WHITE PAPER

THE RISE OF INDUSTRY 4.0 BOOSTS MANUFACTURING EFFICIENCY

LECTRA

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Part 1

STATE OF THE ART IN INDUSTRY 4.0

The industrial sector is always seeking to optimize its production and performance. To achieve this, it uses new organization methods, such as agile project management methods (PERT, OPT or Kanban), and new technologies that regularly emerge. Following the arrival of electronics, wire-guided vehicles and robots, it is now time for digital technology in all its forms to make its presence known in factories and workshops. **Connected objects, 3D printing, big data, data analysis, the cloud, virtual reality and artificial intelligence (AI)** are transforming manufacturing processes in all sectors and contribute to improving both productivity and operator working conditions.

The concept of Industry 4.0 first appeared on the industrial scene in the early 2010s, bringing together all these technologies. It is considered to be the fourth major revolution in production, following the introduction of the steam engine at the end of the 18th century, electrification at the end of the 19th century, and then automation, which began in the 1960s. This is the industrial sector's equivalent of the "digital transformation" that has been applied to all service and commercial activity since the early 2000s.

Applied to industry, this concept aims to integrate physical and digital systems into a single production value chain, by doubling the design and production chain with its digital twin, a type of virtual 'double.' The main challenge of Industry 4.0 is still anticipating consumer demand by interconnecting all stakeholders in this value chain, moving beyond isolated industrial facilities. Brands, suppliers, subcontractors and distributors – all players need to communicate automatically and transparently to provide the product that meets the consumer's need.

Needless to say a goal like this cannot be achieved overnight! This is why we wanted to review the current state of play and provide a progress report on Industry 4.0. The aim is to see how far we have come in **adopting different technologies, evaluating the progress they have enabled us to make, but also identifying the challenges that lie ahead between now and 2030 and seeing how we can meet them.**

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A profound transformation

Whether we are talking about **smart manufacturing,** the industry of the future or a smart factory, the digitization of industry has the same goal: optimizing manufacturing processes to produce better, more, faster, and at lower cost, while respecting the environment.

Different models take into account six phases for achieving these objectives:

01 Process digitization

02 Interconnection between systems and equipment

03 Visibility on what is occurring throughout the production chain

04 Understanding what is happening

05 Anticipation and predictability

06 Adaptation and optimization

"Industry 4.0 is transforming production methods even more profoundly by adding data, connected objects, and by placing people at the heart of the process. "

Marco Taisch

The arrival of **automation** and robotization in the 1980s has sometimes been viewed negatively, particularly by workers, as these technologies were suspected of ultimately aiming to replace humans in the production chain. "But today, the countries with the best cost-optimized production and who therefore have greater competitive access to a larger market, are Germany and South Korea. These are also the countries with the highest robot equipment rates and some of the lowest unemployment rates in the world," says Marco Taisch, Professor at the School of Management at the Politecnico di Milano (PoliMi) and President of MADE, the transalpine Industry 4.0. Competence Center. For him, Industry 4.0 is transforming production methods even more profoundly by adding data, connected objects, and by **placing people at the heart of the process.**

He cites the example of an automobile assembly line in Sweden, where operators have improved their productivity by 20% simply by using a connected watch that displays necessary data. "They haven't been replaced by robots! **On the contrary, Industry 4.0 values people.**

This is what we might call cognitive automation, which enhances human capabilities. "This 'enhancement' also frees up the operators' time, time that they can spend on **tasks with greater added value.**

"100% automation is not possible, in fact, it is neither reliable, economical, nor adaptable! "

Tobias Helberg

Porsche's experience supports this approach. "It's all about finding the best mix between people and robotic capabilities. 100% automation is not possible, in fact, it is neither reliable, economical, nor adaptable!" says Tobias Helberg, a partner at Porsche Consulting, an entity implementing the **Industry 4.0 model** in automaker plants.

Combining vertical and horizontal integration

As digitization accelerates across all activities, the industry faces new challenges. Whether it's cars, clothing, furniture or accessories, consumers want customized products at mass-produced prices. And they want them fast! The Covid-19 pandemic popularized—if not normalized—online shopping and home delivery services, accelerating this "I want it now!" trend. Manufacturers have to produce more, better and faster, all while meeting environmental challenges.

To achieve this, they must optimize their processes while making them more flexible, producing in close collaboration with their partners, suppliers, distributors, even their customers, which is increasingly the case with products customers can personalize online.

The principle of Industry 4.0 is to interconnect two axes that share data flows, putting the customer at the heart of this organization:

- **Vertical** integration, from logistics and planning to production;
- **horizontal** integration, from creators and designers to suppliers and distributors.

The interconnection of these pre-digitized systems translates to a fluid end-to-end process and avoids the need for silos. Analyzing the data collected throughout each stage provides visibility on what has been produced, helps optimize business processes and anticipates the future.

"In short, the end goal is to manufacture products that consumers will want to buy, of high quality and in the right quantities. "

Maximilien Abadie
Chief Strategy Officer (CSO) and Chief Product Officer (CPO) at Lectra.

Nesting models

Dorothée Kohler, founder of Kohler Consulting & Coaching, and Jean-Daniel Weisz, her associate, identify **three Industry 4.0 models**, distinguished by two criteria, quantity and product variety.

HYPERAUTOMATION

This model is suitable for mass production of standardized products such as mechanical parts for the automotive industry or circuit boards;

"STANDARDIZED CUSTOMIZATION"

Production is automated but organized in a more decentralized manner, often in cells, to produce different models within an existing range, such as planes or cars manufactured on the same base but where each model coming off the line is different from the previous one;

UNITARY

This model consists of producing a customized, and therefore unique, product, with modular production organization. The product is designed with the customer, implying an on-demand production system that can be dynamically reconfigured.

"The Adidas Speedfactory, probably the most advanced example, illustrates the advantages of this on-demand production model. "

Dorothée Kohler

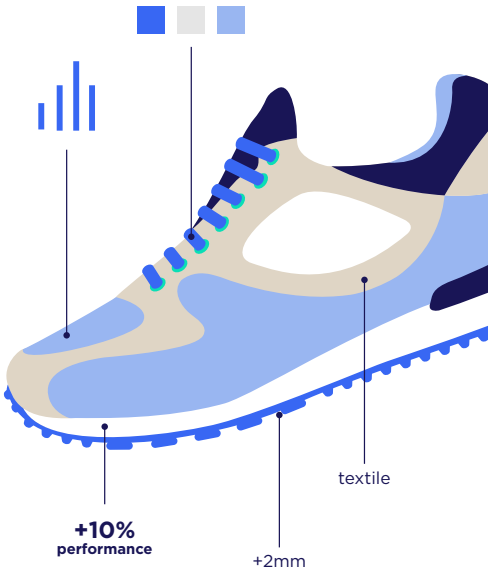
"From the beginning, the unitary model has been the holy grail of Industry 4.0", say Dorothée Kohler and Jean-Daniel Weisz. There are very few examples, and they are often at the prototype or demonstration stage.

The sole of a standard sports shoe is designed and produced in real time based on the athlete's data, their foot morphology, running style, etc.," says Jean-Daniel Weisz. Tomorrow, an athlete's digital twin, or avatar, will evolve with them and will integrate their updated data to produce soles adapted to each parameter change, the athlete's weight, their age, etc. "With this model, the role of the various functions is also evolving. The end consumer becomes a 'maker.'

The consumer contributes to the evolution of the existing base, customizing it according to their needs. This is already the case and this model will increasingly spread to jewelry, clothing, medical devices, cosmetics, furniture and even food products, " adds Dorothée Kohler.

"The end consumer becomes a 'maker.' They contribute to the evolution of the existing base, customizing it according to their needs. "

Jean-Daniel Weisz



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An approach as much cultural and methodological as technological

When asked "where are we with Industry 4.0? ", evangelist Jake Hall, also known as The Manufacturing Millennial, answers without hesitation "the ideas and tools are available and are not expensive. But Industry 4.0 is not just a question of technologies, it's also a question of culture and agreement on objectives. While various steps have been taken, many companies still have a long way to go, in particular by moving away from the silo approach and integrating their processes into a global solution."

Technology may be at the heart of Industry 4.0 projects, but it is only a support. As proof, major aviation companies **Airbus** and **Boeing** use the same technological solutions but do not produce the same aircraft.

"Many companies still have a long way to go, in particular by moving away from the silo approach and integrating their processes into a global solution. "

Jake Hall

"Such a transformation requires the establishment of a digital culture and organization within a company. "

Fabrice Nisol

The same thing occurs in the automotive industry, where automakers share a technological platform to produce different makes and models of their vehicles. Fabrice Nisol, Consulting Expert, is assisting **Tesca**, a textile and seat component manufacturer for the automotive industry, with its digital transformation. He explains, "beyond the implementation of new technologies, such a transformation requires the establishment of a digital culture and organization within a company, as well as the governance and change management necessary for the selection, implementation and adoption of these digital technologies and processes."

TECHNOLOGIES USED IN INDUSTRY 4.0

Big data and data analysis

The cloud

Artificial Intelligence and Machine Learning (AI, ML)

Simulation and digital design (digital twins)

Virtual and augmented reality

Connected objects and 5G

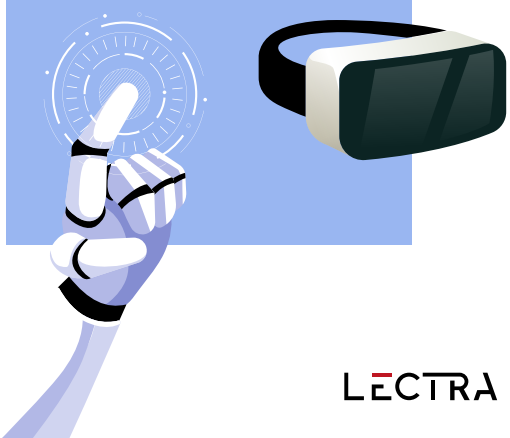
Cybersecurity

Blockchain

Autonomous robots

New materials

Integration of systems, machines and people



One project, one vision, one goal

"You have to start with a clear vision and understanding of the project"

Frank McCleary

For factories, digital transformation consists of **integrating and implementing a wide range of highly innovative technologies.** They do this at different speeds. If it is a new factory created from scratch, such as a battery gigafactory or a semiconductor plant, they immediately embrace all the innovations at their disposal. Existing factories tend to proceed step by step according to their needs and their capacity to innovate and adapt.

Regardless of the approach and rhythm they adopt, companies that are making these changes are proceeding in stages. "We have to start with a clear vision and understanding of the project," explains Frank McCleary, Partner at Porsche Consulting. We look for the best route between the starting point and the objective we are aiming for. Along the way, we identify problem areas and either work around them or find solutions"

Unsurprisingly, the most advanced Industry 4.0 plants like Tesla, Johnson & Johnson and John Deere, are the largest. They have the resources and skills to dedicate to their transformation.

"Above all, in these large companies, there is a transformation leader to create a vision, take charge of the project, and manage, which is absolutely essential if the transformation is to be a success"

Jake Hall

For Marco Taisch, aside from the size of the company, the type of production makes a real difference. "The biggest companies are more advanced, particularly in the automotive, mechanical engineering, industrial goods and packaging sectors, as they have more resources at their disposal. But while smaller companies may be less advanced, this is also because the design of their product is more important and they are more subject to fashion trends. This is especially the case for SMEs in the furniture and clothing sectors." Production becomes more complex, for example, with on-demand sofa manufacturing, which requires different materials and patterns from one model to the next, or in fashion, with the frequent renewal of original collections. Industry 4.0 technologies allow these challenges to be met almost transparently – even in small companies.

Many tangible benefits

The benefits of the Industry 4.0 model are tangible in many areas. These are the main ones:

01

The availability and analysis of large volumes of data provide **a high level of production visibility**, help **identify areas for improvement** and **facilitate component and product traceability.**

02

Process digitization enables **systems to be interconnected** not only in all stages of the product lifecycle, but also in marketing activities and points of sale.

03

Thanks to shorter lead times, **time-to-market is significantly reduced by between 20% and 50%,** depending on the products and sectors (see page 17 of the Lectra Industry 4.0 Concepts & Case Studies document, June 2021).

04

The company, being more reactive, can adapt or modify production very quickly, or even move toward **on-demand manufacturing.**

05

This helps **reduce inventories of raw materials and finished products**, and **cuts warehousing and transport costs.** By reducing the break-even point for products, the company can achieve economies of scale on smaller volumes.

06

Predictive maintenance, enabled by the availability of data and the digital twin of processes, **reduces machine downtime.**

07

Digital design and simulation prevent design errors and **open the door to the creation of new products and services.**

Finally, employee involvement, reduced waste and rejects, improved quality and the ability to control the entire production run and not just a sample batch, are all advantages that quickly impact company revenues.

After adopting an on-demand production solution, outdoor pool furniture manufacturer **Leisure Creations** saw improvements on several fronts. For example, it increased fabric-cutting productivity by 20%, while reducing fabric waste by 20%, equating to savings of around $12 per meter. Greater precision in cutting and sewing reduced the number of errors and remakes. A total of 200 man-hours were saved, allowing teams to manage tasks with higher added value. Not insignificant with a 15% average annual growth and ongoing recruitment difficulties!

Huge development prospects

The variety of available and mature technologies, process documentation, interface standardization and the growing number of players (publishers, integrators, consultants) are encouraging more and more companies to implement Industry 4.0 solutions. "With just a few clicks, the cloud provides access to technologies for working on digital twins, performing predictive or big data analysis, printing in 3D or using augmented reality," says Fabrice Nisol.

"The arrival of artificial intelligence, coupled with existing digital offerings and the robotization capabilities of the industry, opens up huge development prospects. We just have to learn to select them, combine them, and master them! "

Fabrice Nisol

Part 2

THE FOUR CHALLENGES TO UNLOCKING THE POTENTIAL OF INDUSTRY 4.0

Produce, integrate and analyze ever more data

"You need KPI's* and data for everything, for each step of the process, for all partners and suppliers, to know what can be done. "

Miguel Angelo

Data, its quantity, and its availability throughout processes, are undoubtedly what characterize the Industry 4.0 model. And this is also one of the main challenges the digital transformation of the industrial sector will face in the coming years. "Data is the lifeblood of a company.

We will succeed in managing the digital transformation of the industry if, and only if, we have data that we know and understand. In other words, you need KPI's* and data for everything, for each step of the process, for all partners and suppliers, to know what to expect and what can be done. Our ability to progress depends on what I call our "collaborative attitude", because no one grows alone!" says Miguel Angelo, Head of Innovation and Industrial Engineering at Valerius Texteis, a Portuguese group specializing in garment manufacturing. The project he currently leads for Valerius consists of **creating a cluster to share the group's vision with all the entities collaborating within its ecosystem.**

The aim is nothing less than to create a **smart factory** that will give each entity instant access to available data in digital form, rather than by exchanging hard-copy tables or information over the phone... And this applies not only to production data, but also to information about the order, the customer, the availability of materials and components, and so on.

Data integration is strategic for streamlining all processes, from order entry to delivery and customer invoicing, from digital design to production line and manufacturing management, from raw materials inventory and supply management to logistics and transport. This capacity for integration has played an essential role in Leisure Creations' decision to get onboard with an on-demand manufacturing solution. "We wanted a smooth end-to-end process, from order entry to delivery of the product to the customer. To achieve this, the solution had to interface with our **Salesforce** cloud ordering system and the data had to be automatically transferred to the cutting machine. We have all the planning information in a condensed dashboard," explains Brent Collum, Engineering Manager.

In its Smart Factory, **Porsche** has prioritized automated information processing. In its plant, production is organized in cells and cars are moved from one station to another based on the operations to be performed on them, from bodywork to painting and assembly. Each station has screens on which operators can view schedule data and operations to be carried out. Porsche has installed at least 1000 screens on its production lines so that everyone has access to all necessary information at all times.

"Every second, decisions are made based on data, whether they involve allocating employees or managing resources"

Tobias Helberg

The omnipresence of data, its increasing volume, its hosting in the cloud and the strategic role it plays in the smooth running of the production process **present cybersecurity risks.** Up until now, you had to physically sabotage a machine to prevent it from operating, now, an invisible and anonymous attack via the networks is enough to bring an entire production line to a standstill. This point should not be ignored in any Industry 4.0 project.

** Key Performance Indicators*

Reconnecting brains and brawn

"Industry 4.0 implies hybridization between systems and people, or even a return to a form of craftsmanship with the unit series concept. "

Dorothée Kohler

From its outset, the Industry 4.0 model and the automation concepts it has generated have fueled (revived) fears of seeing robots replacing people in factories. "But we are seeing the opposite occur. This model enables **'reconnecting brains and brawn'** where Fordism disconnected them," states Dorothée Kohler. "Better still, Industry 4.0 implies hybridization between systems and people, or even a return to a form of craftsmanship with the unit series concept. The tasks that require repetitive and strenuous movements can be performed by robots, while an industrial craftsperson can focus on tasks with higher added value.

This raises the question of how to enhance team competency skills and means that we need to give more thought to career development and break down barriers between design work and manual labor. This reconnection of brains and brawn changes the data in terms of labor cost and geographic location."

Digital transformation breaks down the walls between offices and factory floors. By decompartmentalizing them, it also decompartmentalizes functions and expands the capabilities of each individual. This in turn brings about a transition from manual labor to more intellectual work, which Marco Taish summarizes by saying, "the blue collars are becoming a little whiter!"

This migration of skills raises a number of questions about employee training and behavior. Some jobs will disappear, probably those that require fewer qualifications and diplomas. Other people, mainly in support functions, will have to rethink their jobs and their role within the company.

Employees will need to be trained in new skills and those whose jobs will disappear will have to be retrained.

"Young people see the physical world as a representation of the digital world. When they go into a factory, they see a different world from the one the previous generation sees. "

Marco Taisch

At the same time, new jobs will appear. But those who take these jobs will not be the ones who previously worked on the factory floor, since this transition will also be a generational one. "There are about **600,000 open jobs in manufacturing** in the United States," says Jake Hall, "but no one wants to work in factory production any more, it's considered outdated! The new generation is connected, learns by watching tutorials on YouTube and knows how to use a tablet and a dashboard." The 'old-timers' find it hard to change, to adopt these new technologies; they grew up in a physical world. But for younger generations, the world is digital. "Young people see the physical world as a representation of the digital world. When they go into a factory, they see a different world from the one the previous generation sees. ," says Marco Taisch.

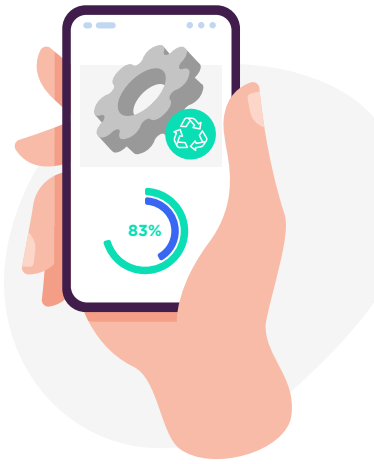
While technologies are evolving faster than generational change, it will be up to human resource managers to meet the challenge of training, recruiting and retaining talent that factories need to make their transition. Because this evolution is inevitable. Technology changes the way we work, "just as ATMs have changed the way we withdraw money," says Jake Hall, who continues: "Artificial intelligence will eliminate jobs just as the harvester did for farmers and ATMs did for cashiers! "

Human resources are one of the critical aspects of the Porsche experience.

The automaker points to the need for – and the scarcity of – new skills, on the factory floor as well as in management, communications, and other functions. For Porsche, the lack of trained employees involves another risk: having to turn to experts outside the company and relying on them long term.

We see it, the human factor is a natural consequence of the Industry 4.0 model, and one of the main challenges for the coming years.

An opportunity for the circular economy



"We expect Industry 4.0 to enable us to quickly collect the data we need and to reliably calculate our emissions at the group and factory level. "

Fabrice Nisol

Because it makes processes more efficient, because it provides accurate data at each stage of production and because it helps significantly reduce errors, rejects and waste, Industry 4.0 prides itself on being "sustainable." For companies, faced with the injunction to be more energy-efficient, more respectful of the environment and to reduce their carbon footprint, this organization of production promises to be virtuous. "With the Industry 4.0 model, we waste fewer resources and we have accurate, shared data on all the processes in our different units. Not only does this help reduce potential errors and therefore waste, irregularities and rejects, it also enables us to see our environmental impact so we can take action to reduce it. Our goal is to do better than yesterday, better than previous generations, for the good of the planet!" says Miguel Angelo (Valerius).

This opinion is shared by **Leisure Creations**, which reduced its fabric offcuts by 20% using its on-demand manufacturing solution, and by **Tesca** which relies on the deployment of its solution to solve quality problems, control energy consumption and significantly reduce its environmental footprint. "We expect Industry 4.0 to enable us to quickly collect the data we need and to reliably calculate our emissions at the group and factory level," says Fabrice Nisol.

Sustainability and respect for the environment are major concerns for the younger generation entering the job and consumer market. "They are **conscious and well-informed consumers.** They are sensitive to the subject and are not fooled by greenwashing," says Marco Taisch. With this generation, a new axis is also appearing, the circular economy.

"Ambitious recovery and recycling goals will be harder to achieve without digital technology and Industry 4.0," says Jean-Daniel Weisz. He cites the example of a company that produces thermoformed trays for transporting products, trays that are rarely reused or recycled. "Thanks to RFID chips, the company can track the trays, recover them at the end of the cycle, check them, put them back into circulation or, if they can no longer be used, crush them to produce new ones. This traceability also allows us to provide customers with information about their own intra-industrial logistics." In other respects, the traceability possibilities provided by the digitization of processes add to the virtuous side of Industry 4.0. As long as you use it... and use it well!

"Ambitious recovery and recycling goals will be harder to achieve without digital technology and Industry 4.0"

Jean-Daniel Weisz

Agility, time and again

One of the assets of digital technology is the flexibility it provides. Thus, with an Industry 4.0 model, processes are adaptable, modular, and reconfigurable according to the requirements of the business. This asset is invaluable in our economic climate where rising interest rates, inflation, price hikes and therefore higher costs can turn markets upside down in no time. The Industry 4.0 model strengthens the resiliency of companies, gives them back their agility and makes them more resistant to market hazards. It enables them to react to a sudden slowdown or resumption of orders, modulate their supplies, make their supply chain as agile as possible, manufacture on demand and integrate their partners and suppliers into their ecosystem.

This modularity and adaptability are also driving change in business model development.

Pioneering companies in Industry 4.0 are starting to sell their services and advice, a way for them to share, but also monetize, their experiences.

And this applies not only to large industrial groups, but also to SMEs. This is the case for **JPB Système**, which produces self-braking systems for the aerospace industry. "After setting up the model to meet its own requirements, the company now resells the Industry 4.0 solutions it has developed," says Jean-Daniel Weisz. Others market new products or solutions that they developed thanks to the digitization of their processes. In jewelry or cosmetics, for example, customers can create their own models using base models offered on the company's website.

CONCLUSION

The transitions underway in all economic activities – digital, ecological, energy, as well as the rapid evolution of consumer needs and demands, require the industrial sector to optimize all its processes, and in particular, **to thoroughly reorganize its production methods.**

This is what the Industry 4.0 model offers.

Successful implementation depends on companies being able to integrate all players in their value chain into **an extended, digitized ecosystem.**

This ecosystem must include product designers, brands, creators, as well as suppliers, partners and customers in a virtuous continuum in order to manufacture the right products for consumers at the right time with the right quality and at the right price.

Manufacturers who succeed in this integration will not only be able to produce more and better, but also with optimized lead times and costs. The companies who have shared their experiences in this white paper are proof of that!