Information-Driven Manufacturing

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Disruptive Information Technologies Will Change the Industrial Sector

It Is Time to Adopt an Information-Driven Strategy
Executive Overview

New information technologies such as cloud computing, mobility, social technologies, Internet of Things, big data/analytics, and 3D visualization have been getting a lot of attention in the industrial community. The reason is that each of these technologies and probably a few others as well, has the potential to disrupt and radically change the way manufacturers do business. Still, manufacturers tend to be conservative and slow to embrace new information technologies. When they do, they often demand concrete references from industry pioneers, together with hard ROI business cases, before considering any information technology investment.

However, this go-slow strategy can be far riskier than anticipated. New information technologies may disrupt not only what happens within the four walls of a plant, but entire business processes throughout the supply chain and across the value network, and do so in fairly short order. The manufacturing environment is increasingly dynamic and volatile. New business models such as “Industry 4.0”, “Industrial Internet”, “Connected Manufacturing,” and “Collaborative Value Networks” are emerging. In addition to a host of potentially disruptive technologies entering the marketplace, companies must also face rapid changes in government regulations, energy and raw materials availability, markets, and competition. By deploying leading edge information technologies, today’s companies can thrive.

New competitors in new markets, unencumbered by legacy systems, may leapfrog to the latest technologies and, based on the new capabilities provided, serve their markets in completely new ways. Existing competitors may seek to leverage technologies to attract your customers with better products and services. Customers will soon expect products themselves to be more intelligent (consider the advent of the “connected car” and the “self-driving car”) and accompanied by a portfolio of software and services from manufacturers.

Manufacturers that choose to stay at the back of the information technology pack will find it becoming increasingly difficult to reverse that decision.
Not only is technology changing at an ever-faster pace, but the resulting hurdles that must be jumped to catch up will become ever higher. Those with better skills in software will be better positioned to succeed. Those who tend to run the latest software revs will be able to react more quickly when things change. So, what strategies can manufacturers adopt to help position them to take advantage of the latest round of technology changes?

This ARC Advisory Group report introduces the Information-Driven Manufacturing strategy and provides a framework for manufacturers to use to determine how to best approach technology decisions.

A Twenty-First Century Approach to Technology Adoption

On the whole, manufacturers have a reputation for being conservative, especially when it comes to new information technologies. Manufacturers in developed economies often have a 20th Century mindset of “run it forever,” especially when it comes to the plant floor. This mindset avoids the cost of technology additions, replacements, updates, and associated disruptions and represented a winning strategy when things were fairly static and the environment didn’t change very much or very quickly.

In the past, this approach often paid off. [See Figure 1] With a go-slow approach to technology adoption, manufacturers could still obtain significant benefits, while avoiding the risk of reaching too far with technology and failing. But in the last decade or so, that has begun to change, with leading companies adopting a “fast follower” strategy to stay abreast of technology changes and help ensure that they don’t get blindsided by competitors who discover a way to use a new technology to their advantage.
Today, changes come at an accelerating pace. Technology is not only flattening, but also shrinking the world; engendering more and better competitors, more volatility, and faster innovation. We are seeing increasing governmental regulations, unpredictable energy costs, and scarce raw materials drive up costs. In addition, the rapid rate of introduction of new information technologies – such as cloud, mobile, big data/analytics, Internet of Things, and 3D visualization - promises to enable dramatic, yet difficult-to-discern disruptions to the business processes, value networks, and people of industrial companies. In this dynamic environment, companies that hold on to the 20th Century technology adoption mindset face far more risk, because there are many more ways that significant disruptions may occur within their competitive ecosystem [Figure 2].

While the 20th Century mantra was “It’s risky to go too fast with technology,” the new reality dictates that, “It’s risky to go too slow with technology.”

Of course, this does not apply immediately and equally across all industries and all industrial companies. But the trend is clear. It’s equally clear that all manufacturers should, at minimum, review and evaluate their technology adoption strategies to ensure that they are appropriate at this point in time, and for the foreseeable future.

**Disruptive Information Technologies**

For several years we have seen a growing trend of information visibility in the industrial space, as companies seek to surface information from existing assets and systems and make it available throughout the enterprise. One of the primary drivers behind the growth of plant floor software has been the
Information-driven companies embrace IT technologies throughout the enterprise. Almost every plant or facility runs the latest version of the appropriate software (or soon will), so that it can operate in a connected, information-driven mode consistent with the rest of the organization.

need to exchange information with business systems and business processes outside the plant. This is becoming even more important, because the pace of change of information technology has accelerated. This section presents a short list of some of the information technologies that are already beginning to impact the industrial segment. Each has the potential to significantly change the normal way companies do business. It is important for companies to have a strategy to deal with the changing ecosystem, and what that means for their own information technology.

**Big Data and Analytics**

Industrial data sets are growing in size. Many sources drive this increase in data, including capturing audio, photographic and video information; remote sensing; information-sensing mobile devices; radio-frequency identification readers; wireless sensor networks; social content and sentiment analysis; and others.

Large data sets are difficult to work with using existing tools such as relational databases, spreadsheets, desktop statistics packages, or visualization software. But the current generation of in-memory, parallel processor servers running columnar databases now make it practical to deal with data sets on the order of exabytes in size, or even larger.

**Cloud Computing**

Cloud computing is a model that enables ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (such as networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. The essential characteristics of cloud computing include on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. At its most basic, the Cloud is a place to run applications and store data online. It is expected that enterprise, supply chain, engineering, and manufacturing operations management solution suppliers will all offer cloud-based solutions, and that these will eventually extend deeper into the plant than many people anticipate.
Internet of Things

The European Research Cluster on the Internet of Things (IERC) definition of the Internet of Things states that IoT is, "A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual ‘things’ have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network." It will likely take several more years before the IoT is substantially realized, but here again the trend is clear, with enormous potential to disrupt current industrial business processes and practices.

For manufacturing, this is a big step beyond embedded RFID tags with onboard data. In the not-too-distant future, cyber-physical production systems will enhance conventional production technology with embedded IT, to allow intelligent production machines and the intelligent products they are building to communicate with each other to ensure quality and optimize and track production.

Intelligent Assets

Physical assets are not only becoming connected to the Internet, to other machines and systems, and to people, but many will also become dramatically more intelligent. These assets are comprised of hardware (physical components, instrumentation, and communications hardware). But software, analytics, and ecosystem play increasingly important roles. The software and analytics provide the intelligence and the ecosystem provides additional support and services for individual assets, fleets of assets, or dynamic networks of assets. With the addition of software, analytics, and an ecosystem; products (physical assets) may be deployed and managed “as a Service.”

The Next Decade Will Bring Dramatic Increases in Asset Intelligence
**Mobility**

Today, smartphones and tablets can provide workers with the latest information at their fingertips. The information and applications vary depending on the worker’s role. Maintenance workers will have work orders, repair instructions, and spare parts availability and ordering capabilities, and the like. Operators will have real-time plant operating information. Executives will have rollup performance information and drill-down capabilities. Everyone will have email and corporate social apps.

Implementing and supporting this can be challenging for IT and typically involves the use of a Mobile Enterprise Application Platform (MEAP). These platforms can typically support multiple types of devices securely; manage the devices; and help create, manage, and deploy applications.

**Social Technologies**

Industrial companies can improve internal and external information sharing through the use of social technologies such as unified communications (IM, videoconferencing, VoIP, etc.) and social platforms that provide community sites, decision-making tools, shared applications, and the like. Social technologies allow employees to find experts, become informed, collaborate, make decisions, get real-time answers, and solve problems.

**3D Visualization**

3D visualization technology enables information to be presented in an easily understood manner. With 3D visualization, a realistic representation of a particular machine or asset might be connected to real-time data and other information and documentation, so that an operator might see temperatures, pressures, and work orders; a maintenance worker might see cycle times, vibrations, and calibration dates; or anyone approaching the machine might see safety information.

**Ubiquitous Internet**

With the growth of 3G and 4G wireless technology, the Internet is becoming readily accessible from most anywhere. This availability will drive ever more machine-based Internet communication in the future.
Disruption Example

We can get some idea about the kinds of disruption that might be expected by looking at a recent example. Consider the growth in “Product as a Service” business models.

Instead of organizing a manufacturing value network to build products to sell to customers, a Product as a Service business may build the products as before; but instead of selling those products to customers, the company provides the use of that product as a service. Instead of the manufacturer selling a jet engine to a customer, it provides “power by the hour” as needed. Similarly, in the case of medical machines, the manufacturer could provide CAT scan capability rather than selling CAT scan machines. In either case, information exchange is one factor that enables the new business model. These machines can be connected via the Internet to third parties and are intelligent enough to share the necessary information to support the new business model.

The Product as a Service model represents a significant change for manufacturers. They can still leverage their expertise in designing and building product and setting up supply networks; but now they need a service organization to ensure that each asset is properly maintained, available, and in the right place to meet service-level agreements with customers. In many ways, this is a completely new business in its own right. In fact, Product as a Service disruptions need not necessarily involve the manufacturers directly. One example is the car sharing model pioneered by companies like Zipcar and positioned as an...
alternative to buying or renting a car for consumers. However, this does not mean that car manufacturers don’t need to be concerned about it.

**Putting Information to Use: Information-Driven Manufacturing**

Information-Driven Manufacturing is a manufacturing strategy that builds on the concepts of collaboration and network manufacturing and embraces newer technologies to achieve and sustain a competitive edge. This strategy explicitly recognizes that avoiding change, while comfortable, may represent a bigger risk for the organization than the risks associated with introducing new solutions where appropriate. However, this is not about technology for technology’s sake, but instead, a rational response and measured means of dealing with the increasingly dynamic manufacturing ecosystem.

Information-driven manufacturers take a holistic view of manufacturing and the production plant’s position within an extended value network. With this perspective, they apply information technology broadly to improve or replace business processes. Information technology has matured to the point where a host of new possibilities can be considered, and the latest set of disruptive technologies only amplifies that trend.

Let’s consider some of the implications of the term “information driven”:

Information-driven companies have a bias toward making decisions based on process and business process data and typically employ software to collect, contextualize, visualize, and analyze the data. With the advent of extremely fast in-memory computing platforms and Big Data analytical tools, information-driven companies are beginning to use ever more massive datasets in a host of new applications.
Information-driven companies embrace IT technologies throughout the enterprise. Almost every plant or facility runs the latest version of the appropriate software (or soon will), so that it can operate in a connected, information-driven mode consistent with the rest of the organization.

Information-driven companies have resources to manage IT systems. But this also means that they are exploring new ways to access computing resources, so cloud computing is an important part of any IT discussion.

Information-driven companies are demand driven. They use information systems and supply chain data to generate real-time signals to their supply, production, and distribution networks.

Information-driven companies are fast followers. They have a bias toward using the latest technology, rather than sticking with legacy solutions.

Information-driven companies put information at their employees’ fingertips. They recognize that smartphones and tablets are a necessary and important tool for many workers, and make the necessary investments in mobility platforms to extend all applications to employee devices. In addition, they give employees access to new analytical, social, visualization, and other new technologies at their devices so they can be highly productive and make better, more informed decisions. Workers are also supported by intelligent training and assistance systems.

Information-driven companies collaborate. Their systems and business processes are well integrated within the enterprise, and they connect and share and information with partners in a real-time ecosystem. This collaboration also extends to social technologies and communities, which can be a good source for marketplace inputs throughout the lifecycle of a product or service.

Information-driven companies are increasingly focused on services. They use real-time data and execution and transactional information systems to invent, promote, and manage new services and business models to their customers.

Information-driven companies actively look for opportunities to expand or even re-imagine their business using connected, intelligent machines. In
information-driven production, products will direct the machines that are creating them, and the machines will organize the production themselves in a distributed manner. Maintenance will be initiated by the assets themselves. Rigid production lines will be modular and more efficient.

Information-driven companies are excellent software companies. With the maturation of IT technologies, it is possible to embed software in all kinds of products. Indeed, software is often the key to differentiating the product by connecting it to other “things” or ecosystems.

Today’s information and analysis technologies can be transformative. With the information-driven approach, companies employ information-driven value networks, business processes, and decision-making to support corporate initiatives such as energy management and sustainability programs; global growth initiatives; and innovation in product, process, systems, and business models.

Information-driven manufacturers recognize that IT technologies will increasingly drive a manufacturer’s competitive advantage, and sooner than many realize. They embrace a technology adoption strategy wherein advanced technology is considered as soon as practicable, and where it’s seen as a virtue to be part of the “early majority,” or even the “early adopter” community, instead of a technology laggard. Of course, ROI and business justifications will remain important, but the cost of falling behind the technology curve should also be factored in.

**Information-Driven Manufacturing Ecosystem**

An important reason for manufacturers to adopt an information-driven strategy is the fact that manufacturing exists in an increasingly dynamic and complex ecosystem. A manufacturer should be information driven not only because it may be the only viable way to deal with issues brought about by dynamic complexity, but because information technology will inevitably be deployed throughout the rest of the ecosystem, perhaps to the manufacturer’s disadvantage.

Disruptions may arise because new technologies allow changes to existing business processes or models. They may be triggered by emerging business drivers and requirements, and they could easily affect various stakeholders in your organization, as well as peers and competitors across the landscape of industries.
On the other hand, the disruption could also take the form of a new, service-based ecosystem carved out from the broader environment, as could be the case in the Product as a Service example.

**Don’t Neglect Core Solutions**

Applications and application platforms supporting ERP/CRM, PLM, SCM, and MOM/MES continue to be important under an information-driven strategy, because this is where the bulk of the transactional and operational
processes are executed. But the tendency to settle on a working system, and upgrade it as infrequently as possible can no longer be tolerated. To remain competitive, information-driven manufacturers will seek to deploy these solutions aggressively throughout the enterprise and update them regularly so as to gain and maintain the latest technological edge.

**Recommendations**

Information-driven manufacturers utilize core solutions extensively. They actively seek opportunities to leverage disruptive technologies to their competitive advantage. Information-driven manufacturers have a bias toward using the latest technology and implementing the latest software updates and therefore they tend to avoid building their own custom systems.

Instead, they work in close partnership with core solution providers, tend to use much of the latest available technology from those providers, and actively drive the providers to introduce new technologies to solve specific problems.

Based on ARC research and analysis, we recommend the following actions for industrial companies:

- Fund technology projects and pilot projects
- Prioritize key technologies and deploy them widely
- Ensure that core IT technologies are in place and up to date throughout the enterprise
- Seek opportunities to disrupt and transform business processes
- Track technology advances and their uptake in your industry and other industries
- Empower the CIO to pursue appropriate technologies
- Change the culture to embrace earlier adoption of technology
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Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/Research/IndustryTerms/

ALM Asset Lifecycle Management
CMM Collaborative Management Model
CRM Customer Relationship Management
EHS Environment, Health, and Safety
ERP Enterprise Resource Planning
IDM Information Driven Manufacturing
IM Instant Messaging
IoT Internet of Things
IT Information Technology
MEAP Mobile Enterprise Application Platform
MES Manufacturing Execution System
OpX Operational Excellence
OEM Original Equipment Manufacturer
PLM Product Lifecycle Management
ROI Return on Interest
SCM Supply Chain Management
VoIP Voice Over Internet Protocol

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