

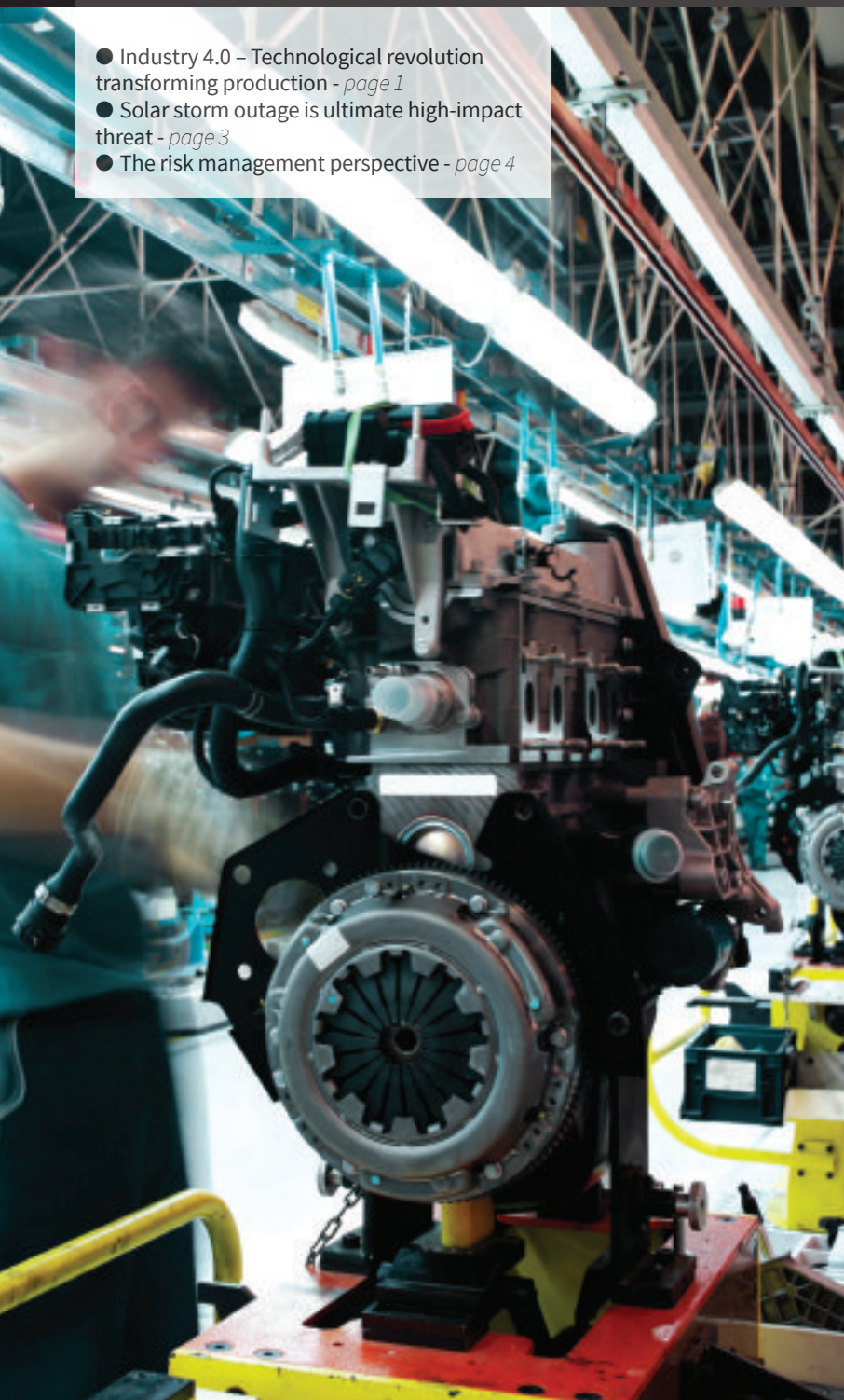
# SPECIAL REPORT

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## MANUFACTURING

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## Industry 4.0 – Technological revolution transforming production

**The biggest change to production processes in almost two centuries offers unprecedented opportunities but companies must balance these against a complex downside**

The most significant and fundamental advance in manufacturing since the original Industrial Revolution more than 200 years ago is radically transforming the sector in a way that was unthinkable even a decade ago.

Industry 4.0, also known as Manufacturing 4.0, is the fourth major change in mechanised production since steam power and offers businesses extraordinary flexibility and efficiencies through smart working practices.

Defining the concept in precise terms is difficult. There are several perspectives on what exactly 4.0 is and what it means. In essence this is a marriage of cyber physical systems [engineered mechanisms monitored or controlled by computational algorithm] working and communicating between themselves and human operators with everything and everyone connected via the Internet of Things and/or the Cloud.

Perhaps the most significant aspect of the 4.0 interface dynamic between people and intelligent machines is the decentralised decision-making process which is undertaken by the cyber physical systems themselves so they can be fully autonomous, unless in exceptional circumstances.

Whereas earlier industrial revolutions affected physical processes, people were still the decision makers. With 4.0 people ultimately remain in overall control but localised decisions are made by machines which learn and adapt. Just as the mechanisation of physical processes means fewer people working on a factory floor, 4.0 removes another layer of human involvement.

The motor industry, which led the way with first-generation mechanised robotic production back in the late 1970s and 1980s, is already embracing 4.0, albeit in a piecemeal and iterative way. Audi's tool-making division has reportedly developed self-learning technology for certain production operations. It is also using so-called

helper robots for car assembly – a process being introduced by other major auto manufacturers.

Wholesale change through purpose-built production facilities is happening but most developments are being introduced gradually across this and other manufacturing areas.

Steel maker ArcelorMittal is one such business where 4.0 is starting to get traction, according to its corporate operational risk manager Adrian Clements. However, the fundamental issues of how, where and when are dependent on the maturity of individual production sites.

“We have plants in Kazakhstan which are very robust but are also very manual,” he says. “You need thousands of workers, there is very little automation and these are basic in the way they operate, so you can forget 4.0 for them.

“Then you have other plants such as the one we have in Ghent, Belgium, which are much more sophisticated.” This, he says, makes 4.0 easier to implement.

### Smart factory

Fredrik Motzfeldt, GB industry leader, technology, media & telecommunications at Willis Towers Watson, and a specialist in 4.0 risk, highlights a further problem.

“Some of the newer stuff that is being built is being designed as a smart factory from the beginning,” he says. “You look at traditional industries such as the power industry however and they have created vulnerabilities by building smart infrastructure on top of what is traditional infrastructure. Some of the industrial control systems were never meant to be connected to the internet.”

Such exposure increases the risk of cyber-related threats which could seriously damage production.

Nonetheless, the range of possibilities promised by 4.0 means companies are examining its deployment carefully. “We are already testing something in this direction,” says Clements. “Our maintenance people wear helmets and we are testing a version with a headup display so that when they look at a pump

or transformer it automatically searches through the database, finds the drawings, finds the instructions for how to take it apart, so that the maintenance people are able to work on the equipment properly. The aim is to reduce errors by people not knowing what to do.”

However, there are also issues. Total uninterrupted connectivity is required which is not always straightforward in a large volume steel plant “producing lots of electro-magnetic emissions”.

Further, Clements says, the technology is only as useful as the data it is given. “In the worst case, relying on [out of date] data could mean doing something wrong.”

Hans Læssøe, senior director, strategic risk management at toy manufacturer LEGO Group, has seen plenty of changes to the production process in his 35 years with the business.

For a company which produces 2300 bricks per second, any break in schedule no matter how short, is significant and this is where 4.0 advances can be especially effective. New automated technology means producers such as LEGO can ensure efficiency optimisation with less time lost to quality issues or slowdowns.

Læssøe says 4.0 was being undertaken on an “ongoing basis”. “We are upgrading our moulding machines, we are enhancing our technology and improving our equipment for packing lines. We are undertaking a project which

is examining analytics to predict when our moulding machines might stop so that they don’t stop at all.”

In addition to minimising downtime, 4.0 also offers LEGO the opportunity to minimise other potential production issues caused by the supply chain.

“In terms of the material we use [for moulding bricks] there could be differences in the granularity, the structure, humidity and so on. There can be temperature and air pressure changes – a tonne of differences that can have an impact on the final element. We are using technology to create a process which takes as much variety as there can be from all these factors that we cannot change and still come up with a brick that lives up to our specifications. If you can do that then you will have a much bigger success rate.”

Monitoring the entire production process should also be much easier and can be done remotely, according to Motzfeldt.

“The whole idea of 4.0 is that you can run a factory from somebody’s iPad,” he says. “Move forward 10 years from now and we will see complete automation of some industries... these will be run by a very small crew, almost like a nuclear power plant.”

Motzfeldt warns that while 4.0 is developing very quickly it is easy to miss the broader implications and risks in the race to maximise the advantages it offers.

“A manufacturer may well think that 4.0 is a great idea... but they haven’t really thought about what the vulnerabilities are by connecting all of these systems.”

Aside from concerns around technology exposure, the social and societal impact of 4.0 could be the biggest single risk.

“I don’t think there is any doubt that robotics and automation is going to come in very heavily and we may not end up working much at all,” Motzfeldt says.

### Efficiency optimisation

While traditional roles might disappear, Motzfeldt says 4.0 will also create new jobs but the process needs to be managed carefully: “You need a strategy that goes from kindergarten to primary, to high school and up into the workforce – so you can get the right engineers, the right type of people. This will create a whole economy around cyber-physical expertise.”

In the meantime, there is plenty of work to be done managing the risks of 4.0 so that the opportunities outweigh the threats and benefits are maximised in a realistic way.

“I don’t think some companies have a good enough idea of what they are getting themselves into,” says Motzfeldt. “They feel the benefit – the efficiencies of the process, the fact it will be easy to run things at lower cost, but they don’t look at exactly what they are doing.” **SR**

## INDUSTRY 4.0: ‘INSURERS HAVE CRUCIAL ROLE TO PLAY’

Insurance is critical in giving confidence to manufacturers to embrace the technological changes and make important leaps of faith to transform their business models, according to Simon Gallimore, manufacturing industry lead UK at AIG.

“Insurers will need to adapt, listen to manufacturers and develop solutions and products with them,” he says. “Co-creation has to be a key part of that evolution.”

With change happening at an increased rate, it is important that insurers also evolve at that pace and adapt their current business models to reflect the changing world around them to remain relevant, Gallimore says.

“Helping clients understand the emerging risks, especially around cyber, is a key role of the insurance market,” he says.

The importance of data is fundamental in achieving this.

Gallimore says: “Data insights at the heart of risk mitigation is a key focus for the manufacturing industry and insurers who are also evolving their own business models to reflect the transformation of the manufacturing market.”

# Solar storm outage is ultimate high-impact threat

**Space weather concerns may not be top of the risk agenda for manufacturers but research from Cambridge University should be heeded by those most vulnerable**

Major manufacturing businesses need little reminder of the potential impact that natural catastrophes can have on production. The events of 2011 in Fukushima, Japan, and the flooding in Thailand the same year have almost become clichés in this regard but continue to serve as a stark demonstration of the damage that can be caused to global supply chains by a regional event.

Nonetheless, these impacts risk being dwarfed by the potential consequences of a rare weather phenomenon triggered beyond earth – a catastrophic solar storm.

Here, in what is known as a coronal mass ejection, the sun throws out a massive explosion of billions of tons of charged particles and magnetic fields that hit the earth with less than an hour's warning, destroying any electrical system in its direct path.

Researchers at Cambridge University's Centre for Risk Studies have been examining the possibility of such an event and calculating potential losses. Its Helios Solar Storm Scenario is a hypothetical example, based on historical and contemporary evidence, of such an extreme event.

According to the Cambridge study, a catastrophic solar storm that takes out US generating capacity could result in business interruption and supply chain losses in the US and around the world of more than US \$470 billion, on a conservative measurement.

Depending on precisely where it hits, the CME would cause immediate power blackouts initially affecting 90 million US citizens or 28% of the US population. The power outage would also affect interdependent infrastructure systems, disrupting transport, digital communications, water, health and financial services. Outages could last a few days or many months, depending on the severity and impact of the CME.

The manufacturing sector

would be hit hardest as Centre research associate Dr Edward Oughton explains: "Manufacturing is, at least in the scenario that we carried out, the most affected.

"Manufacturing here is more than just a single sector. It is a major portion of the economy that represents a lot of individual sectors. If you compared it to the size of services, which is obviously huge in the US economy, it would not be the largest sector affected but this is partly due to the accounting methodology used. I want to emphasise that manufacturing is a huge sector in the US economy and it is also huge in many European economies – and they are predominantly high value businesses as well. We need to recognise that fact."

## Large impact zone

Manufacturing is especially vulnerable because of the length and complexity of supply chains used by many companies in the sector.

"If you are building a car then the likelihood is that due to specialisation you will be getting components from all round the world," Dr Oughton says. "So-called 'just in time' production also means you are more at risk if you do have a supply chain failure because you don't have a big inventory that you are able to draw from.

"If you have an extreme space weather event and it knocks out your electricity system then there is a potentially large area with no electricity and therefore you get a very large impact zone. The direct effects are on all the companies that are immediately within the blackout zone but then ultimately you have firms outside of there that are either upstream or downstream in the production process. As a consequence, because of the very long supply chains in manufacturing you end up with a large amount of disruption

throughout the economic system."

Despite the potential impact, risk mitigation strategies are of limited effectiveness. With latitude 50 and 55 degrees geomagnetic the most vulnerable – an area known as the auroral electrojet region which includes cities such as London, New York, Paris and Chicago – manufacturers could transfer their production facilities elsewhere but this will do little to stop supply chain impact.

The cost of moving would also usually be prohibitive for most manufacturers given the potential event likelihood.

"The issue here is that it is a low probability, high severity event," Dr Oughton says.

"I have spoken with engineers about this and the costs of installing protectors for transformer assets and replacing them every ten years are astronomical, so this is not an option in terms of mitigation."

Developing an early warning system that would give governments and some businesses time to react and protect vital equipment appears the most cost effective way forward, he says.

Dr Oughton says the space weather community is "highly interested in our research" and wants to know if they should be investing in launching more satellites to identify space weather effects and give more warning.

"If you have more warning then you are able to do more things with the electrical grid – you can turn it off or change how you are working to make it more resilient," he says.

The earlier the warning, the more time there is to prepare.

"It can take between three and four days to implement all the mitigation plans," Dr Oughton says. "In the grand scheme of things the UK and the Nordic countries are relatively well prepared compared with other countries.

## EXTREME SPACE WEATHER EVENTS AFFECTING EARTH

**1859** – The Carrington Event, regarded as one of the largest ever solar storms, caused significant disruption to telegraph systems.

**1921** – Similar in size to the Carrington Event, a storm caused fires at several telegraph stations in Sweden.

**1958** – Transatlantic communications were disrupted between Newfoundland and Scotland. There was a blackout in the Toronto area.

**1989** – It took only 90 seconds for the entire Quebec power grid to collapse. The well-documented Quebec power outage lasted nine hours.

**2003** – The Halloween Storms led to a one-hour power outage in Sweden, a radio blackout of high frequency communications and disruption to GPS systems.

**2012** – Major solar eruptive event on Carrington scale went through Earth orbit. A week earlier and Earth would have been directly affected.

“Looking at some of our anecdotal evidence, the US is less prepared, partly because of the way its system is set up. We do not have any idea about how China might respond to something like this.”

Shutting down vital equipment cannot always be done quickly enough, however, according to Adrian Clements, corporate operational risk manager at steel producer ArcelorMittal.

“You need a certain period of time to empty out the liquid steel and this is something you don’t test because even though a blast furnace is massive it is also quite delicate.

“One of the problems we would have is coke because you can’t shut that system down. Anything producing coke or charcoal, whether it is steel or the cement industry, you cannot turn off because of thermal shock, otherwise it will break and you cannot rebuild the system. You could not shut these down in 18 hours, five days would be needed to cool them and there is nothing you can do about this.”

### Develop resilience

Developing an effective response to such events is problematic and this is one reason why AIG has been supporting the Cambridge University team around solar storm risk and other research.

Fabrice Brossart, chief risk officer for international operations at AIG, says reducing fear is the role of the insurer in terms of events with low or difficult to determine probability but a huge potential impact.

“One of the aims of AIG is to understand the potential impact to help develop resilience,” says Brossart. “We want to make sure we protect our insured companies so that they are not exposed to any extreme scenarios. We are very concerned about the supply chain situation, for example.

“When it comes to exposure that cross-cuts several industries, the impact on insurance is really on contingent business interruption. In terms of manufacturing, when transformers go offline they have to be repaired and a number of them will have to be replaced. There are not plenty of these in storage in reserve just waiting to go online.”

Transformers can cost US \$10-20million each and take up to three years to build.

Even if a manufacturer was willing to bear the cost there is little to be gained from keeping spares just in case “because they are likely to be fried as well”, says Clements unless they are kept in another region.

Brossart says that increasing numbers of AIG’s customers are turning to the insurer for help to develop scenarios and to plan for resilience on a range of large scale disaster scenarios.

“They want advice on contingency planning and risk management,” he says.

The consequences of a major solar storm could be one of the biggest business disruption events in history, not only for manufacturing but across all major sectors.

It could also trigger insurance payouts to dwarf almost anything seen before.

“This is not a peril that is mentioned specifically so the interpretation is that you are covered as per the terms of the policy – there is no exclusion of solar storms in general in our policies,” Brossart says.

Despite the likelihood of a catastrophic solar storm being a one in 150-200 year event, raising awareness of such a prospect is important in terms of assessing the preparedness of a business to deal with other risks, Brossart says.

“It helps insurers develop a better understanding of who is good at managing and who is less good at managing,” he says. **SR**

## The risk management perspective

**Hans Læssøe, senior director, strategic risk management at LEGO Group outlines his biggest risks**

**Demand volatility:** “Our end users are seven years old and they do not understand the concept of loyalty. They will only buy our products if they think they are hot so we have very big volatility. We are deploying a team to see if we can use big data to forecast demand better than we are doing currently. Right now [November 2016] we are deep into planning around 2017 – there will be new products in every line. Each of these novelties for the different lines is here as a launch project. We have about 25 of these a year. We know for a fact that a minimum of one, probably two, possibly three of these will fail and they will sell probably less than half of what we forecast. On the other hand one maybe two will be great successes and sell twice as much as what we expect. We just don’t know which ones are which.”

**Losing a factory:** “We have four factory sites so losing one of them would be fairly serious. It would be easier if we had 50 sites but that would impact on efficiencies.”

**Deficient quality:** “The risk is materialising because we are growing so fast. Suddenly we have 3000 people in a factory in a new territory [China] who did not play with Lego as a child and so all of this is new to them. If they don’t understand the quality issues we could have then we could lose quality. When we opened the factory in China we took operators from our factories in Hungary and Mexico and flew them to China to teach Chinese people how to work with the product.”

**Loss of vendors:** “Some vendors are more important than others but there are certain vendors that if they go bankrupt or have

some other form of disruption then we could be in trouble for a significant portion of our turnover.”

**Trade restrictions:** “The TTP has just been pretty much cancelled, the TTIP could also be in jeopardy – not just from the American side but also the European. You also have Brexit in the UK. The free flow of money is not likely to be as easy in five years as it is now. The issue with this is the difficulty getting our product from the factory to the destination markets. Also, given the fact that we have one supply chain that we collaborate with very closely, basically all factories buy and sell to each other and that flow could be hampered and that could pose more difficulties for us than the flow of finished goods with a duty tariff. Of course the tariff could be cumbersome enough and we are looking into the potential impact of this.”

**Economic crisis:** “An economic crash was the best thing that ever happened to us. When times are good people give children expensive presents such as personal electronics. In a financial crisis, spending goes down and suddenly toys become relevant again and in that range we are stronger, especially on the high price point. As the squeeze increases people want to make sure they don’t buy something that is broken by new year and forgotten soon after that. This is where the brand name comes in. So from a consumer perspective we were helped by the financial crisis. Our competitors lost a third of their market cap in a month because of the financial crisis. We did not lose anything. Which means we kept our manoeuvrability so when they had to cut back on market spend we increased ours. So we got help from our competitors because they got weaker.”