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Intelligent factories: toward a new frontier

Exploring the building blocks of the smart factory of the future

Factory of the future

This white paper, presented by Tietoevry in collaboration with KTH Royal Institute of Technology and Radar Ecosystem Specialists, explores the building blocks of the factory of the future.

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Introduction

The road to smartville

Instantly appears in many people's minds is of a production plant run entirely by robots. But robotics is only part of the overall technology stack that will enable today's factories meet the demands of tomorrow's markets.

In just a few decades, industrial manufacturing has changed dramatically in the continuous effort to keep pace with ever increasing market demands. Basically, this transition has occurred in three distinct phases, each with its own pathway to success.

First, the age of distribution in which the widespread availability of products was the driving force. Next, came the age of information, in which data about customers' buying habits and preferences was key, and now the age of mass customization, the age we currently find ourselves in, where the ability to satisfy individual customers' specific requirements is the name of the game.

Of all three, the current age is the most challenging. Customization requires factories to be quicker to respond than ever before, both in terms of production processes as well as decision making in order to support a "lot size of one". And this, in turn, is giving birth to manufacturing plants based on a high level of intelligence, agility and flexibility.

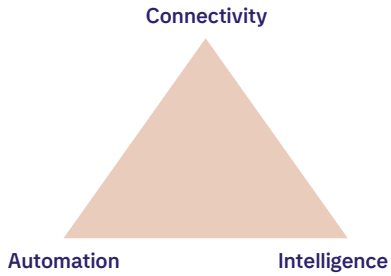
These "smart" factories are unlike any that have gone before. They are characterized by transparency and visibility across the production process, end-to-end, including the entire supply chain. They are places where lead times and change-over times are constantly kept to a minimum; where the use of technology and data drives operational efficiency; and where information technology and operational technology converge.

The rewards that smart factories can generate are well worth pursuing. But the road to "smartville" is not an easy one to travel. It has many twists and turns and technological bumps and pitfalls that must be overcome.

Understanding the building blocks

As always when it comes to technology development, a good starting point is to study the trends. What are others doing? What seems to work well? What doesn't? Can the successes in closely related businesses be applied to your situation with the same positive outcome?

Before you attempt to create a roadmap for any future factory project, it is important to address the three building blocks that must be put in place:



Connectivity is the first priority. Whether you are designing infrastructure to make it possible for employees to access real-time information via various devices, or looking to set up an operation that can be guided by technologies such as augmented reality, real-time visualization of OEE and real-time IoT-based performance management, a high level of connectivity is a must.

The second most important building block is insight, or intelligence, which is built on systems integration, advanced sensors and Big Data analytics. This, in turn, lays the foundation for the smart manufacturing capabilities we read about every day: machine learning, AI, predictive analytics using digital twins, simulations with AR/ VR, Internet of Things and so on.

The third priority is automation. Implementing smart robots will be a prerequisite in many industries for keeping pace with productivity expectations as well as demands for shorter lead times and adaptable output in small batches (customization). But factory automation typicallyconsiders more than operational technology such as robots and cobots. It must also include the automation of decision-making to reduce leadtimes for complex batch set-ups, material mixes and production planning. These processes for automation are essential building blocks, too.

In many ways, this journey is already under way. Data from Gartner's research shows that the market for Robotic Process Automation (RPA) – which enables companies to adopt automation in legacy processes – grew by 63%.

The key enabler for all of these three priorities is to leverage data at the core, which needs to be catalogued and managed for activities and assets across the enterprise. This topic will be unpacked in the fourth edition of the white paper series.

How to jumpstart

the journey to agile manufacturing

Investing in automation technologies and Big Data tools will not automatically guide you to the intelligent and customer-centric factory. So what's the answer? In short, it's all about building an understanding of the next stage of modernization – and putting together a carefully considered and planned roadmap.

In this context, it is worth exploring the four stages on the maturity spectrum which culminates in the factory of the future:

When business leaders agonize over how to go about change, conducting a self-assessment of today's operations is where focus should lie. In order to measure progress, you first need to understand your starting point.

Are you still in the traditional stage of manufacturing or, indeed, genuinely learning the ropes of connected manufacturing? Explore the definitions in the Tietoevry Digital Operations Maturity Model to determine your "state of play":

Fragmented manufacturing	**Intelligent manufacturing**
Connected manufacturing	**Cognitive manufacturing**

Fragmented manufacturing:

The goal of the traditional manufacturing approach is to achieve process stability through standardization and continuous improvements. Performance objectives are managed in silos and so are key functions such as production engineering, maintenance and logistics. IT and OT are still largely separated.

Connected manufacturing:

Connected manufacturers have mastered the art of generating, collecting and analyzing data which is then used to optimize performance. The goal is to understand and control each process proactively based on having a digitized factory-floor. Performance is measured in real time and semi-automated processes mean that personnel in IT and OT can focus on working together to implement embedded solutions. Most companies still rely on descriptive and diagnostic analytics.

Intelligent manufacturing:

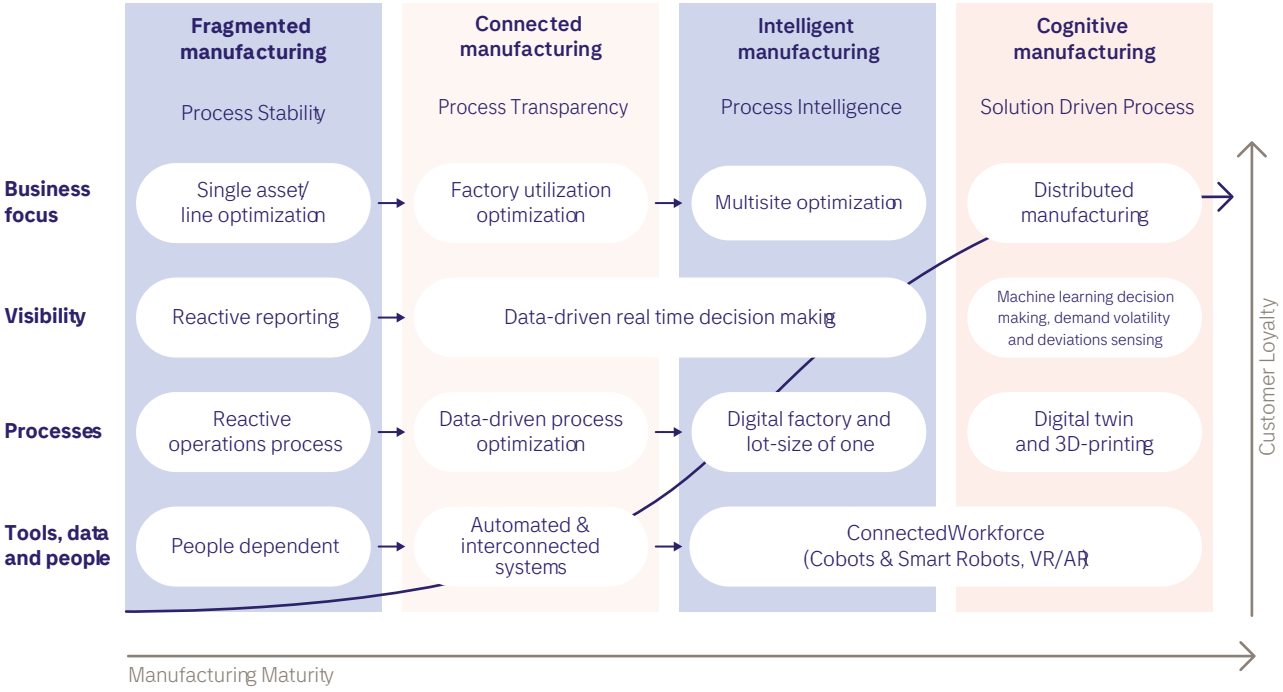
Core processes and production systems are integrated with individual manufacturing sub-functions. Lean management principles are integrated with Industry 4.0 practices. Co-bots are introduced on the shop floor and augmented reality is used to support factory workers and facilitate knowledge transfer. Lead times and production cost are significantly reduced while common ways of working and information transparency are implemented across the organization worldwide. A “digital twin” of operations is launched to simulate changes and unlock predictability.

Cognitive manufacturing:

Cognitive manufacturing is the ultimate destination. By this stage, the production system will become self-aware and self-configurating based on real time input from every facet of manufacturing and customer interaction. A continuous feedback loop of data from stakeholders is fed into the system and lays a new foundation for both adaptability and ecosystem collaboration. Productivity, reliability, quality and safety are optimized on a running basis resulting in reduced cost and minimized downtime. Machine learning, IoT and AI have all become standard tools in the factory operation.

By applying this model of self-assessment based on your current maturity level and capabilities, you are far more likely to start off on the right foot. This saves you time, effort and resources further down the line. The importance of pre-planning cannot be overstated in the transformation journey.

Getting smarter in four stages: where is your company on the maturity scale?



Champions show the way

More and more manufacturers are stepping into the digital world by connecting physical assets to networks. And some companies are blazing a trail for predictive analytics, virtual twins and intelligent operations in line with the factory of the future.

Then
Monitoring of vehicles and parts

Now
90% automation and multiple design variants

From deploying RFID sensors tracing vehicles, components and reusable parts, one of the world's leading car manufacturers accelerated the journey toward intelligent production and mass customization. A virtual twin of the company's concept car assembly line has been launched and the flagship plant is now 90 % automated using self-corrective machines. Popular vehicle models can be produced in more than one million possible variants.

Then
Integrated automation

Now
Smart manufacturing with lifecycle analytics

A global conglomerate specializing in industrial automation, energy and healthcare has increased productivity ten-fold by seamlessly integrating physical value chains. Machines at digital factories carry out 75 % of all labor. With data captured and analyzed via an IIoT platform from 50 million sensors and devices, manufacturing processes can be simulated and reconfigured within minutes. Production quality has risen to 99.9%.

Then
Control system for hot-rolled steel

Now
Flexible automation and real-time dust supervision

By deploying a new IIoT-enabled architecture and platform, one of Europe's largest steel plants achieved greater flexibility and process quality. Engineers can perform machine maintenance and modify the automation control system without slowing or halting production. The connected architecture has improved safety and operational efficiency and reduced the amount of dust in the atmosphere on-site.

Then
Chemicals production

Now
Digitally-enabled products and customization

A large chemicals manufacturer is pioneering the digital transformation of its sector with a pilot smart factory. Augmented Reality apps support employees. RFID tags have been fitted on products that communicate with the assembly line to accelerate predictive planning and efficiency. Consumer products such as schampoos and liquid soaps have been upgraded with customizable options.

Then
Aircraft manufacturing

Now
Digital factory and ecosystem services

A major aircraft manufacturer is reimagining design and shop floor operations by connecting software, hardware and customer perspectives. 3D visualization of manufacturing processes and monitoring of parts has led to shorter lead times, faster maintenance and production agility. The company is also adding digital services to its onboard experience, such as in-flight e-commerce, in partnership with online providers.

Navigating the future

Q&A with Mauro Onori, KTH

Mauro Onori is Head of the Department of Production Engineering at KTH Royal Institute of Technology in Stockholm, Sweden.

What challenges need to be overcome before smart factories can become widely adopted?

“Mainly mindset. When companies see the benefits and understand they are to demand such technology, then it will happen quickly. Companies supplying and building conventional production systems make vast profits on keeping low-tech, so users must start to demand a shift.The technology is practically ready and has been industrially tested already years ago.”

Which industrial sectors will benefit the most in the short-term from the technology shift?

“This is highly speculative, but one would expect start-ups to have a major advantage here. These companies can immediately do things the right way, rather than having to transition all their current methodologies and systems. Also, companies that produce relatively simple products have an advantage. Complex products have large sub-supply chains for example.”

How can companies connect legacy systems to smart automation and still achieve competitive advantages?

“This is the focus of research at the moment – how to transition from legacy to new. The technology is ready, what is needed is a bold new approach to business models and to link sustainability aspects to the equation. There is a lot of ‘noise’ around this. Everyone claims to know how to go about it, but the reality is different. Rethinking business models is the main target here.”

What steps should manufacturers take now to prepare for smart production?

“Initiate a strong and requirement-based dialogue with your production system suppliers. Be aware that a long, stepwise approach is needed and so is a total revision of how one does business. Follow what the main research channels are doing, such as Horizon2020.And try to join consortiums that are moving towards demonstrations of CPS technology.”

Conclusion

The big challenge

Before embarking on the road to smart manufacturing, companies both large and small, need to have a clear idea of their current status.Next, they need to know where they want to be in the years to come. This is probably the biggest challenge facing companies today. Many business leaders have just a vague idea of where their operations are on the maturity curve.

If companies have a clear vision it will make it much easier to start creating the intelligent factory they want and need. To start out small and then scale up step by step is the best way to reach the goal of digitizing your operations.

It is crucial at this point to get stakeholder management on board, i.e. clear ownership and governance. As always, moving beyond strategy to testing and proof of concept will be key to convincing the people who matter most. So let's take a look at the different phases in that scenario:

1. Create a long-term vision:

Outline what your future factory will look like and which processes and decisions should be automated. Establish when you intend to introduce collaborative robots (co-bots) and how humans and robots should interact in tomorrow's production lines. How will real-time insights and predictive analysis be achieved? By establishing a common set of goals you stand a far better chance of getting stakeholders on board at all levels – from executives to factory floor workers.

2. Start small with use cases:

Explore future digital initiatives with one or two use cases that can provide a benchmark. Which measures will create new business value, reduce lead times and speed up throughput for a given process? Remember that technology is merely the enabler. Stay focused on business outcome.

3. Scale tried and tested solutions:

Transfer successful technology solutions, knowhow and adoption techniques to other internal units of the company. Create the best possible conditions for change in all respective regions and focus on upskilling that takes local skills and culture into account.

So now the journey has begun. Manufacturing companies are taking their first steps towards developing the factory of the future. It remains to be seen, however, which of these do it in the most efficient, cost effective, and results-oriented way. Building a solid and detailed roadmap based on the three phases above is your ticket to the future.

Factories that are equipped for the “age of the customer” stand to benefit in numerous ways. Reduced inventory costs and production per unit costs, greater operational transparency and integrated supply chains for ecosystems are all long hanging fruit. Studies confirm that combining lean manufacturing with Industry 4.0 methods unlocks cost savings of at least 40 percent.

Last but not least, by progressing to digital manufacturing and self-optimizing systems, companies will lay the foundation for mass customization. This trend is front and centre of the quest for competitive advantage. In fact, frequent changeovers are already entering mainstream demand in manufacturing alongside rising expectations on speed, reduced costs and sustainability – all of which will set the stage in the next decade.

Manufacturing on the move is a white paper series which is provided for you by Tietoevry in collaboration with KTH Royal Institute of Technology and Radar Ecosystem Specialists.

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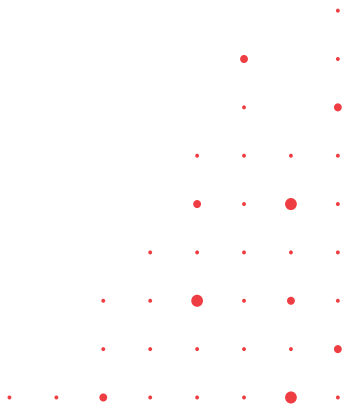

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