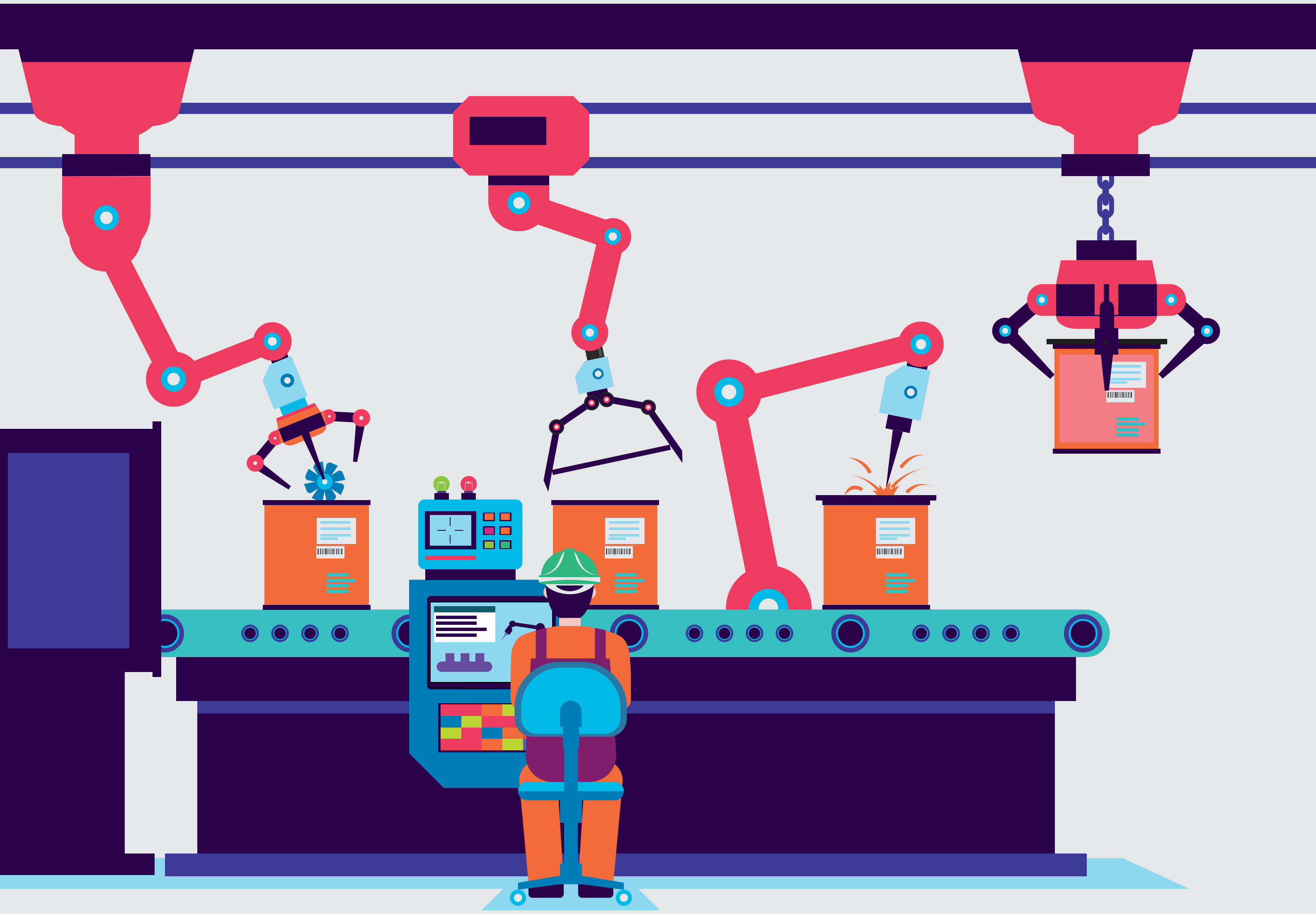
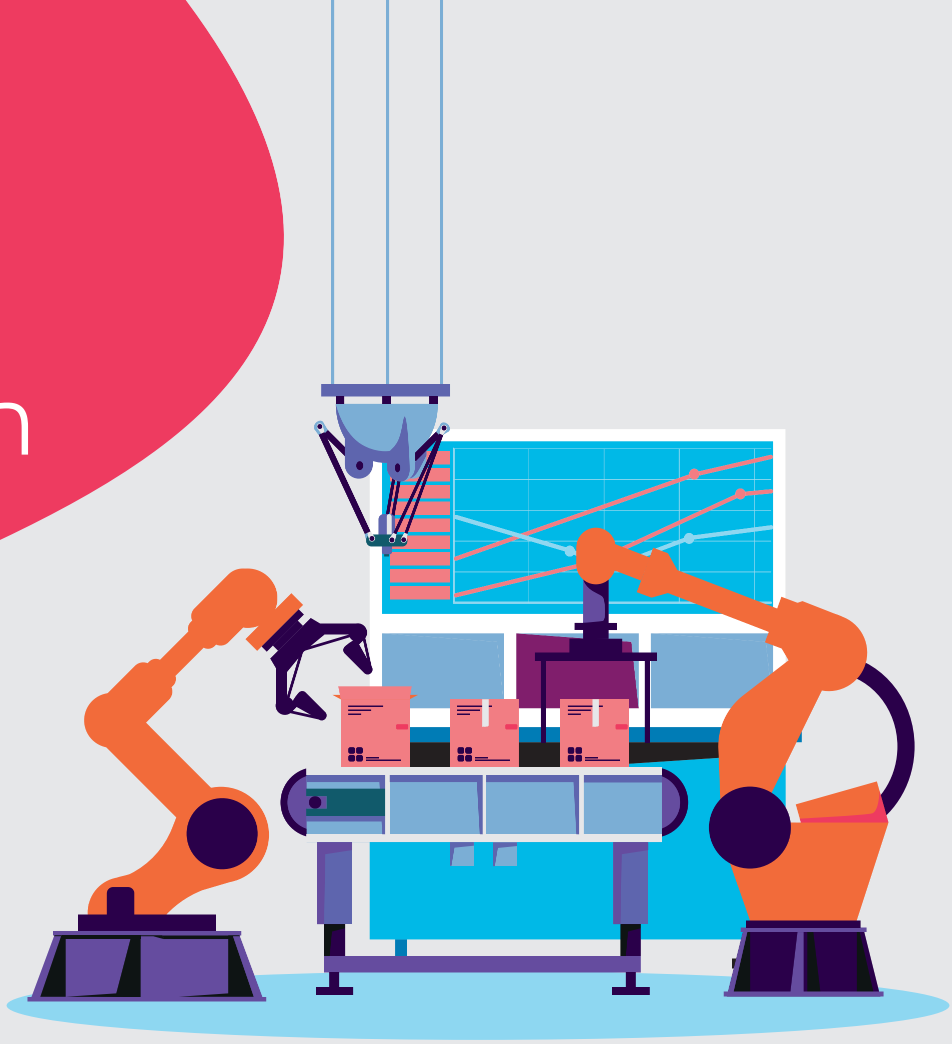
Digital, the next "big thing" in Manufacturing Industries

Digital technologies build upon the foundations of Lean Manufacturing to deliver the next wave of industrial performance



Introduction



Across industries, operations managers understand that "digital" has indeed unlocked a new wave of performance improvement opportunities. IoT technologies make it possible to leverage the wealth of data hitherto locked in production equipment and improve their reliability, performance, and flexibility. Early pilot initiatives have demonstrated that digital technologies help build on the foundations laid by Lean Manufacturing and extend those benefits to entire facilities or even to end-to-end supply chains.

To scale beyond the initial successful pilots, companies realize that they need to bridge the age-old IT/OT gap and achieve seamless integration across the manufacturing "stack" while drastically improving its flexibility and scalability. Here again, IoT technologies make it possible to envision progressive transition—starting with high-impact analytics solutions deployed alongside the existing stack and progressively building a modern manufacturing operations platform.

However, technology is just an enabler; digital transformation will also require a profound evolution of management practices, where data-driven decisions become the norm. This will require that data analysts get out of the IT department and become deeply integrated in operations, leveraging the capabilities of the operations platform to constantly improve supporting analytics and applications.

The digital revolution will not be limited to operations, but rather will extend to the entire lifecycle of production assets. Digital twins will shorten the time-to-first-product of complex production facilities and make it possible to proactively manage their entire lifecycle. The next frontier is not just about optimizing the production of a given product; it is also about shortening the time-to-market of ever faster-changing and more segment-specific products.

Why Digital Manufacturing

We have all read about "Industry 4.0" and the promises of digital technologies including, among others, 3D, Augmented Reality, Big Data, and Artificial Intelligence. These technologies are already deeply impacting:

1. The design and capabilities of most products (smart and connected) we use
2. How products are designed and serviced (end-to-end digital lifecycle)
3. How they are manufactured (faster, better, and higher quality).

The first two opportunities fall under Product Lifecycle Management—a domain with significant growth opportunities that we continue to innovate with major partners.

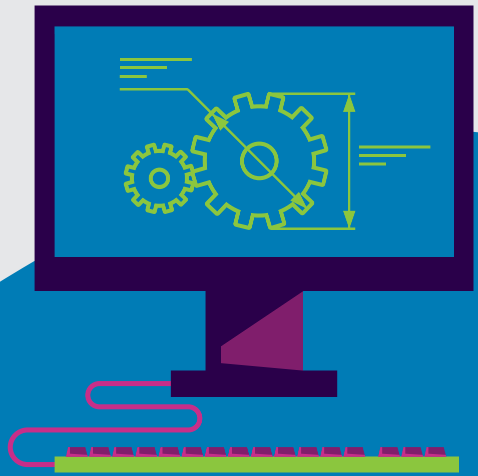
Digital Manufacturing concerns the third opportunity which, unlike the first two, doesn't involve building new things in most scenarios. Most industrial companies are increasingly burdened with massive investments in factories and assets and face slowing and uncertain markets. They simply cannot afford to invest in new initiatives. They need to progressively upgrade their factories, selectively implementing new production technologies while constantly improving performance.

Lean Manufacturing is hitting a complexity hurdle and risks losing momentum

Operating a modern production facility is among the most complex jobs in the industry. Over the last decades, many techniques were developed to manage that complexity by eliminating it. Years of improving simple techniques such as JIT[1] and SMED[2] have converged into "Lean Manufacturing." A Lean plant is a precise choreography that regularly churns out products. However, it does not cope very well with the shrinking lot sizes of increasingly personalized products.

1 Just in Time is a simple and visual method of managing flows in a factory with minimal inventory, sometimes less than an hour's worth of production. JIT increases the visibility of buffer inventories that are reserved for production problems. This allows any operator to stop the line when encountering a problem. This in turn "forces" a culture of understanding and eliminating the root cause of problems.

2 Single Minute Exchange of Dies is another simple method to eliminate the second cause of non-productivity—production change-overs. Initially developed for heavy stamping presses to change the die, SMED helps to prepare for frequent tooling changes required to switch from one product to another and allows to execute the change itself in under one minute.



The combination of increased complexity of production technologies and the exploding variety of products has driven the low-tech beauty of Lean to its limits.

Digital Manufacturing is about the constant "data driven" optimization of manufacturing operations, leveraging the power of modern IT

Since the highly efficient choreography of a Lean factory does not tolerate equipment breakdowns, Total Productive Maintenance (TPM) became an integral part of Lean. As production equipment became increasingly automated, engineers could monitor more parameters and started leveraging statistical techniques to anticipate failures. As computational power grew exponentially, they went from simple algorithms to complex "machine learning" that could anticipate over 90% of the potential failure scenarios of complex production equipment.

Using similar techniques, engineers progressed from preventing failures to optimizing the performance of the most critical assets. Statistical Process Control, as the technique is known, routinely delivers 5–15% performance improvement on continuous processes.

So when Lean reached its limit, the question became—"Can the same techniques be applied to the entire factory or beyond, or even to the entire supply chain?"

The "low-hanging fruit" of applying analytics to manufacturing operations is preventative maintenance.

With their complexity, multiple moving parts, and intense "wear and tear," welding (or gluing) robots are among the most problem prone equipment in a modern car production facility.

Using off-the-shelf technology, a first two-month phase allowed a core team of 10 engineers to build a "minimum viable product" solution. The solution was first used to analyze over 25 million welding and gluing operations and extrapolate the results to build failure-prediction models. It confirmed that failures could be predicted with over 90% accuracy, resulting in eight hours of downtime reduction per week across 600 robots.

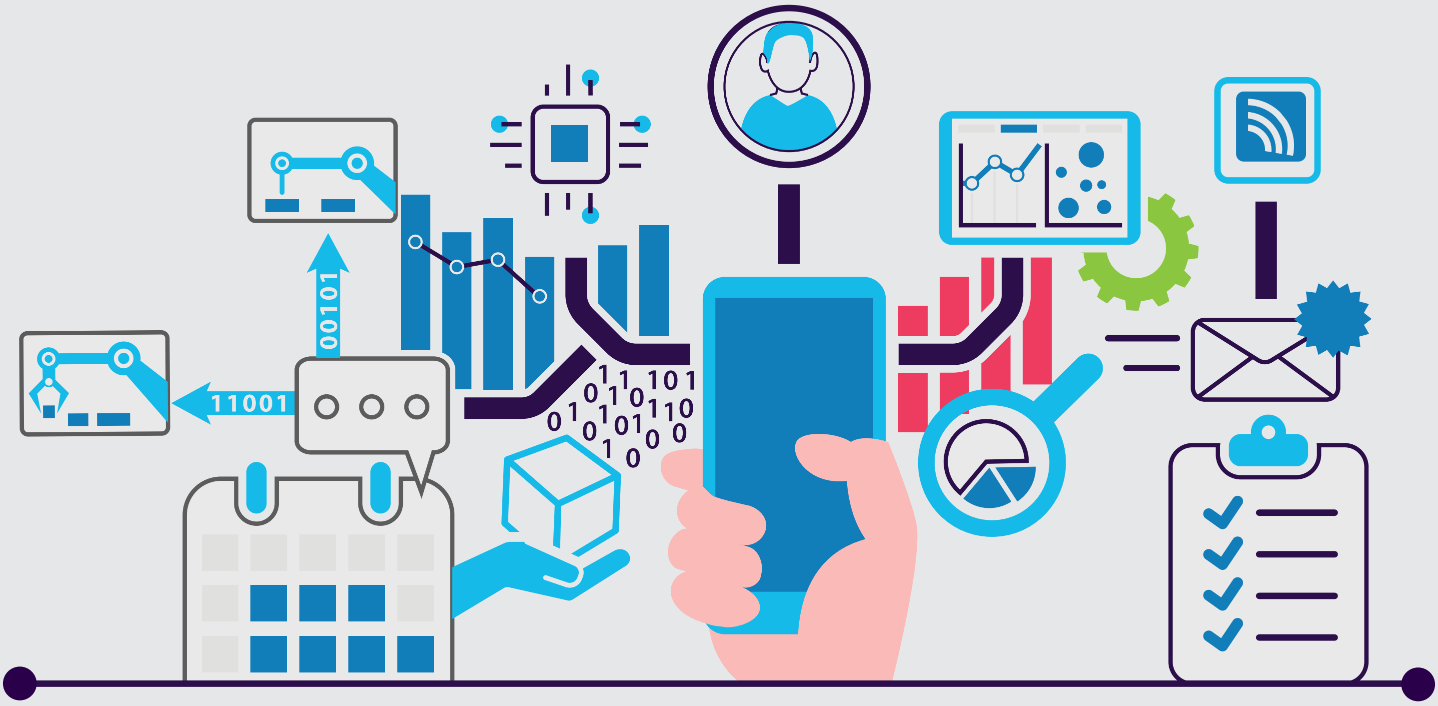
A second three-month phase offers a fully packaged solution to harvest the benefits in day-to-day operations. Once the first application is deployed, the same data enriched with additional parameters makes it possible to attack the second opportunity—the quality of welding or gluing.

Leveraging the power of data will first require bridging the IT/OT gap

Far from being an enabler, the technology—and the IT/OT gap in particular—is a major roadblock to the development of Digital Manufacturing.

Collecting data from an entire factory and its environment to feed optimization algorithms significantly increases the complexity when compared to collecting data from a single machine and its immediate environment. The former must aggregate and analyze data, not only from disparate equipment, but also from production tracking systems and enterprise applications. This is where most companies face several challenges, including:

1. Automation/OT is a world governed by specific and proprietary standards, making data extraction very difficult
2. It is poorly integrated with enterprise level (IT), limited by specific and low bandwidth technologies
3. Neither can cope with the volume and "velocity" of data required to optimize a modern manufacturing operation
4. Any interruption with this fragile "stack" means lost production, disgruntled customers, and a big financial impact.



IoT technologies can progressively bridge the gap

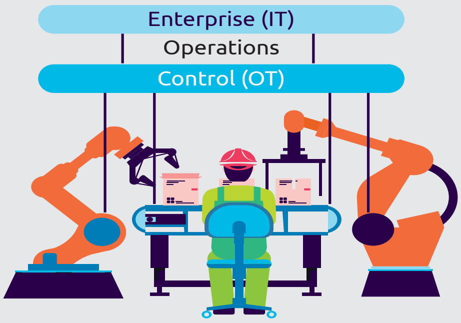
In the absence of the constraints posed by legacy systems in factories, engineers who attempted to optimize standalone assets, such as jet engines, started leveraging the emerging IT technologies to connect those assets (3/4G networks), store the data (Big Data storage), and then analyze it (Big Data analytics).

They soon realized that the successive systems were cheaper, more powerful, and more flexible than their traditional OT systems. Beginning with standalone applications, IoT entered the plant and gave rise to Industrial IoT—the technology innovation behind Digital Manufacturing.

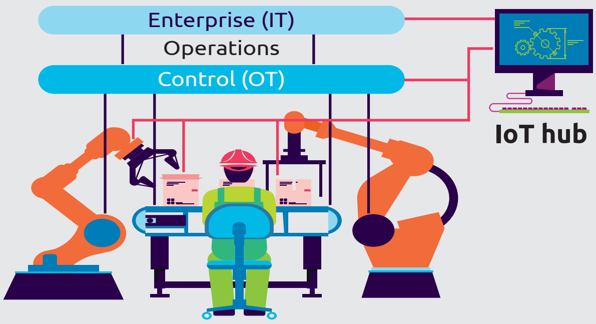
Today, CIOs believe that IoT technologies can coexist with the traditional OT "stack" and progressively bring the "cheaper, more powerful, and more flexible" revolution to the factory.

Digital Manufacturing will accelerate the progressive "softwarization" of automation architectures and the emergence of a new category of "Smart Operations Platforms."

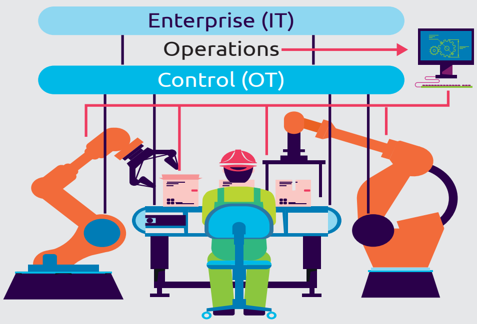
Limited data is collected by the control system, which is loosely connected with the enterprise level, via bespoke operations applications



IoT makes it possible to collect more production data, bypassing the control system, and combine it with existing data into powerful "operational analytics"



Over time, the "IoT hub" becomes the platform on which integrated operations management are built, leveraging open and flexible IT tools



Beyond PoCs, scaling is the next challenge

Deploying Digital Manufacturing will challenge both enterprise architects and automation experts to invent a new Operations "stack" converging IT and OT technologies.

After experimenting with IoT technology as part of proof-of-concept projects, most manufacturing companies are now convinced that Industrial IoT and Digital Manufacturing can indeed deliver the next wave of performance improvement.

However, even though IoT technologies are more flexible than "traditional OT," upgrading Manufacturing Operations—skills, processes, and systems in a safe and progressive manner is a significant challenge that is giving many CXOs pause.

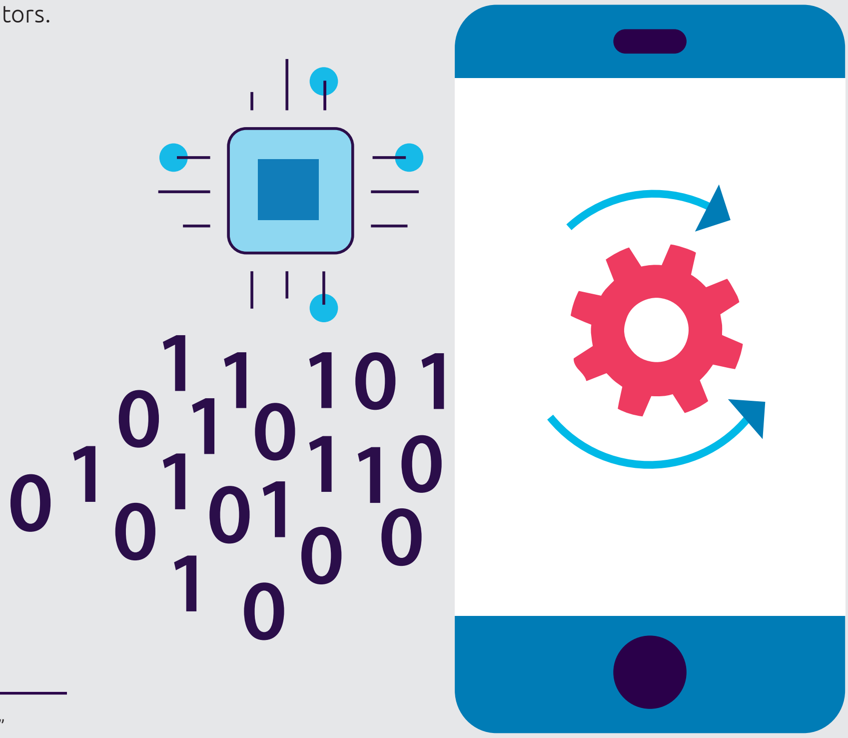
Success will require a new level of collaboration between IT and Operations in designing a roadmap made of self-funded increments that nevertheless add up into a highly integrated and scalable Manufacturing Operations Management architecture.

Digital is not just a technology

As always, technology is just the enabler. Digital Manufacturing, not unlike Kaizen[3], is about the systematic discovery, understanding, and elimination of performance inhibitors, leveraging data rather than casual observation.

Establishing a data culture in the factory that builds on Lean, requires everyone—from the operator to the COO—to experience and progressively master the basics of data-based management. This is why the traditional data analyst, who is typically part of the IT ecosystem and produces rear view reports, is progressively moving to the shop floor to work shoulder to shoulder with production personnel while constantly optimizing the forward-looking indicators.

Traditional (rear-view) Business Intelligence needs to come out of IT departments to the shop floor and evolve into forward looking "Operational Intelligence."



3 Kaizen is the Japanese word for "continuous improvement," where workers look for small improvements that can be implemented quickly, ideally the same day. The purpose of Kaizen goes beyond simple productivity improvement. It is also a process that, when carried out correctly, humanizes the workplace, eliminates overly hard work (muri), and teaches people, using a systematic method, how to spot waste in operations, perform experiments on their work, and implement lasting improvements.

The digital opportunity extends beyond manufacturing

In many industries, like Consumer Goods, the main benefits of IoT will come from the Supply Chain and improving its integration with Manufacturing.

In some industries, like Food & Beverage, manufacturing is relatively simple (not underestimating the complexity of producing yogurt) and involves only a small percentage of overall costs. Here, synchronizing manufacturing with the supply chain, "from farm to fork," is essential to remain competitive.

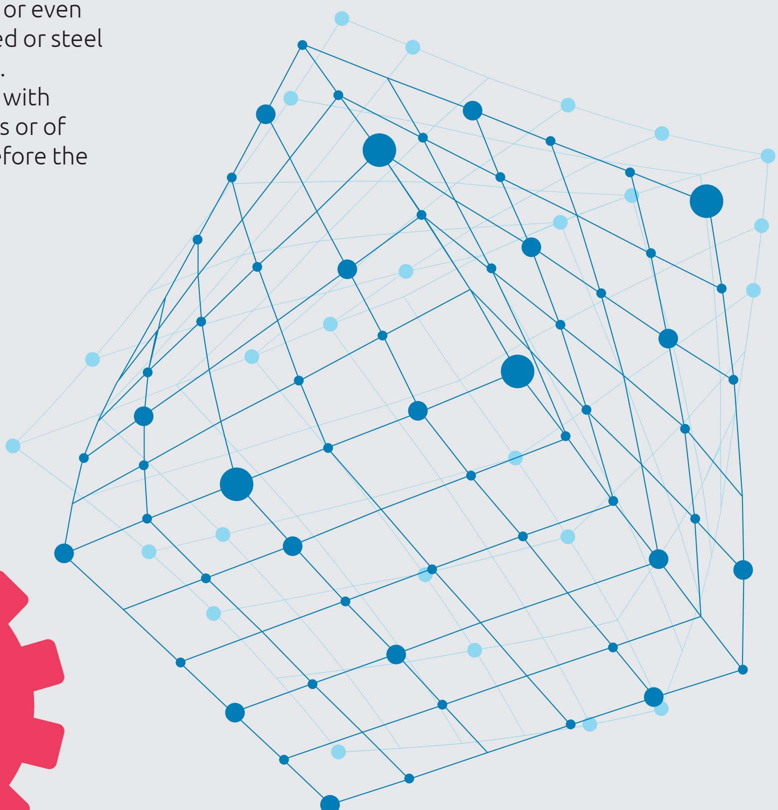
As is the case on the shop floor, the ability to have a real-time status of the entire supply chain, starting with the customer order up to product delivery, and leveraging real-time analytics to adapt instantly, can deliver significant savings and increased customer service.

… and even beyond operations

While industrial organizations mostly strive to improve asset utilization within existing facilities, there will always be a need to construct new factories and distribution centers. Increasingly, new production assets are designed using 3D tools, which opens the other major opportunity in manufacturing.

As it extends from design to the complete lifecycle of equipment, 3D revolutionizes every step of the lifecycle of industrial assets:

1. The 3D model can be used to simulate the line, or even the entire factory, before any concrete is poured or steel cut, thus saving time and avoiding costly errors.
2. In some cases, the 3D model can be integrated with the control system, allowing for testing of parts or of the complete system and training operators before the equipment is commissioned.
3. Finally, once the equipment is operational, live data originating from the control systems is injected into the 3D model, transforming it into a "virtual twin" of the real equipment, line or factory. This virtual twin not only makes monitoring more intuitive for operators, but also makes it possible to simulate potential problems and even anticipate them.



Digital twins will profoundly change the way complex manufacturing assets are built and operated, **significantly decreasing investments and time-to-market.**

About
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