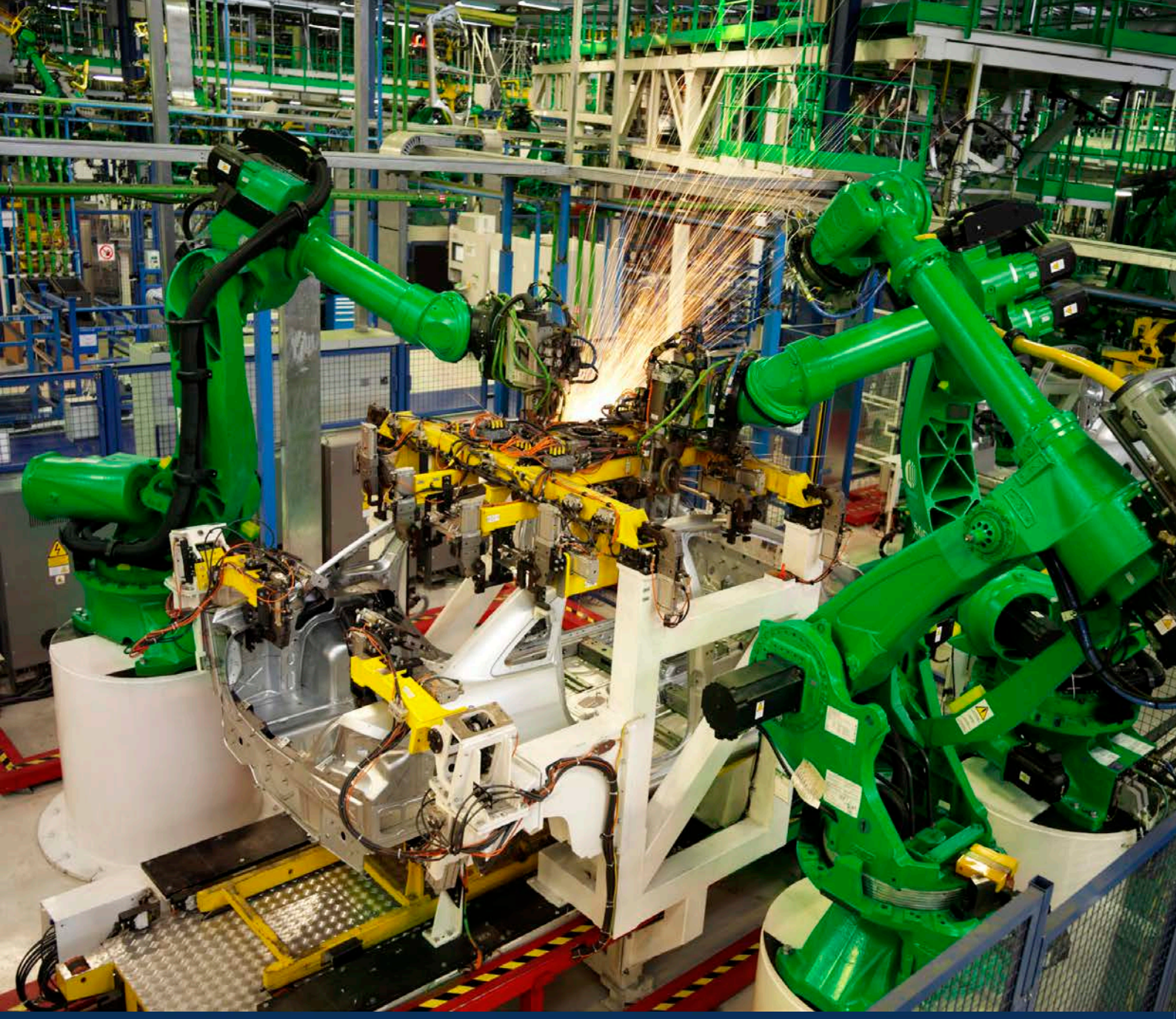

The Smart Factory – Risk Management Perspectives

December 2015

CRO FORUM

The CRO Forum's Emerging Risk Initiative

The Emerging Risk Initiative (ERI) was launched in 2005 to raise awareness of major emerging risks relevant to society and the re/insurance industry.

The ERI pursues the following goals:

- Raising awareness and promoting stakeholder dialogue.
- Developing best practice solutions
- Standardising disclosure and sharing knowledge of key emerging risks

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1 Executive Summary

"Ten years from now, the global manufacturing sector will look nothing like it does today. Advanced manufacturing technology is rapidly transforming the global competitive landscape. The companies – and nations – that act now to seize its promise will thrive in the 21st century. Those who are devoted to incremental change and fail to engage in smart manufacturing will rapidly fall behind."

Sujeet Chand, Chief Technology Officer, Rockwell Automation

1.1 A fourth industrial revolution

Imagine… an iPad rebooting a factory's production lines following a power outage or creating a personalized car to exact specifications at a cost far lower than a conventional sticker price. Fiction? Hardly. The first is already a reality, the second is in testing. **The world is about to embark on a fourth industrial revolution.**

The foundations of this new wave of industrialisation are already here, rapidly building upon and transforming 21st century technologies. Taken together they will disrupt industrial development, production and entire business value chains. The catalysts for this revolution are the emergence of the "Internet of things" and inter-connected machines - people and devices all communicating together in unprecedented ways. The requisite, however, is information and vast amounts of it to make, move, mobilise and manage the entire means, materials and methods of production and distribution to the end customer. Various names have been given to this phenomenon, such as "Industry 4.0", "the Smart Factory" and the "Industrial Internet of Things".

Industry 4.0

The term originates from a project in the high-tech strategy of the German government. This project involves the investment of 40bn Euros in the digital transformation of the industrial sector, every year until 2020. The sheer number of terms used to describe Industry 4.0 indicates this development is still in flux and will continue to evolve rapidly.

For clarity, this paper will adopt the term "the Smart Factory" to describe these innovative technologies, those that are converging to propel a fourth industrial revolution.

Innovative Technologies

These include the digital automation of manufacturing, and "disruptive technologies" that span the fields of automation, autonomous mobility, artificial intelligence, augmented reality, robotics, new materials, energy use, "Big Data", life cycle management, and, importantly, communication.

"It is highly likely that the world of production will become more and more networked until everything is interlinked with everything else." according to Siegfried Dais, former Deputy Chairman of the Board of Management of Robert Bosch GmbH.

This new mode of production is characterised by the merger of the material and virtual worlds in "cyber-physical production systems". In other words, these innovations add up to a fourth industrial revolution. This is reminiscent of the way that the mechanisation of the textile industry in Britain, the automobile assembly line process pioneered by Henry Ford that enabled mass production, and the use of computers in the latter half of the 20th century, all ushered in earlier waves of industrial innovation.

1.2 Revolutionary developments

The real world will be turned into a huge information system bringing about a new paradigm in industrial business models affecting supply chains, transportation systems, and labour skills.

With the concept still in its infancy, it is difficult to envisage exactly the scale and speed of its impact on the global economy. But it is likely that, while some areas will see fast and disruptive changes, others will change at a more evolutionary pace. In either case, there will be no going back.

1.3 Risk Management Implications

The complexity and interdependence of processes embedded in the Smart Factory concept will present significant challenges from a risk management perspective. Key issues identified include difficulties in determining liability for losses, the use and securing of data flows, increased vulnerability to cyber-attack, increased risk of business interruption and supply chain problems and changing labour requirements.

1.4 Role of the insurance sector and interest in the Smart Factory

The complex and information intensive nature of the Smart Factory is likely to drive changes in customers' insurance needs affecting both the type and amount of insurance coverages. Despite the hope that manufacturing processes will become more robust and safe, the increased vulnerability to infrastructure breakdowns and cyber-attacks in a highly inter-connected world means that the insurance industry will be faced with changed loss patterns, towards low frequency, high severity losses. Risk assessments will have to evaluate the potential for non-linear loss events implying a high degree of uncertainty. This leaves the insurance industry with a demand to build tailored solutions for the residual risks.

1.5 Purpose of this paper

This paper addresses all these issues; it looks at the drivers shaping the rise of the Smart Factory, some of the risk management implications this poses for our customers, and, considers in broad terms the ways in which the insurance sector can assist with appropriate risk mitigations, while recognising that not all risks will be insurable.

2 WHAT IS THE SMART FACTORY?

2.1 Features

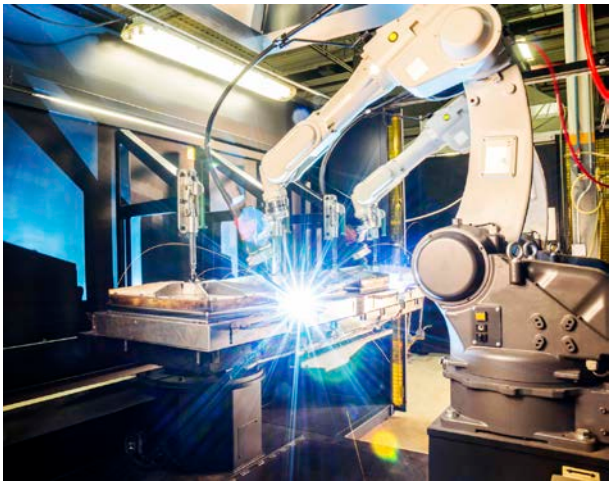
The convergence of the virtual and physical worlds has given rise to the Smart Factory. This integrates artificial intelligence, machine learning, automation of knowledge work and machine-to-machine communication with the manufacturing process.

The Smart Factory will fundamentally change how products are invented, manufactured and shipped. At the same time it will improve worker safety and protect the environment by enabling low-emissions and low-incident manufacturing.

These advances in the way machines and other objects communicate and the resulting way in which decision-making moves from humans to technical systems means that manufacturing becomes "smarter".

Underpinning these developments are several key technologies:

- Automation, robotics, and autonomous mobility;
- Machine-to-machine communications enabled by the "industrial" internet of things;
- "Big Data"- which in this context, refers to the analytical possibilities offered by the volume and variety of data that is generated by a networked economy;



- Optimized industrial processes; implying less maintenance downtime, fewer outages and much reduced energy consumption;
- Augmented reality; which offers the potential for improved maintenance and fault diagnosis as well as training through the use of virtual reality headsets to explore the inner workings of equipment; and
- Additive manufacturing; otherwise known as 3D printing, providing customised production to customer specifications.

2.2 Automation, robotics and autonomous mobility

A large number of processes are already fully or partially automated or are in the process of becoming automated. From early beginnings in 1954 when robots were used to automate the production of cathode ray tubes for televisions, robots have become steadily more sophisticated. The current wave of robotics, however, will see robots becoming ever more adaptive and responsive to their environment. Sensing devices, currently in development, will be able to communicate the need for new materials or for logistics involvement to deliver a necessary part or material for production without human intervention. Similarly, the next decade will see the deployment of autonomous vehicles equipped with reliable sensing devices that will know when to collect and deliver production output.

According to PwC , 59% of manufacturers in the United Stated (US) are currently using some sort of robotics technology, mainly in the automotive industry, for assembly and machining applications - tasks that require high levels of dexterity and precision - and to a limited extent, for warehousing and highly dangerous tasks. Enhanced in mobility, and enabled to learn, interactive robot tasks in the smart factory may not just be limited to serial assembly, but may be extended to more complex duties in logistics, such as quality and process optimization.

2.3 Machine-to-Machine communication

A **Machine-to-Machine (M2M) communication system** is a system of information and communication technologies. It comprises a device (such as a sensor) to capture an event, status or fact (e.g. changes in inventory levels) which is relayed through a network to a software program that translates the captured event into meaningful information (in this case, that the items need to be restocked).

M2M communication systems are currently developing into systems of networks that transmit data to appliances. The concept of M2M communication in a manufacturing context is also known as the "industrial" internet of things.

Two important enabling technologies for M2M communications are radio-frequency identification ("RFID") and Near Field Technology ("NFC"). The implementation of these technologies allows M2M communication in wireless mode, thus opening a confined manufacturing space where the machines that are supposed to interact with each other do so flexibly and without unwanted interception.

The Industrial Internet of Things will be shaped by the appearance of three features:

1. *The enhancement of basic mechanical devices through sensors and other data producing devices ("smartness");*
2. *The possibilities of ever faster and more flexible data allocation, transfer and processing (computing capacities); and*
3. *The ever increasing digital interconnectivity between the engaged devices and computational capacities (digital integration).*

M2M systems are not yet a reality. There is still development work to do in order to connect devices, tools and objects in interactive networks. Quite apart from making the business case for the capital investment and business process changes, there is the issue of as yet undefined industry standards for interoperability. Until this is resolved, the potential from shared data will be trapped in existing silos. Plans are being formulated, with different initiatives being undertaken by, for example, AT&T, Cisco, General Electric, IBM and Intel, as part of strategic alliances to develop M2M systems and standards.[1]

2.4 Big Data

The volume, variety and velocity of data produced through a myriad of connected devices in the Smart Factory will be of a magnitude greater than anything seen before. The challenge for companies will be to extract value from this explosion of data. Gaining real-time actionable intelligence has the potential to increase productivity, undertake pre-emptive maintenance and generate cost savings.

Within industry, Big Data is already being used to optimise production schedules. For example, to acquire production plant floor data and to manage production optimally, the Industrial Internet of Things is able to integrate real time data from distributed control systems, manufacturing execution systems (MES), and asset management systems (AMS), all with the aim of improving plant operating efficiency.

[1] The New York Times, *Consortium Wants Standards for 'Internet of Things'*, retrieved from http://bits.blogs.nytimes.com/2014/03/27/consortium-wants-standards-for-internet-of-things/?_r=0

In the next phase of data use, production information will be connected through to the supply chain from customer specification to raw material availability and through to ultimate order fulfilment. All of this will enable enterprise-wide operating flexibility and manufacturing optimisation.

Rolls-Royce has developed a predictive maintenance capability based on big data: it can now identify correlations between different part failures and different operational environments. This is allowing the company to predict engine failures several days before they occur, with high accuracy and low false alarms.

2.5 Optimising industrial processes

Through the use of M2M communication and operating data, machines will become self-tuning and calibrating and able to undertake self-diagnostics of performance and faults. The emerging technologies that play a role in optimising industrial processes can be divided into enabling predictive maintenance techniques and energy optimising technologies.

Predictive maintenance

Predictive maintenance techniques are designed to help determine the condition of in-service equipment in order to predict when maintenance should be performed. Those techniques are based upon real-time monitoring of the equipment in use. The risks of machinery breakdown are mitigated through systematic maintenance. Under traditional preventive maintenance protocols, scheduled maintenance is performed based upon specifications provided by the Original Equipment Manufacturer. Because many machines have components with different lifetimes and different maintenance intervals, the industry has pushed for predictive maintenance techniques to prolong maintenance intervals. As maintenance downtime implies a reduction or suspension of production, predictive maintenance can help to cut costs.

To enable predictive maintenance, the industry is using a variety of measurements, such as vibrations and ultrasound and acoustic measurements, permitting the early detection of slowly developing malfunctions.

"The big money (of Industry 4.0) is on two things; zero unscheduled downtime and resource efficiency," concludes Bill Ruh, GE's vice president of GE Software.

Energy optimizing technologies:

The integration of Big Data and the Industrial Internet of Things will allow for the timely powering down of development robotics and production systems.[2] Currently, all or part of a production line typically continues to run, and thus consume energy during breaks in production.

It is estimated that 90% of power consumption during breaks in production is accounted for by machinery such as robots, extractors and laser sources and their cooling systems.

2.6 Augmented reality

Augmented reality is a digital overlay of the view of the real world. The current use of augmented reality in manufacturing is still limited, but many augmented reality systems are developing. Limited prototype use has been implemented in, for example;

- instructing skilled manual operators whose work cannot be automated;
- training on how to manufacture new items including visualising the outcomes;
- improving quality control;
- finding ways to improve workflow; and,
- providing guidance for complex maintenance and repair tasks, such as, the repair of a printer through interaction with a remote expert.

[2] German Industry 4.0 Working Group, *Securing the future of German manufacturing industry: Recommendations for implementing the strategic initiative INDUSTRIE 4.0,* Retrieved from: http://www.acatech.de/fileadmin/user_upload/Baumstruktur_nach_Website/Acatech/root/de/Material_fuer_Sonderseiten/Industrie_4.0/Final_report__Industrie_4.0_accessible.pdf

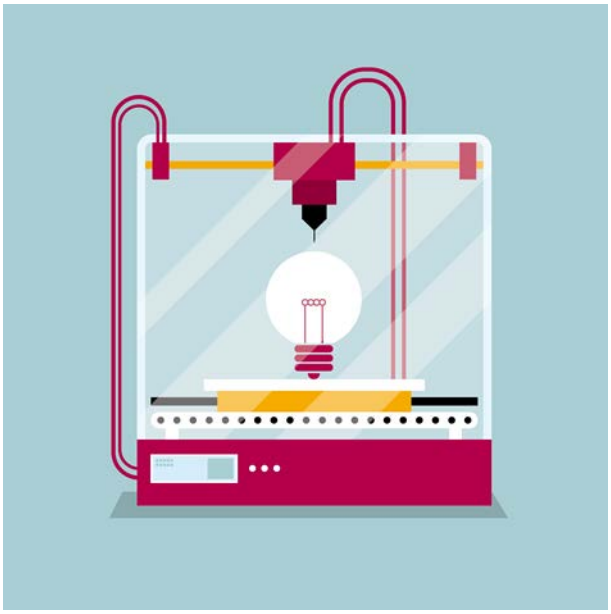
The Bosch Xperience Oculus Rift tour in 2014 trained 8,000 to 10,000 service technicians on direct-injection and braking technology using the Oculus Rift headset. Technicians took three-dimensional tours of the inner workings of a car engine to enhance understanding. The mobile tour consisted of a classroom experience, which was supplemented by wearing the Oculus Rift DK1 to watch automotive parts in action.

2.7 Additive manufacturing and supply chain changes

Additive manufacturing, or 3D printing, is the process of starting production with loose material, either liquid or powder, and then building it into a three dimensional shape using a digital template (as opposed to subtractive manufacturing, e.g. carving wood). 3D printing is an enabler of distributed manufacturing, under which the supply of raw materials and methods of fabrication are decentralised and the final product is manufactured in close proximity to the final user/customer. 3D printing also enables on-demand production; if a product or a part is in demand, it may be printed on the spot, rather than needing to be brought in from storage or suppliers.

"additive manufacturing is potentially highly disruptive to conventional processes and supply chains. But it remains a nascent technology today, with applications mainly in the automotive, aerospace and medical sectors. Rapid growth is expected over the next decade as more opportunities emerge and innovation in this technology brings it closer to the mass market." The World Economic Forum,[3]

3D printing is already used to make some niche items, such as medical implants, and to produce plastic prototypes for engineers and designers. General Electric has launched a project to mass-produce a critical metal-alloy part to be used in thousands of jet engines. Airbus also announced on 6 May 2015 that it had more than 1000 airplane elements printed in 3D.[4]

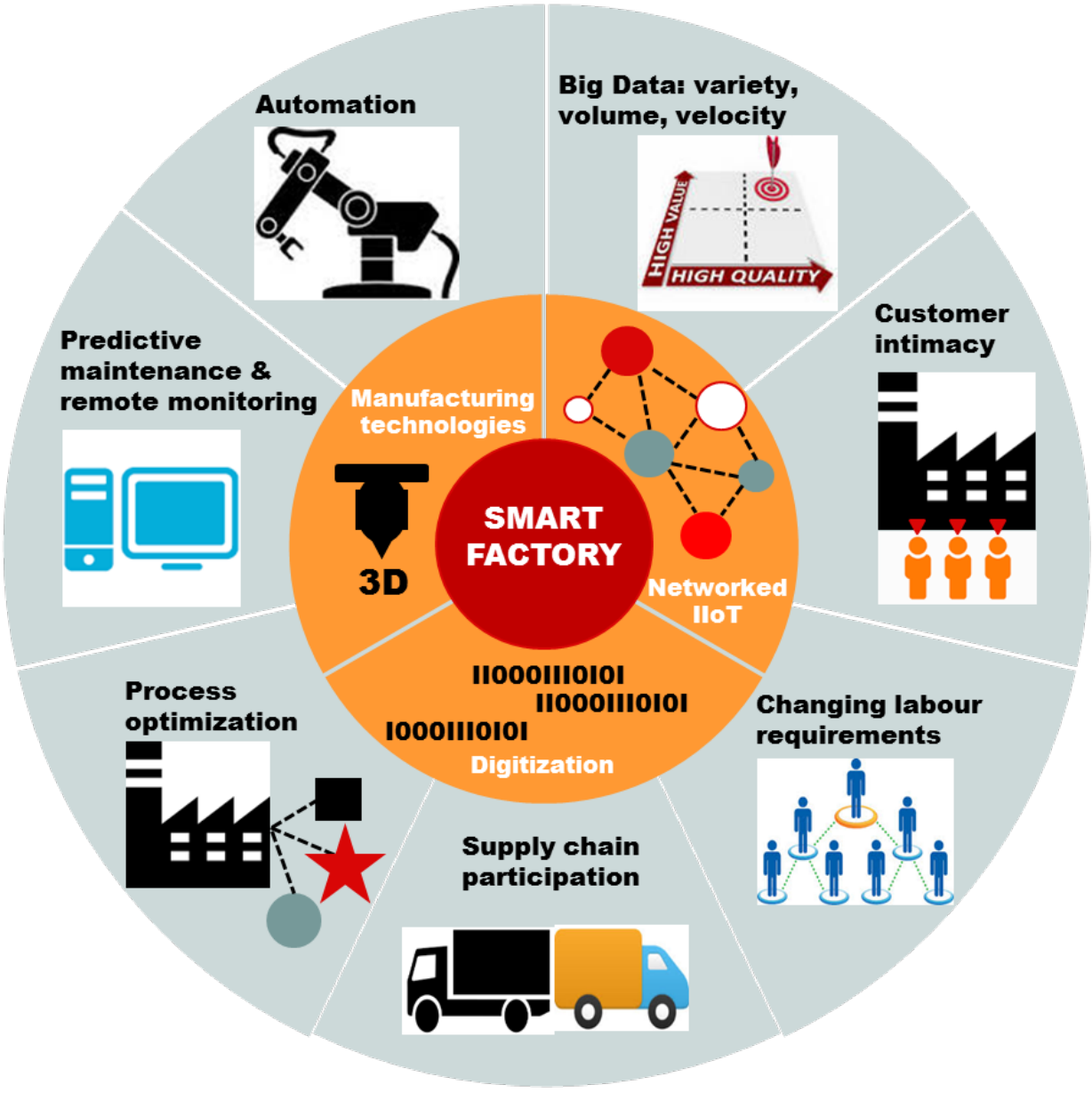


[3] World Economic Forum, *Top 10 Emerging Technologies of 2015*, Retrieved from http://www3.weforum.org/docs/WEF_Top10_Emerging_Technologies_2015.pdf

[4] BBC News, *Airbus had 1,000 parts 3D printed to meet deadline*, retrieved from: http://www.bbc.com/news/technology-32597809

2.8 Bringing It All Together

The Smart Factory concept integrates all these technologies to produce a new business model for industry. Amongst other things, it will enable highly customised and bespoke products to be produced at acceptable unit costs, using autonomous self-optimising manufacturing processes and with much lower levels of emissions and environmental impact. The landscape of the Smart Factory will feature complex and extensive networks linking suppliers, manufacturers and customers, as graphically illustrated in the figure below.[5]



[5] Adapted from: Vizexplorer, *6 Critical Ideas Behind the Smart Factory and the Internet of Things (IOT)*, retrieved from http://www.vizexplorer.com/6-critical-ideas-behind-the-smart-factory-and-internet-of-things-iot/

3 Risk Management Implications

A 2014 PwC survey of 235 German industrial companies in the manufacturing, electronics and information and communications industries, outlined a few of the challenges in moving to this new world.[6] These include the fact that: 1) there is a lack of clarity about the economic benefits, 2) there is an insufficient pool of qualified employees to manage the transition and operations, and 3) there is a general lack of standards, regulations, and legal clarity on the use of external data.

Although it is not yet possible to determine the full extent and nature of the risks that the Smart Factory will give rise to, it is clear that the complexity and interdependence of processes embedded within the concept will present significant risk management challenges for companies. Several key issues can be identified:

- Difficulties in determining liability for losses;
- Using and securing data flows;
- Increased vulnerability to cyber-attack;
- The potential for much greater disruption from business interruption; and,
- Changing labour requirements.

3.1 Difficulties in determining liability for losses

The Smart Factory and its associated technologies (especially the increased emphasis on machine autonomy) will bring with it questions of liability in the event of errors or accidents. If machines are responsible for monitoring and executing all steps of the manufacturing process, who will be held liable if the process or product causes damage or injury? Will it be the original designers of the specifications fed into the manufacturing machines, the operating software governing the factory systems, the machine itself or the operator of the machine? Furthermore, this chain of liability will continue to lengthen as products become increasingly customisable by the end-user.

The riskiest stage of adoption of this technology will not be when fully-autonomous production is ubiquitous, but in the interim, when machines are given increasing autonomy while human operators are still involved. This leaves open the possibility of human error.

For insurers, the question of assessing claims arising under liability policies will become more complex as the determination of responsibility becomes more elaborate. For instance, if significant decisions are made on the back of automated knowledge work and Big Data analysis, the software designer or owner of the IT programme responsible may be vulnerable to claims for lost profits, or similar negative financial consequences. In the case of autonomous vehicles, the liability may sit with the writer of the vehicle software, the vehicle manufacturer, or the driver. Considering the strict liability in place, it might be sufficient to allow redress from the driver's liability insurer back to the general liability/product liability provider.

3.2 Using and securing data flows

The volume of data generated and processed across the Smart Factory environment will vastly increase as technology develops and more and more devices are connected to the networks. Existing IT infrastructure and personnel may be strained to accurately process and analyse this information in real time. Current processes will have to be upgraded to handle faster data-transmission, which will require labour with advanced skill sets. This may mean manufacturers will need to outsource some of their data analytics to external service providers with specialist know-how.

As data sharing will also grow in importance, data theft will become an ever increasing risk for companies. Customer information, intellectual property including design blueprints used in Smart Factories and performance data (such as on the efficiency and profitability of different stages in the value chain – which would have economic and strategic implications for the business itself), will all need to be effectively protected in a way that still leaves the data available for sharing internally within a business.

Companies will have to navigate an evolving and uncertain regulatory environment with respect to issues such as, data protection, privacy, and

[6] PwC, I*ndustry 4.0: Opportunities and challenges of the industrial internet*, Retrieved from http://www.strategyand.pwc.com/media/file/Industry-4-0.pdf

information security. Developments across multiple jurisdictions could constrain their ability to extract valuable information from networked data sources.

Finally, securing data is an expensive undertaking that will require companies to engage in early investment planning.

3.3 An increased vulnerability to cyber risk

Given the centrality of information networks to the Smart Factory concept, as well as the reliance on connected devices (via the Industrial Internet of Things), companies will be increasingly vulnerable to cyber-attacks. These could halt production, or result in faulty products. Automated vehicles and automated manufacturing robots could be vulnerable to attack by hackers wishing to disrupt transportation and manufacturing or cause damage and harm. This is a risk to which current transportation and manufacturing technology (that predominantly exists offline) is not remotely exposed.

As noted, given the extensive linkages between devices and processes in the Smart Factory model (both within the factory and the wider economy), a system failure (including from a cyber-attack) may lead to larger losses from the ripple effect. Losses could mount not only from the system under attack but also the other dependent businesses in the supply and distribution chains. Moreover, this vulnerability is likely to increase as more and more firms rely on cloud solutions. Thus the aggregate cost of contingent business interruption (CBI) due to a cyber-attack on such systems could rise dramatically in the future as described below.

3.4 Potential for greater disruption from business interruption

The hypothesis behind the Smart Factory operating model is that through the constant performance monitoring enabled by the technologies underpinning operations, including ongoing data feedback, greater supply chain resilience should be evidenced along with increased flexibility to adjust to changes outside the factory's control. As a result, the incidence of supply chain and business interruptions should fall.

However, the deeply integrated nature of production means that where problems do occur the impact may be more severe and more widely felt than within the "old-economy", non-networked manufacturing sector. Cyber-attacks, software malfunction, internal sabotage or accidental data corruption and deletion can result in severe and long-lasting business interruptions with high-financial impacts for industry and society.

3.5 Changing labour requirements

The advent of the Smart Factory is also likely to lead to shifts in the size and skills of the workforce needed to support this new model of manufacturing. The skills and knowledge that are likely to be increasingly in demand include data modelling and analytics, and cyber security and data privacy. Big data analysis in the context of behavioural economics will require economists and psychologists with computational skills to interpret outputs. In addition, engineering and scientific talent will be required to help insurers understand the increasingly complex and interconnected nature of industrial processes.

However, manufacturers will need to compete with other industries such as the 'Tech' sector for these scarce skills, and it is by no means certain that companies will be able to source all the talent that they need. There is a risk that insufficient availability of skills and expertise within the labour force could hinder the transition to this new economy.

The changing pattern of labour demand may also have important societal implications. This view is based on the experience of past phases of industrial innovation, which profoundly affected employment - many jobs were eliminated as they were automated – both skilled and non-skilled. Increased income inequality and rising social tensions are possible if the labour displaced by automation cannot be reabsorbed (e.g. through worker retraining).

4 The Role of Insurance in Smart Manufacturing

Past waves of industrial innovation have led to the emergence of new risks and insurance has historically adapted to support the changing needs of its customers. The Smart Factory concept will be no different. However, given the complexity of the business model, its interdependencies on all parts working as they should, there are new approaches and considerations to risk management and traditional coverages to consider.

Insurers will be assessing how they can support their customers' transition to this new economy. In the process they will need to determine which categories of risks they are willing to take and which risks will need to be altered. Some risks may be, or become, uninsurable, some coverages of risks may be capped or, subject to being highly structured between insurer and insured – all of this will evolve.

For customers, their insurance needs will be driven by the risks that arise out of the complex, interdependent, networked and information-intensive nature of the Smart Factory. This will likely affect the type and amount of insurance required by customers. To give an indication:

- ***Product liability and recall:*** With the elimination or diminution of human involvement there could be lower product liability exposure and, therefore, fewer recalls resulting in lower loss ratios.
- ***Workers Compensation*** may somehow be unaffected, because a reduced number of workers might imply a reduced number of workers compensation covers. However, new occupational diseases could appear and should be monitored in the future.
- ***General liability***: Minor bodily injuries and minor property damage is to be expected due to automation and the general nature of a Smart Factory.
- ***Professional liability***: Errors and omission can lead to severe accidents or business interruption losses. During the construction of a Smart Factory a lot of planning is needed and it could be the case that due to flawed planning higher loss ratios will occur.
- ***Contingent Business Interruption and standard Business Interruption.*** Due to the business model of the Smart Factory insurance coverages will need to be reconsidered in the context of all business interruption coverages.
- ***Sudden and accidental losses*** in smart factories are possible due to the complexity of the business model - the drivers and severity as yet unknown.
- ***High value concentration losses*** as a result of the extensive investment in complex and bespoke technologies found within Smart Factory sites. This creates a vulnerability to damage or destruction from natural catastrophes or other disasters.
- ***Cyber coverage:*** Cyber related losses may increase following the increasing trend of automation within Smart Factories.

4.1 Challenges to insurance providers

Companies are vulnerable to disruption anywhere along the value chain, from the product manufacturer, to the customers, from subcontractors, to the cloud and outsourced services. This results in significant dependencies between all parties that are involved in the production and life cycle of a product, regardless of role and the size of participant. For example, a small contributing software company can at the same time become a critical risk factor for all connected companies, e.g. when being used as a doorway for criminal attacks that spread elsewhere in the value chain.

This interdependence feature is an important concern. Normally risks would be independent or unrelated and insurance companies would benefit from the diversification of risks in their portfolio. With the rise of the Smart Factory, there is the risk that accumulations of risks could develop which will require insurers to place greater focus on the aggregate portfolio view. This is likely to make effective portfolio diversification a more onerous task.

Several challenges can be envisaged of quantitative and qualitative natures. First, past loss experience may become less representative of future loss potential. To explain this further, unlike in the old economy, where future losses could be predicted and modelled using past loss experience, the more

complex and interdependent nature of the Smart Factory economy implies a discontinuity that should make past experience less meaningful as an indicator of future losses.

Second, the pattern of losses will be different from the past. There are different views on what will happen (a testament to the evolving state of the Smart Factory). The reduced incidence of business interruption from maintenance downtime and supply chain problems, as well as reduced injury claims from lower levels of manning (in factories) and greater levels of plant operating safety could reduce the frequency of claims. On the other hand, the cumulative effect of things going wrong (as a result of the higher levels of interdependence) may result in potentially larger losses.

This means then, that the pattern of losses will change from high frequency relatively low individual loss patterns to a lower frequency but relatively higher individual loss patterns.

Third, on a related point, it's likely that some of these new risks will not fall under the "traditional risks" with which insurers are familiar.

Last, the industry may need to re-visit their approaches to underwriting, pricing, as well as ensuring compliance with evolving legal and regulatory requirements.

These challenges will test the sector's ability to design products that effectively meet customers' requirements while not exposing providers to excessive and unwanted risks.

4.2 The Insurance industry as enabler of the Smart Factory

Despite the difficulties in designing and pricing solutions for the Smart Factory model, there are opportunities for the insurance sector to support its customers. A few suggestions that insurers could consider are in the following areas:

- Utilise the possibilities that Big Data and digital channels may offer to make better informed pricing decisions.
- Forge strategic partnerships with Big Data analytics firms to leverage the increased variety of data to develop new services.
- Analyse customer specific risk exposures to develop bespoke solutions.
- Increase emphasis on partnership with customers, for example, to act as a conduit for best practice in areas such as predictive maintenance. Alternatively, via data aggregation, insurers can provide and manage early alert systems which automatically trigger loss prevention actions at customers' locations and prevent losses (e.g. flood protection measures prior to a flood event).
- Change the pattern of customer relationship management by interacting more intensively. Insurers that move from periodic, scheduled engagement to continuous engagement can develop high added value services as described above.
- Improve the efficiency and speed of claims handling enabled via automated claims notification, assessment and payments.

5 Conclusion

Smart Manufacturing or Industry 4.0 describes the convergence of innovative technologies, methods, materials and products that will transform business and the global economy.

Of course, these benefits will not come without costs including vulnerability to cyber-attack, data and intellectual property protection and supply chain and business interruption incidences, amongst others.

Insurers will need to rethink the infrastructure of their organisation and internal processes to cope with increased real-time and digital risk information such as - vessel/vehicle positions, location of goods in transport, maintenance data streams and much more.

The high interconnectivity of the Smart Factory model also increases the potential for risk accumulation. The impacts of critical infrastructure breakdowns will be more substantial than in the "old economy". Insurers can help businesses to manage and mitigate these risks, even with the challenge that there is no significant loss history available for accumulation risks posed by the rise of the Smart Factory. That said, not all risks will be insurable – a cautionary note to Smart Manufacturers.

Insurance has historically played a part in assisting industrial customers through evolutionary and revolutionary changes, and will continue to do so in this fourth industrial revolution. In the world of Smart Manufacturing insurers can partner with customers to help them identify, manage and mitigate risks arising from a pervasively interconnected economy and society and develop innovative products and services aligned with the demands of the new industrial risk landscape.

To benefit jointly with customers, insurers face the challenge of expanding services and transforming to risk advisory engagements while providing coverages for risks deemed insurable.

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