

# Spotlight on Smart Manufacturing

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# Introduction: Welcome to the fourth industrial revolution

**New concepts and buzzwords appear with stunning regularity and, usually, sink without a trace soon afterwards. But, Industry 4.0 seems to be sticking.**

Compared to most, it's not much of a buzzword. It's solid, simple, but also surprisingly enigmatic. What is it? It just might be the 'fourth industrial' revolution. Only history will judge if it is, but right now, as digital technologies rapidly change the way we live and work, it's wise to develop a deep understanding of what Industry 4.0 means to your business.

Manufacturers know that their world is changing. They understand that any definition of an industrial revolution is predicated on how goods are produced. Manufacturing drives change. It is at the vanguard to economic development.

New business models based on service and different means of ownership are fundamentally changing a manufacturer's position in the supply chain. Servitization (another buzzword that seems to be achieving longevity) is rapidly becoming established in a sector which used to be solely focused on mass production and basic support services.

Factories are becoming cool, clean places which are digitally connected to the entire ecosystem – from raw materials through to end-users. Big Data, AI, robotics, and IoT are transforming the way workers interact with the goods they produce and the

customers they serve. Suddenly, there are 'teams' of people and machines working together to see a product through to completion in its entirety. The smart factory is real, and its rise is inexorable. A new industrial revolution is underway; it's time for manufacturers to think about co-creating the digital factory with a strong and experienced partner.

Enjoy.

# Revolution meets evolution: How a step-by-step approach to Industry 4.0 will pay dividends now and in the future



'Revolution' is a dangerous word. It suggests sudden, violent change, and often gets used for trends that turn out to be anything but revolutionary. But, what's happening in the manufacturing sector is a revolution. The Fourth Industrial Revolution. It will transform all aspects of manufacturing and enable us to produce ever more sophisticated goods in smaller and smaller batches to match individual customers' needs, and at the cost that, until now, could only be achieved through mass production and standardization. And it will enable manufacturers to create entirely new business models focused on service rather than just producing goods.

But, the revolution will not happen overnight. In fact, it will take a decade at least to fulfil its entire potential. That's because industrial revolutions take time. The first took a century. The second took two generations. The third, perhaps a generation. And the fourth? Well, we can only guess.

The point is that it's happening and it's important to realize that you do need to act. Now. To do that you need a vision of what you want to achieve for your customers and your employees. You need a step-by-step plan and roadmap that will get you there. It's evolution rather than revolution.

## History illuminates the present

The past yields valuable lessons for the present. The first Industrial Revolution harnessed the power of steam and, for the first time, enabled immense amounts of energy to be focused through machinery to make goods at scale. Then, when electricity replaced steam and exponentially increased the amount of power available to manufacturers, new business models arose, and the era of mass production began. Next came electronics and computers. And now, the Internet of Things and huge volumes of data enabling AI and machine learning are the next set of transformative technologies.

In each revolution the technology transformed not just machines, but business models. Business could create demand, manage it, and get closer to what customers wanted. They could manipulate the world to suit their ends. But, many companies could not survive. That's because they didn't see what was coming over the horizon. Andrew McAfee and Erik Brynjolfsson, in their book, *Machine/ Platform/ Crowd* put it down to a surprising fact:

**"Research in many different fields' points to the same conclusions: it's exactly because incumbents are so proficient, knowledgeable, and caught up in the status quo that they are unable to see what's coming, and the unrealized potential and likely evolution of the new technology."**<sup>1</sup>

It's called 'The Curse of Knowledge', or the 'status quo bias'. Existing processes, customers and suppliers, pools of expertise, and more general mindsets blind organizations who seem to be doing well to what's happening around them.

McAfee and Brynjolfsson make an important point: "The coming of electrification [for example] did not just replace steam – it enabled the redesign of processes and products."<sup>2</sup> Simply, manufacturers could do more, better, for less. That's exactly what Industry 4.0 is enabling.



**Andreas Rohnfelder,**  
Head of Industry 4.0 Competence Center

<sup>1</sup> McAfee & Brynjolfsson: *Machine / Platform / Crowd* 2017 Norton

<sup>2</sup> Ibid



### More than a buzzword

The Germans aren't known for their buzzwords. They mostly arise from California. So, when Industry 4.0 was coined a couple of years ago in Hanover, the world knew that this was something serious. I define it this way: It builds on manufacturers pioneering work in the use of sensors and data-based monitoring to apply advanced networking, real-time controls and machine intelligence to take the sector to a new level of sophistication and productivity. It is, in effect, becoming a hyperconnected industry.

So, Industry 4.0 goes far beyond automation and is about to completely reinvent manufacturing. Hyperconnected technologies are enabling manufacturers to better understand their operations in real-time so they can optimize and transform the way they interact with suppliers, partners and customers.

As I said at the start, get it right, and the cost to produce a single item can be very close to what it would cost if mass produced. That's

a real game-changer. It allows you to offer new, smart services and shift to a much more service orientated business model.

### Kick start the evolution now

At Fujitsu, this is much more than theory. It's practice. We are a manufacturer. We make goods for customers, and we are evolving our smart manufacturing capabilities around the world. In Germany our factory at Augsburg is a revolutionary place in many ways, but it's also one in which the future of the sector is evolving at a steady pace.

And that's the pace that we believe is necessary if the full potential of the technology – which is still evolving in its own right – is to be implemented. We encourage manufacturers to come and see what we're doing, and our conversations reveal that, thankfully, most of them understand the need for digital transformation, but need to help to focus their plans on their specific business and create the right ecosystem to support their evolution.

I think that most manufacturers understand the need for change. Their vision isn't obscured by the 'status quo' bias. As a sector, we are determined to move forward through collaboration and co-creation. That's the key. Again, history teaches us that organizations which embrace partners with expertise in technology, and can work to apply those technologies to new business models based on changing customer needs, survive. Those that don't, go out of business. It really is that brutal. Over the next few years, there will be some high-profile casualties.

The point is to evolve now. A recent study we conducted with PAC, showed that 90% of German manufacturers say that digital transformation will have a high impact on their business model, but only a third have a detailed strategy and roadmap to make the most of the opportunity. So, the priority is to build them.

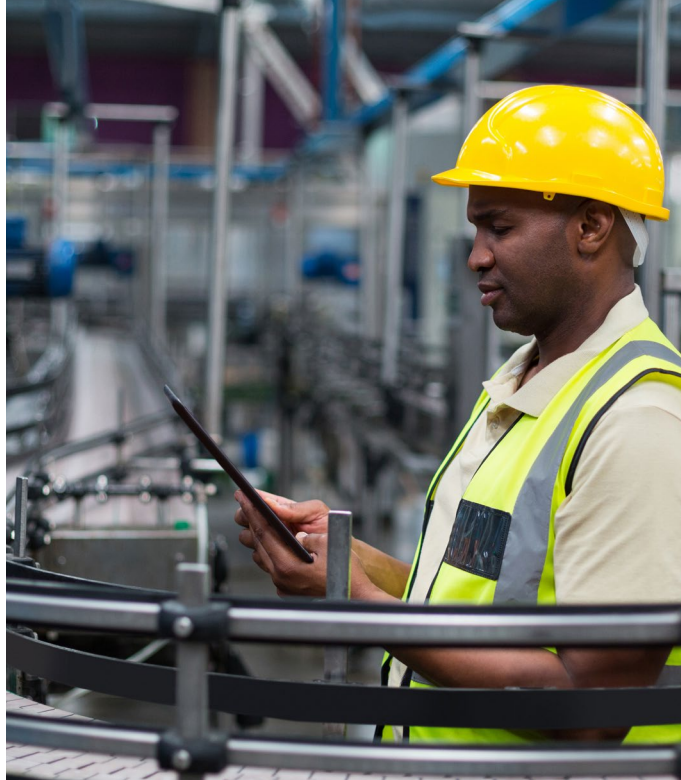
### The step-by-step approach to revolution

Another finding of our survey was that higher level executives are less likely to have a good understanding of Industry 4.0, which is one of the key reasons there's a lack of strategies or roadmaps. The first task is to get them engaged so they can see both the threats and opportunities. We always emphasize the opportunities.

Bringing IoT as Industry 4.0 enabling technology into your operations and products is the priority. You need the people who know how to do that, and how to manage the increased data flows that result. The data needs to be analyzed, and acted upon to help evolve your efficiency, productivity and creation of new business models.

Focus on IoT as a first step. One customer we worked with realized that they could start their journey by embedding sensors into their installed base so that it could relay usage information to enable predictive maintenance. That helped to cut down service visits to check the condition of the machine, and helped them pre-empt problems. Both outcomes delighted the customer, and saved the manufacturer time and money. It was one, simple step.

It doesn't sound revolutionary, but to this customer it was a revelation. They achieved a quick win and proved that there was ROI in IoT.



Another customer that made sophisticated wind turbines wanted to speed up the usually time-consuming quality assurance process for the turbine blades, without compromising on accuracy or safety in any way. Artificial Intelligence helps us reduce it by a factor of four! We used AI's deep learning capabilities to achieve that objective. This solution was developed through co-creation.

So, my advice is start with projects which deliver swift ROI. That engages all the stakeholders and proves that Industry 4.0 is more than a buzzword, it's the key to the future. Collaborate with engineers and technologists, and those responsible for IT and Operational Technologies (OT) inside and outside your company. Collect as much data as meaningful from your sensors – make the most of 'edge computing' to boost the intelligence of your people and your organization. Make the most of analytics to yield insights (and surprises) from your data. And, make sure you do it all securely.

No one will achieve Industry 4.0 overnight. And nor should they. Industrial revolutions only have long lasting and deep effects when they unfold in a measured, evolutionary way. That's why this revolution will unfold in an evolutionary way. And, like all significant journeys which are long and challenging, they begin with the first step.

# From volume to quality: How the Smart Factory revolution delivers both speed and craftsmanship



**A conversation with**  
Frank Blaimberger,  
Head of Services & Tools

## **There's a lot of hype about Smart Factories, is it justified?**

I am always suspicious when a 'New Era' is announced in any field. Usually, it's just a minor change to the old era. But the Smart Factory is different. I work in one. I know. I can see how different it is. It really is much more than the latest buzzword. The idea of a factory hasn't changed: it's a place to make things in using the best people and machinery to deliver quality to customers. That will never change. The point is that new, smart digital technologies are transforming the way that people and machines can interact to offer speed, agility and the ability to go beyond mass production. It's also enabling manufacturers to create entirely new business models and bring down the cost of making smaller batch sizes to the point where, very soon, delivering one product for a price that's not much higher than a mass-produced item, will be entirely possible.

## **But cost is always the bottom line, isn't it?**

That's changing. In the past, we spent a lot of time talking about how the cost per unit could be reduced. Now, we're talking about changing the way a factory is set up so that it can respond to shorter timescales, lower production sizes, and ensuring that the factory is agile enough to respond to short-term market dynamics. In a world where consumer preferences change almost instantaneously, you can't mass produce items and put them into a warehouse in the hope that they'll be bought. The new digital economy doesn't work that way. Consumers are looking for niche products, personalized goods, that can't be anticipated over long production or sales cycles. Only organizations which can adapt to changing demand can satisfy end-users, and doing that takes agility.

## **So, what's at the heart of the Smart Factory – digital technology?**

People are at the heart of a Smart Factory. Instead of trying to replace workers with robots to make products in a fragmented way, we are being smart: we are transforming the relationship between the human and the machines. In the past, we'd expect humans to carry out a series of tasks in a repetitive fashion.

A machine would do other tasks. The imperative was always to try and reduce the human input, increase the mechanical input, and do the same thing faster for less money. That makes sense in a world where everyone wants the same product. But, as I said, we don't live in that world anymore. So, now we must be smarter. The human and the machine are no longer rivals, they are a team.

"The point is that new, smart digital technologies are transforming the way that people and machines can interact to offer speed, agility and the ability to go beyond mass production."

## **This is the end of the 'time and motion' approach then?**

Not entirely. You need to understand actions and their consequences. Order them properly and so on. But, what we're seeing is a return to the idea that making things in a factory is about craft and quality, rather than just uniformity and achieving every higher output of the same product, over and over again. I really think that we can go back to the idea that the humans are craftsmen, skilled, intelligent, and able to make the entire product from start to finish.



**Some might say you're talking about solving the problem of alienated work – is that right?**

Well, that sounds quite philosophical. But, I think this is an opportunity to ensure that people become more important in the manufacturing process. The idea of the 'alienated worker' arose during the First Industrial Revolution, as the old craft-based, small factories were replaced by large, steam-powered factories that produced the first mass market goods. The worker actions were broken up into specific tasks and shared out across the production line. No one worker made the entire product. They were 'alienated' from the output of their labor. It worked to lower costs and increase output, but caused problems between manufacturers and people.

**Many will be surprised by the fact that this industrial revolution is changing that – we all expected machines to take over entirely!**

If you read the newspapers too much, you might think we're all going to be replaced by digital technologies. But, that's just the usual media hype. The truth is that the Smart Factory uses IT to enhance the human worker's skills. As, Greg Pincar shows, the worker is enabled to do more sophisticated work and develop their career in new directions. The machines do specific tasks, but as part of a team working on ever small batches. That means production can be focused in different production areas instead of across a long, complex and linear production line that's hard to re-tool and set-up for new products. The customer wants quality and flexibility. Now, a worker can be guided by a Context Sensitive Instruction Terminal that's linked to the entire process – from customer need to supply chain to production line, quality assurance and beyond – to see the job through from start to finish.

**Each shift can be different then?**

Yes. And the technology available to the worker encompasses all that's needed to fulfil the order. That means, if there's one thing to produce, they can reconfigure the production area to meet its needs. The robotics that support them can do the heavy-lifting or the fetching-and-carrying, or the precise weld or handling of a PCB that few humans can manage with as much accuracy as a machine. The tasks are not cut up in to small, repetitive bites, but apportioned by the workers to suit the demands of what they are making on that particular day, or week, or month. It all depends on what the customers want, and how the manufacturer does business with them. So, if the products are customized, the team is agile enough to deliver on individual specifications. If the manufacturer is supplying the goods on a pay-per-use basis, then the team can ensure quality in terms of both operation and the collection of data and so on.

The truth is that the Smart Factory uses IT to enhance the human worker's skills.



### So, the word 'smart' goes far beyond the technology?

It does. At Fujitsu, we take our human-centric approach very seriously. To us, 'smart' means human first. The technology enhances human intelligence. It should not fundamentally replace it. We know that, ultimately, it can't. I know some people would argue with that, but I don't believe we could, or should, work to replace people. We must think about every process and how it can be done better by people working with machines. That means leveraging the abilities of people and machines so that, together, they deliver quality. How can we do things in new ways to achieve our objectives? That takes collaboration.

### By collaboration, do you mean within your factory or outside it?

Both. At our Augsburg campus where we are putting our philosophy into practice – remember we are a manufacturer too! – we have made sure that we have an open technology center very close to the production area. We think like a start-up. We look for new ideas everywhere and anywhere: from our people, from our colleagues around the world; other manufacturers; our customers; and academics too. We look beyond the fences: from each machine to the factory door, to the offices and workshops of customers and partners. Being smart means working and thinking without limits. It's the smart way to innovate. Co-creation is the key to any start-up, and that's where the disruption comes from in all markets. So, why not adopt that approach? It doesn't matter if you've been manufacturing goods for century or for a few years: smart always works. Knowledge-transfer powers innovation.



Learn to learn from others and foster internal innovation which can deliver results day-to-day. That helps you build a culture that's open and forward looking.

Co-creation is the key to any start-up, and that's where the disruption comes from in all markets. So, why not adopt that approach?

### As you said, the Smart Factory isn't about technology – it's about how you approach it and approach the future – is that right?

It is. Smart is the person, the method, and the machine. If all work together and are aligned, then you will be able to improve what you do every day. And that's the challenge. This is not a 'revolution' – it's a focus on daily business and improving technologies, methods, facilities and so on. We have our Monozukuri approach which ensures that all Fujitsu's factories share best practices. It is famous around the world. Its focus is on craftsmanship. It fuses tradition with modern methods. It's an approach that's open to all. It guides manufacturers in a very open and collaborative way. And openness is vital. We want to help our customers discover great things, so we can do the same. It works the other way around too. We share great ideas – smart ideas - so people don't have to 'invent the wheel twice.'

# Manufacturing outcomes: The future demands new digital business models



**Q&A with**  
Reijo Sihvonen,  
Head of Manufacturing Vertical

**Q: It's been claimed that manufacturers are experiencing an 'epochal change', do you agree?**

Reijo: I do. We are manufacturing a new industrial epoch. As we speak, manufacturers all over the world are thinking hard about what they do, how they do it and, even, what they are for. The digital revolution is, in my opinion, much bigger than the move to mass production and the introduction of robotics over the last century. Digital changes everything.

**Q: How does it change 'everything'?**

Reijo: Because, if you look back just to the 1970s, you had the introduction of ERP systems and then robotics as well as lean manufacturing and Just-in-Time production. Over the course of a generation they became essential elements to all manufacturing organizations. But, in the end, it was mass production. A line of products, all basically the same, produced in large batches and then shipped to customers for use in whatever industry they happened to be. The relationship with the customer became very tenuous once the item was dispatched. Servicing and some support, but the customer was, basically, on their own. Digital is changing that fundamentally.

**Q: But isn't manufacturing about making things?**

Reijo: It is about making things. But, things aren't an end in themselves anymore. It's what the product does that counts. With the advent of the Internet of Things (IoT) and the ability to collect immense amounts of data about how products behave and how they are used when new opportunities arise to add services to that product. So, the product is not the end of the story, it can be turned into the start of

one. The foundation for an ongoing relationship between the manufacturer and the customer and, ultimately, the end user.

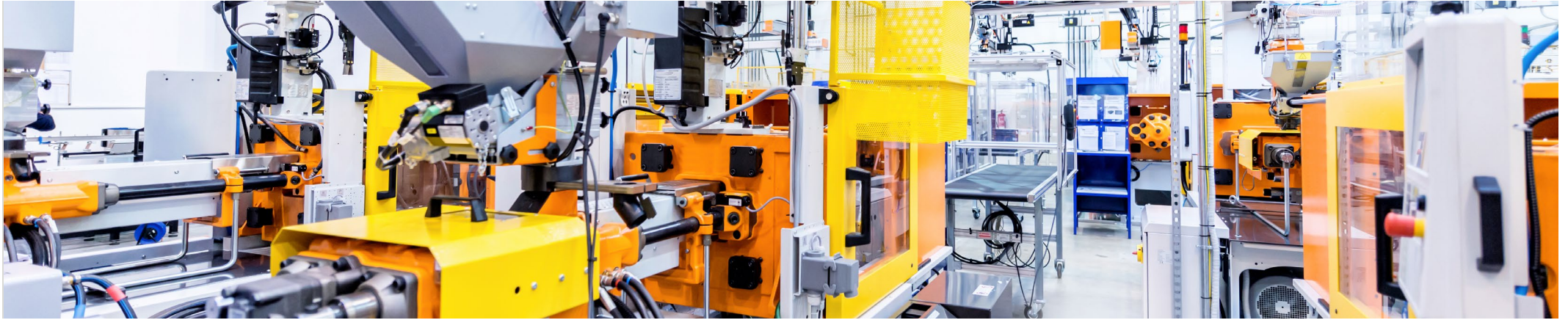
The product is not the end of the story, it can be turned into the start of one. The foundation for an ongoing relationship between the manufacturer and the customer and, ultimately, the end user.

**Q: So, making things is out of date?**

Reijo: Not out of date, just different. Augmented. Expanded. Deepened. The truth is that, in the digital age, a manufacturer can't only be a manufacturer. They have to offer services as well as physical products. Services that extend across the life-cycle of the product and beyond into the design of new versions of that product as well as entirely new ones based on feedback from markets, consumers, and data from usage.

**Q: we're talking about what's been called 'servitization' here, right?**

Reijo: Yes. It's not a nice word, but it describes a transition from basic production to something more complex and rich. It's about relationships based on outcomes. I could put it this way: you should not be making mere products, you should be manufacturing outcomes.



**Q: What do you mean by outcomes?**

Reijo: OK, think of a coffee machine. The kind you see in a café. Or, maybe the kind you find in offices that serve, for instance, 50 people in a department. The machine was manufactured by a specialist in coffee machines. It's been designed to produce large numbers of cups of coffee – of all different kinds – over the course of its lifetime. In the past, that machine was bought outright from a manufacturer who may or may not have a contract to service it. The relationship between the manufacturer and the buyer – as well as the end users – was thin. Now, with digital technology, especially in the form of IoT sensors, each coffee can be tracked and analyzed. The performance of the machine can be monitored, any faults can be predicted and repaired before they hinder the creation of one espresso macchiato or latte – and everyone is happy. It's an entirely new business model.

**Q: Predictive maintenance is a well-known aspect of IoT, but how does that represent a new business model?**

Reijo: Yes, predictive maintenance has been talked about for a long time. It's important, but it's not the point I'm trying to make. The café chain or the office concession that provides catering to office buildings doesn't have to buy the coffee machines outright anymore. They can enter into an agreement with the manufacturer to pay a royalty for every coffee that's served. That cuts the need for capital outlay on the part of the customer, and it offers the manufacturer the possibility of a strong revenue stream based on end-users love of coffee. And we all love coffee. Consumption is rising year on year. Before digital, manufacturers could only make money from the production of the machine. Now, they can make money from our addiction to caffeine. You can work out which has the most potential for profit.

**Q: So, the outcome is the guaranteed cup of coffee?**

Reijo: Exactly. And the outcome could be the number of miles a jet engine flies, or the fuel that engine saves by being lighter and more efficient. It could be the nautical miles achieved by a cruise ship, whose owners have not had to raise capital for a turbine, but have entered into an agreement with its manufacturer based on how effective it is. The agreement can be something like, you make an engine that saves substantial amounts of money on fuel costs and the manufacturer gets a cut of that saving. Over the lifetime of the turbine that can add up to substantial revenue. It also creates a deeper relationship between the manufacturer and the customers. That means they come to you to make more turbines... and future turbines. You take the data that comes from the current turbines and use AI, machine learning and data analytics to improve it, reduce maintenance costs and increase efficiency even further. All are outcomes, and all are mutually beneficial.

**Q: It's a relationship rather than a simple production process?**

Reijo: Yes. A new business-model. One that's almost entirely different from the classic approach to manufacturing. The old Fordist approach – 'Any color so long as it's black' – is over. We thought that was over a long time ago, but really it wasn't. Digital has truly brought that era to an end. Now, we're moving into an era of extreme customization. We're heading to a time when the cost of producing a single lot is very little more than producing a thousand or even a million. That means a manufacturer can have a day-to-day relationship with customers based on producing what the market needs week-to-week or, maybe, day-to-day. If a storm is forecast in three days and there's a need for umbrellas, a production line can switch from garden furniture to umbrellas with ease.

**Q: The outcome is enough umbrellas in stores for when it rains – that makes sense, but most consumers now want to customize their ordinary day-to-day shopping too, is that part of the story?**

Reijo: Definitely. Take sports shoes. Digital means you can tool a production line to offer any combination of color or size or even embroidered names or images. The consumer goes online and orders the shoes they want, and it gets made, shoe by shoe. And, if the data shows that pink is trending, and demand is likely to grow, then the production line itself can connect with suppliers to ensure that there's enough pink thread or laces or whatever else might be needed. That's why one of the world's leading fashion retail brands decided to become a manufacturer. They saw that being vertically integrated would give them an advantage in a fast-moving marketplace. Now, most retailers aren't like that and don't want to



become their own manufacturers, so they will want to create long-term relationships with manufacturers. Digital enables all the things I've described.

**Q: Are manufacturers ready for the new business models?**

Most advanced manufacturers accept they need to embrace digital. They are doing so in many ways, but they are still working to understand and be ready for the new business models I've described. Of course, we don't yet know all the possible models there could be. That's the great thing about digital, the possibilities are endless. That means there will be disruption across all areas of the sector. The point is to get ahead of it, and be your own disruptor. Fujitsu, importantly, is a manufacturer. We are pioneering different ways to run a factory and interact with customers. We are focused on outcomes and that's how we can claim to be the best partner for forward-looking manufacturers. Our Activ8 approach is a framework for innovation that enables customers to go from igniting ideas to developing, prototyping and adopting new products and models.

**Q: Manufacturers can't do this on their own?**

Reijo: We don't believe they can. It makes sense to co-create solutions. The point is to build an eco-system of partners and technologies that can swiftly deliver results. We have that ecosystem in place, with partners across all areas. The market is moving too fast to build that from scratch. We can help deliver a strong, deep customer experience that's focused on outcomes. It is what customers want and expect.

# From design based on problems to design based on success: How AI and Machine Learning is transforming manufacturing



**Hugo Lérias,**  
Director, Industry Sectors,  
Business Application Service EMEA

Manufacturing is about making things. Products that customers say they want. That could be a jet engine or a car-seat or a coffee machine. The demand comes from a specific market, a product is designed and a manufacturer tools a production line to make it based on a specification. The product rolls off the production line, gets sent to the customer and, apart from a service visit or two, the relationship basically ends there.

The only intelligence about how the product is behaving comes either during a service, or when there's a problem. The knowledge generated by interaction might then inform the next iteration of the product's design. Or it might not. The manufacturer is in the dark about what's happening in the real world. Often, the only time they realize that their products aren't up to scratch, is when the customer doesn't repeat the order. They opt for a totally new design or they go to a competitor to make their goods.

## Know more, do more

There's a lot a manufacturer does not know, and can't know. The point of moving to a new Industry 4.0 model is to know more and know it faster. And evolve the design products based on feedback from usage and customer experience, so they get better with each iteration.

To do that you have to generate a flow of data across the entire process: from usage to design to production and back again. You need sensors embedded within the product to collect real-time information, and the ability to analyze the data to discover insights into how you can make the product better based on its advantages to the customer.

That's what Artificial Intelligence (AI) and machine learning (which enables that intelligence to be applied) offers manufacturers. It's a key element in the creation of new business models and forging a much closer, collaborative relationship with customers over the long-term.

You need sensors embedded within the product to collect real-time information, and the ability to analyze the data to discover insights into how you can make the product better based on its advantages to the customer.

## Be superhuman

For me, AI is crucial. It enables you to be superhuman. That's because it enables you to cope with increasing volumes of data. The 'machines' that take in the data from multiple sensors on every product, can learn as they analyze. They are guided by your experts and designers, but they work autonomously to sift through the data, organize it, and then highlight trends and opportunities. And they can be very surprising. Which is the point. If they surprise you, then you can delight your customer with a new feature or a performance improvement that saves time, money and boosts productivity for that jet engine or coffee machine.



The point is to have a goal: enable a product to build on its success. In the end, that's the definition of intelligence. Just because AI has the word 'artificial' in it, does not mean that the intelligence it delivers is not the same as the kind that humans can achieve. Philosophers and scientists have long debated what intelligence is, but they generally agree that it is the capacity for logic, understanding, planning, emotional knowledge, self-awareness, creativity, problem solving and learning.

Human's intelligence encompasses all those things. Machines don't need to be emotional or even self-aware (though they might well be soon!), but they can do all the other things in that definition. The bottom line is that intelligence can be defined as the ability to accomplish complex goals.

### **The goal is success**

So, the goal that is set is what informs the outcome. Tell your AI to look for problems and that's all it will find. Set it up to find success and then build on it, and that's what you will achieve. The goal is set by humans, AI uses the data to suggest new ways to design and make products, and then humans make the final decisions – and forge the relationships to sell and support the products within evolving business models.

AI is a tool. It's an approach. It's a mindset based on positive goal attainment. That's why I believe that you need to base design on success not problems. If you make a product like a jet engine, and you establish a new business model that's based on the miles that

engine flies, how it economizes on fuel, and each successful, safe flight, then the data you received from the IoT sensors within the engine should be analyzed to help you improve your design of each part of that engine to deliver continuous improvement across all those factors. That delivers end-customer satisfaction for the passenger (cheaper fares and efficient schedules) and for you, more revenue per flight.

AI will learn what is good and what can get in the way of good: it will then apply that learning to the recommendations it generates to designers as they plan the next model. That goes for the whole product as well as individual parts. The manufacturer becomes an active, collaborative partner in their customer's business. And the goal is always success.

### Generative by design

AI is fast becoming an important part of the design as well as production process. It's the key to fulfilling a dream that most manufacturers have long tried to achieve: being able to influence the products they use long after they've left the factory. As I've said, that ongoing interaction with what you make is at the heart of the new, servitized business models that smart manufacturing is enabling. But, AI can be used to go one step further and help you design new products and features.

Generative design is all about goal attainment. You tell the computer that you need, for instance, a better, lighter, cheaper component for that jet engine. You've 'taught' the AI all about jet engines, materials, parameters, stresses and strains and so on. And then you let it 'think'.

The AI can come up with some surprising answers. There have already been fascinating trials of this new wave of AI, and soon designers will be using generative design much more regularly. It's an opportunity for manufacturers because it enables them to become an important part of the creation stage of product. The IoT within the finished product allows them to be involved as the product is used in the real world. For instance, think about applying what Tesla can do to its cars to a washing machine. Tesla replaced the dashboard with a large screen. That allows them to send out upgrades and new features based on daily usage. The dials and buttons on a washing machine can be replaced with a touchscreen (which we're all so used to now!) and new spin cycles or wash-programs can be downloaded in an instant.



Naturally, that connectivity also helps with predictive maintenance as well as overcoming problems without resorting to costly – and reputation damaging – recalls.

### Enabling AI depends in HI (Human Intelligence)

AI is not a system, it's science. It's a means by which you can cope with, and make sense of, huge amounts of data. IoT sensors need to be embedded in each product. They generate the real-time data across the entire supply chain. And it's all dependent on people. Intelligent people who are committed to attaining a simple goal: the success of a product based on an ongoing relationship with the manufacturer.

Yes, you need specific hardware and software, and you also must make good use of the cloud. So, the design of the correct infrastructure is fundamental. You need to handle processes and workloads so that data flows freely to the machines and people that need it. You need the right analysis tools to achieve the insights that both the people and the machines needs to work together.

AI does not work without HI. It's that simple. Sure, the AI will do much of the work on its own – it will learn in both a supervised and unsupervised way – but it depends for its goals and parameters on people. You set the objective, the AI works to achieve it. And, it will surprise you. But, again, that's also part of the objective. Great new ideas. Wherever they come from, take them and make the most of them.

# A new vision of teamwork: How robots are working alongside humans instead of replacing them



**Greg Pincar,**  
Senior Director, Strategic Consulting

Bob ponders a choice between two components. It takes just a fraction of a fraction of a second to choose the right one. The choice is based on experience hard-wired into his brain. Dexterous fingers swiftly deliver the small component to Lisa, who smiles, nods, and with a cursory check to ensure that Bob's choice was correct, inserts the component into the device that both Lisa and Bob are making today: a high-end, customized coffee machine ordered by one their company's most important clients.

Lisa is a human being. Bob is a robot. They work as a team. Of course, Bob is actually called 'Bob' – that's Lisa's name for her 'colleague'. Like most of us, Lisa can't help but humanize a robot. It's an instinct. It helps her focus on doing great work. It might sound like science fiction, but it isn't. This kind of human-machine team working is fast becoming the future of manufacturing. Robotics has moved from production lines populated by a forest of hydraulic arms repetitively bolting components together, doing welds, or stamping out sheets of metal and is continually moving to an intelligent collaboration of man and machine.

The emerging Smart Factory is, as Frank Blaimberger puts it in his article, freeing the human worker to focus on their craft and expertise with greater freedom. The era of mass production is shading into one of customization and smaller batches and, eventually, the ability to achieve Lot Size 1 at a price close to mass produced goods, is getting closer and closer.

And robotics will be at the heart of that new world of manufacturing. But, not the robotics that manufacturers pioneered in the Third Industrial Revolution. The new robots are much smarter than ever before, and they're not going to herald the end of the human in the factory. In fact, you could argue that the opposite will be true.

The factory – and the goods its produces – will be more human than it's been since before the First Industrial Revolution.

I've been working in factories for four decades. So, I've seen how they've been transformed by technology over that time, and I can safely say that this transformation – the digital revolution that characterizes Industry 4.0 is different. Very different. It's a real quantum leap. The idea behind it isn't new: no idea is. I was working to create what we called a 'Connected Factory' back in the 1980s. The point was to connect every stage of the manufacturing process – from the customers' needs through to the design of goods, the sourcing of materials, their delivery to the production line, the way the goods were manufactured as efficiently as possible, and then delivered and serviced. And back to the evolving needs of markets. Data had to flow to achieve insights that would improve margins, quality, and drive innovation.

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That's what Industry 4.0 does. The big difference is the technology. Now IoT, AI and machine learning have achieved that connectivity, and done so with such speed and agility, that manufacturers are now able to create completely new business models. Robots are making it happen. They are an important factor. But, some people are afraid of them. They fear that they will take jobs away from skilled workers. That's not the case. In fact, it never was. Back when the automotive industry adopted robotics in a big way, the same fears were splashed over newspapers across the world. The truth was, that the robots took over the heavy lifting (literally) and did the repetitive but necessarily intricate tasks (like tiny, vital welds) and did them to a high quality over and over again.

That freed people to develop their skills in managing the robots, supervising them, and ensuring they kept pace with production through maintenance, programming and upgrades. And a lot of tasks remained in human hands. The teamwork between human and robot was a key feature of most automotive production lines. Workers were upskilled. Their jobs became more sophisticated.

More opportunities to develop rewarding careers arose because the grunt work was done by machines.

Now, the new generation of robotics is enabling that process to go much further. As Silicon Valley entrepreneur and author, Martin Ford puts it, "The world economy is moving into a new era that's defined by a fundamental shift in the relationship between workers and machines. That shift will ultimately challenge one of our most basic assumptions about technology: that machines are tools that increase the productivity of workers. Instead, machines themselves are turning into workers, and the line between the capability of labor and capital is blurring as never before."<sup>1</sup>

That can sound scary. It suggests that the side of 'capital' – i.e. the manufacturing business and its investors – can use robots to undermine the role of the human worker. But, we're seeing the opposite. As the Lisa and Bob example shows, robots can and should be a good thing. A positive advantage for both capital and labor. That's because, as robots get more and more intelligent, and

can be spoken to as you'd speak to a home assistant like Alexa or Cortana or Siri, then the interaction between human and machine becomes more natural and nuanced. That then means the human can be more skilled because the machine can support their creativity and experience in more sophisticated ways. That then enables the manufacturer to offer higher quality goods and services that generate more revenue.

The new robotics is a dialogue between a person and a machine. Naturally, there are many who are skeptical about how this can work in daily life on the production line. But, every idea is met with initial skepticism. It's a learning curve that will yield value. The worker has the chance to be in charge. To lead the creation of a product, with machines supporting either mundane, repetitive tasks, or those that need an incredibly steady and minutely targeted hand. That speeds up production rather than slows it down. As I said before, it boosts quality and the range of goods that can be made. Bottom line is – it's a way of adding value. And value is what investors love.

<sup>1</sup> The Rise of the Robots by Martin Ford: Oneworld Books 2015

That's why I think it's important to run the numbers on how you use robotics. You can set up a five or six production lines, 'manned' by robotic arms or other parts, and then focus them on single tasks or product lines. But, you will be running six lines. They will be inflexible. It will take you time to re-tool as new goods need to be manufactured.

Creating one or two more flexible production lines, where people work with robots in small, focused and highly trained teams (trained people plus machines that can learn and be talked to via AI) might cost more in terms of capex at the start of the process. The benefit is that the lines will be much more flexible as you produce smaller batch sizes based on closer relationships with customers and integration into changing markets.

This flexibility saves you money. It enables you to boost production, achieve higher margins, and the ROI will then speak for itself. There will also be less maintenance, greater accuracy, and more and more data. And the data is also valuable. Sensors on robots not only tell you how the robot is doing, and how it might be enhanced, it also generates data about the entire production process, the use of materials, the time it takes to do each batch or section of a batch, and so on. That data can then be mined for insights about how you can do things better, faster and for a higher price. And the robot can become part of the supply chain management: that's because it can immediately sense, for instance, that the team is running low on a certain component, calculate need based on the order, and connect with the warehouse to get more delivered (by other robots), or even send through an order to a supplier so the right number of components get delivered the next morning.



It's a journey. No one expects manufacturers to become robotics experts overnight. They never have been. They've always worked with key partners and suppliers to bring in the right technology and operating systems. That's the best way to move forward. Working with Fujitsu is a collaborative process during which we co-create a robotics solution that matches your ambitions. And ensures that your people feel valued.

I've seen three generations of the same family working side-by-side on the production floor. Yes, some fear the rise of the robots, but I believe that we should support them.

In my experience, the great majority of manufacturers really do care about their people. I've seen three generations of the same family working side-by-side on the production floor. Yes, some fear the rise of the robots, but I believe that we should support them. They are not in competition with us. They enable us to do more. To be more skilled. More ambitious as well as productive. More human. With more intuitive user interfaces, each robot will become a member of a team. Supporting us to do more, and achieve smart manufacturing now and into the future.

# It's smart to be safe: Digital manufacturers that put people first are smarter manufacturers



## An interview with

Julie Carugo,  
Business Development Director -  
IoT & Innovation, EMEA

Worker safety is a duty. It's enshrined in laws across the developed world and, with increasing effectiveness, throughout developing economies. Many of the regulations use the word 'duty' and it defines the approach that an employer should take. It's about much more than a requirement to follow health and safety regulations; it's about respect for people and a moral obligation to their wellbeing and safety whilst at work. Increasingly, that obligation has wider implications: with the rise of digital technologies that extend work outside a specific place or time, worker wellbeing now includes the right to switch-off devices, get adequate downtime and rest, and achieve a work-life-balance that reduces stress.

"I think it's very important to look at the subject holistically," says Julie Carugo, "and to realize that worker safety is a key element in digital transformation. Much of the discussions around smart systems, especially in manufacturing, focus on technology and customers. They are important, of course, but the people who do the work, whether on the factory floor, or out in the field servicing products, or in the offices working with digital devices, are an essential part of getting digital transformation right. You can't do this all with machines alone!"

## Digital must be about people

Some commentators have worried that people often get left out of digital transformation planning. "Of course, people are factored in, but as cogs in the machine," says Julie, "But it's people who really deliver the value to the end customer in the great majority of cases. If they don't feel valued, then they will not enable the machines to be productive."

"Your approach to worker safety must not be about simple compliance with regulations," stresses Julie. "We need to be clear about that up-front. It's got to be about people. You and me. Not them and us. It's got to be based on a realization that your reputation in any marketplace is informed more by how you treat your people than your share-price or your quarterly figures."

With the rise of digital technologies that extend work outside a specific place or time, worker wellbeing now includes the right to switch-off devices, get adequate downtime and rest, and achieve a work-life-balance that reduces stress.

Any form of financial value is determined by both the output of things and attitude to people: employees, citizens, stakeholders and even citizens of the wider society. There have been many instances of organizations that have achieved success, only to see it undermined by bad work practices, accidents, and stories about workplace stress and even bullying.



“Worker safety affects the bottom line,” says Julie. The statistics back her up. The UK’s Health and Safety Executive shows that, on average, the British manufacturing sector lost 2.6 million days each year to work-related accidents, illness, injury and stress.<sup>1</sup> The UK’s accident rate at work has been slightly lower than the European average, at 0.51 per 100,000 workers. Germany recorded 0.81, Italy 1.24 and France 2.94<sup>2</sup> – but the trend over the last 17 years has been edging down. Workplaces are becoming safer. That’s due to a greater emphasis on health and safety training as well as regulation.

“Employers understand that they have a duty to their people and they know that if they don’t fulfil that duty then they will lose skilled

people to their competitors whose reputations are better,” states Julie. “At Fujitsu, we also make digital transformation about people – we call it our ‘human-centric’ approach, and that’s because in our experience it’s the best way to achieve a smart future.”

### **Worker safety affects the bottom line**

Cutting the amount of time that’s lost to injury, illness or stress, means that the production line and all the allied services that come with a servitized approach to manufacturing can continue uninterrupted. “Simply, you’re more productive. The happier and safer your people are the more they can and will do. I believe that the great majority of people at the most senior levels of manufacturing businesses really do care for their people.

They know that they cannot succeed with technology alone, and that digital has to augment people, making them smarter and safer.”

So, what can be done? “Just as digital transforms what a manufacturer can do on the production line and with customers, so it greatly enhances how workers can be kept safer while improving their wellbeing,” says Julie. “The rise of IoT has created an expectation that data can transform products, the same is true about worker safety. IoT can enhance safety policies and highlight risk for workers in dangerous situations, over exerting or working with potentially hazardous tools or materials. It also helps workers out in the field, especially if they’re working alone or at height.”

<sup>1</sup> <http://www.hse.gov.uk/statistics/industry/manufacturing/index.htm>

<sup>2</sup> <http://www.hse.gov.uk/statistics/european/>

### IoT, wearables, geo-fencing – a host of possibilities

Wearables are becoming part of our everyday lives outside of work – from fitness trackers to VR headsets for entertainment – and they are also key to worker safety across all kinds of work environments. “The wearable can serve two functions: it can augment the productivity of the worker, providing them with real-time information and support them, for instance, inspect anything from a jet engine to a wind-turbine, using things like a head mounted display. But they also monitor environmental conditions, track actions like climbing masts or towers, and send back information about how the worker is doing,” says Julie. “If something happens at height, then the device can identify the fall and send out an alert to get help. Or if the worker is incapacitated, then the device understands that the worker isn’t moving, and uses location information to enable the business or a colleague to respond.”

Another aspect of worker safety, especially in a busy manufacturing environment, is ensuring that humans and certain machines (as well as substances and materials) keep a safe distance from each other. Digital solutions such as geo-fencing can ensure that work teams don’t interfere with each other on the factory floor to create a hazard, or that moving parts of robots or other machinery, can respond to human incursion instantly to avoid contact. “That will be more and more important as manufacturing in some industries becomes more team focused, with separate teams creating entire products,” points out Julie.



### Communicate and put people at the heart of digital transformation

“We also believe that it’s important to communicate with workers about all kinds of change, but especially digital change,” says Julie. “Reassure workers that the data you collect on what they’re doing will not undermine their privacy. Be clear what it’s for, and why you need it. Ring-fence it from their private lives. Work with trade unions to establish clear policies about what digital is for and why it’s important, but always consider what your people think and feel about change.”

“I think it’s about trust, in the end,” concludes Julie. “In past industrial revolutions, the workers have often had a very bad deal to begin with. Especially in the 19th and early 20th centuries. There are some people saying that we’ve gone back to those kinds of times, but I don’t agree. The law is on the side of the worker, and that is as it should be. In a modern, hyperconnected world, bad employers get found out very quickly and the world gets to know about them in an instant. A smart business isn’t just smart in the way it makes and sells things, it’s smart in the way it treats its people. Digital manufacturing is as much about using technology solutions to enhance a worker’s wellbeing as it is about making more stuff. Get the balance between the two right, and you can achieve a truly human-centric outcome.”

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