Industry 4.0 & how manufacturing is adapting to the new technologies

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Abstract

Producing various objects is old as mankind. Basically every product realized by individuals or groups can be assimilated with a basic manufacturing process. During times, humas managed to manufacture objects for their own usage or for commercial purposes, into small workshops and using basic tools

1 A brief history of Industry X.0

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A first major shift came during the First Industrial Revolution (Industry 1.0) in the 18th century where, instead of items being produced by basic means, processes were invented and allowed items to be produced by machines. This began in England in 1760, then finally reached the United States by the end of the 18th century.

The First Industrial Revolution marked a shift from an agrarian and handicraft economy to one dominated by machinery and significantly impacted industries like mining, textile, glass, and agriculture.

The dramatic reduction of material cost and production time impacted several industries including the textile industry. Prior to this period, textiles were mainly made in people's homes and merchants would provide the basic equipment and materials needed. This meant workers would make their own schedules, which made it difficult to regulate. Inventions as the steam engine, the spinning wheel, and the water wheel changed the face of manufacturing and set its path to an innovation that is present in our days.

Because the demand was greater than the supply, one major downside of those times it was the pressure on the lower working class. Until 1833, almost no standards existed for workers, which meant long hours and dangerous working conditions, especially for children. This led to the 1833 Factory Act, which placed restrictions on the working hours of children and set standards to protect workers.

The next shift in manufacturing is the period between 1871 and 1914, known as the Second Industrial Revolution (Industry 2.0), as result of extensive railroad and

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telegraph networks, which allowed for faster transfer of people and ideas. Introduction of electricity allowed factories to develop modern production lines. As fact, the first assembly line was patented in 1901 by Ransom E. Olds, producer of Oldsmobile cars. His method allowed his company to produce 20 units per day, which eventually increased their output by 500 percent in one year. As effect, Oldsmobile was creating more vehicles, allowing a drastic decrease of prices in the same time. The method used by Olds ended up serving as the model for Henry Ford which created his own system. Ford is now credited as the actual father of the assembly line as well as of automotive mass manufacturing.

The Second Industrial Revolution was a period of great economic growth, with an increase in productivity, but also caused a surge in unemployment since many factory workers were replaced by machines.

The Third Industrial Revolution (Industry 3.0), also known as the Digital Revolution, began in the ’70s in the 20th century through partial automation using memory-programmable controls and computers.

The central point of this phase is the mass production and widespread use of digital logic, MOS transistors, and integrated circuit chips, and their derived technologies, including computers, microprocessors, digital cellular phones, and the Internet. These technological innovations have transformed traditional production and business methods. Basically, we can say that the digital revolution converted technology that had been analog into a digital format.

Is important to mention that Industry 3.0 is still present, most of the factories being at this level of evolution.

2 The Fourth Industrial Revolution

Nowadays everybody relates to The Fourth Industrial Revolution, known as Industry 4.0 - an union between physical assets and advanced digital technologies -like Internet of Things (IoT), Artificial Intelligence (AI), robots, drones, autonomous vehicles, 3d printing, cloud computing and others, that are interconnected, having the possibility to communicate, analyze and act. Organizations adopting Industry 4.0 are more flexible, responsive and intelligent, therefore more prepared for data-driven decisions.

Industry 4.0 originated in 2011 from a project in the high-tech strategy of the German government, which promotes the computerization of manufacturing. Actually the term "Industrie 4.0" was publicly introduced in the same year at the Hannover Fair.

There are four design principles identified as integral to Industry 4.0:

- Interconnection — the ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of things, or the internet of people (IoP)
- Information transparency — the transparency afforded by Industry 4.0 technology provides operators with comprehensive information to make decisions.
- Technical assistance — the technological facility of systems to assist humans in decision-making and problem-solving, and the ability to help humans with difficult or unsafe tasks

- Decentralized decisions — the ability of cyber physical systems to make decisions on their own and to perform their tasks as autonomously as possible.

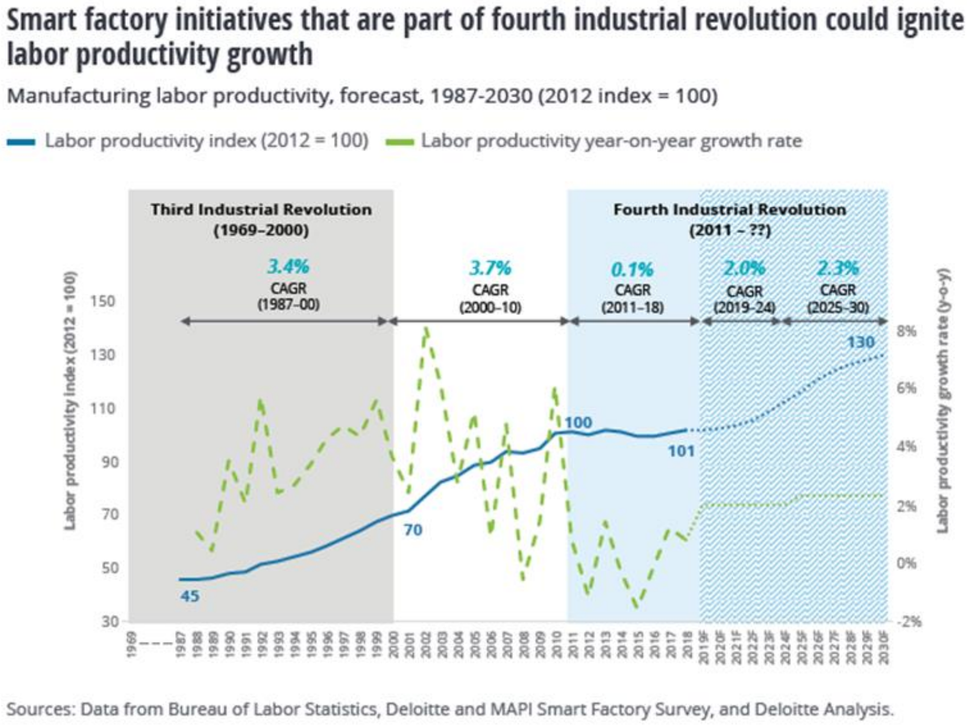

Fig.1 Industrial Revolutions

Since 2011 the focus of technology companies was to include the newest technologies into their products and deliver Industry 4.0 principles into real production. This also was possible due to an unprecedented evolution of technologies, easy to adopt and integrate, shorting the time for creating and launching of new products.
The reality showed that for some years after 2011, Industry 4.0 solutions struggled to gain traction, manufacturing companies being reluctant into changing their processes.
Meanwhile, between 2010-2018 studies show that manufacturing productivity appears to be stuck. Labor productivity continues to perplex most manufacturers, posting annual growth of around 0.7 percent between 2007 and 2018, in a stark contrast to the 3.6 percent average annual growth rate seen between 1987 and 2006. With other words, economic output is moving in lockstep with the number of hours people work, rather than rising as it did for much of the last seven decades.
Taking into account the market and the adoption speed, it is estimated that in the next 10 years there will be two steps into Industry 4.0 evolution : (1) 2019-2024, a slower phase, then (2) 2025-2030, when factories will adopt with accelerated speed the new technologies.

The numbers are based on studies that estimates 85 percent of manufacturing decision makers believe smart factory initiatives will be the main driver of manufacturing competitiveness in the following five years.

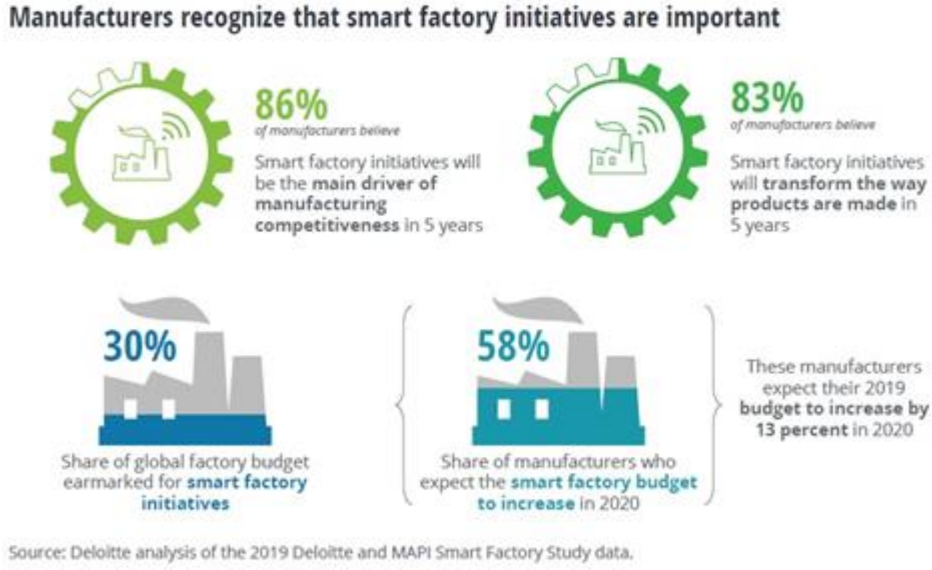

Fig. 2

As a conclusion, the market is starting to embrace Industry 4.0 technologies, even all started at a slow adoption rate since 2011, and understands that the value added by new technologies will boost productivity and profits.

3 The path to new technologies: a big challenge for small and medium manufacturers

When Industry 4.0 was first announced, the early adopters were the companies which afforded to invest and had the human resources to handle complex digital projects: the big enterprises.
The situation has not changed much since 2011: big companies from automotive, aeronautics or other industries had founded research and development centers, hired IT teams, opened accelerators for Industry 4.0 startups. Those companies are investing huge amounts of money into developing technologies related to Industry 4.0 (sensors, robots, software, etc) that allowed them to become real smart factories, to improve productivity and boost profits.
But approx. 80% of manufacturing companies from the EU are small and medium sized companies. They face many constraints, starting from mentality to budgets and digital education.
An extras from a CapGemini Research Institute study from 2020 shows that “organizations realize that they have a massive task ahead in scaling their smart factory initiatives. Of all the organizations that have smart factory initiatives, nearly 60% say their initiatives are either struggling or that it is too early to comment. Only 14% said they would characterize their smart factory deployments so far as a success.”

The major challenges faced by manufacturers in achieving performance at scale are seen as following:

- Deployment and integration of digital platforms and technologies (for 51% from study responders)
- Data readiness and cybersecurity (46%)
- Hybrid, soft, and digital capabilities (45%)
- Leveraging data to continuously improve operations (42%)
- Vision, leadership, and transformation (40%)
- Being efficient by design (38%)

Another big challenge met in all small and medium factories is the level of digital education of employees. People are not used to work with digital systems and to change this a massive effort is needed from their employers. In many cases, decisions not to acquire a digital system are taken exclusively due to lack of personnel digital knowledge, a situation that leads to a vicious circle : digital solutions are not implemented due to people's lack of knowledge, and people do not gain more knowledge due to lack of digital solutions at their workplace.
To help small and medium manufacturing companies to digitally evolve, the future I4.0 solutions and vendors need to take into consideration simultaneously aspects like:

- Affordability : as possible, the solutions offered should be packed as service (SaaS)
- Ease of use : the usability should be facing the fact that many users have almost no digital education
- Technology usage : complex technologies should be transparent for end users. Augmented analytics, natural language understanding and others should ease the mission to adopt the solution for end users
- Reachable support : when users have questions, vendors need to be there on multiple channels like web chat, phone, mail - whatever is handy for end users.

4 The story of KFactory: the role of startups into Industry 4.0 ecosystem

Part of the Industry 4.0 solutions ecosystem at EU level is KFactory (www.kfactory.eu), a Romanian based startup.
KFactory is positioning itself in the first wave of Industry 4.0 startups which disrupts the manufacturing industry and innovates a core process specific in all sub-sectors - performance management of production line - the most important issue for manufacturing CEOs (as described in all relevant studies).
KFactory targets exactly the companies described above - small and medium companies, without IT knowledge and important investment budgets.
Flexible and intelligent, KFactory provides decision makers and managers with a clear picture of performance, resource utilization and efficiency. The system is able to

signal in advance the possibility of production incidents, either of a technical nature, either related to supply, maintenance or quality.
KFactory started as a product dedicated to data collection and data analytics. It evolved in time as a platform with four major components :

- KFactory Core, collects data from various sources and actors, and understands the process, showing weak points.
- KFactory Analytics, a business intelligence tool that wraps up historical data, correlations, trends and patterns, delivering a clear view over factory performance.
- KFactory Knowledge, dedicated to predictive performance and predictive maintenance by learning from actual data.
- The Team of Virtual Engineers, an unique solution that allows operational personnel from factories to interact with data and internal processes using Microsoft Teams

KFactory is proposing to tackle top 10 operational issues for manufacturers :

1. Data collection is manual or not working as it should
2. Decisions are hard to made because events are not visible in real time
3. Human actions affects substantially the production process
4. The performance of the production line is not high enough
5. Processes like maintenance, quality and supply chain needs improvement
6. The factory has a complex IT landscape, with multiple data sources
7. Advanced IT solutions are used, but context analysis is complicated
8. Long and exhausting meetings are often required to understand root causes of problems
9. Entire teams struggles with data aggregation and report consolidation
10. Data is isolated inside departments and not used into daily decision-making process

The various KFactory components are managing the issues with dedicated functionalities like automated data collection from industrial equipment, real time

notifications on multiple channels, dedicated analytics engine that allows managers to make data-driven decisions and seamless integration with other IT solutions from the IT landscape.

One good example of how KFactory is helping its customers into resolving operational problems is the rollout from G - Romanian industrial group, a joint venture with a French manufacturer with 17 factories around the world. It holds an annual turnover of 70 million euro and around 700 employees working in a 24/7 regime.

G customers are automotive companies, spread around all continents, but 70% of its production is for its biggest customer - Dacia-Renault group.

The challenges of G in production were multiple :

- No visibility of the production process. Operators were writing down on paper the shift evolution (stop reasons and pieces made), then a data collection team was introducing data into Excel. Usually reports were available for management in 1-2 weeks after the production moment, making any analysis late and ineffective.
- Every time operators were encountering issues, either they were expecting a manager to pass near them and announce the issue, or they were leaving the workplace and starting looking around in the factory for responsibles.
- Due to incomplete and late reports, improvement decisions were almost impossible. Also the entire chain dependent on the production cycle was ineffective, including maintenance, quality, supply chain and commercial.

The G management estimated a loss of around 1 million euro per year in revenue due to the cumulative effect of the operational challenges.

KFactory started the roll-out with two industrial presses as a pilot project. The first objectives were to accurate read data and accommodate operators with the application workflow.

After six months of pilot project, due to the good results, G management decided to extend KFactory to another 8 industrial presses.

Nowadays, KFactory is used on 45 industrial equipment into G : industrial presses, welding machines and robots.

As result of KFactory rollout, the production flow was optimized :

- The operators are interacting with the KFactory mobile app on a tablet near the industrial equipment, giving inputs on projects or stop reasons.
- The tablets read automatically the sensors from equipment, showing production realized in real time.
- When stop reasons involving support teams (quality, maintenance) are raised, KFactory automatically sends notifications using SMS or Microsoft Teams to responsibles. Therefore the entire support process is monitored : from the moment a notification is sent, to the moment that is received, then when the intervention is taking place and its duration.

- Data is available in real time for all managers.
- Reports are sent by email in several minutes after the shift is over, so instant visibility of the production is ensured.
- By integrating a business analytics platform, G managers have access to all data, production trends and patterns, allowing them to take the right decisions.

The following year after KFactory rollout, the measured results were impressive :
The overall performance of the production process was increased by 15%
For a part of industrial equipment the growth was even more - up to 25%
KFactory triggered major decisions at shop floor level, like replacement for three industrial presses which did not perform as required.
The data collection team was reallocated for other activities

KFactory still is rolling out new functionalities for G, adding more value for this customer in months and years to come.

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