and their associated stakeholders must be developed. From a technical point of view, there are four main value-added processes in manufacturing companies:

- Product Lifecycle Management: This includes all value-added processes involved in designing and managing a product type. Typically, this is created in the virtual world.
- Production System Lifecycle Management: Manufacturing companies deliver physical products that are produced using a production system (i.e. factory). The production system lifecycle includes all value-added production planning (conceptual and basic design) and production engineering (detailed engineering, construction, installation and commissioning) processes and management along the entire lifecycle of the production system (operation, maintenance, upgrade, and decommissioning).
- Supply Chain Management: This comprises production execution and thereby all order-related value-added processes, including order planning and scheduling, logistics processes, and management of the supply chain.
- Service: This includes on the one hand the value-added processes after a product has been delivered (product-related services such as spare parts or software updates, also value-based services such as availability guarantees, up to "as-a-service" business models) and, on the other hand, services such as optimization of production systems.

Typically, a number of companies will be involved in these value-added processes, comprising a value network of stakeholders:

- In value added processes associated with production execution, various suppliers of raw materials, intermediate products, and logistics service providers are typically involved.
- The production machines used in a production system are typically delivered by machine supplier and integrated by system integrators.
- There may be an integrated engineering service provider and consultants in the value-added processes for development and engineering of the product and the production system. This may even mean that production planning and engineering are completely outsourced.
- Service providers, for example in the areas of production system maintenance or manufacturing, may be involved.



Graphic based on: GMA 7.21. (vdi Fachausschuss "Industrie 4.0")

- A manufacturing company's value-added processes may be supported by the products and services of various software and IT companies.

The application scenarios describe hypotheses as to how the organization, control and configuration flexibility of value-added processes can be managed in the future through improved use of digital systems. Collectively, they provide a big picture of the digital transformation.

Application Scenario: Seamless and Dynamic Plant Engineering

Plattform Industrie 4.0 published an update of its application scenarios at IT-Gipfel in November 2016. The scenarios cover all core value-added processes in manufacturing. One of these application scenarios is "SDP – Seamless and Dynamic Plant Engineering," which addresses the value-added processes in production planning. SDP addresses the increasing dynamics in plant engineering along a plant's entire lifecycle and the importance of validating engineering decisions. Thus, in focusing on this application scenario, we will detail one aspect of digitalization in manufacturing.

Plant engineering – both during conceptualization and operation – is increasingly characterized by alterations and upgrades that require complex engineering decisions. In the future, such decisions will be supported by an integrated model of the plant. This model will be managed and consistently maintained in all interrelated engineering, operational, and service processes throughout the entire lifecycle of the plant. In addition to a model of the real system, this model will also include the boundary conditions, context information, possible variants, and engineering decisions – including their potential and real effects.

This application scenario takes into account the numerous interest groups involved in the value-added network associated with plant engineering:

- Integrator, ensuring the implementation of all requirements from a technical and commercial point of view, and coordinating the partners involved,
- Owner/operator, who specifies a plant's requirements,
- Suppliers in the form of engineering service providers and licensors, as well as suppliers or contractors for components, systems, and technologies,
- Construction companies that transform a plant model into reality,
- Consultants as well as regulators defining specifications and granting approvals, and
- Software providers in the form of suppliers of design and engineering tools and collaboration platforms.

The development and maintenance of an integrating plant model as well as the evaluation of the model with regard to the optimization of engineering, operation, maintenance, and upgrade of a plant will create new roles with new business models. These stakeholders will offer new value-added services.

The core of this application scenario is a structural model for all participating stakeholders. In the future, plant engineering will become more dynamic in the sense that alterations will become more frequent and short-term, and stakeholders' interests will be increasingly interrelated, thus demanding a more granular level of documentation to follow the consequences of alterations. This process will have to include overlapping changes in planning and implementation phases, such as planning alterations that take place during construction. In this context, a comprehensive plant model will support optimized engineering decisions. This will be a prerequisite for the future competitiveness of plant engineering and operations.

Example: The Solvay/Butachimie Chemical Platform in Chalampé

The future-oriented PCS-7 project from Siemens (Germany), Solvay (Belgium) and Butachimie (France) is an example of how core aspects of this application scenario can already be implemented using commercially available products.

The Solvay/Butachimie chemical platform in Chalampé is amongst the world's largest specialized facilities for the manufacture of polyamide 6.6 and its intermediary products. What distinguishes the platform is its high-efficiency processes, its production volume, and the high quality of its products, which are sold the world over. Starting in 2010, Siemens began a multi-stage modernization of the facility. The first leg of the refurbishment program was successfully completed in October 2014 with the virtual commissioning of a new process control system using a simulated process.

When deciding to invest in future-proofing their facilities, Solvay and Butachimie opted to rely on Siemens' technological expertise. The platform's entire process control system was replaced with a PCS 7 system from Siemens. What's more, this conversion was optimized through the use of Siemens SIMIT Simulation System, which comprises a plant model and allows the migration and recommissioning of every unit using simulation software prior to actual execution.

The complete overhaul of the plant's management system is set to continue until 2023. All in all, the project is a prime example of how we are shaping the digital transformation. It constitutes a concrete step towards implementation of the factory of the future.

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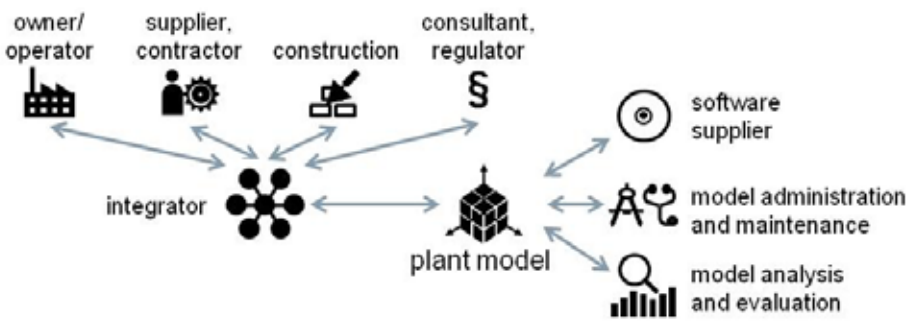

Industry 4.0 – A strong lever to create the Chemical Plant of the Future

Creating value through all cycles of industrial assets

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The chemical industry is undergoing a profound transformation made possible by new digital technologies. This transformation touches all parts of our value chains: we need to rethink the way in which we do research in our labs, we organize our supply chain, we run our plants and we interact with our clients. But we also need to take into account the disruptions affecting our ecosystem: our clients in the automotive industry grapple with the disruption coming from autonomous driving, our clients in health and personal care with the attack on their business model through e-commerce platforms. Finally, digital technologies change the way in which our employees communicate and collaborate together and require adaptations in our organization and management culture.

Solvay has decided to embrace the digital change around us by launching its own digital transformation journey called Digital@Solvay. Multiple initiatives are being implemented with the objective to speed up Solvay's transformation towards becoming a more customer centric, agile, innovation driven multi-specialty chemical company. In this context, developing the chemical "digital plant" of the future is one of our priorities for the years to come.

The industrial plants of the future are more agile and flexible in the face of an ever changing customer market; they are sustainable, ensuring employee health and safety, they are secure regarding access to infrastructure and data; they are transparent and open for learning; they are predictable and reliable; they are customer oriented, i.e. pro-actively connected to customer needs and creating value for them through innovative products and services. To make that vision become a reality, Solvay is working with external partners (experts, consultants, start-ups, and universities) on concrete and pragmatic steps forward in five different priority areas.

Asset Performance Enhancement through Data Analytics: In one of Solvay's Italian plants, production engineers recently observed that the furnaces used to produce a specific chemical compound had run at exceptional yield for two months without any apparent reason, when normally they run below that level. They started to search for the factors explaining this sudden increase in performance. Solvay Italy partnered with a German start-up to search for answers: using Advanced Data Analytics, a pilot has been launched to better understand the relationship between all production parameters and find an optimum that can be reproduced with high daily productivity and minimized raw material consumption.

Asset-Network Value Optimization: The objective here is to maximize the profitability of a network of different plants – on a single complex site or on different sites – by applying dynamic optimization algorithms to end-to-end product flows. Applying this principle, Solvay Energy Services, Solvay's business unit in charge of the energy management for Solvay's 150 plants across the world, developed, with the help a French start-up, an optimal way to use our European energy production resources. The software, on one side, collects the energy needs (in terms of steam, electricity etc.) from a number of European plants and,

on the other side, analyses the availability of internal generation resources compared to resources offered by the market (notably electricity), and finds the optimal supply-demand balance. The intent is to reduce energy costs (and use) while maintaining efficiency. The project has been successfully implemented in 2016 and is now ready for scale-up to other plants and industries facing similar challenges.

Data enabled asset reliability: The maintenance costs of our industrial assets can be reduced significantly by applying preventive maintenance instead of repairing – taking into account real operating conditions and extending the time between maintenance operations or shutdowns for maintenance. This is being implemented at a Solvay site in France that encountered a maintenance problem on rotating equipment. New sensors were installed to capture vibrations in addition to temperature and pressure measurements. The sensors collect data that is sent to a Manufacturing Execution System to be stored and further analysed and compared with historic data to detect any deviation to "normal" equipment behaviour. The system works like a live health check-up: by evidencing irregular equipment behaviours at the time they are happening, breakage can be avoided. A pilot project is underway since January 2017, with the aim to achieve 30% less reliability related downtime.

Digital Workforce: Digital technologies have the potential to make the employees in our plants both more efficient, and also safer at work. At Chalampé (France), Solvay invested in a next generation Distributed Control System (DCS) provided by Siemens to control and optimize production. An Operator Training System has also been installed: this "digital twin" of the real system allows to virtually control and test the whole DCS before implementing new functionalities. This reduces the risk of human errors and accidents.

Chalampé is also continually testing a number of other new technologies, such as the use of electronic whiteboards to improve collaboration between operators in the field and those in meetings or in the control room, or the use of tablets to perform round guards. We use a RMAD (Rapid Mobile App Development) software to program a user-friendly sequence of screens on the tablet that are consistent with the trajectory of the round guard in the plant and allow the operator to record data (equipment pressure, temperature etc.), fill in his or her observations or take pictures. The data is sent in real-time to either the Manufacturing Execution System or our enterprise resource planning tool (SAP), and the maintenance notification is automatically emitted if a problem needs to be fixed. The main benefits are fewer errors due to double encoding and less paper use. The intention is to deploy this scheme to other sites around the globe at the end of the test period at Chalampé.

Robotics & Cobotics: Solvay also examines the possibilities offered by Robots or Co-Bots (collaborative robots) to improve productivity and reduce repetitive jobs. The first pilots are to be launched in 2017.

Solvay's "Digital Plant" initiative, as almost all other initiatives under Digital@Solvay, pose great challenges in terms of training, people development and work organization that need to be addressed. This is an area where public policy can help in order for companies to be able to find the right talents on the job market or train them in-house.

Industry 4.0 has reached the chemical industry and is here to stay: it will transform the way we process and make our materials. **Solvay is determined to continue its exploration of digital technologies to optimize its production to better serve its clients and be more sustainable (protecting workers, environment and assets)**. Our approach is built on continuous tech scouting and a "win fast, fail fast" approach with proofs of concepts that quickly allow judging whether a new technology or service adds value and merits deployment to other industrial sites. Our challenge is to bring the digital success stories emerging from this process to the next level, by developing and deploying sustainable integrated solutions and platforms with the right partners. This will further accelerate Solvay's digital transformation and help us create more value for our clients across the globe.

Paving the way for digital transformation in the European machine tool industry: what role for the EU?

Filip GEERTS
Director General of CECIMO

> *"New business models of the digital era are not achieved with short term goals, and developing digital solutions providing value to customers requires long-term commitment. In other words, digitisation should not be considered as a revolutionary event but an evolutionary process. Machine tool companies need to go step by step in their digitisation journey and invest gradually in the solutions needed by customers."*

Europe has the world's most competitive machine tool industry. European machine tool builders represent almost 40 percent of the global machine tool production. The sector is an export champion as well: every second machine tool exported in the world originates from Europe. The sector's competitiveness is based on know-how, high skills and customized solutions.

Nevertheless, the advanced manufacturing industry is changing. The digital era brings new business models that European machine tool builders need to follow for continuous success in the market. Capital goods are getting increasingly connected and becoming part of a global cyber-physical system. Advanced manufacturers gradually improve the performance, energy-efficiency and safety of products by exploiting industrial data. They more and more build network-connected capital goods and introduce new service-oriented business models. Yet, the potential deriving from digitisation of manufacturing is far from being fully exploited by our businesses. According to a study, 92 percent of today's 64 million machines from across the world are still not network-connected. Another research reveals that only less than 20 percent of the European machinery industry have already implemented new business models (i.e. platform-based, product-as-service, IPR-based or data-driven solutions) and for more than one-third, digital business models are not yet a strategic focus. Against this finding, many companies expect a shift in profit pools from products to services in the future. To tap into this digital transformation's full potential, an EU-level forward-looking policy approach is required.

Early intervention by policy-makers can put severe barriers against new business models

As the manufacturing business is being rapidly transformed, having a strict regulatory approach would not be supporting the growth of European manufactures in the long run. Decision-makers should keep in mind that prematurely introduced regulations may put severe barriers against new business models since innovation cycles are getting shorter as an answer to changing customer demands. Future European regulations affecting our businesses should rather provide a general framework and key principles without any detailed measures. This approach is needed to remain future-proof, technology-neutral, and support the growth of European machine tool builders.

Machine tool builders need a pan-European innovation policy that pools resources and that brings together actors with complementary expertise

Various public authorities at national and regional levels have developed initiatives aiming at supporting digital transformation in the manufacturing industry. Yet, with its value chain including both SMEs and global players widely distributed across Europe's regions, cross-border issues brought by digitisation cannot be tackled by a single EU Member State or region. In this regard, we should accelerate efforts to develop pan-European initiatives. Public-private-partnerships with several access points and common goals would put together ICT providers, machine tool builders and end-users, creating a new European manufacturing ecosystem. This would help machine tool builders develop a thorough understanding of their customers' needs and making use of cloud products, high-performance applications and ready-to-use data analytics provided by ICT companies. To this end, key enabling technology centres as well as digital innovation hubs

would play instrumental roles in providing actors along the value chain with state-of-the-art facilities, services, network and training needed for the development of new business models.

Manufacturing SMEs need policy makers' particular attention

Developing digital business models require considerable financial resources and human capital, whereas manufacturing SMEs have limited financial resources and knowledge, making them vulnerable to the complexities, costs and risks of digital transformation. The misalignment between the broad requirements of digitisation and limited resources prevent SMEs from investing more and creating solid business cases, as the potential return on investment would be too low. All things considered, public policies pertaining to digitisation need to be designed with specific attention to SMEs, since they are the backbone of Europe's manufacturing (for instance, 80% of the European machine tool industry is composed of SMEs). Manufacturing SMEs face difficulty in following recent digital trends, so they require practical guidelines, training as well as exchange of best practices to facilities their involvement in the new business models. To this end, identification and dissemination of best practices by forerunner manufacturing SMEs towards the wider European industry should be supported by public authorities, with the involvement of sectorial representatives.

Hybrid skills pipeline and work-based education are key to digitisation

Machine tool builders are increasingly facing difficulty in finding the workforce possessing the knowledge and skills needed to apply digital solutions in the field of advanced manufacturing. In order to tackle this pressing challenge, public authorities at national and regional levels as well as education providers together with the industry should invest more in the design and delivery of a new hybrid curriculum merging various disciplines including software programming and production technologies. Furthermore, work-based education should be the key component of manufacturing education in Europe, since in the machine tool sector learning is best done in the real working environment.

Financial institutions should understand the new advanced manufacturing industry

Europe should also ensure that the financial sector is ready to finance new and sophisticated manufacturing projects. The European financial sector faces difficulty to understand the new manufacturing industry, its new business models and its globalized markets, which delays much need investment by advanced manufacturers. To overcome this lack of understanding, Europe needs to develop a mechanism bringing financial actors and manufacturers closer and developing investment tools ready to be used by manufacturers.

Industry 4.0 and the digital transformation: pursuing a competitive position in the new technological revolution

Laïla GIDE

President of ARTEMIS Industry Association

When Europe's policy makers and industry leaders were alerted to the essence of speed in their pursuit of competitiveness and much needed economic growth and jobs, the call for immediate and bold action to accelerate the digital transformation and seize business opportunities could not have been clearer: act now or risk being left behind.

The recently published ARTEMIS Industry Association Strategic Research Agenda (2016) echoes this sentiment. It highlights the need, in creating a pathway to digital transformation, to enable a more agile and shorter development cycle of smart products, i.e. those products embedding software . This Research Agenda highlights the need to adopt new design methods, particularly those related to design-by-composition and correct-by-construction principles. Key to this is a focus on providing strong technological capability over the whole value chain, removing barriers between application contexts to yield multi-domain, reusable components (building blocks) for such systems that have embedded intelligence. Extending the use of digital platforms to build the stronger eco-systems, with the participation of end-users and suppliers, is essential to accelerate innovation and create new innovative business models for jobs and value creation.

New unprecedented opportunities

The digital transformation provides great prospects to open new markets to every business in Europe and beyond, bringing a new and wider variety of smarter products and services that will reshape the future and create new unprecedented opportunities. European companies will be able to generate international market opportunities with new products and services empowered by digital investments, disruptive business models and improved production processes. From engineering and automotive to healthcare, pharmaceuticals and farming, all industrial sectors are impacted.

Europe must use its leadership in the now so-called 'Cyber Physical Systems'. These are products that link the physical world to the cyber one by embedded intelligent ICT systems to make products smarter, more interconnected, interdependent, collaborative and autonomous. By harnessing these capabilities in time and across space, applications will emerge that have enormous and disruptive new qualities (features) and functionalities with unprecedented societal impact and economic benefit for citizens and societies. In the future, Cyber-Physical Systems will manage complex systems like smart grids, transport or water management systems, and will make everyday objects such as homes, offices, cars, trains, cities or clothes intelligent, connected to the Internet ... the Internet of Things.

The fourth industrial revolution is here. Its major power lies in combining digital technologies with other advanced and leading-edge technologies. Creating suitable solutions and services as well as related innovation strategies and new business models is helping to modernise Europe's manufacturing capabilities; in the near future, traditional factories will increasingly be transformed into smart digital manufacturing environments.

Collaborative automation

Collaborative automation, as embraced in the ARTEMIS Innovation Pilot Project Arrowhead, will be driven by software (systems) and connected through the Internet of Things, and will know no borders. The significant gains in productivity (higher efficiency, lower costs) of this approach have already been demonstrated, especially in production, smart buildings and infrastructures, electromobility and the virtual market of energy.

The collaborative and cross-domain approach has shown its effectiveness, but now it will be complemented by the development of common building blocks to make significant advances in design-by-composition. This will also accelerate the development cycle, maximise the reuse and the time to market, be more cost-efficient in the adoption and deployment of technological solutions, master their growing complexity, ensure safety, security and privacy, allow flexibility and facilitate interoperability between the various systems. And, in the end, bring innovative products faster to the market.

Cyber-Physical Systems of Systems and the Digital Transformation

An analogy to the whole evolutionary process from the mechanical to the digitised eco-system can be found in the development of photography. The first products existed in a mechanical or analogue (physical) form. They were then transformed into a digital form in the evolution from integrated electronic components to embedded software. The next step was integration into the digital mobile phone, as photography and music converged into one device, the internet-connected smart phone, and consequently a system in a large system with cloud storage and computing.. In a shift from a product to a smart product integrated in a system possibilities are created for completely new types of application that have not been possible to date. Thus, as Cyber-Physical Systems of Systems emerge, characterised by a large number of physical devices and computing elements that are interconnected in both physical and informational terms, the vastly increased amount of information and the new level of connectivity offer unprecedented potential for more efficient operation, higher flexibility and adaptability, improved levels of reliability and better quality of products and services. They pave the way for new markets such as Big Data, which is considered now as the new 'oil', as data have to be extracted, processed and used to fuel various types of applications.

The time is ripe to seize the tremendous opportunity we have to make the digital transformation happen. Greater pan-European collaboration and open innovation can accelerate the process, bring new thinking into organisations and ensure that the best ideas are implemented and successfully brought to market. And keep Europe at the forefront.

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Industry 4.0 and smart production

Adrian HARRIS
Director General of ORGALIME

Industry 4.0, the Fourth Industrial Revolution, the digitisation of industry – however it is dubbed, the new era of manufacturing is powered by one key concept: smart production. But what exactly makes it 'smart'? After all, there is nothing new about robotics or computing modules on the factory floor. The difference lies in the integration of the physical and cyber worlds: combining sensors and automation technology with connectivity, big data analytics and machine learning. This creates truly intelligent systems that not only passively measure data, but increasingly 'think' for themselves – processing information in real time, communicating with each other, and making autonomous decisions. For manufacturers, smart production can enhance processes, streamline supply chains and enable profitable new business models. And for both manufacturers and citizens, it can lower resource and energy consumption, create skilled jobs and generate value throughout the economy.

Smart manufacturing facilities are often called 'factories of the future'. But in fact, they already exist. Producers today are investing in sensor technology and big data analytics to optimise processes in-house. Data gathered from machinery can pinpoint inefficiencies, while analytics streamline production planning to maximise productivity. Smart manufacturing boosts operational efficiency, too. With sensors constantly monitoring production processes and 'talking' to each other often via wireless networks, issues can be identified in real time – translating into better quality control, lower breakdown rates and safer workplaces. Moreover, intelligent systems reduce resource consumption. Not only can sensors detect potential energy savings, but by integrating real-time assembly line information with up-to-the-minute data from order systems, it is now possible to accurately predict material requirements and minimise waste. And the benefits extend beyond company boundaries: by enabling data exchange with clients and suppliers, clients can get a better service, production can be monitored, components tracked, and data fed back into systems to fine-tune processes across the supply chain.

For manufacturers, these internal cost savings are a significant draw. But the possibilities of smart production are not limited to the factory floor. The data captured by machines is a valuable raw material – and with the right know-how, companies can use it to open a world of opportunities. New business models are emerging as value creation moves from the production line into the realm of service offerings. Again, this is not a distant future: it's already happening. For some equipment manufacturers, the majority of value-added now comes from integrated software and services such as 24-hour maintenance or data-driven process optimisation. And the trend is set to reshape the B2C sphere, too: the growing catalogue of IoT-enabled products will allow producers to connect directly with customers, while flexible, responsive assembly lines create personalised items to order.

However, the road to smart production is not without challenges. While many manufacturers are already leveraging big data analytics, some – especially small and medium-sized enterprises – lack the resources to invest in digital technologies or the know-how to unlock the value from the mass of raw data they can now collect. Here, public support for R&D and forums to exchange experiences will be key to helping firms make the transition. Moreover, security is a concern. Open the lines of communication between in-house production and external suppliers and customers, and you run the risk of exposing sensitive data and trade secrets. Robust cybersecurity is essential to foster trust in these new systems. Plus, legal questions surrounding data ownership and liability may need to be clarified in a framework that provides certainty without stifling innovation.

A final challenge will be training and re-skilling employees. As with the industrial revolutions that went before, there are fears Industry 4.0 will make certain jobs obsolete. Indeed, it will require major adjustments for the workforce. But if we get it right, it presents an opportunity to replace repetitive, strenuous assembly-line work with skilled jobs in the exciting new areas opened up by digitisation. Plus, the growth potential of smart production can strengthen Europe's manufacturing base and enhance competitiveness, preventing jobs from moving elsewhere. In Orgalime's industry – which spans the whole area of engineering from metalworking, though machinery to electrical and electronic products and systems – the results are already there to see: output grew in 2015, reaching 1900 billion euro, while employment rose to 10.9 million.

European manufacturers have long led the way in automation and manufacturing-based services, particularly in mechanical engineering and energy technologies. We are ideally placed to amplify these strengths through data and digital technology. But the time to act is now. It is no secret that US-based digital giants are seeking to bring their ICT expertise to the manufacturing sphere. Wait too long, and we could see value creation moving outside our core competencies and outside of Europe. EU-level initiatives to support the digitisation of industry are necessary and welcome; the right conditions must be in place before companies will invest. And if we get it right, we can open the door to a bright new future not only for European industry, but for all of Europe's citizens. By unlocking growth, creating employment and delivering sustainability through resource and energy savings, smart production can create a win-win situation for manufacturers, consumers and society at large.

Digital transformation of Europe's enterprises - it's where the money is

John HIGGINS
Director General of DIGITALEUROPE

When Willie Sutton, a well-known American criminal, was asked why he robbed banks he replied (probably in the manner of a bored teenager making a statement of the obvious familiar to many a parent), "because that's where the money is". It's the same answer I give when asked why Europe should care about digital transformation. Bemoaning the fact that we don't have a European Google misses the main point and doesn't take us very far. The key to Europe's future prosperity and social well-being is to ensure we have a large range of highly efficient and effective tax-paying and job-creating enterprises. In 2017 to be globally competitive, enterprises must use every digital trick in the book. To help European enterprises become and remain world leaders we need to focus on three things: new opportunities from data; Europe's communications infrastructure; and finally enterprise transformation. And although there are horizontal aspects, some things are best dealt with by industry sector.

Ask most Europeans: "what word follows Europe and data?" the answer would most often be "protection". We're rightly proud of our leadership in personal data protection but for Europe's future prosperity it's not enough. Necessary, but not sufficient. In some parts of Europe national initiatives are being planned to help develop what we might call data opportunity awareness. This can only be a good thing. Many enterprises are waking up to the fact that they have access to a lot of data. Big data is the term used to refer to data that has volume, velocity, variety, variability and veracity. Deriving value, such as more reliable predictions, trends and patterns from such data often requires new techniques and analytical methods, for example, harnessing machine learning. Value depends on the industry and application. Examples range from image recognition to fraud prevention; from credit scoring to better management of patients' medication. Value could of course come from a completely new business idea like the BMW/Mini/Sixt scheme, Drive Now, which allows users to access cars parked randomly throughout a city via an app, book them at a few minutes notice and pay only for the minutes used. Enterprises need to develop the know-how to understand these opportunities and then manage the business and organisational change needed to realise them.

Imagine that you're planning to transform the travel from, say, Paris to Brussels, from horse and carriage to high speed trains, and then discovering the cities aren't connected by rail tracks, but only farm tracks. That's the risk we're running with digital transformation; we have telephony farm tracks rather than data super highways. A major reason for this is because we regulate the sector to prevent all the possible wrongs the horse and carriage and farm track businesses might do to its customers, but give little or no thought as to how we encourage farm track owners to invest in high speed rail tracks. The problem seems likely to get worse before it gets better. Member states covet valuable spectrum and the income it generates and are slow to think on the European scale needed. We're risking a decline in our competitive situation with this approach. Other regions of the world readily make the link between state-of-the art communications infrastructure and globally competitive enterprises, with China being perhaps the best example.

You don't have to look far to find types of business activity being turned upside down by digital technologies; hotels, travel agents and taxi companies are only the beginning. European business leaders need to be leading the change, not waiting for their business to disappear in the face of a more effective competitor with "outside the box" thinking.

Modern dynamic European cities like Lodz, Amsterdam, Helsinki and many others are helping to bring about this change. These cities have developed an exciting approach to digital transformation of their local businesses. A blueprint has been developed which draws on the experience of 13 like-minded cities. It can be found on the Strategic Policy Forum on Digital Entrepreneurship page on DG Grow's web site. The blueprint identifies four critical attributes: leadership & collaboration; digital and entrepreneurial skills; providing access to data and technologies; and key infrastructures and investments. At the heart of the approach is the concept of bringing together "the old and the new". Established businesses are cross-fertilised with ideas from new digital economy companies and vice-versa.

Although some aspects of digital transformation are general, a number of things are better considered by industry sector. For example many of the approaches to the digital skills gaps are at a sector level with sectors being encouraged to create detailed workforce development plans. European money will be available initially to help six pilot sectors to create such plans; automotive, maritime technology, space, defence, textiles and tourism.

It's easy to feel overwhelmed by the pace of technology-driven change, especially when this is happening in what feels like an increasingly uncertain and changing world. But all good entrepreneurs know that disruption and discontinuity throw up opportunities. Europeans just need to get better at exploiting them.

Ensuring Europe's pioneering role in the digitization of the industry

Wolfgang DORST

Head of Industrial Internet at Bitkom (the German Federal Association for Information Technology, Telecommunications and New Media)

The digitization of industrial processes creates great opportunities for new added value and thus for prosperity and employment in Europe. A Fraunhofer IAO study commissioned by Bitkom showed productivity gains and added turnover potential of 1.7 percent annually across the six most important industry sectors, totalling EUR 78 billion by 2025 in Germany alone. Digitization however applies to all industrial sectors in all of Europe.

We should aim to strengthen our leading position in many industries by taking an international pioneer role in the use of the Internet in the industry. This also requires strategic cooperation between governments and industry. First steps have been taken in Germany with the "Digital Agenda" and the successful establishment of the "Plattform Industrie 4.0". At European level, the Commission has kickstarted the debate with its "Digitising European Industry" package.

Where do we stand?

To find this out, Bitkom has conducted a representative survey of the entire industry for the first time. We surveyed 550 German industrial companies, including 100 companies from the electrical engineering, machine and plant engineering and automotive industries, as well as 250 companies from diverse sectors. For years we have debated both the competitive benefits and the effects on our societies of digitization. However, companies are still reluctant to invest in technologies for smart production and products.

Almost every second company in the manufacturing sector uses Industrie 4.0 applications, and another fifth of the surveyed have concrete plans for deployment. However, the study also shows that entrepreneurs are still more cautious in terms of investment. Almost all of them have budgeted for industry 4.0, but only 4 percent of the total turnover. Two thirds of companies primarily want to optimise existing processes. Only 14 percent aim to develop new business models or to change existing ones based on Industrie 4.0.

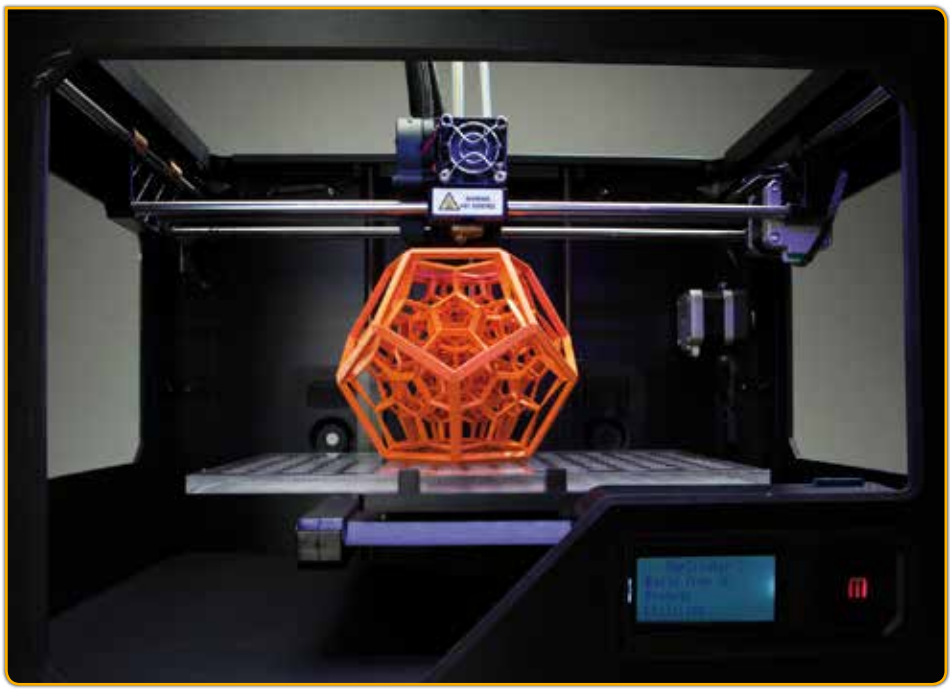
The large majority of Industrie 4.0 strategies are developed with internal resources. Only 28 percent cooperate with companies from the digital sector, 11 percent with competitors and 8 percent with research institutions. A meagre 6 percent have included start-ups in their strategy process.

The many possibilities of this development will depend on whether and how we succeed in introducing new business models by combining goods and services in the traditional industrial sectors.

How do we boost Industrie 4.0?

It is important that governments continue to support structural change in 2017 and beyond in a constructive manner building on the positive outcomes of national and European digital strategies. Our top priorities should be the following:

- **High-performance industrial internet**: So-called specialised network services (quality of service) ensure key network features (latency, security, robustness) necessary to develop successful business models based on Cyber Physical Systems or the Internet of Things. Today's internet is only to a limited extent suitable for the concepts of Industrie 4.0.
- **Pilot projects**: Europe will only be successful in the area of Industrie 4.0 if we need to raise awareness and involve SMEs. Demonstration projects and industrial competency centres close to the market make the concrete benefits visible and provide platforms for questions of technological progress, business models and standardization.
- **Public funding**: High investment requirements in current funding programmes frequently pose a challenge for SMEs. Therefore, either we significantly increase funding rates, especially for investments in (digital) infrastructures, or we target large companies to take ownership of pilot applications as they can bear the



financial risk of initial investments and are necessary to prepare for a new market.

- **Innovative start-up and growth financing**: Start-ups and growth companies are often the driving force behind innovation. While Europe has caught up with regard to start-ups, it is striking how few are active in the area of Industrie 4.0. We need an ecosystem and the framework conditions beneficial for the emergence and development of ideas in the context of Industrie 4.0.

What role for policy-makers?

As in previous industrial revolutions, it is above all the companies' commitment that will drive the digital transformation of industry. Nevertheless, policy-makers can support the long-term success.

- While the rollout of high-speed broadband needs to continue, regulatory authorities should allow for commercial solutions with regard to data traffic management and quality-ensured services in the Industrial Internet. This way, innovative business models can be implemented for the benefit of all (end users and content / service providers) without adversely affecting the competitive structure of the digital economy.
- Currently, the need for legislation is limited to few legal areas such as contract law, data protection law and the protection of know-how. This only requires minor changes to existing framework regulation or secondary legislation. Where necessary, we could consider legal experimentation clauses with a narrowly defined scope.
- For the success of Industrie 4.0 we need to ensure data security and data protection, for example through encryption. However, SMEs often lack the human and financial resources for specialised systems. Governments could support such efforts through 'vouchers' that are cashed in with certified service providers.
- The entrepreneurial risk and business uncertainty in Industrie 4.0 is high. For this reason, Industrie 4.0 is a textbook case where the tax-deductibility of research and innovation costs would have a significant positive impact.
- Most public research funding schemes require the research outcomes to be published. Against the background of international competition, we should cautiously consider for example introducing lock-up periods for research results at national and EU level, which in turn would incentivise participation in such projects.
- Creating Industrie 4.0 Hubs: It is likely that many successful start-ups, currently only active in the B2C market, could expand their applications and business models to companies in traditional manufacturing sectors. In order to enable the necessary transfer we need platforms for "Meetings of Minds".
- Mobilise venture capital: Institutional investors should be allowed to invest in start-ups; losses from start-up investments should be tax-deductible and venture capital funds require legal certainty for the exemption of from business tax.

Industry 4.0, standards and standardization

Elena SANTIAGO
CEN and CENELEC Director General
CEN-CENELEC

CEN (European Committee for Standardization), **CENELEC**, (European Committee for Electrotechnical Standardization) and ETSI (European Telecommunications Standards Institute) are recognized by the European Union (EU) and the European Free Trade Association (EFTA) as European Standardization Organizations responsible for developing standards in relation to a wide range of materials, processes, products and services. European Standards (ENs) are developed through a process of collaboration among experts nominated by business and industry, public authorities, research institutes, consumer and environmental organisations as well as other stakeholders. When correctly applied in 33 European countries, they contribute to enhance safety, improve performance and quality, facilitate cross-border trade and strengthen the European Single Market.

CEN and CENELEC cooperate with the European Commission to develop and adopt harmonized standards and other deliverables that support the implementation of EU policies and legislation. They work with the research and innovation community to get market access for their innovative solutions, through European Standards. Additionally, they work to promote the international alignment of standards in the framework of technical cooperation agreements with ISO and the IEC.

Industry is undergoing a fourth revolution, driven by digital transformation through the uptake of a new generation of digital technologies including: Internet of Things, Big Data and Cloud Computing. This digitization of industrial systems, processes and supply chain gives rise to a wealth of opportunities, but it also brings new challenges and threats around data security, privacy and trust.

Standardization to support the digital transformation of industry is addressed through national initiatives including Plattform Industrie 4.0 (DE), Industrie du Futur (FR), Catapult Centres (UK), Action Agenda Smart Industry (NL). Through their national members, CEN and CENELEC are building on these important initiatives to ensure the necessary supporting standards will be available to industry across Europe.

Smart evolution

European industry needs timely and trusted solutions that also address higher levels of complexity and uncertainty. Commercial product lifecycles can be as short as 6 months meaning that industry has to adapt its internal processes, systems, and even business models, through connected equipment and devices that allow increased flexibility, product customisation as well as more flexible 'automation'.

Through smart evolution, more than 10 billion 'things' will soon be connected to the Internet, so that the 'Internet of Things' risks becoming the 'Internet of EVERYTHING'. Standards are essential to enable the interaction of this huge array of products, systems and services in the most appropriate way. For example, as a result of connectivity it is estimated that 2.5 quintillion bytes of data are generated every day; so that 90% of the data in the world today was created in the last two years alone. Standardization will play a significant role to aid the capture, storage, protection, processing and analysis of the data to benefit industry.

In Europe, CEN and CENELEC, and where relevant ETSI, are already active in areas such as smart metering, Smart Homes, Smart Grids, e-Mobility and Smart Charging, Urban Intelligent Transport Systems, Cyber Security and Data Protection, Smart Cities.

Standards for Smart Metering are enabling interoperability of utility meters (water, gas, electricity, heat) that will in turn improve the means by which customers' awareness of actual consumption can be raised in order

to allow timely adaptation to their demands, including:

- A Functional reference architecture for communications in smart metering systems (CEN-CLC-ETSI TR 50572:2011)
- Guidelines for the development of Smart Metering Use Cases

Standardization for 'Data Protection and Privacy' has the objective of defining the implementation of privacy by design principles for security technologies (e.g. video-surveillance, security systems, access control etc.)

What is our strategy?

CEN's and CENELEC's approach to digitization challenges and opportunities is based around five pillars:

- **Building on European assets:** including leadership in technology areas such as electronics, robotics, lasers and the experience of digitization of our national members and industry partners.
- **Deepening engagement with stakeholders** to identify digital standardization needs for smart technologies (applications and services such as robotics, additive manufacturing, printed electronics, Building Information Management (BIM), e-Learning, e-Skills) beyond connectivity issues.
- **Coordination with relevant organizations including** ISO, IEC, ISO/IEC JTC1, oneM2M, Alliance for Internet of Things Innovation (AIOTI).
- **Promoting and raising awareness of the role and benefits of standards** to support take up of digital technologies in non-digital sectors and other industry engagement actions.
- **Addressing transversal topics** including cybersecurity and a range of data-related issues including security, ownership, privacy, functional safety, product security, identity of objects and persons.

The digital world is not limited by national borders and an international approach is always preferred when relevant. CEN's and CENELEC's links with ISO and IEC are key strengths and we will take full advantage of the significant international ICT standardization activities that meet the needs of European industry.

CEN and CENELEC are building on their significant 'footprint' in 30 industry sectors that are all undergoing digital transformation. The more 'connected' businesses and consumers become, the more necessary are the enabling benefits of standardization.

CEN and CENELEC currently putting these principles into action in projects including the joint leadership with ETSI of Action 14 'Standardization to support digitization of industry' of the Joint Initiative on Standardisation and in the joint response with ETSI to the EC Communication on ICT Standardisation Priorities for the Digital Single Market.

The increasingly complex landscape of digital technologies, policies and alliances add to the challenge faced by industry undergoing digital transformation.

CEN and CENELEC aim to be the key providers of digital standardization solutions to European industry.

CEN-CENELEC website: www.cencenelec.eu

Digitalisation for equality, participation and cooperation in industry

Dr. LAURENT ZIBELL
Policy Adviser, Industrial Policy
industriAll European trade union

IndustriAll European Trade Union proposes policies and actions for more and better industrial jobs in the digital age. Their common strategic objective is that digital technologies should be leveraged to develop cooperative, integrative, democratic and egalitarian workplaces and societies, in the long-term interest of workers and of society at large.

1 Digitalisation massively impacts employment, and has specific effects

Digitalisation is the **networking** of any object and any person, at any time, in any place. In industry, it leads to the **digital integration** of all processes: design, manufacturing, maintenance and administration.

This digital integration has the positive potential to deliver huge **gains** in productivity, reliability, adaptation to customer needs and speed. It can significantly improve the comparative advantages of European manufacturing, and thereby protect or even **reshore many industrial jobs**.

On the other hand, the negative consequences of digitalisation on **employment volume** of existing jobs are potentially **massive**. These threatened jobs are mostly routine jobs typical of industry, including white-collar jobs.

Digitalisation also has **specific** effects, beyond the productivity gains that have been common to all technological transformations of industry in history:

- It **concentrates** power and wealth in Digital Marketplace platforms, thereby depriving all other companies along the value chain with the capacity to invest, to innovate and to provide good wages and working conditions.
- It challenges the foundations of the permanent, full-time **employment relationship** based on collective agreements, because all functions of this relationship can be performed individually, automatically and remotely. Consequently, **precarious work** with **individualised** terms & conditions (e.g. crowdsourcing) is exploding.
- It opens up unprecedented possibilities for asymmetric, vertical and unilateral **control** over workers, but also of symmetric, horizontal, multilateral and democratic **cooperation** between them.

2 Digital technologies must foster equality, participation, and cooperation, for more and better industrial jobs

IndustriAll Europe considers that technological developments are not deterministic. It is the trade unions' duty to engage with them and to **shape them positively**, to take advantage of the digital revolution, for the welfare of industrial workers in Europe, and of society at large.

IndustriAll Europe therefore proposes **policies** and **actions** to seize the opportunities of digitalisation and to orient its evolution towards more equality, participation and cooperation in industry, and towards more and better industrial jobs in Europe. These proposals also aim at alleviating the threats posed by the impact of digitalisation on employment volume and on the employment relationship itself, and by its potential to concentrate wealth and power.

2.1 Leverage digitalisation for responsible innovation

Digital technologies can significantly reduce employment in existing economic activities. However, they also have the potential to create new markets and new jobs, by meeting societal needs. IndustriAll Europe has identified some fields where digital innovation has a great potential for job creation in Europe, and where political action is needed:

- Restore a leading industrial position in electronic components and systems
- Mandate ambitious standards for the security and confidentiality of data
- Develop automated dis-assembly factories
- Digitally trace and monitor social and environmental conditions of manufacturing.

2.2 Regulate the sharing of value added along digital supply chains

If the value added is captured by a dominant player along the industrial value chain, and specifically by a digital platform, no other company has the capacity to be a decent and sustainable employer. The **distribution of value added along the value chain** is thus a new and essential issue for workers. IndustriAll Europe recommends the following actions:

- Regulate and tax value creation according to the rules of where work is physically performed
- Set up open standards, accessible to all under Fair, Reasonable and Non-Discriminatory (FRAND) conditions, for the digital integration of manufacturing
- Regulate monopolistic digital platforms

2.3 Invest in the skills and in the physical infrastructure supporting the digital transformation of industry

The digital transformation of industry must include the long-term **anticipation of change** for workers. Once these changes are identified and quantified, the **skills** of the existing and upcoming workforce should be adapted to this new situation.

IndustriAll Europe supports the deployment of **broadband radio and fibre networks** across Europe, with specific care to include all regions and all Member States.

2.4 Ensure essential social rights

IndustriAll Europe demands that **essential social rights** be maintained and reinforced in a digitally-transformed industry:

- Information and consultation rights
- right to training & education
- right to collective bargaining
- Occupational Health & Safety.

2.5 Ensure good working conditions and work-life balance

We demand the right to **disconnect**, so that mobile work does not translate into constant availability and limitless work. IndustriAll Europe also supports the development of "**assisting technologies**", where digital devices support the human worker in taking decisions and in solving problems.

2.6 Reflect on working time and productivity gains

The benefits of more flexible work brought by digital technologies should be fairly shared between employers and workers. Similarly, workers should get their **share** of the **productivity gains**.

3 Conclusion

Digitalisation of manufacturing is a major social, economic and industrial upheaval. It challenges trade unions and societies on a massive scale. IndustriAll European Trade Union invites political institutions at all levels, companies and social partners, to a thorough and concrete **political dialogue** to make the best – and avoid the worst – of this structural change in our lives and in our working environment.

A New Way to Work

Evelyne GEBHARDT
MEP (S&D), Member of the IMCO Committee

Undoubtedly, the digitalisation shift is providing the EU with an unprecedented opportunity to modernise its economy and societies but it also poses threats to Europe's inclusive and competitive social market economy model. The rising income and wealth inequality, the rise of xenophobia, the citizens' tumbling belief in the establishment, Brexit and all that it stands for, are all expressions that it is time to put people back into the centre of EU policies.

The many conducted analyses on the future world of work point in the direction of a hyper-mobile labour market, where workers shift between various forms of employment (online platform work, permanent employment) and will at times have multiple workplaces simultaneously. At the same time, researchers tend to agree that the labour force will be divided between jobs that require highly skilled workers and jobs of a more manual, low skill one. The medium-paid, middle level jobs will gradually disappear.

Robot technologies and the further development of e-services, e-government, e-health, etc will also displace and transform jobs and tasks. The intermediaries or on-demand economy and the online platforms we know today, are most likely only the beginning of a fundamental change that will transcend and compress space and time. The predicted blockchain revolution will even further disrupt and change the way our societies function, and the way users, consumers, business and workers interact and co-exist.

Most people working via online platforms do so as (bogus) self-employed. As our current social protection systems are now, the self-employed have no rights to social protection. This then fundamentally means we have a growing number of citizens, who bear the risk of market fluctuations in terms of demand for their goods and services, yet have no income protection, holiday rights, pension rights, maternity or paternity rights etc. This is unacceptable and can risk growing a whole new group of underprivileged and under-paid citizens. We cannot accept the flexibility of the market with no security for the workers.

The Commission has stooped to picking out more or less isolated policy areas in its two communications on the "platform economy" as well as on the "collaborative economy" and suggested remedies for the reconciliation of an offline and online market place in Europe without examining the totality of circumstances and the structural changes that are already underway. This applies especially to the social impacts of digitalisation on companies and labour in general.

Furthermore, these (bogus) self-employed are regarded by law as single unit companies. Precisely this causes a problem. The workers on online platforms can join a trade union, but the moment the union helps them bargain their wages (costs), this can currently be regarded as cartel building. This is, given the situation above, unacceptable. Workers on online platforms must have a right to collectively organise and build negotiation power. The economic and social consequences of blocking this right are large and will lead to a race to the bottom in terms of labour standards and wages in the remaining market.

As EU legislators, we have to pass framework legislation, which create the necessary conditions to increase union density in order to promote the bargaining power of workers, most importantly for those independent workers in the on-demand economy.

Some forms of the so called sharing economy or how I prefer to call it intermediaries or gig economy are premised on access to rather than ownership of resources and are thus rather providers of infrastructure than tech companies. This misconception has lead to many platforms growing into monopolies. I believe, that the EU has a strong interest to regulate those monopolies in order to avoid averse affects like rising costs for consumers and wage stagnation. More importantly, however, we have to create a level playing field for platforms in order to foster horizontal competition and innovation.

By adapting current laws and regulations to new industries will leave consumers and industries alike better protected in a rapidly changing society. At the same time companies evolving from the intermediaries economy can become a key component in our societies' efforts to rebuild resilient economies. Cashless transactions may help to combat tax evasion and undeclared work, sharing commodities proves to be environmentally beneficial. Further, the flexible nature of some forms of this new economy concerning working hours, but also the de-localisation of work can have a positive impact on factors such as work-life balance and family life, or rural and remote areas

I fundamentally believe that the European Union can lead the way globally by making sure workers and societies have a just transition to the digital economy. One which empowers all citizens of all ages, skill type and geographic location; which is inclusive in the sense that structures that enable workers to organise, bargain and influence are developed and adapted; and which is cohesive, in the sense that it is not in Europe's interest to create a new group of underprivileged citizens with no fundamental rights and poor pay.

The new reality of work

Gen Vagula

Kaja KALLAS

MEP (ALDE) - Member of the ITRE Committee

In political discussions, we often ask whether a specific policy will create or destroy jobs. The success of an economic sector is often measured by the number of jobs it provides. The question of jobs is particularly topical in the context of new businesses or start-ups, because they do not, as a rule, create jobs for masses. But perhaps we are not asking the right questions. Shouldn't we be focusing on the new reality of work instead? Maybe we shouldn't prefer stable long-term contracts and assess the success of economic sectors by the number of jobs?

The emerge of Industry 4.0 affects every part of the economy and the society. The digital world is now an integral part of our lives and influences the way we think, our actions and desires. Our behaviour has changed a lot. This has happened imperceptibly, and has also affected the way we work. People have more choices than ever before. They want to consume wherever and whenever they want. The same applies to work.

At present, labour laws are built around a certain ideal - a stable, long-term contract with one employer. However, this is no longer the reality for the majority of people. In 2015, 75 percent of people were on interim, short contracts or informal agreements or worked for a family without a contract. Over 60 percent of all workers had no contract. In Europe, 15 percent of workers are self-employed, in the US the percentage is as high as 25. The creation and loss of jobs is in constant motion - 20 percent of all jobs are created or destroyed every year. 50 percent of today's children will work at positions that do not yet exist today.

Moreover, companies are no longer eternal. The average corporate life expectancy is 15 years, so there is no chance of a lifetime working for a single employer. Nor does a stable and steady job automatically mean a good job these days. Even more interestingly, people no longer dream of this ideal. The workers of new generations have completely different expectations for their work. They increasingly find it more important to have a good working experience, a nice working environment, and personal development, than a good salary. They are seek personal freedom at work.

Thomas Malone, a professor at the Massachusetts Institute of Technology, wrote that in the long term, these changes may be more important for businesses than democratic transition has been for the governments. Companies should treat their employees as internal customers, because they have individual needs. Previously, an employee had to adapt to the organization, but now, a modern organization adapts to the needs of employees. Companies who make their employees happy will win the war for talents.

Innovation, creativity and a sense of initiative, as well as the ability to maintain relationships with others are the keywords that count in modern businesses. Increasingly, we see that the working relationship is less direct and clear. Americans even have even come up with the concept of a *tempreneur*, that is, the combination of a temporary worker and an entrepreneur. It has been pointed out that long-term contracts slow down the entrepreneurial mind, which is one of the key qualities of future employees. Work is no longer a place to go, but something to do. Employees are more and more appreciative of their personal freedoms and the opportunity to reconcile work and private life, both for the purposes of raising children and investing time in their hobbies.

According to Forrester, a think tank, 29 percent of the global workforce are "people who work with information anytime and anywhere". Man is a herd animal who wants to belong somewhere and nowadays we can work alongside people with whom we don't share the same employer. There is even a concept for that - working alone together: to avoid traffic jams, you go to a co-working centre close to your home, define the length of your working day, exchange views with other people using the co-working space, even though you're not professionally related.

According to sociologist Marc Halevy, the new generation of leaders should be more like entrepreneurs than managers, more designers than budget focused, more charismatic than technical, less like supervisors and less focused on the revenues. Josh Linker, an entrepreneur, has said that leaders need to encourage passion and autonomy, welcome new ideas, value the courage to fail and increase diversity. Employers can no longer insist on complete obedience, because they know that the future of their employees is not solely related to one employer.

Current labor standards are no longer applicable. Although some details of the system have been modified, the central ideas have remained the same. Labour Law Reforms are not questioning the key issue - the relationship between the employee and the employer.

In addition to labour laws, we should review social security systems that are entirely based on open-ended labor contracts and stable family models. Denis Pennel wrote in *Ego Revolution at Work* that we should not build our social system around a specific job, but rather take into account the whole job market. This is necessary for people to be able to switch easily between different employers. In practice, this could mean the rebirth of medieval guilds in a modern form.

We need further discussion on how to change the rules and define the problems that might appear with the new age of working. Given that we live in the new reality of work, we should certainly stop the contradistinction between the self-employed and the people working under stable contracts and build a suitable framework that would cover all working people.

High-tech manufacturing: The balance between ICS security risk management and added value

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The increasing complexity of the digital factory increases the potential risks. For some time now, cyber security has not been an end in itself, but rather a decisive business requirement for ensuring that companies can still compete in the digital revolution.

Even if every technology manufacturer has to develop and implement its own unique strategies, all smart industry concepts ultimately share a common paradigm: manufacturing in the future will be data-driven, networked and transparent. Today's typical production no longer consists of a single supply chain, but is the coordination of hundreds of interlinked, value-added processes and stages of manufacturing.

Production processes, material flow and ERP information are merging. The number of real-time data flows and connections are growing exponentially – as are the number of potential security vulnerabilities as a result. 'Traditional' security concepts, which are mainly based on production systems and office IT being separated, will not be able to cope with the challenges of the digital factory. A strategy for digital change must include requirements for the secure operation of new technologies, where the boundaries between the IT level and production systems are increasingly disappearing. The new technological direction here offers a perfect starting point for a fundamental review of security measures and the evaluation of potential security risks, particularly with a view to planning a company's own digital agenda.

Long-standing structures become security problems

When modern automation technology started to be used, nobody seriously thought about the possibility of connecting production systems to the internet. Industrial control systems were regarded as isolated units – safety functions such as authentication mechanisms, password management or access restrictions were therefore unnecessary and simply not planned for at the protocol level. Practical advantages such as real-time capabilities and reliability were the decisive parameters in the production network.

But despite the high real-time requirements, where the flexibility of TCP/IP was useful or costs could be reduced, many connections were transferred to the IP protocol. This, however, was not always done using the required methodology and only rarely with the necessary security awareness. One of the main drivers of this was the provision of remote access to technician and maintenance personnel.

From silo mentalities to an interdisciplinary consensus

The discussion about security in production systems has become more public recently, especially since the emergence of Stuxnet and other malware variants that target industrial networks. In addition, specialised search engines now exist that can search specifically for open internet connections with production-specific protocols. There is now an interdisciplinary consensus that this is not ideal for the smooth running of a production environment.

The silo mentality between IT and production managers is being steadily broken down thanks to increased reporting, additional education in teaching and research, and more standardised security guidelines (IEC 62443). Today, most production managers welcome or even actively call for professionally coordinated security initiatives. After all, they are ultimately responsible for ensuring a smooth production process and efficient machine output. A complex hacker attack or malware that specifically targets industrial facilities can put this objective in jeopardy. One single security incident is all it takes to cause prolonged and very costly production downtimes or for critical company secrets to fall into the wrong hands. Not to mention the brand reputation damage all attacks have the potential to cause. ICS security is therefore no longer seen as a barrier for manufacturing but rather as one of the crucial requirements for reliable production planning. Without the expertise of production technicians and process control engineers, it would not be possible to secure manufacturing environments in a way that would work in practice. A balanced security concept that unifies real-time requirements and security mechanisms can only be achieved using an interdisciplinary approach that combines the perspectives of both IT and production specialists in a meaningful way.

Risk assessment leads to a reliable production network

Just like digital change overall, industrial security is not static; it is a continual process. Therefore, the fundamental first step towards a valid ICS security strategy must be a detailed risk analysis. All-encompassing security strategies aim at working closely with the operator's IT and production teams to identify and document the top five risks and to recommend feasible countermeasures.

The specific objectives are as follows:

- Setting up secure remote access for maintenance and analysis
- Securing the production network and isolating or monitoring legacy systems with vulnerabilities using passive security sensors
- Securing endpoints, databases and servers (MES, HMI stations, notebooks and mobile devices)
- Secure usage of portable media such as USB flash drives or CDs
- Transferring know-how and providing methods for continual risk analysis

Securing production facilities is a complex challenge that at times can be expensive, particularly for high-tech manufacturing companies. In the light of Industry 4.0 and the Internet of Things (IoT), a review of security measures is crucial for providing a solid basis for digital change. A security assessment is a suitable starting point and forms the cornerstone for all further recommendations for action and the development of a long-term security strategy. The costs of analysis are manageable and are quickly recovered thanks to minimising the risk of downtime and having a more reliable production network overall.

The Plant of the Future: a Cybersecurity Challenge

Guillaume TISSIER
CEIS Managing Director
Co-organiser of the International Cybersecurity Forum (FIC)

The Plant of the Future offers huge opportunities: increased productivity (25% of tasks could be automated vs less than 10% currently); improved competitiveness; production flexibility; quality improvement; production relocation; etc. But it also raises considerable challenges in terms of cybersecurity. At the end of 2014, a German steel mill was targeted by a cyber attack. A hacker entered the company's information system via a phishing e-mail sent to a staff member, gained access to the production management system and triggered the safety stop of the blast furnace, leading to major damage. Other example: in 2010, the Stuxnet virus damaged the Iranian nuclear programme's centrifuges, despite them not being connected to the Internet. Albeit the number of cyber attacks targeting industrial infrastructure is low - at least for what we know - the risk is progressively increasing as all fields of activity embark on digital transformation.

Contrary to traditional factories, which operated in a vacuum, disconnected from the company's information system, the Plant of the Future is hyperconnected. The digital revolution, which started with the gradual digitisation of robotics, has gained momentum with the development of numerous cross-cutting technologies, such as predictive maintenance, 3-D printing, connected objects and mechatronic components. This has two main consequences: the industrial Internet of Things (IIOT) is playing an essential role in enabling communications between all objects (robots, sensors, actuators, etc.) and stakeholders (employees, suppliers, clients, etc.); data have become of paramount importance and must now be secured from end to end, in particular when stored on the cloud.

This technological change is increasing the risk exposure of the Plant of the Future, especially through connected objects, and aggravating the impact of each security incident. As a matter of fact, we are at the very boundary between the physical and virtual worlds: through industrial automatons, information science can affect the real world. Information security and operating safety go hand in hand. Risks are further increased by the specific constraints of industrial environments: necessity to work in real time; production requirements; and difficulty/impossibility to stop production lines. For instance, one cannot update the antivirus software of a manufacturing machine in the same way as that of a basic workstation, since it could severely disrupt the system's operation. Furthermore, countless machines use antediluvian operating systems that are no longer maintained, since the life cycle of physical devices (sometimes up to 20-30 years) is much longer than that of digital technologies. Lastly, the heterogeneity of OSs and diversity of protocols make it very difficult to map the systems' physical, logical and application layers.

Such a context requires multiple, yet specific, answers. The standard solutions rolled out in general IT cannot be directly copied and pasted to the industrial context. They must be tailored, sometimes reinvented, to make sure they address the specific needs of extremely complex industrial processes. The first step is to work on the culture of the teams who design, roll out and operate such solutions and technologies. Indeed, there is sometimes a real gap between automation experts, for whom machine availability is the top priority, and IT specialists, whose key objective is data confidentiality. Working on the culture starts with implementing an adequate organisation, where industrial IT is no longer totally independent from the CIO and CISO. It also requires raising the awareness of all stakeholders (manufacturers, operators, maintainers, integrators, engineering & design departments, etc.) about digital best practices: banning of USB sticks, modification of manufacturer's password, etc. Finally, it requires training in both automation and IT specialists taken from the cohort of architects, cybersecurity experts or data scientists.

After culture, additional priorities include security governance through a comprehensive security policy, and roll-out of tailored technological solutions further to an accurate need assessment. But as always, there are no miracle solutions. Tools come in different shapes and forms to cover the various aspects: protection, prevention, detection and reaction. A few companies are now offering solutions that are specifically tailored to the industrial environment: detection sensors and tools; network diodes for unidirectional interconnections; supervision tools; etc. But beyond security solutions, the requirement is also to integrate 'security by design' in the equipment and technologies of the Plant of the Future. In other terms, manufacturers must tackle the issue to secure their very machines so that they remain safe throughout the life cycle of the equipment. As regards industrial players, they must add to their specifications precise security requirements (in terms of availability, integrity, confidentiality and traceability), as determined by a thorough risk assessment.

To systematise this 'by-design' approach, standardisation and product certification are essential, but one should not overlook regulatory provisions, as already enforced in some countries for operators of vital importance. Finally, we should be aware that major differences remain between large industrial players, which are gradually tackling the issue, and SMEs, which are struggling with the barrier. In the numerous industrial contexts where the subcontracting chain is quite long, we must thus work on securing the entire ecosystem. In this respect, large industrial contractors bear a great responsibility.

Industry 4.0: advantages and difficulties A cybersecurity point of view

Mathieu MOREUX

Technological partnership Manager, Stormshield

"The digital era is our new industrial revolution, an opportunity that needs to be seized by an industrial sector representing 2 million businesses and 33 million jobs in Europe today."

This quotation[1] from a speech by Jean-Claude Juncker, President of the European Commission, particularly illustrates the strategic importance of the so-called Industry 4.0 for Europe. With this fourth industrial revolution, leadership of the European industry is at stake.

The 4th industrial revolution is about merging real and virtual capabilities and technologies into cyber-physical production systems, extensively using cloud applications and leveraging analytics and big data. Self-configuring robots, drones, intelligent sensors and 3D printers are some of the many disruptive technologies that support the digital transformation in the industry, and proof that the impact is on all sectors.

New opportunities and jobs

Yet this industrial revolution is not only about technology; it is also about creating new business opportunities, new business models and new jobs. It holds the promise of increasing industrial competitiveness and improving economic growth. The digitalization of products and services could inject 110 billion euros of annual revenue into the European economy over the next 5 years (source: European Commission) and digitalized European manufacturing can expect to see growth of 15% to 20%. Advanced manufacturing helps to speed up the development, prototyping and production of goods and services, improve their quality, optimize the use of production resources, achieve customer-specific and individualized production, and accelerate logistics and delivery.

Smart industry is also about connecting objects, services, people and data. It truly embraces the 4 freedoms that define the European Union and illustrates how well Europe is positioned in this race. To accelerate the transformation of European industry, the European Commission has created the Digital Single Market.

In order to make sure that Industry 4.0 helps to achieve economic and social improvements, regulatory authorities and businesses must anticipate and correctly cover the risks involved. It has now been well established that the industrial Internet is risky, particularly when considering cybersecurity, and is highly exposed to data theft, industrial espionage and sabotage.

Cybersecurity is key to the success of Industry 4.0

For valid reasons, cybersecurity is currently the primary concern when considering the adoption of Industry 4.0. In a survey conducted by Deloitte on Industry 4.0 challenges and solutions, 84% of respondents believed that the level of cyber risk could rise sharply or very sharply as a result of Industry 4.0[2]. In another survey about industrial Internet, Accenture found that 76% of manufacturers worry about data vulnerability and 72% about system vulnerability[3]. It is true that a successful cyberattack could potentially lead to a major industrial accident.

"Business imperatives have driven the convergence of the Internet of people, computers and things, transforming most enterprises into digital businesses and reshaping cybersecurity", says Christian Byrnes, managing Vice-President at Gartner[4].

What industrial businesses come up against

The first risk comes from transposing all the interconnections between physical and virtual assets into cyber-physical production systems. Smart factories today rely heavily on such interconnections. Until recently, operation technologies such as sensors and industrial control systems, were operating in confined environments without access to the outside world and therefore had rudimentary security. But this is no longer the case. They now are interconnected with enterprise business management systems, such as the ERP and HR. Moreover, software upgrades and maintenance operations are now regularly conducted remotely over IP or with a USB key. It considerably enlarges the attack perimeter and paths for hackers, as proven by Stuxnet some years ago. Following this example and others ever since, cyber attacks no longer target only intangible assets but production assets as well with the potential to cause major physical damage, especially to people and property.

Another risk is the extensive dependence on analytics and big data management as Industry 4.0 is fundamentally data-driven and will become increasingly so as the Internet of Things spreads. For example, Siemens' installed base of 300,000 connected systems generates more than 17 TB in operations data per month[5]. According to a McKinsey survey, using such analytics should correct data inefficiencies and improve productivity by about 25%[6]. But then again, data confidentiality, integrity and availability must be ensured.

In sum, smart industry is a conjunction of business and technological changes in which cybersecurity must be taken into serious consideration and at a very early stage. While data breaches and business interruption are very costly in terms of revenue and intellectual

1 Jean- Claude Juncker, Construire l'Europe Industrielle, Speech, Paris, October 27th 2015

2 Deloitte, Industry 4.0: Challenges and solutions for the digital transformation and use of exponential technologies

3 Accenture, Machine Dreams: Making the most of the Connected Industrial Workforce, 2016

4 Gartner, Gartner says cybersecurity professionals are the new guardian of digital change, Press release, October 7th, 2015

5 Rajiv Sivaraman, Industrie 4.0, Smart Factories, Cyber Security, Siemens AG, 2016

6 Cornelius Baur and Dominik Wee, Manufacturing's next act, McKinsey&Company, June 2015

property, they also damage customer trust and brand image. Moreover, through the development of connected operational technologies and IT/OT interconnections, Industry 4.0 forces us to redefine the paradigm of cybersecurity in order to include safety, along with the traditional availability, confidentiality and integrity triangle. Christian Byrnes from Gartner confirms: "Protecting information alone isn't enough, and ensuring the confidentiality, integrity and availability of that information isn't enough. Leaders in risk and cybersecurity must now assume the responsibility of providing safety for both people and their environments".[7]

With such needs in mind, Stormshield developed a portfolio of certified cybersecurity solutions specially dedicated to supporting customers for whom information and industrial resilience are key assets.

Endpoints are often the weak points exploited by attackers, especially when considering industrial environments in which operating systems are ageing and unprotected. Corrupted files or USB sticks are threatening industrial systems. To tackle malicious intrusions by external agents into production-controlling systems, Stormshield has developed **Stormshield Endpoint Security** which proactively blocks attacks, both known and unknown, thanks to its innovative non-signature-based protection.

Network protection is also a key concern. Stormshield is the European leader in Unified Threat Management systems and Next-Generation Firewalls with its **Stormshield Network Security** portfolio. Industrial systems used to rely only on specific protocols but now work using IP protocols, in addition to industrial protocols. They now face the same network-based threats as information systems. Interconnections between both worlds open a new door for hackers to target production systems. For this reason, Stormshield has specifically developed the **SNi40** appliance, the first ANSSI-qualified industrial firewall specifically dedicated to protecting production assets, providing operators with network protection and visibility over the security of their systems. The appliance is capable of monitoring MODBUS, S7, UMAS and OPC UA protocols.

As previously discussed, cloud applications and storage are essential to decentrally networked smart manufacturing systems. However, data is threatened when not properly secured. Encryption protects data from cloud service providers, malicious hackers targeting cloud infrastructure and intrusive local regulations. To address this issue, Stormshield has created **Stormshield Data Security for Cloud & Mobility**, providing end-to-end data encryption in any cloud environment.

Stormshield is fully committed to offering best-of-breed security solutions and being its customers' trusted partner in helping them through a smooth digital transformation.

7 Op. cit., p. 2

A framework for Sensitive Industries

Jean-Pierre MASSICOT
CEO of Advanced Track and Trace (ATT)

Industry 4.0 and connectivity

The basic principle of Industry 4.0 is that by connecting machines, work pieces and systems, businesses are creating intelligent networks along the entire value chain that can control each other autonomously. Some examples for Industry 4.0 are machines which can predict failures and trigger maintenance processes autonomously or self-organized logistics which react to unexpected changes in production.

It also means that the complexity of production and supplier networks will grow enormously. Networks and processes have so far been limited to one factory. But in an Industry 4.0 scenario, these boundaries of individual factories will most likely no longer exist. Instead, they will be lifted in order to interconnect multiple factories or even geographical regions.

Track and trace solutions for identifications

The key factor here becomes interconnectivity and real time information on products and parts. This means managing traceability and supply chain, within sites, between sites, internal or external , up to tracing the products during their life cycles on the market and even up to final users.

This means identifying objects and relating objects together such as subsets of parts integrated into complex systems and/or associated at the packaging stage with aggregation levels for the supply chain.

Sensitive industries specifics

Identifying may not be good enough if counterfeiting or real origin of object is a concern for the industry: aeronautics, military, electronics ... Nowadays the sensitivity goes further among consumer goods where alien objects and control defaults can lead to major industrial havoc. Authentication on top of identification becomes definitely required as to be 100% on the safe side as far as the connected object is concerned : it has to be really, genuinely what it says it is. Security cannot be compromised without endangering the producing company.

New technologies availability

The development of new technologies has made it possible to identify, authentify, track and trace with low costs using simple and efficient processes for billions of objects.

Standardized 2D Codes , marking and checking

First the expand of standardized supply chain codes (data matrix or QR) with automated reading tools has allowed object tracking easier. The technology of object direct marking has brought new opportunities for object identification through improvement in speed, size, quality... The implementation of new optical systems on the control side allows quicker reading and update of databases with latest information. RFID has developed as well but with a higher cost per item and some usage limitations (physical strains...).

From variability to authentication

Therefore within this context of mass identification and interconnections, 3 new functions have become key to master : 1 - Managing variability on masses of items, 2 - With easy identification, 3 And automated authentication for the sensitive industries.

Digital printing

The development of this new set of printing technologies has brought tremendous opportunities for the safe and efficient generation of object identification solutions. This technology allows small personalized individual runs with unique labels/ documents inside.

Managing variability means the capability to issue billions of codes all unique and perfectly readable for easy interconnections. That is what the development of digital printing technologies allows to perform : the printing of billions of labels all unique and not counterfeitable.

Variability management

Linked to software managing the variable parameters from one object to the other billions of unique numberings, labels and identifications can be created with individually differenciated designs.

Generation of unique IDs connected to Information Systems

From digital creation on, the unique code created can be followed all along his life cycle through its integration into the Information System bringing valuable information to the operators or to the interconnected machines.

Supply chain management

The supply chain can be tracked and trace through reading of objects at several stages : packing, finishing, loading, receiving ...New generation of software allows an easy control and management of parent to child relationship from the items .

Industry 4.0 will fulfill all its promises provided that identification and authentication be easy to implement, reliable and cost efficient. The advance of digital technologies and secured track and trace software will bring its contribution to the information management flows implied by this constant interconnection requirement.

With Vary.IDs, make Mass Serialisation easy

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