THE FACTORY OF THE FUTURE

What will the most advanced factories look like in a few years? Robots and sensors will push forward the boundaries of automation. Preventive maintenance will save billions of dollars to manufacturers. But above all, tomorrow will be the era of *mass personalisation*.

Francis Ramiandrasoa (MBA.03)

Santosh Krishna Prasad (MBA.15),

In this brand new BMW factory, a worker is moving heavy body works without any effort thanks to his exoskeleton. A colleague nearby is teaching a robot a specific move for painting a signature on a limited edition car, while another one is checking the quality of an engine with the help of an augmented reality headset. In the background, dozens of automated guided vehicles are moving metal frames, smoothly avoiding all obstacles that stand on their way. Science fiction? All of that could actually become plain reality very soon – and some of it already is.

Collaborative robots (cobots), who can learn from humans and collaborate safely with them, are indeed already in the picture. "*We use cobots in a factory near Rouen in France*", illustrates **Francis Ramiandrasoa (MBA.03)**, lean expert at the Renault-Nissan-Mitsubishi Alliance. French competitor PSA Peugeot-Citroen also has acquired collaborative robots (UR10 from Universal Robots, to name them) in its Mulhouse facility. In a few years, operators will be able to use these cobots as simply as they manipulate their smartphones.

Site managers will use the potential of virtual reality (VR) to optimise the layout and efficiency of their factory. "*We basically have avatars of all equipment and people in the virtual world. With VR, we can simulate changes in the production line, so that their implementation gets much quicker*", Francis Ramiandrasoa explains. Simultaneously, augmented reality (AR) is becoming common practice. The Boston Consulting Group's Innovation centre for operations (ICO), at Saclay near Paris, is experimenting it for scooter manufacturing. Workers can film the base frame of the vehicles with their tablet. The device immediately highlights the pieces that need to be checked. On a production line, any shutdown can cause severe losses to the company as it wastes time, money and may ultimately cost some delay penalties. But the Internet of Things (IoT) is changing the story. It will help companies save at least 160 billion dollars in their worksites by 2025, according to McKinsey, not least through predictive maintenance. "*Sensors will be deployed in the whole production chain and collect data like temperature or pressure. They will also continuously monitor machines to predict and prevent any failures*", explains **Santosh Krishna Prasad (MBA.15)**, a business development manager at HCL Technologies (an Indian IT multinational). "*Within two years, every single part of a factory will be tracked with sensors*", claims **Aurélien Verleyen (EM.14)**, president of Dataswati, a French start-up dedicated to artificial intelligence for "*data-driven industries*".

LOT SIZE OF ONE

But the most impressive side of the so-called *industry 4.0* is probably the prospect of personalising mass-market products – in other words, manufacturing completely different models and products on the same factory line without any calibration time at the same unit cost, no matter the volumes. It bears the promise of extreme flexibility in the product mix without having to consider minimum quantities, as the paradigm of economies of scale will not play any role at all. "*Robots will know what the final product is supposed to be and will behave accordingly. For instance, ten plastic bottles on the production line will be filled with orange juice with stickers in German, then an urgent order of 1,000 glass bottles filled with cider and with stickers in French will be squeezed in with highest priority, as the weather forecast predicts a heat-wave in France and an increase in the consumption of quenching beverages is expected*" illustrates **Ingrid Winter (Pim.90)**, industry specialist at Worldline France. 3D printing makes it now possible to personalise physical products to a client's

254,000
industrial robots were sold in 2015, an increase of 15%. Asia was the #1 market, followed by Europe.
Source: International federation of robotics

5 million
jobs could be destroyed by robots by 2020
Source: World Economic Forum

Inside a Tesla Factory

preferences. It was first used for prototyping but now factories use this production process to create final components, like car interior lightning. "*Small lamps on the ceiling of the vehicle were traditionally built through injection moulding. Now they are made by additive manufacturing*", notes Francis Ramiandrasoa (MBA.03) at Renault-Nissan. 3D printing will also enable industrials to replace spare parts on a timely manner, wherever they are needed. "*In the future, there will be a 3D-printer at each airport so that airlines will be able to print locally many of the spare parts they need. The availability rate of airplanes, and therefore profits, will improve*", anticipates **André Loesekrug-Pietri (H.97)**, the founder of technology fund ACapital. Experts even foresee that *global* will turn *local* as large facilities will be decomposed into many smaller, low-cost factories that will be close to customers. "*Lead time and transportation costs will decrease while customer service will improve. Companies will be able to respond rapidly to changing local demand. Additive manufacturing will turn into 'social manufacturing'*", states Dr **Laoucine Kerbache**, professor of operations and supply chain management at HEC Paris. Industry leaders will become more collaborative, too, and get closer to their ecosystem. "*IoT is breaking silos inside and between corporations*", claims André Loesekrug-Pietri. "*Industry players will gain competitive advantage by sharing information to partners and opening the doors of their factories*", adds Aurélien Verleyen. As a matter of fact, PSA is collaborating with small and medium-sized companies like Nt2i and AkeoPlus for its Mulhouse site.
The "extended factory" will however be more exposed

IN A FEW YEARS, FACTORY OPERATORS WILL BE ABLE TO USE COBOTS AS SIMPLY AS THEY MANIPULATE THEIR SMARTPHONES

to cyber attacks than the traditional one. Massive reliance on connected things and information sharing with external players both imply an exponential number of potential security breaches. The WannaCry ransomware virus last summer, which led to Renault and Honda shutting down factories, raised the alert. Security will need more sophisticated resources in the future, "*with a combination of artificial intelligence tracking suspicious activity on a network, and more traditional protection systems*", indicates André Loesekrug-Pietri.
That leads us to a key challenge for industry companies: education. Factory automation will require operators to learn how to handle robots and monitor sensors. "*Governments will need to adapt their vocational programmes*", comments Ingrid Winter. Manufacturers are already internalising some training. Among others, the German scale-model railroad maker Märklin, which extensively relies on digital printers, has implemented a dual system ●●●

Aurélien Verleyen (M.14)

Ingrid Winter (Pim.90)

André Loesekrug-Pietri (H.97)

Laoucine Kerbache

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of classroom education and on-the-job training.

With so many evolutions going on, the global manufacturing landscape may well change significantly. *"China is the most exposed country to the risk of being disrupted. Up to 80% of its workforce could be potentially automated, versus around 40% in OECD countries"* emphasises André Loesekrug-Pietri. Mass personalisation is already translating into some "reshoring" initiatives. Shoe-maker Adidas, for instance, has recently inaugurated a fully-automated facility near Nuremberg in Germany. Machines get instructions from a design program that defines the size and shape of each shoe according to the taste and morphology of the related customer. The brand is then able to deliver customised shoes to its German clients within days, compared to weeks if it was produced in Asia.

Well aware of that relocation risk, China is heavily investing in automation. The government wants domestic robot makers to get 50% of the global market share by 2020. Last year, Chinese group Midea acquired robot maker Kuka, a flagship of German "Industrie 4.0". The 3.7 billion-euro takeover deal raised political concern in Berlin and scrutiny in Washington. China is still lagging behind Germany in factory automation, but it definitely intends to catch up. ●

70%
of companies expect to increase dramatically their level of digitisation.
These firms expect 2.9% of revenue increase and 3.6% of cost reduction per year on average.
Source: survey of 2,000+ companies by PwC

FOR MORE INFORMATION
"Industry 4.0: Building the digital enterprise" (PwC, 2016)
https://lc.cx/GWaJ
"Transforming industry with digitisation", (report in French by Syntec, 2016)
https://lc.cx/GWaA
"Unlocking the potential of the Internet of Things" (McKinsey, 2015)
https://lc.cx/GXVz

THE MOST IMPRESSIVE SIDE OF THE SO-CALLED "INDUSTRY 4.0" IS PROBABLY THE PROSPECT OF PERSONALISING MASS-MARKET PRODUCTS

Lockheed Martin
Industrial Exoskeleton

PRICELESS DATA

In the years to come, industry focus will switch from hardware to software. *"We can only see the peak of the iceberg – machines and sensors. We don't see the data, and that is really the next big thing"*, underlines **Francis Ramiandrasoa (MBA.03)** at Renault-Nissan. Going forward, 3D modelling and computer-aided simulation will dramatically accelerate time-to-market. IT systems for warehouse, product lifecycle and management execution will interact with each other. Smart factories will gather all the collected information in data lakes and use advanced algorithms to spot correlations and make relevant analyses. *"One of our client monitors 50 facilities with a single system.*

It is the equivalent of SAP in the manufacturing world!" testifies **Santosh Krishna Prasad (MBA.15)** at HCL Technologies. Ultimately, artificial intelligence will help optimise processes. A French startup, for instance, has helped one of its client improve its output of bricks by 5% thanks to a predictive model using neuronal network and deep learning. *"Drying can last fifty minutes to two hours depending on the quality of clay, internal humidity and weather"* explains **Aurélien Verleyen (EM.14)**, founder of Dataswati. *"By tracking these criteria and predicting humidity in output, we enabled our client to save drying time"*. And as we all know, time is money.