

# Transforming Manufacturing Operations

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The strategy of digital transformation will impact every aspect of an organization. Traditionally, organizations focus attention on the information technology department and processes. However, it also creates the need for major changes in the management and processes of other business functions. Digital transformation fundamentally changes the way data is created and used in the organization. The success of the digital transformation of an organization depends upon how all departments react to the introduction of digital technologies and systems or fail to react. In this paper, the manufacturing operations will be discussed.

## **Digital Transformation**

First, let us quickly review what we mean by digital transformation. The Institute for Digital Transformation defines digital transformation as, “The integration of digital technologies into a business resulting in the reshaping of an organization that reorients it around the customer experience, business value and constant change.” This definition recognizes that digital transformation is much more than just a change in IT technology. A digital transformation goes to the heart of the business processes and transforms them to leverage digital capabilities that were unavailable during the industrial age. Customer demands, including the customer experience, and business value are different in a digital business. Added to that, a digital business doesn’t stop and rest on its laurels, it embraces constant change to adopt and leverage new digital technologies and new business models. This is not your father’s industrial-age company.

## **Digital Manufacturing Technology**

In most enterprises, manufacturing is a system made up of multiple processes. These processes are normally characterized by capital equipment, a manufacturing labor force, the movement and management of raw materials, work-in-process, and finished goods. It is controlled with scheduling systems, quality control systems and work instructions for the actual manufacturing steps. The system is complex. Let’s identify some of the technology aspects of a digital transformation that would have a significant impact on manufacturing operations. This is an illustrative list, not an exhaustive list. In fact, the specifics of each of these technologies is changing almost monthly, so this list is really a list of categories of digital technologies.

- The Internet of Things (manufacturing often refers to it as the Industrial Internet of Things) is a digital technology that has grown rapidly during the past few years. Every piece of equipment in the manufacturing operation can have multiple sensors and monitors that are measuring both the effectiveness of the process and the health of the equipment. This dramatic increase in the number of communicating devices and data

streams require a robust network and real-time communication infrastructure. And with all that data running around, a data security process is needed to ensure the data is not corrupted or hacked. Many of these data sensors are providing direct input into enterprise-wide applications such as an ERP system that is scheduling and tracking costs within the organization. In a complex business, this ERP will need to run in a data center that is often managed within a cloud computing operation.

- The widespread adoption of business analytics provides real-time processed data that is used to monitor and manage the manufacturing processes. Data from multiple sources is aggregated and this data is available at any workstation in the business and in some cases, it is made available externally through a digital platform or on smart devices. These platforms, devices, and associated apps provide monitoring of the manufacturing processes by the management team, the production associates, and the customers.
- Factory automation has been used in manufacturing for decades, but the automation available in the digital age is more sophisticated and is connected into the Industrial Internet of Things. The automation controls both the manufacturing operation at a given workstation, it also can control the flow of materials and inventory through the operation. In some cases, advanced techniques such as artificial intelligence or machine learning may be used to further improve speed and efficiency of the factory automation.
- Additive manufacturing technologies such as 3-D printing are gaining widespread acceptance for manufacturing selected parts or assemblies. This equipment can make parts from plastic, metal or wood materials and create complex geometric forms without the need for designing and testing tooling or other manufacturing aids. The 3-D printers have the additional advantage of requiring little or no changeover as they fabricate different parts

Each of these technologies are continually improving in their breadth and depth of performance. For the purposes of our discussion, the precise performance level is not critical, rather it is the impact that these technologies create on how the manufacturing processes are designed and managed.

### **Transformation of Manufacturing Operations**

Let's consider how the nature of work changes in the manufacturing function due to these digital technologies. It is not just that equipment operates faster and with better quality, although that is almost guaranteed to happen. The most important and fundamental change is that the business model and manufacturing KPIs have changed. Regardless of the product, the goal of manufacturing in the industrial age was to make products "fast, cheap, and good." Achieving these goals allowed the company to be competitive in their industry. A critical KPI for achieving "fast, cheap, and good" was that the production line remains stable and under statistical process control. No changes! New equipment, new operators, new products all created uncertainty which led to slower processes, higher costs, and more defects until the system became stable again. But in the digital age, change has been transformed from an

unwelcome problem to an expected and embraced way of life. Change is now the competitive advantage and manufacturing operations find they are in a state of constant change. This means that a new manufacturing KPI is flexibility to rapidly adjust the manufacturing system for a new or unique product.

This has implications for every aspect of the manufacturing system; both in design and operation. The manufacturing process design is now based upon very small production runs – often a “lot size of one” which is known as mass customization. This changes the nature of the requirements for capital equipment and facilities. Small flexible workshops are much more practical than massive production lines that take months or years to construct and install. These small workshops still rely on automation, but now the automation must be designed to be flexible and can be reprogrammed rapidly by the operator. This equipment and the operators work instructions must not only be flexible, but they also need to be connected to the sales processes so when a customized product is sold, the information needed to make it is immediately digitized and sent to the workshop where the product will be made. In addition, the Industrial Internet of Things and business analytics allows each workshop to provide real-time status and control information to manufacturing management on their output and any problems they have. Resources can be instantly redeployed to accommodate changes in customer demand or to resolve problems and issues that have occurred in the operation. In this environment, the role of both managers and operators changes and will be discussed in more detail below.

### **Manufacturing Business Model**

Let’s look at how manufacturing is different in the digital age business model. We start with the change in customer expectation. Every customer wants and expects a product that is uniquely suited to them. It is customized with their customer profile and adapted to their normal use for the product. This means that for manufacturing, change is not a “problem,” it is now the expected normal condition and the pre-eminent KPI. Whoever can change the best – fastest, cheapest, and with the most quality – has the competitive advantage. The key enabler for that change is data. Data from customers defining what they want and data from the manufacturing process controlling what is produced. In addition to the change in the product, the product demand can spike or evaporate overnight as items “go viral.” So, the ability to instantly scale the operation is also required.

The strategy of mass production of standard commodities has given way to a new term, “mass customization.” This means that the manufacturing operation can produce unique customized products at the same rate that it formerly produced standard commodity products. And it does this at low cost and with high quality. Change, the “enemy” of manufacturing in an industrial age business, is the competitive advantage in a digitally transformed business

In the design of manufacturing processes, flexibility and configurability is now the driver for the design and purchase of capital equipment. Supplier selection is based upon responsiveness, not

cost. and the workforce training program creates multi-skilled workers who can be deployed to multiple areas of manufacturing. The process is designed to rapidly scale up or scale down based upon demand and even be quickly relocated to be closer to the customer demand. Therefore, instead of specialized equipment or robots that only do one function for one design configuration, the manufacturing equipment and process configuration can produce many different products and can switch from one to another with a minimum of setup by an operator.

Digital age manufacturing systems are based on flexible operations and scheduling with a “lot size of one.” This implies a constant reconfiguring of manufacturing process steps, work instructions, facilities, equipment, materials, and workforce required. In this environment, 3-D printing of fabricated parts is significant advantage because it can product totally different parts just by selecting a different program to run. To be this flexible, accurate real-time data and information is needed at each step in the process. This was impossible to achieve in an industrial age business, but the Industrial Internet of Things and business analytics can provide that information. This is the “digital” part of a digital age manufacturing operation. Without these, the business cannot effectively react to the real-time changes.

### **Manufacturing Operations and Control**

While the change to digital technologies has created significant technical challenges, an industrial age business will likely find the change in workforce and culture even more difficult. To manage the continual change that is occurring in real-time, the typical job of manufacturing managers and manufacturing operators’ changes. The operations shift from a top-down command and control management approach to one of enabled operators implementing the continually changing schedule and production. Therefore, the operators in the process must have the knowledge and authority to instantly react to changes in manufacturing demand and to changes in process configuration and process performance. They can’t wait for a manager to analyze the situation, create a new schedule, order material and assign duties. The operators must have the knowledge and skill to quickly setup or reconfigured the digital equipment in order to fabricate the changing products. The operators at the workstations now have analytics they must monitor that makes real-time product and process performance information available. They know exactly how they are doing with respect to, “fast, cheap, good” for every unique part, product, or assembly they are making.

The day-to-day interactions between managers and the operators changes. The manager’s role is no longer the “boss” who tells everyone what to do and how to do it. Now, the operators are in charge of front-line decisions and what to do next in the process based upon each unique item being produced. The manager’s role is to ensure the operators have the correct information at the correct time to do the correct next thing. The manager has become the trainer, the problem solver and the facilitator of communication within the systems and between operators. That means they must let go of power and delegate decisions to the operators.

A concern I have heard voiced is that robots will replace the workers in the digital age manufacturing environment. Robots may replace those individuals making commodity products or doing repetitive identical actions on each product that goes through their workstation. Robots traditionally do one or two things very well and so they are suited to that role. However, in the digital manufacturing environment, there is a critical need for operators to make those real-time decision of what to do next and to setup and configure the equipment and robots that are doing the welding, molding, soldering, or fabrication.

The digital age manufacturing worker operates autonomously at their workstation, but in a team environment that is reacting to the manufacturing demand. They can switch workstations within their workshop at a moment's notice. The digital systems are giving them real-time data and direction. But keep in mind that every item is unique, so the worker must often make decisions about what must be done on each unique item that is being produced. This greatly increased the authority and the responsibility of a digital age production worker.

Digital age manufacturing operates on a very different level and at a different pace than industrial age manufacturing. Instead of driving out variation and turning workers into automatons on the assembly line doing the same operation again and again; those jobs are turned over to the 3-D printers, robots and automation equipment. Now the operators are reacting to the constantly changing demand. They are shifting manufacturing resources and capabilities in real-time to meet that demand. The industrial age worker was hired for his strength and skill. The digital age worker is hired for his agility and judgment. The industrial age manufacturing manager was the smartest and most experienced person in the room. The digital age manufacturing manager is the one who solves the problems the fastest and does the best job of empowering their people to make good decisions.

## **Summary**

Flexibility is the overriding KPI for digital manufacturing. That flexibility is guided by the real-time data from Industrial Internet of Things sensors and the constantly changing demands from customers. The new business model is based upon mass customization and the ability to rapidly scale the production system to meet the constantly changing customer demand. The digital technologies are incorporated into the processes and systems so as to provide data and information to the operators, who are now controlling the process. The managers are facilitators, trainers and problem solvers who ensure their operators are empowered and capable to run their portion of the manufacturing system. Digital transformation within the manufacturing operations is not just an IT upgrade, it is a completely different way of doing business.