DASSAULT SYSTEMES

MANUFACTURING
IN THE AGE OF EXPERIENCE

Position Paper

REACTIVITY RULES: MODELS, SUPPLY CHAINS, PRODUCTION PROCESSES ALL MUST BECOME FASTER, MORE INTEGRATED AND MUCH MORE AGILE.

THE EXPERIENCE ECONOMY AND ITS IMPLICATIONS

The age of the product is finished. Products are no longer enough. Consumers demand more from the things they buy. They want products that are better, cheaper and more customized; they want full-blown *experiences*.

Experience is a concept that has been variably equated with customer service and support, product usability, design, brand, shopping experiences and online interactions with customers. In fact, experience is bigger than product or brand, and far larger than any single touch point.

However, every successful experience requires an efficient way to produce the product.

As a result of pressures from consumers for better experiences, the world of manufacturing, already transformed by waves of technology and globalization, has a new goal, across all markets: mass customization and quick delivery to an on-demand generation of consumers. The traditionally very fragmented manufacturing of yesteryear will simply not do anymore.

Speed and agility in industrial manufacturing operations will require complete synchronization and integration of operations, from digital manufacturing and manufacturing operations management to supply chain planning and operations. Not only will this enable faster manufacturing, but also the modularity and predictive analytics for the agile manufacturing needed to meet consumer demand efficiently.

GLOBAL FOCUS ON MANUFACTURING

This emerging imperative—and opportunity—to knit the traditionally siloed functions of manufacturing into one seamless package is manufacturing's new global focus. However, the solution to the need for simultaneous mass customization and improved time to market is not only the digitalization of previously siloed functions, but also the integration of new digital data being generated by low-cost wireless sensors and cameras on the shop floor.

There are various initiatives underway around the world to achieve these goals. American industry calls this prospect the "Industrial Internet of Things." In France, it's called the "Industry of the Future." Germany is pursuing what it calls "Industry 4.0". And China has launched a "Made in China" initiative to surge into the forefront of smart manufacturing. Everyone is racing toward the same objective.

THE MANUFACTURING LANDSCAPE OF TOMORROW

It is going to take time to integrate the industry's existing manufacturing software and systems to make this global vision a reality. Today's challenges and solutions tend to fall into three areas of the broader manufacturing equation:

Digital Manufacturing handles everything related to helping a manufacturer define the way to produce things. This layer exists between the engineers and the actual shop floor. Because the product has been designed and engineered fully in 3D, the manufacturing processes also can be modeled virtually. This is where the concept of *digital continuity*, or the *digital thread*, first showed its promise: using 3D design data all the way through to 3D manufacturing process models. Expertise delivered in this layer touches on ergonomics, flow simulations, machining, process planning, manufacturing management, robotics, and more.

Virtual models of products are created before anything is manufactured. When those highly sophisticated models, encompassing massive amounts of data, are validated, a factory starts making the product. The challenge for the manufacturers of the future is to extend the *digital thread* beyond the start of production. Product and process models must integrate feedback from the shop floor, the from the supply chain, the distribution network, and even from consumers. Such data should be recycled back into those models to test them and improve them. This is an obvious extension of manufacturing's focus on continuous improvement, now enabled by virtual experience modeling.

More Than A Twin

In today's experience economy, where digital manufacturing is omnipresent, a virtual model encompasses processes, intelligence, connectivity, functional and logical design goals, as well as geometric design. Such a comprehensive model is more sophisticated than a simple "virtual twin." The manufacturing industry is struggling to find a suitably sophisticated moniker for such a complex 3D experience model.

Manufacturing Operations Management is the definition of what happens on a day-to-day basis during production. It connects all the people and machines on the shop floor and assigns them tasks and makes sure that the necessary parts or materials are in place. It is communicating "material requirements" back up the supply chain. It will, in the near-term future, use artificial intelligence in small but important ways. For example, manufacturing operations management efforts will look at all production data and use artificial intelligence to correlate that with the weather, the time of shift changes and other factors to pinpoint times and situations in which quality may suffer. Another imminent application of artificial intelligence and operations management systems is the monitoring of the "health" of shop floor machines to determine when they need routine preventative maintenance.

One of the biggest challenges facing companies with strong manufacturing operations management implementations is the explosion of data being generated by smart, sensor-connected machines and processes. With the rapidly interconnected shop floor via these new systems, manufacturers worldwide can measure and control their processes like never before.

But the question is *how do you understand* this rapid influx of data? This is where the complicated algorithms behind manufacturing systems software become critically important. Do they link all the different functions in the manufacturing process? Do they allow you to make major decisions or do they bog you down? Do they give you visibility or does the massive amount of data obscure a company's critical issues? The ability to make sense of data is a key component of next generation manufacturing in the Age of Experience.

Supply Chain Planning & Operations allows manufacturers to decide how much capacity they need and where they need it. They can improve their visibility into a global manufacturing and supply chain footprint and better synchronize it, attacking bottlenecks through the entire value chain and solving them efficiently.

Manufacturers are struggling to evolve the traditional definition of a supply chain to include not only materials in the hands of suppliers that are necessary for production, but also the products once they've been made. Do they go to a warehouse? If so, they are still in a company's possession and information about them should be integrated into an operations plan for optimization. And once the products are in a customer's hands, information also should be gleaned and integrated. For some products, maintenance or servicing should be part of the equation. Increasingly, the concept of a supply chain will extend all the way from raw materials to how a product is being used by a customer.

It's well-known and well-documented that labor amounts to just a few percentage points of the costs involved in making an industrial product. The rest is in the supply chain writ large. When the famous American robber Willie Sutton was asked why he robbed banks, he said "because that's where the money is." It's the same with supply chains. The efficiency effort should not (only) be focused on labor, but on managing the entire chain of suppliers and distributors, whether internal or external, to achieve major gains in profitability while improving predictability, agility and speed.

Similarly, in modeling production and distribution processes, manufacturers can synchronize, organize, and balance suppliers, as well as their own production capacity, storage and transportation needs.

These three pillars of manufacturing software and systems—Digital Manufacturing, Manufacturing Operations Management, and Supply Chain Planning and Operations—are typically connected in today's enterprises but not fully integrated into a single product or system. The next evolution in the industry will do that. The Experience Economy and the consumer demands driving manufacturers *require* it.

The result of this evolution is a single, federated view of models, processes, operations, and planning optimization that helps target production and greatly reduce time to market. Right now, because of the multiple silos, there are too many lags in design, development and engineering of a product. There have to be many iterations as different silos struggle to come up with a common vision of what they are trying to achieve. They may not be looking at the same images or speaking the same technical language. It's definitely not the most efficient way of working. But if all these stakeholders are connected on a common platform in real time, they will be able to move much faster.

A federated view of a manufacturer's business, a "platform view," can tell you immediately whether a product is "*available to promise*."

A platform view of product and experience development isn't only management and optimization of existing production, but visibility into the supply chain, as well, seeing production data of Tier 1, 2 and 3 suppliers, extending back to the purchase of raw materials. That means if a Tier 2 supplier, for example, suffers a labor disruption or an unexpected quality problem, you will know about it before it affects your own production

schedules. It may be days or weeks in advance, but you will have time to find other solutions. As many executives say in confronting a crisis, the problem is not fixing the problem. The problem is finding the time to fix the problem. It's unfortunate that many manufacturers in this day and age have to halt their production lines to respond to a crisis that could have been anticipated with a full platform view of their production.

Similarly, if a platform integrates forward looking value chain data about how products are being used, as jet engines are monitored after they are installed on airliners, companies can use predictive analytics to recommend when to service the engines so that they do not break down. In short, if all aspects of the business are highly integrated, an event can be seen and dealt with before it actually happens.

The net result of all this will be agile manufacturing and an agile supply chain, shorter production runs and more product customization for customers.

SUCCESSFUL MANUFACTURING IN THE AGE OF EXPERIENCE

Recognizing that consumers are demanding more customized products, it will no longer suffice to make quantities of a product, ship them to a warehouse, and wait for retailers and customers to draw down those stocks. Instead, the consumer is going to walk into a store or go online to a shopping site and say, "Here's what I want."

A tightly-knit platform that integrates products, processes and supply chain, that gives a federated view of a manufacturer's business, can tell immediately whether that product being demanded is "available to promise." You must be able to tell the customer whether you can make the product and how long it will take.

The models of that product, and models of the processes necessary to make it, will show very quickly whether the product can be made, where it should be made, whether all the raw materials and components are available, and how long it will take. "Available to promise" means taking a product demand and projecting it backward up the food chain, so to speak. This can be called "make to order" or "manufacturing on demand."

Without comprehensive, sophisticated modeling, a manufacturer must make assumptions about its capabilities. Essentially, a guess. It's inevitable that some wrong decisions will be made—and customers won't tolerate that.

This modeling also will obviously save money because millions of dollars' worth of products will not be stacked up in a warehouse. Nor does a manufacturer have to spend other millions of dollars maintaining stockpiles of raw materials or components. What point is there in producing something and then waiting to find out whether someone will buy it? That is what most manufacturers are doing today.

Customers will choose designs from a catalogue or online site and even specify what type of material they want. That information is fed backward up the agile supply chain and production bandwidth is allocated, both at the macro and detailed shop floor level.

The Additive Manufacturing Future

Additive manufacturing is making rapid gains in manufacturing, albeit from a low base, and it has clearly moved beyond the mere making of prototypes and short manufacturing runs.

But the real allure is that 3D printing is going to allow entirely new types of parts and products to be designed. Designers will have blank drawing boards, so to speak, that allow them to ask, "In an ideal world, what should this part look like?"

Some of these designers are finding that organic shapes, more in keeping with Mother Nature, are sometimes better and more streamlined than the clunky industrial-style shapes that have prevailed in the past. In one study of what the next generation of a jet engine fuselage should look like, researchers examined the way a swan's skeleton works as a possible model. Under normal circumstances, such an organic model would be impossible to produce, but because additive manufacturing is not limited by traditional manufacturing techniques, such a design is now manufacturable.

Designers also will be able to design a part or a subsystem that can be assembled at one time rather than relying on many different components that must be assembled together. Additive designers can dare to go where no CAD-CAM designer can imagine because the range of topologies available to the 3D designer is so much greater.

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WHAT TO DO?

This platform revolution in manufacturing, from the supply chain, to the processes, to the shop floor, promises to be as big as the arrival of Industrial Robotics and Automation—if not bigger.

Add it all up and it's clear that many industries are engaged in the reinvention of the manufacturing model that has prevailed for decades and even centuries. It is not going to be easy. But the dream of dramatically enhanced agility is luring all of us into the future.

The message to industry is clear: start preparing now because the machines, materials and processes are advancing quickly. If manufacturers have not yet digitized their processes and created the product definitions and models, they won't be ready for the Experience Economy. The competitive losses could be severe.

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