



MANUFACTURING



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DIGITAL MANUFACTURING

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INTRODUCTION

"When you're finished changing, you're finished" – Benjamin Franklin

"By 2020, 60 percent of plant floor workers at G2000 manufacturers will work alongside automated assistance technologies such as robotics, 3D printing, AI and AR/VR."¹

Disrupt or Die

The definition of digital has changed. It is bigger and bolder, always on, real time, visual, intuitive, and getting smarter. Organizations today are faced with challenges introduced by digital—extreme automation, extreme connectivity, advances in Artificial Intelligence (AI) and the Internet of Things (IoT), and changes to security, the nature of work, and the workforce.

Based on how their organization responds to these challenges, 72 percent of CEOs believe that the next three years will be more critical for their industry than the last 50 years.² By 2020, 25 percent of the world's GDP will be digital.³ The mandate for all is to embark on a journey of digital transformation into the intelligent and connected enterprise. The options are clear: to disrupt operations, processes, infrastructure, and workforce—or risk becoming obsolete. In the digital world, it is disrupt or die.

The World Economic Forum estimates that the combined value to society and industry of digital transformation will be upwards of \$100 trillion over the next 10 years. Digital transformation requires a pervasive shift to digitize tools, processes, and information to uncover new paths to value. There are many different routes to success, from technology adoption to building capacity to reinventing processes to partnering with digital innovators in evolving ecosystems of value. This book is an exploration of these paths in context of the manufacturing industry.

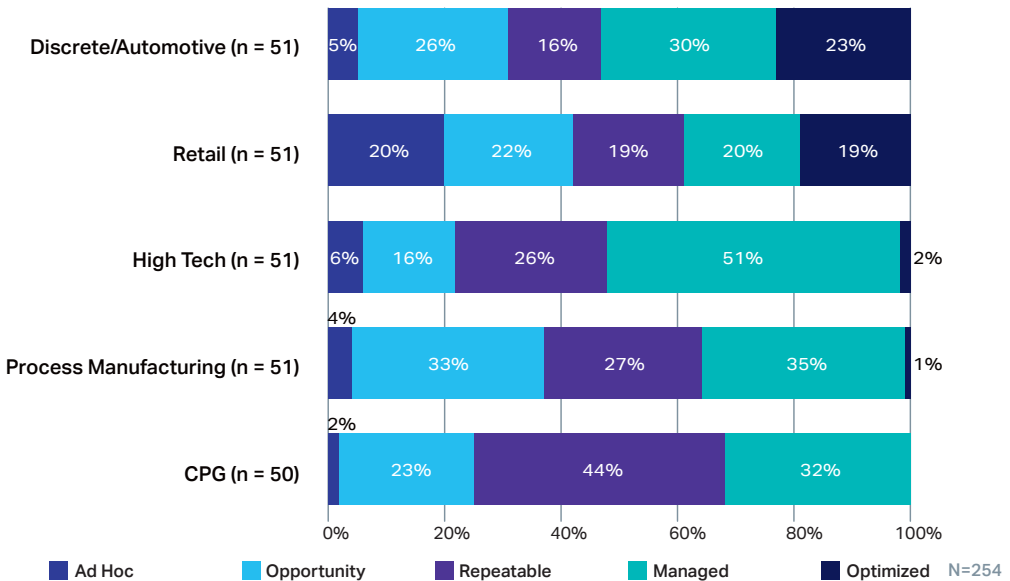
The Fourth Industrial Revolution

We are in the midst of what has been called the Fourth Industrial Revolution, also called Industry 4.0. This digital revolution is being driven by technology advancements in software, analytics, AI, machine learning, quantum mechanics, robotics, the IoT, material science, 3D printing, automated cars, and more. Technological change is unstoppable. The scale of change is larger than it has ever been.

Advances in technology are having a profound impact on the manufacturing industry. The IoT, for example, will redefine human and machine interaction by adding connectivity to every kind of machine, from mobile devices to traditional appliances to wearable devices. Models like intelligent predictive maintenance, proactive replenishment, and inventory monitoring, along with pay-as-you-go, machine-to-machine (M2M) communications and the IoT will make manufacturers more efficient and profitable. The expected proliferation of IoT-connected devices alone will significantly enhance operations, enabling organizations to save \$3 trillion through optimized logistics and next-generation digital supply chains.⁴

Likewise, AI, 3D printing, and robotics are upgrading the industry to digital. At a global level, manufacturers are embracing these new technologies to transform their business models and operations, improve customer engagement, and secure competitive advantage. According to recent predictions, by 2020, as they move closer to the “service economy,” 65 percent of manufacturers will adopt digital manufacturing practices.⁵

Q. Which of the following best describes the state of digital transformation in your supply chain?



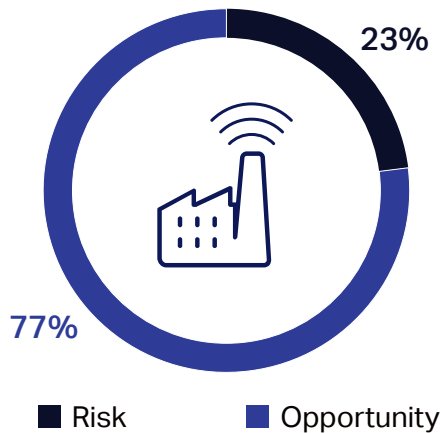
Stages of Digital Transformational Maturity in Manufacturing Industries⁶

Some sectors within the manufacturing industry are embracing the potential of digital faster than others. Organizations in discrete/automotive manufacturing and retail are leaders when it comes to optimizing their supply chain with digital technologies. High-tech is embracing the digitization of products, services, and customer experiences.

Both process manufacturing and Consumer Packaged Goods (CPG) are in the early stages of implementing digital technologies and practices to deliver innovative products and services. In general, discrete manufacturers are the most advanced, while those that produce expensive assets or equipment are lagging.⁷

The majority of manufacturing leaders realize the tremendous potential of digital solutions. According to IDC (see figure below), more than three quarters of manufacturing companies view digital transformation as more of an opportunity than a risk. Despite this recognition, only one in four are experiencing a Return On Investment (ROI) from implementing digital solutions.⁸

Is Digital Transformation a Risk or an Opportunity?



Digital Transformation is a Top Business Priority for Manufacturers⁹

With opportunity comes risk. As disruptive technologies introduce new formats and growing volumes of information, expectations around security, IT infrastructure, and regulatory compliance are rising. Manufacturers require a proven digital information management platform to balance disruptive innovation with security and regulatory compliance.

EIM powers the Intelligent and Connected Enterprise

During this digital revolution, the capacity to generate and collect information is greater than it has been at any time in human history. As the extremes of automation, connectivity, and computing power converge, the need to manage new types of information is critical. Deriving meaningful insight from this information will be the next major transformative activity for manufacturers.

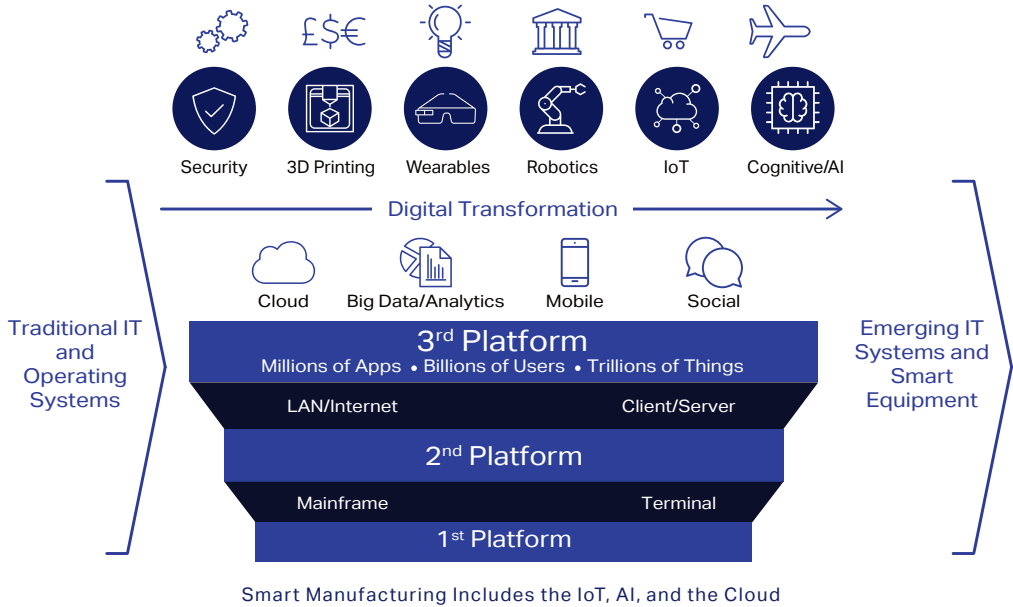
Information lies at the heart of transformational change. To compete in the digital world, manufacturers will be required to manage and analyze their vast stores of information at each stage in the manufacturing process. Information is delivered across business processes, from product design to manufacturing, logistics and distribution, asset management, and sales and aftermarket support, as part of a larger system of ecosystem applications. Advanced Enterprise Information Management (EIM) and Business-to-Business (B2B) integration provides the digital platform that manufacturers need to transform their operations and organizations into the smart factories of the future.

As the basis of a transformational digital strategy, EIM helps manufacturers consolidate information internally across silos and applications and digitize processes, from end to end. Operations are more easily coordinated and streamlined throughout an ecosystem with digital consumers at its hub. At every stage in a product's lifecycle, operations can be automated and analyzed for deeper insights to improve efficiencies, output, and engagement with customers, partners, and suppliers. Empowered with intelligence and connectivity, manufacturers are better able to compete with agility, adapt to market changes, and respond to opportunities for growth.

Digital transformation can only happen when all nodes in the network are connected. For many manufacturers, transforming their supply chain is a strategic goal. More than 24 percent of organizations in the industry believe that the role of digital transformation is to revolutionize the supply chain.¹⁰ While the approach typically takes a tactical route focused on operational efficiencies, it is expanding to incorporate innovative product and service offerings and new business models.

Smart factories are digital businesses that excel at the production and global exchange of goods and services, and can efficiently manage the underlying volumes of cross-border data, communications, and commerce. They rely on tightly interconnected networks and ecosystems to achieve the levels of speed, accuracy, and visibility required for digital supply chain excellence. The ultimate vision of the smart factory is an intelligent enterprise—one that is fully automated, connected, and has the ability to respond and adapt its operations as information changes.

Transformative enterprise technologies like EIM, in combination with the IoT, managed services, and B2B integration, form a comprehensive, secure, and automated platform for the management and exchange of supply chain information. From engagement to digitized processes to governance and insight, EIM is the proven digital backbone for smart manufacturers and factories. EIM brings together key technologies for content services, compliance, automation, discovery, engagement, and AI and analytics, available on premises or in the Cloud.



This book describes how a digital information platform can help manufacturers connect with their enterprise information in new and meaningful ways. The Cloud plays a fundamental role in this. The extension of EIM to include cloud, hybrid, and cloud-to-cloud deployment models is the next logical step forward on the journey to digital transformation.

EIM in the Cloud delivers uninterrupted access to content both internally to departments and externally to partners and suppliers, while ensuring content is consistently available. It brings agility, flexibility, cost savings, and competitive advantage. For these reasons, the Cloud will continue to play a key role in enabling digital transformation in the manufacturing industry. A cloud-based IoT platform gives manufacturers the ability to dynamically integrate multi-tiered supply chain communities and build enterprise IoT solutions for greater efficiency, agility, and new services. Additional value can then be added with cognitive and AI-based operations.


With the convergence of a trillion connected devices, 4 billion connected people, and one million times the computing power, manufacturers have the opportunity to break their data silos and leverage machine learning to unlock the value of their information. Analytics and AI provide actionable intelligence. From implementing more targeted marketing campaigns to improving efficiency through predictive maintenance to greater savings in fleet management, manufacturers can use AI to better analyze and understand their customers, trading partners, employees, orders, invoices, documents and other data managed in EIM repositories.

By 2020 there will be more than 7.6 billion connected things in the business sector, and the annual sales of such devices will exceed \$1.4 trillion.¹¹ With more people connecting and more machines generating information, business will become increasingly digital. As they do, it will become essential for manufacturers to digitize their information-based processes in order to remain competitive. Across every industry, digital leaders consistently outperform their competitors.

In a digital world, with unprecedented opportunities to innovate and evolve, manufacturers will function as intelligent and connected enterprises. They will re-invent their operations to find new customers, markets, and materials. The outcomes will stretch beyond operational efficiencies—to software-driven services, interconnected ecosystems, deeper customer engagement, new revenue streams, and the potential to take collaboration between humans and machines to a whole new level in the global production of goods and services.



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How to Read this Book

A digital manufacturing enterprise digitizes activities throughout the complete lifecycle of manufactured products and the facilities used for production and distribution—from end to end.

Each chapter of this book addresses how Enterprise Information Management (EIM), B2B integration, the Business Network, Managed Services, IoT platforms, and information applications work together to address each stage in the product manufacturing lifecycle.

Using this book, you'll learn how to:

- Embrace Industry 4.0 disruptive technologies for improved insight and agility.
- Transform your business into a digital business to improve efficiencies, reduce operational costs, and decrease time-to-market.
- Optimize the flow of information across the manufacturing value chain.
- Automate your procurement and supply chain processes with a single, cloud-based B2B integration platform.
- Increase the uptime and efficiency of robot work cells, machining centers, assembly equipment, and utilities-related infrastructures.
- Establish consistent, auditable, and defensible Information Governance across your business to comply with internal policies and external regulations.
- Extend your Enterprise Resource Planning (ERP) systems to deliver collaboration, information governance, and process control to operations and associated maintenance procedures.
- Build capacity, fill skill gaps, and manage change.
- Engage with all stakeholders in the extended ecosystem—from partners to distributors to customers with omni-channel delivery for improved satisfaction levels.

The following diagram is a guiding principle of the book. It illustrates each stage of product development with the digital consumer sitting at the hub. Each chapter explores these stages in detail. The topics to be discussed are highlighted in the diagram at the beginning of each chapter.



Each icon pictured below represents a specific stage in product development. When a specific stage is discussed in the chapter, the corresponding icon will appear.

-  New Product Design
-  Product Prototype & Testing
-  Digital Supply Chain
-  Digital Manufacturing & Production
-  Governance, Risk, Compliance & Certification



Plant Maintenance & Asset Management



Logistics & Distribution



Digital Engagement



Aftermarket Services & Support

CHAPTER 1

DIGITAL DISRUPTION



Digital technologies are driving transformation across the entire manufacturing value chain by disrupting all aspects of production, from research and development to engineering and design, factory operations, and sales and support.

Digital Disruption

“The explosion in data and new computing capabilities—along with advances in other areas such as artificial intelligence, automation and robotics, additive technology, and human-machine interaction—are unleashing innovations that will change the nature of manufacturing itself.”¹

The Fourth Industrial Revolution will present manufacturing organizations with unlimited opportunities to acquire new customers, create new markets, and introduce new products and services.

Digital consumers are demanding more customized and personalized products and services. Products are evolving based on smart manufacturing, new ways to prototype (like digital twins), and extreme connectivity. Platforms-as-a-Service (PaaS) are augmenting the delivery of products throughout their lifecycle, enabling organizations to use analytics to monitor both performance and customer preference. Production is evolving thanks to 3D printing and robotics. Same-day delivery and zero-length supply chains are becoming a reality. The supply chain is being replaced by a digital ecosystem; in many instances, the middleman is being disintermediated to allow for more direct relationships between manufacturers and consumers.

To survive, manufacturers in industries like automotive, aerospace, food and beverage, and retail will be required to embrace digital technologies. This chapter examines how technologies such as drone-based logistics, wearable devices, 3D printing, Artificial Intelligence (AI), automation and robotics, and the Internet of Things (IoT) are combining to create the Fourth Industrial Revolution and provide manufacturing companies with unprecedented opportunities to innovate and evolve.

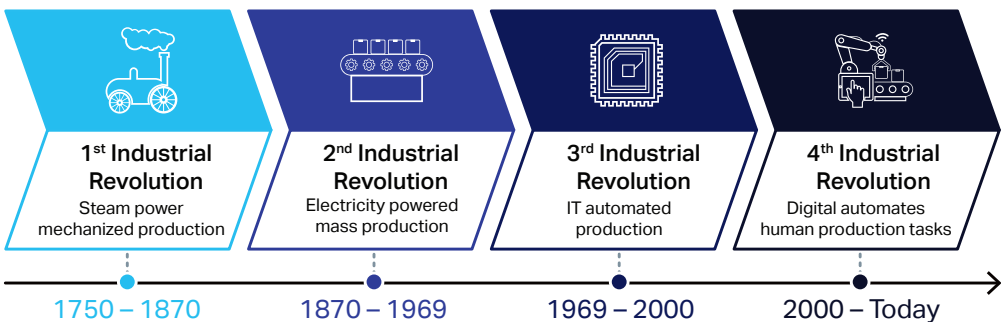


Figure 1.1: The Fourth Industrial Revolution

The Fourth Industrial Revolution

Earlier revolutions have been defined by automation and productivity gains that resulted from inventions like the first mechanical loom, the conveyer belt, and the early stages of IT with the Internet. The next phase in the digitization of the manufacturing sector will be driven by the convergence of extreme connectivity, extreme automation, and extreme computing power.

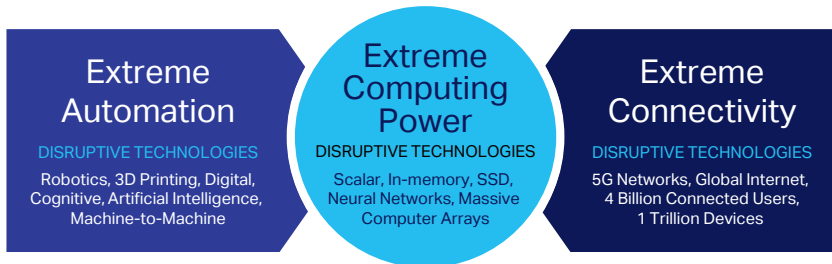


Figure 1.2: Convergence of Automation, Connectivity, and Computing Power

Connectivity is bringing four billion people and one trillion devices together onto the same network. Parts of our lives are being automated through advanced robotics and AI. Computing power is one million times more powerful than it was decades ago. Connectivity, devices, and computing are driving today's wave of innovation on an evolutionary scale. As more people connect with more machines, we are moving closer to zero-distance connectivity with technology.

These combined forces will bridge the gap between the physical and virtual worlds, giving us new ways to interact with machines. So-called "cyber-physical systems" will integrate intelligent sensors, computers, networks, and manufacturing systems and processes. The outcome will be a highly efficient, complex system of machines operating intelligently with each other and humans in real time. This is where the opportunity lies, with information at its core. Our capacity to generate and collect information is greater than at any time in human history; deriving meaningful insight from this information is the next major transformative activity for business that will present new possibilities for new business models.

Manufacturing enterprises will respond by developing platform architectures to support both hardware and software, bringing together engineers and IT departments. The automated car is a great example of this. Joint Advanced Driver Assistance Systems (ADAS) and infotainment systems are creating a more seamless human-to-machine interface in cars. Automotive giants are hiring developers: GM announced plans to hire up to 1,000 engineers in Canada, which will be a major boost for the future of self-driving cars.² Software competence is becoming a key differentiator in the industry, as auto and high-tech supply chains come together to meet consumer demand for smart cars.

In the future, car components will be upgradeable in the same way that software is. This will redefine the automobile's product lifecycle, adding opportunities to engage with consumers to upsell throughout the duration of a car's lifetime. To accommodate this, car manufacturers will establish new processes for product lifecycle management and software development capabilities.

The Impact of Digital Technologies

In the Fourth Industrial Revolution, the technologies that underpin fully integrated and digitized supply chain environments can be placed into three categories.

The first category includes fifth-generation (5G) mobile networks, IoT-related platforms, and other cloud-based network infrastructures. The second consists of the devices that connect to these networks (3D printers, advanced robotics, drones, and IoT devices). The final category describes technologies that help to manage, archive, and process all the information produced by these connected devices, such as analytics, AI, and cognitive systems that can be used to obtain deeper insights about performance, consumers, and much more.



Figure 1.3: Key Disruptive Technologies

Across these categories, the following disruptive technologies are having the most significant impact on the manufacturing industry (especially in relation to supply chain operations):

- **Autonomous Cars, Trucks, and Drones** will impact infrastructure and improve the efficiency of delivery networks
- **3D printing and production** will revolutionize manufacturing with zero-length supply chains
- **Wearable devices** such as smart watches and glasses are helping improve warehouse and logistics management
- **Advanced robotics platforms** like “Baxter” and the “Foxbots” can automate manual production processes
- **The Cloud and the IoT** and their impact on future Business-to-Business (B2B) platforms will improve the efficiency of supply chain networks

The following interview discusses the process of digital transformation in the context of self-driving cars, tracing their evolution from a means of transportation to service platforms, with a reliance on standardization and data to achieve end-to-end digitization.

Deutschsprachige SAP Anwendergruppe

Deutschsprachige SAP Anwendergruppe (DSAG) is the German-speaking SAP User Group, composed of more than 60,000 members from over 3,300 companies in Germany, Austria, and Switzerland. DSAG is the leading and most influential advocacy group for SAP users. Members focus on three pillars: networking, exchanging experience, and exercising influence to extract value from their SAP software while gaining valuable digital transformation insights from peers and thought leaders.

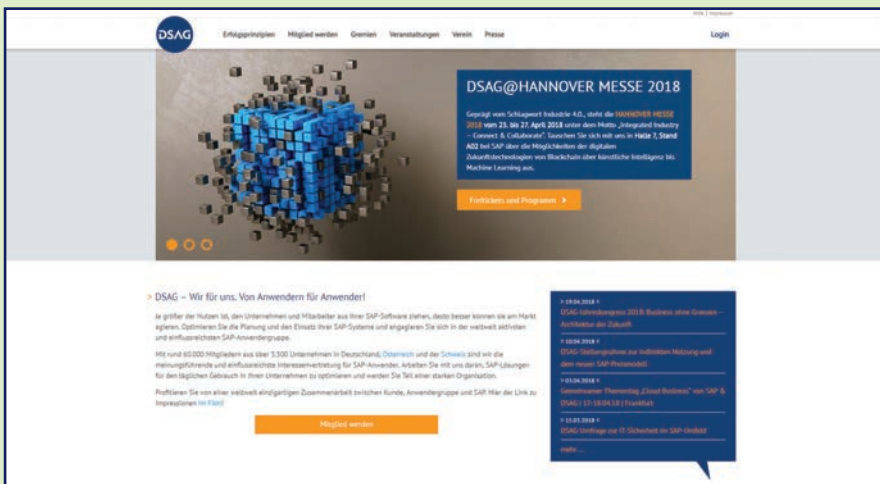


Figure 1.4: DSAG

What follows are excerpts from an interview with Otto Schell, Member of the Board of Directors – Industries Solutions/Digital Transformation, DSAG.

"I have been involved with DSAG for more than ten years. As a member of the Board of Directors, I am responsible for Business Processes, Industries Solution, Globalization, and Digital Transformation. I am also a main contact to international SAP User Groups.

In my world, and among my peers in the DSAG and other SAP User Groups, digital transformation is the relentless pursuit of the conversion of our physical world into an environment represented by information, software, analytics, technology-enabled processes, bits, bytes, and data. For this

conversion to happen, many things need to come together, such as pervasive and omnipresent mobile technologies, infinitely scalable infrastructures—like the Cloud, and connected, sensor-equipped devices (that come together to form the IoT). At the heart of these things is real-time, global information sharing. And for information to be shared effectively, it needs to be digitized.

Digitization is a popular topic right now. A lot of organizations think they are digitizing, but in reality, they are only digitizing a few processes. Or they are just talking about digitization. Very few organizations are connecting the dots across the enterprise for true, end-to-end digitization. The same is true for transformation. Oftentimes, people believe they are transforming their business, but they are only increasing efficiencies and lowering cost. This is not true transformation.

Data and standardization are fundamental for digitization. A lot of people think digitization is about collecting and analyzing big data. But true digitization requires finding patterns and new ways to apply the information that is collected. Digitization means using data. Uber comes to mind. They used their data as an asset to find patterns to create something new. They created a new business model and disrupted an entire industry in the process.

We won't be able to realize the true potential of digitization without standards. Standardization provides the framework to connect everything from people to devices to companies, industries, and governments. The path to digitization is iterative. It starts with end-to-end standardization within the enterprise, then automation through connected networks in the supply chain, and finally with the digitization of business models in the larger ecosystem.

For example, an automotive company that digitizes its enterprise information and processes will have an end-to-end view of all its data. This gives the company the agility required to digitize its supply chain and automate its factory floor with connected, smart technologies (like sensors). With a digital supply chain and connected factory floor, maintenance can be automated, machines can talk to each other, and stock can self-replenish.

When a factory is this smart, customers can order directly from the manufacturer based on real-time availability. If the customer is ordering a self-driving car, for example, the car could deliver itself right to the customer's door. All this is possible because of shared standards across an enterprise, between machines, across a supply chain, and extending into the e-commerce network. The more agile a company becomes, the more it is able to transform. And the more it can transform, the more relevant and disruptive it can be. In this scenario, the auto manufacturer can disintermediate the dealership and sell directly to the consumer. This is true digitization.

My background is in the automotive industry. Over the past 20 years, I've seen a lot of innovation in the industry. Cars have evolved from a means of transportation into a mobility package. I believe in the future they will evolve into service platforms. To me, a car is several channels. Everything in the car is connected—not only information about fuel but information about the brakes, as well as other service requirements. This information can be sent directly to the auto dealer's suppliers. If something happens to the car, if something goes wrong, it's all connected to the service department and even their suppliers. This is all part of the auto ecosystem and the consumer sits at the hub.

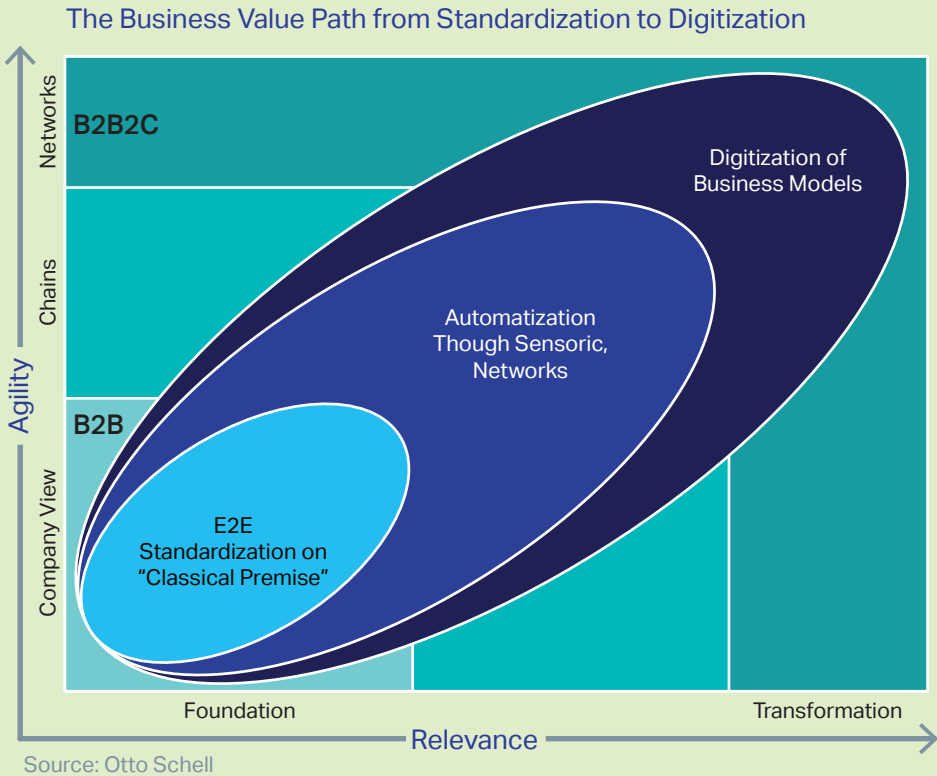


Figure 1.5: From Standardization to Digitization

Like the automated car, 3D printing is also a disruptive technology in most industries, not just automotive. The Aachen University of Technology in Germany recently developed a car where 75 percent of the materials were 3D printed. At the moment, the capabilities are rather basic, with a top speed of 60mph and a range of 80 miles. Even if it takes a sliver of market share away from traditional car manufacturers, that's money that they can no longer invest in research and development. Three-dimensional printing presents the opportunity for industries that currently outsource manufacturing work to other countries to bring much of that work back home.

Soon, everything we do will be influenced or directed by software. Every step of

our lives will be digitized. We will pay for products and services with software, our doctors will use software to operate on us, and we will get from one place to another using our mobile phones to access a service like Uber. Companies will connect software from machine to machine based on the Internet of Things (IoT). And the IoT will connect to everything. There are opportunities to monetize this, or even save consumers money. If someone goes on vacation, for example, they can program their electricity requirements accordingly and be reimbursed based on reduced consumption. This model can be applied to many industries and it will change how we live and work. That is the power of digital transformation."

Manufacturing has been slow to adopt disruptive technologies, leading the cross-industry average only in its applications of robotics.³ According to recent reports, wearables, 3D printing, and machine learning are emerging technologies (with more mature technologies like analytics and cloud computing being mainstream, especially in the retail, high-tech, and automotive sectors). These technologies promise to introduce new capabilities, expanded reach, and new products and services.⁴ Of these, 3D printing will have the greatest influence on the automotive industry, advanced robotics will impact the high-tech industry, and the IoT will revolutionize the Consumer Packaged Goods (CPG) industry.⁵ As these technologies are adopted, organizations in the manufacturing industry will have to restructure their supply chains to incorporate them.

Autonomous Cars, Trucks, and Drones

AI-based algorithms that leverage capabilities, such as reinforcement learning, are driving the development of autonomous vehicles, robots, and drones.

According to recent forecasts, many car manufacturers, including Audi, Ford, Volkswagen, GM, Toyota, and Tesla, in partnership with technology companies like NVIDIA and Bosch, will produce autonomous cars by 2020.⁶ The industry expects driverless cars to be in use all over the world by 2025.⁷ Autonomous transport trucks may hit the road before self-driving cars, eventually automating 1.7 million U.S. trucking jobs.⁸

The ripple effect will extend beyond job displacement; autonomous trucking will completely restructure logistics and transportation industries. Roads, infrastructure, laws, and logistics companies will need to change to accommodate driverless vehicles. Warehouses may even become obsolete, with autonomous trucks doubling as mobile depots.

“Driverless cars will have significant economic ramifications. Dealerships will collapse. Cars will be electric. Gas-powered cars have 2,000 parts in the transmission, electric cars have 20. The average lifespan of a gas-powered car based on mileage might be 150,000 - 200,000 miles. For an electric car, it is one million miles. Car sharing will have the most devastating effect of all. There will be a lot less cars. Considering how many people are employed in the auto manufacturing industry, the impact will be huge. We'll end up with a large number of people with a skill set that is obsolete. Driving will be a luxury.”

– TOM ROBERTS, GLOBAL VP SAP 3RD PARTY TECHNOLOGIES, SAP.

Autonomous vehicles are not confined to the ground. By 2020, Uber plans to have a fully automated fleet in the air, as outlined in their plans for their automated flying taxi service, Uber Elevate.⁹ Drones have already taken flight. A drone is essentially a robot that can be flown autonomously using software, onboard sensors, and Global Positioning Systems (GPS). Used for many years by the military, other, more commercial applications are being explored, such as surveillance and intelligence gathering, farming and crop maintenance, as well as logistics and distribution. It has been predicted that as they come down in price, 12 percent of the \$98 billion spent globally on drones will feed into commercial use.¹⁰

The use of drones will expand to include the delivery of goods like medicines to remote locations, groceries to consumers, and component parts to manufacturers. Amazon has received a lot of press lately with their Prime Air[®] drones that can deliver small packages to consumers. This last-mile delivery of packages is an increasingly important area of development for third-party logistics (3PL) providers. DHL, a global market leader in the logistics industry, is one of the first 3PL providers to leverage drone technology to deliver medicines to remote islands in the Far East. There are initiatives underway to define corridors for air-based drone devices, but drones are not limited to air travel alone.



Figure 1.6: Drone-based Logistics

Starship Technologies, for example, has developed a small autonomous vehicle that has the capacity to carry two grocery bags. The same drone technology could be used to deliver small components from automotive suppliers to a major automotive Original Equipment Manufacturer (OEM). Drones could help streamline the delivery efficiency of parts to car manufacturers to support Just-In-Time (JIT) production environments. While drone-based technologies are relatively new, they offer unique capabilities that support today's production and aftermarket retail sectors.

Increased connectivity will mean greater fuel efficiency and safety. Some analysts predict that there will be around 1.8 billion automotive machine-to-machine (M2M) connections by 2022.¹¹ Connected cars, trucks, and drones will generate a massive amount of data. If this information is adequately managed, protected, and analyzed, governments and organizations will be able to monitor performance and communications between vehicles for greater safety and better efficiency. We could realize significant gains in safety (preventing more than 30,000 fatalities a year in the U.S. alone).¹² There will be improvements in traffic flow and reduced pollution. But issues around liability, privacy, regulations, and cultural acceptance are current barriers to adoption. Future generations may never have to learn how to drive and current restrictions (based on age and disability) will no longer apply. Society will have to adjust to support autonomous vehicles with new skillsets and the knowledge required for maintenance, operation, and any related infrastructure.

In the following interview, a global food manufacturer and supplier is embarking on a transformational project to improve the quality of their products based on intelligence gathered from drones, predictive analytics, and cloud computing.

3D Printing and Production

Three-dimensional (3D) printing is an additive manufacturing process that is computer driven. Using a digital model, objects are printed from materials that include plastics, metals, and even, different kinds of foods. The technology is being developed at a fast pace and is already in use in many sectors, from jewelry manufacturing to aerospace. On the production side, manufacturers such as BMW, Ford, and VW Group are producing 3D metal parts.¹³ The Federal Aviation Administration (FAA) has cleared 3D printed parts for commercial jets.¹⁴

Three-dimensional printing is transforming the design and engineering of tomorrow's vehicles as more parts are being identified for "design for replacement." If a car goes in for service, for example, and a broken support bracket needs to be replaced, rather than ordering a new bracket from a supplier, the replacement bracket can be 3D printed onsite at the dealer's service center and fitted directly to the car. This is the zero-length supply chain in action, which does not involve 3PLs in the delivery of replacement parts. One manufacturer, Local Motors in North America, is manufacturing an entire vehicle using 3D printing. In the same way that Tesla cornered the market in the premium electric vehicle, Local Motors is disrupting the modular construction of vehicles using new 3D printing technologies.

A Global Food Manufacturer

What follows are excerpts from an interview with a director of one of the world's largest food manufacturers.

"As part of our transformation project, we're exploring cloud computing. Right now, we store ten percent of our data in the Cloud. It's not a big number. And the cloud solutions we've used are private to keep our information secure. But things are evolving so quickly, we're more open to adopting public cloud solutions if they are secure and we can maintain ownership of the data. The Cloud is key when it comes to amassing and analyzing large data sets. We are running some analytics on our data. We're pulling information off our systems to help management run our plants as efficiently as possible, which produces a better-quality product adds money to the bottom line.

New ideas spawned from our data intelligence projects are providing new ways to conduct business resulting in cost reduction or improved quality. We're looking at using drone technology in agriculture, which is a huge part of our business. We've been using satellites for years to take pictures of crops and provide us with the information we need to predict what a crop will be like. We can see, based on the colors of the plants, whether they need water or fertilizer or even if they have a disease of some sort. But satellites don't work very well in cloudy weather. Drones can be programmed to fly over an entire field and take pictures. When they land, we can upload that information into our system for crop predictability. That same information can be downloaded into a fertilizer spreader so when it's taken out in the field, it knows exactly where to spread more or less fertilizer, depending on the data.

The other thing we're looking at doing is future crop prediction over two or three years. We're employing weather services that have tons of data spanning many years. Based on the algorithm, you can predict what the weather's going to be like for the next crop season in a certain area of the world. It's not perfect, it's not one hundred percent accurate of course, but it's very insightful. Every region of the world is different—from the weather to the crops to the farmers. We have to be able to deal with them all and technology is helping with that."



Figure 1.7: Crop Scouting with Drones



Figure 1.8: 3D Printed Car

More can be accomplished with 3D printed materials to make them flexible and useful. Three-dimensional printing is evolving into four-dimensional (4D) printing, an emerging technology that enables printed objects to reshape or assemble themselves on-the-fly, based on intelligent data. Examples developed include a printed cube that folds on its own or a printed pipe that senses when it needs to expand or contract. Capabilities like 4D printing will cause a radical shift in rapid prototyping, with objects changing over time to perform functions based on material properties.

As access to printers and the process becomes more mainstream and affordable, the applications of 3D printing technology will expand (along with other additive processes like rapid prototyping and direct manufacturing). Soon, consumers will be equipped to print their own bespoke products in the comfort of their own homes. This will give rise to cottage industries and impact manufacturing in terms of production, distribution, and the experience of shopping itself. This could result in a reduction in labor along with associated costs, shortened supply chains, and less waste and pollution. The data associated with original products (as opposed to 3D printed knock offs) will need to be protected as intellectual property. This will also be true for digital models.

Wearable Devices

Mobility in manufacturing is expanding beyond tablets and devices to include wearable technology. In recent years, there has been an increasing trend in developing apps for wearable technologies to modernize the way people interact with information and processes. Sensors are being embedded into fabrics to monitor both performance and the surrounding environment (such as heat-resistant smart jackets for firemen). Wearable devices have been receiving more attention from the enterprise, driven by the need to provide employees with direct access to smart systems and real-time product information.



Figure 1.9: Logistics Management Via a Smart Watch

Smart glasses enable people to receive information or alerts while remaining hands-on with their work. Volkswagen deployed smart glasses in one of their factories, giving employees the ability to view assembly drawings and videos, and other product-specific information. This helped workers access any digital asset related to the assembly of a vehicle. Wearable devices will also increase the efficiency of the warehouse picker, who can be guided to collection points where they can pick hands-free. Connecting the workforce to information in an immediate and hands-free way allows people to exchange real-time advice or updates, which results in faster time-to-resolution. For large manufacturers, reducing time in the assembly line means significant cost savings.

The ability to view information relating to purchase order status or Advanced Ship Notice (ASN) delivery status improves the transmitting and monitoring of transactions across a business network. One of the challenges faced by suppliers is ensuring that their customers receive their ASNs on time or within the specific delivery window. Many automotive OEMs rate their key suppliers on their ability to deliver ASNs efficiently as they are critical to the smooth running of JIT production systems. Using mapping apps to track shipment deliveries helps to increase end-to-end visibility across a supply chain. For high-value goods such as cars, a smart watch would enhance the logistics management experience with real-time, graphical access to information and intelligence based on analytics.



Figure 1.10: Car Production Using Holographic Images

Just as smart devices will help to mobilize B2B platforms, augmented reality (AR) and virtual reality (VR) will transform tomorrow's B2B and supply chain environments. Technicians can perform maintenance using AR/VR with AI image recognition, following instructions and guidelines for repair. A holographic computer built into a headset, for example, is being used to provide collaborative review processes, not only at the design stage of a new product but also across retail distribution networks where advanced features can be demonstrated to potential buyers. Volvo Cars recently implemented holographic lenses across their dealer networks to allow potential buyers to visualize and experience the various safety features of their vehicles. From giving customers a sensor's vantage point to configuring cars in entirely new ways, AR/VR demonstrates the new ways that technology can bring objects to life.

"We just won a project to do design management for a new hospital and we introduced virtual reality glasses to show key stakeholders a model of the building. This is another exciting technology for us. If we can walk around in a virtual building with a customer and give them information about certain objects on the walk—that will help to engage our customers. This is definitely a technology that will become more prominent in our industry."

—OLE MEYER-SKJØLINGSTAD, HEAD OF INFORMATION AND DOCUMENT MANAGEMENT AT MULTICONSULT

In a digital world, mobile and wearable devices will expand beyond offering personal productivity into tools that provide access to information and business intelligence. The combination of AI and VR results in better and faster ways to address problems. When machines talk to each other across the IoT, the exchange of massive amounts of data will trigger automated responses and deliver greater insights. As wearables and AR/VR find their way into factories, a mobile strategy will be required to enable advanced robotics and digitization.

Advanced Robotics and Automation

In the digital world, an increasing reliance on self-service technology, sensors, M2M communication, and AI will transform the workplace as menial tasks and even non-routine jobs are digitized through robotics and process automation. AI relies on computer systems to perform tasks that normally require human intelligence. Based on more powerful microprocessors, sensors, and improved analytics, smart systems will become more intelligent and applicable to our daily lives. By 2024, 10 percent of workplace activities that can be harmful to humans will require the use of mandatory smart systems.¹⁵

New research shows that nearly half of all jobs will be susceptible to automation over the next two decades.¹⁶ Currently, in the automotive industry alone, one robot is employed for every 10 humans.¹⁷ Over the next 10 years, there will be 60 million robots in the world.¹⁸ The combination of advances in robotics and automation, along with rising wages in developing countries, has encouraged organizations to switch gears from outsourcing and re-invest in local manufacturing and services.

Interest in robotics is sparking an investment boom. After growing at a compound rate of 17 percent a year, IDC predicts that the market will be worth \$135 billion by 2019.¹⁹ Patent filings for robotics technology have increased alongside investments. Competition is fierce in Asia, with spend in Japan and China accounting for 69 percent overall, as both countries look to overhaul their manufacturing sectors.²⁰

Silicon Valley is taking note. Over the past few years, Google has acquired eight robotics companies, including Boston Dynamics—an engineering and robotics company that is best known for the development of BigDog, a quadruped robot designed for the U.S. military. Google has been applying their robotics research towards production environments and is working closely with Foxconn, a leading contract manufacturer in the high-tech sector, to replace manual workers across their Chinese production plants with “Foxbots.” Since 2014, Foxconn, an Apple and Samsung supplier, has reportedly replaced 60,000 factory workers with robots.²¹

One of the key drivers for robotics research is to develop more intelligent robots that can not only think for themselves, but also sense their surroundings in a more accurate manner. Another leading robot manufacturer, Rethink Robotics®, developed the Baxter® robot to improve production line operations. Traditional single-arm robots normally require a safety cell to work within so that workers on the shop floor don't get injured. Baxter, however, has proximity sensors in both of its arms so that if anyone approaches, it shuts down immediately. Advances like these in AI are impacting the evolution of industrial robots.



Photo by: Steve Jurvetson

Figure 1.11: Baxter

When AI is combined with the IoT, production lines will be automated, self-sensing, and more responsive to changing production requirements. Swarms of intelligent machinery will work together. Next-generation AI systems will feed off fast, real-time data streams. Automation will be integrated with key business processes and machine learning solutions that target specific tasks in controlled environments. The full potential of the Industrial IoT will be realized when intelligent devices, systems, and automation combine with physical machines, facilities, and fleets for improvements in productivity and lowered costs across the manufacturing industry.

In the following feature, Knorr-Bremse uses analytics and the IoT to enable intelligent fleet management and condition-based maintenance.

Knorr-Bremse



Figure 1.12: Knorr-Bremse Group

Based in Munich, the Knorr-Bremse Group is the world's leading manufacturer of braking systems for rail and commercial vehicles. For more than 110 years now the company has pioneered the development, production, marketing, and servicing of state-of-the-art braking systems. In 2015, Knorr-Bremse reported sales of €5.8 billion and employed more than 24,000 people worldwide.

Knorr-Bremse's iCOM (intelligent Condition Oriented Maintenance) platform brings digitization to the rail business, connecting wireless-enabled sensors aboard trains to a back-office cloud-based network, using an IoT model. This platform transmits detailed data that can help predict repair and replacement needs. The iCOM platform required a powerful and user-friendly analytics component to enable the analysis of the data received to help users make data-driven decisions.

The ability to make predictive, data-driven decisions results in more efficient and cost-effective repairs. With data being continually collected, the volumes across a fleet are significant. Customers now have the ability to visualize the data through interactive graphical dashboards, reducing the reliance on IT to create new reports. For example, they can provide heat-maps of condition-based events, such as overheating brakes on a specific incline, helping customers put measures in place to reduce component failures, extending component life, and ultimately saving money.

Knorr-Bremse keeps the wheels rolling with predictive maintenance powered by Analytics

The Industrial IoT

If there is one disruptive technology that is getting the most interest from the industrial manufacturing sector, it is the IoT. The IoT, or the Industrial Internet, or the Internet of Everything as it is commonly referred to, is an M2M platform for billions of connected devices.

M2M technologies like Radio Frequency Identification (RFID) tags, sensors, video cameras, GPS chips, and smart cards are the primary enablers of the IoT. They capture data on the identity, status, condition, and location of physical assets. According to research, one million IoT devices will be purchased and installed every hour by 2020, the number of devices connected to the Internet will grow to 35 billion and almost half of these devices (47 percent) will have the intelligence required to request support.²²

The IoT has the potential to transform how companies manage their supply chains. With billions of intelligent devices connected to the Internet over the next decade, organizations will have access to more information from their global supply chains. This means that anything that is a part of a supply chain—storage bins, forklifts, pallets, containers, warehouses, delivery trucks—can send information back to a centralized IoT hub using a simple Internet connection. In much the same way that B2B platforms are being integrated with ERP systems today, organizations will be integrating IoT-related hubs.

The IoT will fuel an intelligent, closed-loop digital supply chain infrastructure, streamlining processes like pervasive visibility, predictive maintenance, and proactive replenishment (see Chapter 4 for more detailed information). Across all manufacturing-related industries, the IoT will enrich business processes to provide operational benefits. Organizations will be able to monitor performance, track materials, and locate workers to make real-time changes or retrofit factory floor equipment.

Eventually, the Industrial IoT will scale to billions of connections and trillions of events, all supporting real-time analytics to help manufacturers get the insights they need from the connections of people, processes, data, and devices. Gartner estimates that improvements to plant automation processes and improved production output from the IoT is a potential \$2 trillion opportunity over the next 10 years.²³ As reams of data are exchanged across the IoT, significant issues such as liability, privacy, and regulatory compliance need to be addressed. Organizations that successfully address these issues will have a significant advantage.

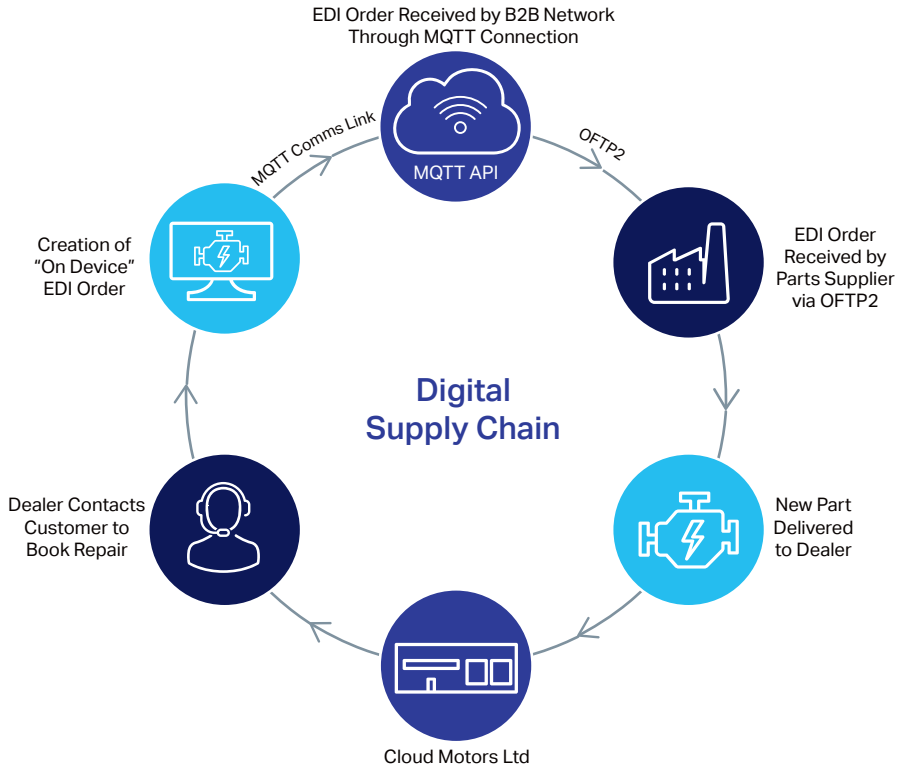


Figure 1.13: The Intelligent, Closed-loop Digital Supply Chain

Building a dedicated IoT platform and processing the data from this infrastructure in a database is only part of the solution. Providing connectivity to a B2B network which can make actionable decisions and initiate supply chain processes is the next logical step in the evolution of a company's IoT-related digital supply chain strategy. Dedicated Application Programming Interfaces (APIs) will connect future IoT networks to a B2B network. The API is a critical cornerstone of developing a completely closed-loop, IoT-connected digital supply chain infrastructure.

In the following interview, Thales, a multinational company based in France, has implemented a transformational program that includes the creation of a Digital Factory.

Thales

Thales Group is a French multinational company that designs and builds electrical systems and provides services for the aerospace, defense, transportation and security markets. From the bottom of the oceans to the depths of space and cyberspace, Thales helps customers think smarter and act faster—mastering ever greater complexity and every decisive moment along the way. Thales has more than 64,000 employees and operations in 56 countries worldwide.

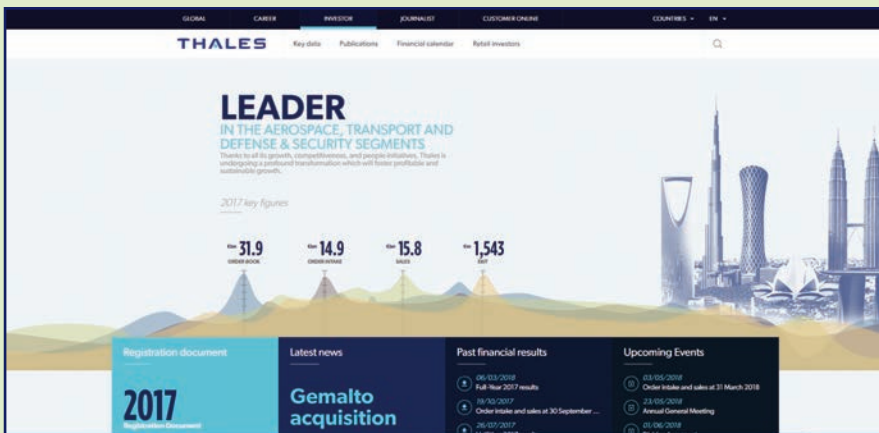


Figure 1.14: Thales

What follows are excerpts from an interview with Lahcène Massoum, Group Enterprise Architect at Thales.

“Thales is a key player in keeping the public safe and secure, guarding vital infrastructure and protecting the national security interests of countries around the globe. Our customers are split between civilian and military markets, which means we provide systems and services for companies like Airbus and Boeing, as well as for departments of defense, including the French DoD. With 55 percent of our total sales in the military market, Thales is the tenth largest defense contractor in the world.”

In our business, information is key. We design and develop everything from simple products to complicated systems, and we need to manage all the associated information. We have to be able to share this information across the organization and manage it throughout its 40-year lifecycle—from content creation to final archive and disposition. Making this information available to employees and mining it for insights is critical to Thales’ digital transformation efforts. Between our experts, engineers, and our products, we have a great deal of valuable information

that is underutilized. We've identified this as an opportunity. We want to tap into this information to transform organizational behavior and become a more data-driven company.

Two years ago, the company started thinking about how we could disrupt the market and digitize our organization. In our quest to become data-driven, we acquired Gauvus, a real-time, big data analytics company, to help us mine, analyze, and derive value from our information. We hope to combine real-time analytics capabilities with our existing products and services to deliver additional value to our customers. For instance, if we can analyze the Health and Usage Monitoring Systems (HUMS) data of a customer's airplane in real time, we can provide them with value-added services, such as predictive maintenance. We could also analyze the data collected to help us design more efficient products and services for our customers. These capabilities would prove to be especially beneficial to our aerospace customers, where sending a technician out to service a piece of equipment, like a satellite in space, for example, isn't always a viable option.

Digital gives us the agility to innovate. That's why it is one of the five pillars of our transformation program. ECOsystem, our Efficiency and Capacity-Oriented solution for aviation, is a great example of digital process innovation. ECOsystem brings together big data analytics, a digital platform, and the Cloud to gather and process air traffic and weather data on a global scale. Depending on a customer's privacy policies and regulations, the data can be stored in their own datacenter, sovereign cloud, public cloud, or a hybrid to support a whole range of applications.

Digital has broken down traditional organizational structures and transformed the way we collaborate. Information is shared outside of "company walls" and

across geographic borders. So, we are seeing a paradigm shift from perimeter security to data security. As organizations transition to digital business models, data security is often one of the biggest inhibitors to their digital transformation. As such, we have collaborated with leading cloud providers to deliver high-assurance data security technology. "Our Bring Your Own Key" (BYOK) Deployment Service Package, for example, allows users to establish strong safeguards around their sensitive data and applications in the Cloud, and gives them greater flexibility while ensuring they retain control over their data.

We are currently exploring the opportunities that disruptive technologies are introducing. In fact, over the last three years, the company has invested over €1 billion in the Internet of Things (IoT) and connectivity, big data, Artificial Intelligence (AI), and cybersecurity technologies. These technologies play a crucial role in enabling our customers, including airlines, satellite operators, air traffic control organizations, rail operators, armed forces and security services responsible for protecting urban infrastructure and energy supplies, to make the right decisions in real time.

Earlier this year Thales announced the creation of our Digital Factory. The Digital Factory represents a €150 million investment through to 2020 and demonstrates our commitment to accelerating digital transformation. It brings together the best experts in key digital technologies to serve customers in our five core markets: aerospace, space, ground transportation, defense, and security. The Digital Factory will also serve as an incubator for internal and external startups and host a digital academy to promote digital culture across the Thales organization. The goal is to capture the innovative potential of this new ecosystem for the benefit of our teams and customers."

A Platform for Smart Factories

The IoT will lead to an exponential growth in data flowing across the extended enterprise and companies will have to acquire personnel with the necessary data analysis experience to be able to process this information. These employees will design robust algorithms for processing IoT-related information and then translate what happens in the physical world into a format that can be managed in the digital world.

With all the devices “talking” across the IoT—communicating things like events, conditions, temperature, etc.—systems can make smarter and timelier decisions. Typically, systems that drive the manufacturing value chain, from product design to production and logistics, function in a silo. Disruptive technologies like the IoT and smart sensors are bringing together the physical and the virtual, so that intelligence can be applied for better visibility into operations, shortened innovation cycles, and increased productivity.

Welcome to the Smart Factory of the future, where machines coordinate the production and distribution of custom products made up of component parts and materials sourced from hundreds of suppliers. Processes like proactive replenishment and predictive maintenance are fully automated. Humans interact with machines, working side by side to guide digitized processes and robots. Analytics helps to improve the operational efficiency of connected industrial equipment.

In the Smart Factory of the future, the foundation layer will be automation intensive: all production processes will be highly or completely automated with few or no people involved in production operations. An IT-intensive operational layer will support real-time decision-making environments. The connection between factory technology and enterprise systems is based around an IoT layer for a seamless transition from Operation Technology (OT) to IT systems. The traditional organizational boundaries between OT and IT as separated domains will vanish.

People are at the center of the Smart Factory of the future as they provide the degree of flexibility and decision-making capabilities required to deal with increasing complexity. Enterprise Information Management (EIM) is the facilitator that eases the exchange of information transparently across organizational or IT/OT silos.

Big data, the shift to new cloud-based platforms, and mobile technologies all play a key role in the success of any IoT-related Smart Factory strategy. Cloud deployments in manufacturing simplify the management of a global IT infrastructure, allowing manufacturers to quickly scale production up or down and making information accessible as large data pools that can be analyzed for intelligence.

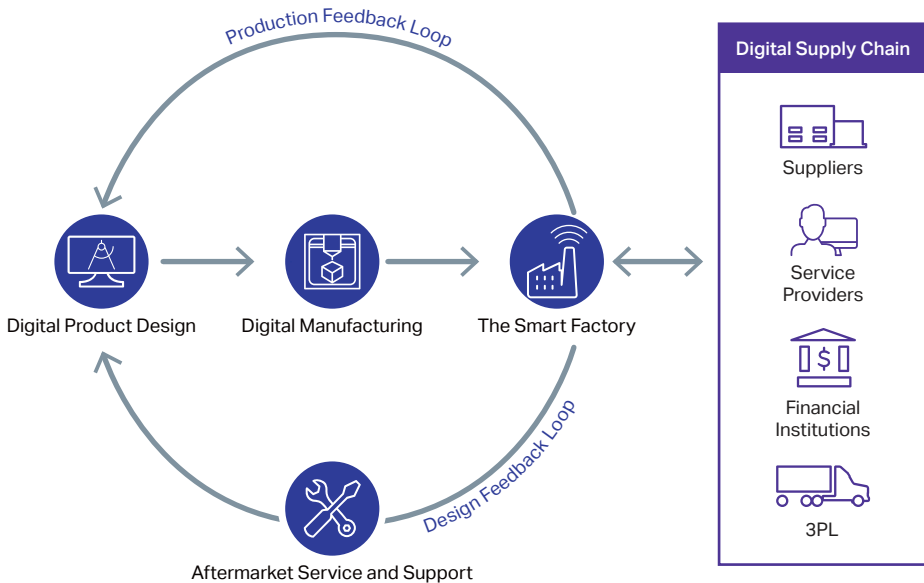


Figure 1.15: The Smart Factory of the Future

Besides quick deployment and cost savings, other advantages of cloud computing include ease of use and operational flexibility. They also give manufacturers the opportunity to digitally transform processes. An increasing number of products are being developed in the form of virtual prototypes in which engineering simulation software is used to predict performance prior to constructing physical prototypes. Cloud-based computer-aided engineering (CAE), simulation, and virtual prototyping enable manufacturers to predict or understand modelled systems or processes for any given environment. Simulations are faster and more collaborative, and revisions, fewer—supporting the ability to “fail fast” in the digital world.

To integrate physical and digital supply chains, manufacturers will need access to a cloud-based integration platform that can connect a wide variety of devices, equipment, and software. An M2M API or middleware that sits between the piece of equipment and the supply chain management environment will provide the link between physical and digital supply chains. Common standards will have to be developed to achieve this.

Standards are only one part of the equation, as ways to process the information being transmitted between devices must also be developed. The key challenge to widespread adoption of the IoT lies in achieving seamless interoperability and common standards that allow machines to communicate across different systems, borders, and cultures. In North America, an alliance of 10 companies is working to lobby the U.S. government on the importance of developing open standards that will encourage broad adoption of the IoT with a focus on addressing cybersecurity threats and issues.

With its combination of smart sensors, wireless communication, and big data analytics, the Industrial IoT is creating the architecture that will shorten manufacturing timescales from years, months, and weeks to hours, minutes, and seconds. When the Industrial Internet unites factory equipment through a common data platform, it does more than just centralize information; it enables machines and people to optimize performance across entire systems, including the global supply chain.

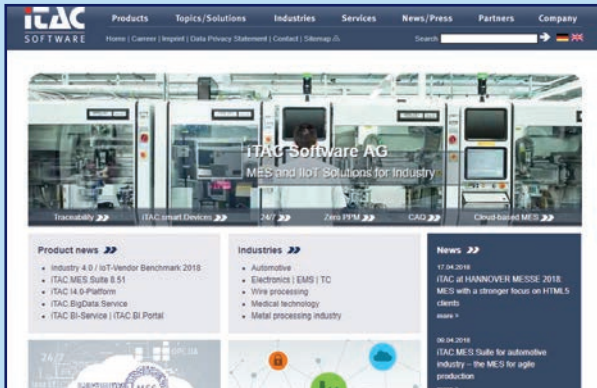
In the following feature, iTAC Software AG uses analytics to enable smart factories in the digital world.

Digital Changes Everything

The convergence of digital technologies discussed in this chapter is heralding in the Fourth Industrial Revolution. Technologies being introduced today will transform tomorrow's manufacturing operations and supply chains. Key to the success of these future digital supply chains will be to establish an end-to-end digital backbone. B2B networks will evolve into more intelligent business networks where connected devices can share structured and unstructured information seamlessly with back-end enterprise systems and big data repositories. To succeed in the digital world, manufacturing organizations will need to determine the value of disruptive technologies and how they can expand their abilities to compete in their markets.

Based on the progress of the past and the present rate of change, how will digital technology transform business models to meet the needs of consumers, partners, and marketing channels in the manufacturing industry? What will the manufacturing enterprise look like in the digital world? How will it operate? The following chapter examines this in greater detail.

iTAC Software AG



Using analytics to enable smart factories in the digital world

Figure 1.16: iTAC Software AG

Since its founding in 1998, iTAC Software AG (Internet Technologies and Consulting) has been specializing in providing internet technologies for the manufacturing industry. The manufacturer of standard software and products for cross-company IT applications is an industry leading system and solution provider of Manufacturing Execution Systems (MES) for the entire supply chain. Implementing the Internet of Things and Services has been the focus of the company’s strategic direction right from the beginning. Its philosophy is connecting people, data, and systems.

To offer its customers the greatest possible transparency and decision-making capability for production control, and to meet growing demands related to the Internet of Things (IoT), iTAC wanted to integrate Business Intelligence (BI) and analytics software into iTAC.MES. Suite. Doing so would support customer demands for manufacturing intelligence, quality control, and traceability. In addition to rapid, effective implementation and seamless integration, iTAC required the customization of reports, analysis, and dashboards with full interactivity and security. All these needed to be web-based, offer transparent personalization for various applications, and be available through different channels.

With Analytics, iTAC has the BI, operational, and analytical capabilities it needs to support customer demands for greater intelligence, quality control, and traceability throughout the entire manufacturing process. The solution ensures transparency in metrics management and supports product lifecycle management, budget control, and quality assurance, as well as field activity management. The company’s clients can access and analyze large amounts of data centrally with extensible support for future expansion, delivering competitive advantage as well as the ability to prepare for the German government’s Industry 4.0—a national strategic initiative to drive digital manufacturing forward.

MANUFACTURING AS A DIGITAL BUSINESS



While the disruptive technologies discussed in Chapter 1 are enablers for digitization, true transformation requires that manufacturing organizations evolve from traditional, stand-alone entities into digital manufacturing businesses that support a digital supply chain and function within a manufacturing ecosystem. This chapter explores manufacturing as a digital business.

Manufacturing as a Digital Business

“Manufacturers are going to face really fierce competition over every scrap of market share available and there will certainly be winners and losers.”¹

New technologies, globalization, regulations, and the emergence of the digital consumer are causing disruption across all sectors, and manufacturing is no exception. Despite being an \$11 trillion industry, much of manufacturing is lagging behind other industries in adopting digital technologies.² In the coming decades, competition will be fierce. Manufacturing organizations in all sectors will need to disrupt their operations or risk being replaced by more nimble players.

These market entrants are using new business models to deliver products and services. Startups like Boxed, DeepMap, and Misty Robotics are challenging the status quo and pushing the limits of innovation and imagination—all while meeting (and, at times, exceeding) consumer expectations. Boxed, the Costco for Millennials, is using machine learning to predict when customers will run out of a product and pre-emptively places orders for home delivery. DeepMap, an autonomous vehicle mapping service founded by ex-Googlers, is outpacing large automotive manufacturers, through agile development and more accessible licensing. And Misty Robotics, the makers of Star Wars’ BB-8, is vying to put a personal assistant robot in every home and office with Misty—the world’s most advanced open source robot.

In light of the threat that new technology-based companies present, established manufacturers are looking to disrupt their operations. In fact, 84 percent of manufacturing suppliers expect to be challenged by new competitors.³ In the automotive industry alone, leading manufacturers are adopting new business models. Audi, for example, has made a fleet of luxury vehicles available to customers as an on-demand digital service for improved convenience.



Figure 2.1: A Traditional Linear Value Chain

While the disruptive technologies discussed in Chapter 1 are enablers for digitization, true transformation involves much more than adopting new technologies. Along with upfront investments to modernize and consolidate enterprise systems, new business models, process support, and the requisite skills (in understanding massive data pools and the workings of cognitive or AI systems, for example) are essential for transformational success. To succeed in the digital world, manufacturing organizations will be required to evolve from traditional, stand-alone entities with linear value chains (illustrated in the previous figure) into digital manufacturing businesses that support a digital supply chain and function in the context of a larger manufacturing ecosystem (as shown in Figure 2.2).

The Digital Manufacturing Ecosystem

As part of a global ecosystem, manufacturers are better equipped to transition from mass producing “dumb” products for consumers to delivering customized, “smart” products and service-based offerings.

An extended digital manufacturing ecosystem is composed of three layers: the external trading partner community (shown in purple), the internal enterprise community (represented in blue), and the Internet of Things (IoT) layer (highlighted in teal).

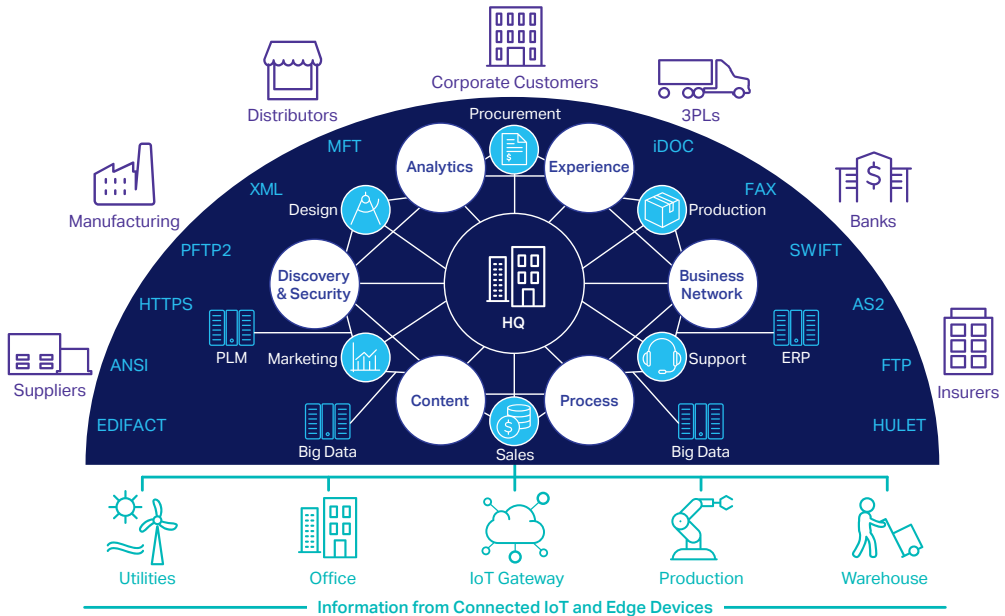


Figure 2.2: The Extended Digital Manufacturing Ecosystem

In global manufacturing, trading partners are typically located across disparate industries and regions with different requirements for information exchange, connectivity, and compliance. An external trading partner community connects the supply chain to trading partners and facilitates both collaboration and the efficient exchange of information.

The internal enterprise community combines enterprise departments and systems, such as Enterprise Resource Planning (ERP) and Product Lifecycle Management (PLM) applications that support the business. These systems can be brought together using an Enterprise Information Management (EIM) platform in conjunction with Business-to-Business (B2B) integration.

The IoT layer pulls in information collected from connected devices and sensors across office equipment, production machinery, and warehouse and logistics equipment. This information must also be captured and processed in real time, or archived for downstream processing by other business systems. As the number of devices requiring immediate or high-volume data processing continues to increase, the combination of the Cloud and edge computing will provide the agility and infrastructure needed to support the ever-expanding IoT universe.

A digital ecosystem is billions of people, businesses, and devices communicating, collaborating, and transacting—all gaining efficiencies through the smarter use of technology. The potential is huge—from digitizing paper and manual processes to moving applications to the Cloud to applying analytics for greater insight and deeper engagement. As supply chains morph into dynamic, collaborative systems, a culture of information sharing is required to connect all stakeholders. Data and standardization are fundamental for the development and sustenance of digital ecosystems. When business networks are reliably and securely connected, they can be layered with intelligence. As information is added, the ecosystem and opportunities for growth will only increase. To function effectively in these global ecosystems, manufacturers will have to operate as digital businesses.

Components of a Digital Manufacturing Business

A digital manufacturing business is characterized by an open, flexible value chain made up of an extended ecosystem of suppliers and partners. As a digital manufacturer, every process, from "create to consume," is digitized throughout the complete lifecycle of a product. Information is managed using a common digital platform that allows all stakeholders to access any type of information from anywhere, at any time. Becoming a digital manufacturer necessitates using digital technology to increase output efficiency, produce better products, reduce product lifecycles, seamlessly engage with business partners and, ultimately, satisfy digital consumers.

The figure below breaks down the lifecycle of a product into component stages or processes with the digital consumer at the hub. While lifecycle activities may vary by sector in the manufacturing industry, some of the common activities involved in the lifecycle of a product include new product design and prototyping, manufacturing and production, logistics and distribution, consumer engagement, sales, and aftermarket services and support. At each stage of a product’s lifecycle, different technologies generate different types of information. All this information must be managed in order to maximize output, performance, and insight. From product specifications at the design and engineering stage, like prototype-based information from a digital twin, to purchase orders exchanged across the supply chain to connected-machine data at the plant maintenance stage, invaluable information is exchanged from various sources in a variety of formats. Volumes of information are associated with the manufacturing of a product and this is only increasing as new data formats are being introduced by disruptive applications of technology, such as the IoT.

For information that is generated to be useful, it must be accurate, secure, and accessible. Only then can it be used to develop collateral in support of retail sales and marketing, for example, or to issue the appropriate certifications during aftermarket service and support. In a digital manufacturing organization, these processes are streamlined and all of the associated information can be captured, managed, archived, made accessible, and in some cases, processed in real time, across the digital supply chain.



Figure 2.3: The Components of a Digital Manufacturing Business

This book explores digitization across each of these stages. Chapter 3 discusses the requirements for different lifecycle activities, including product design and engineering, plant maintenance and asset management, and aftermarket service and support. Chapters 4 and 5 examine the digital supply chain and distributor, retailer, and customer engagement respectively. Chapter 6 focuses on requirements for governance and compliance in the industry, while Chapter 7 describes EIM as the foundational digital enterprise platform for transformation. And, finally, Chapter 8 provides strategies for change management across the enterprise and supply chain to help manufacturers succeed in the digital world.

The Drivers of Digital Transformation

Behind the requirements to digitize manufacturing information and processes is the context that is driving change in the industry today. In the last decade, new disruptive technologies have broken down barriers to create a more connected world, allowing businesses to expand operations internationally. As a result, manufacturers face increased pressure to comply with a growing variety of regulations. Additionally, a geographically dispersed network of supply chain partners and customers poses unique format and language challenges, underscoring the need for the standardization of information exchange between all trading partners.

To respond to changing requirements with agility, manufacturing organizations must consolidate and modernize their enterprise IT infrastructures. With the proper technologies in place, manufacturers can form robust business ecosystems to deliver the products and services that meet the complex demands of today's digital consumers. Several market factors are accelerating the adoption of digital technologies and driving the transformation of traditional manufacturers. These include:

- Digital technologies
- Globalization and international expansion
- Regulatory pressure and compliance
- Standardization
- Consolidation and modernization
- Digital consumers

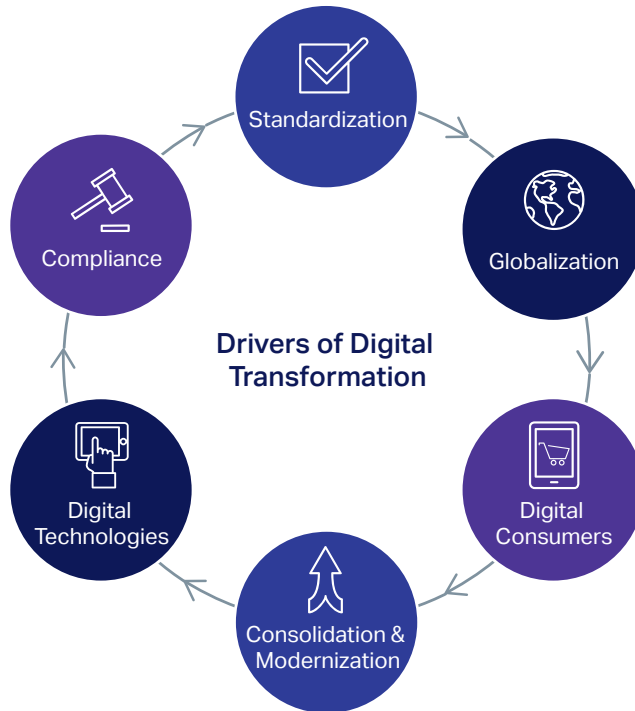


Figure 2.4: The Drivers of Digital Transformation⁴

The Nature of Digital Technologies

As explored in Chapter 1, applications of emerging technologies are disrupting the manufacturing industry. Many of these disruptive technologies are being deployed to automate production. For example, in one of its facilities, Philips “employs” 128 robots to produce electric razors. Because robots require little-to-no human involvement and do not need the lights on to perform tasks, overhead costs associated with traditional, man-powered production like heating and electricity can be significantly reduced.

Companies that automate production are realizing substantial benefits from their early efforts. BMW predicts it will boost productivity by more than 10 percent by automating 99 percent of its newest body shop⁵, while Canon estimates automation will cut production costs by 10 to 20 percent and reduce assembly costs by at least 50 percent.⁶

As impressive as these examples are, the manufacturing industry is still in the early stages of adopting disruptive digital technologies. As manufacturers digitally mature, they will be better able to innovate at scale and expand their ecosystem. To get to this point however, manufacturers will need to integrate digital technology into every facet of the business. As shown in the following figure, this level of digital transformation will yield sought-after outcomes such as differentiated customer experience and optimized manufacturing processes.

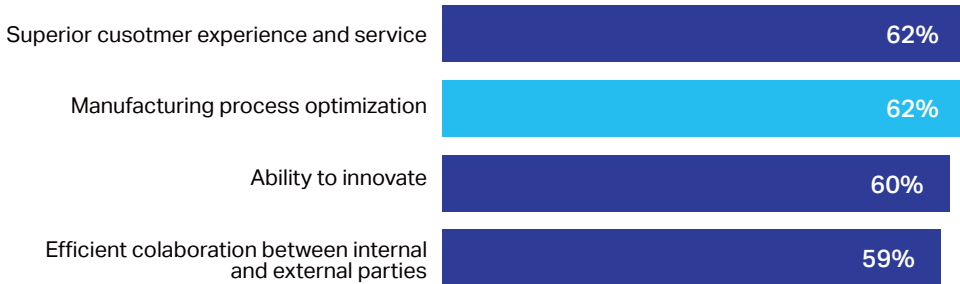


Figure 2.5: Top Outcomes Sought by Manufacturers Looking to Digitally Transform⁷

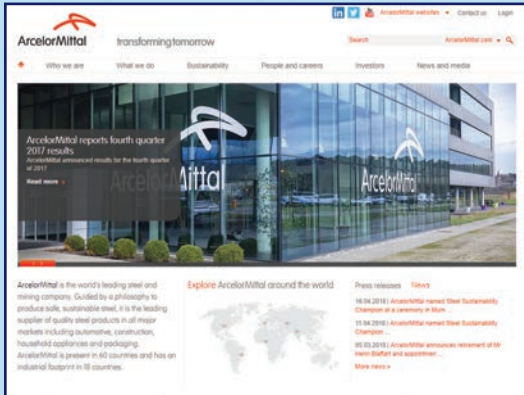
Globalization and International Expansion

Advances in transportation and telecommunications over the past 50 years have been instrumental in the globalization of manufacturing enterprises. Continuous improvements in both have given manufacturing organizations the opportunity to expand into international markets. Using enterprise technologies that support the real-time exchange of information, manufacturers have been able to consolidate their products and services, sell anywhere in the world, and support operations around the clock.

As globalization intensifies, capital, economic power, and influence will shift from established economies to emerging economies. Since 2001, there has been a focus on Brazil, Russia, India, and China (collectively referred to as BRIC countries). But recent macro-economic trends, such as increased wage costs, labor strikes, and a desire to exploit growing markets, have led to the emergence of four new regions with significant economic potential: Mexico, Indonesia, Nigeria, and Turkey—or the MINT countries (as shown in Figure 2.7).

The following feature highlights how steelmaker ArcelorMittal is leveraging digital technology to accelerate the customer onboarding process, improve collaboration between partners, and increase visibility across its global B2B network.

ArcelorMittal



"A global footprint is very important to us as we need to be able to connect to a customer anywhere in the world. B2B Managed Services increases global visibility across our base of B2B transactions and delivers considerably improved monitoring capabilities."

Figure 2.6: ArcelorMittal

ArcelorMittal is the world's leading steel and mining company. Guided by a philosophy to produce safe, sustainable steel, it is the leading supplier of quality steel products in all major markets including automotive, construction, household appliances, and packaging. ArcelorMittal is present in 60 countries, has an industrial footprint in 18 countries, and ranks as today's only truly global steelmaker.

The company wanted to accelerate the process of onboarding new partners to its B2B e-commerce network while enhancing their capability to deliver new solutions. In addition to being time consuming, running B2B applications in-house was proving to be costly. As such, the company also sought to reduce the support and maintenance costs of older mainframe-based B2B applications that had been developed in-house. Outsourcing a patchwork of fragmented B2B trading networks via B2B Managed Services emerged as an effective and powerful way to address all of these challenges.

Entrusting B2B Managed Services with the management of more than 100,000 monthly Electronic Data Interchange (EDI) messages between global trading partners has eliminated the need for in-house B2B technology expertise. It has resulted in smoother and more reliable core business processes, increased global visibility across the business network, and improved monitoring capabilities. Based on the initial success ArcelorMittal has experienced, the company plans to extend the reach of B2B Managed Services to include additional trading partners.

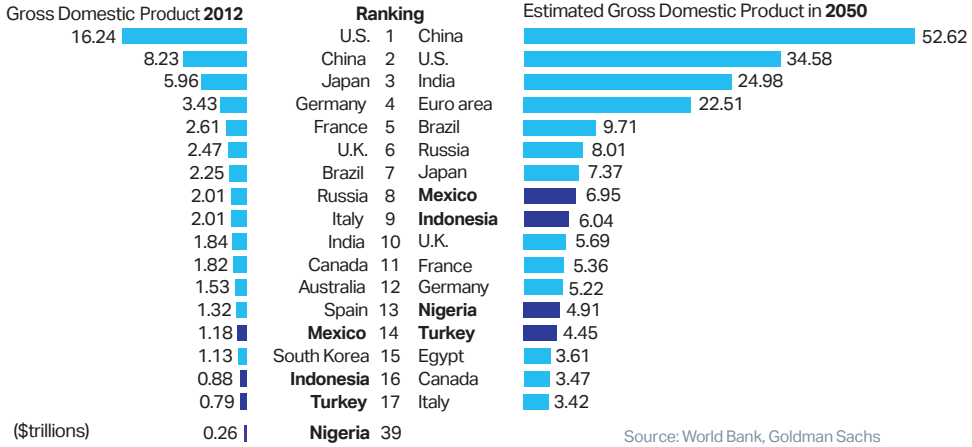


Figure 2.7: Rise of the MINTs⁸

Over the past few years, Mexico has established itself as a key automotive manufacturing hub, with automakers investing a record \$3.62 billion in the first half of 2017 alone.⁹ Meanwhile, Indonesia has the potential to become a powerful player in high-tech over the next decade, which is why it has invested significantly in upgrading its mobile infrastructure to deliver high-speed connectivity across the country.¹⁰ The investment has paid off. Companies looking to avoid the increasingly expensive Chinese labor market are already investing heavily in Indonesia. Other MINT countries are working to upgrade their utilities and telecommunications infrastructures to encourage business development. If Nigeria were to improve its utilities infrastructure, for example, it is estimated the country could double the size of its economy in approximately six years.¹¹

Moving manufacturing operations overseas and offshoring product development to countries with young, skilled, and affordable labor can help lower production costs. A presence in the global market creates opportunities for growth outside of the domestic market, which can lead to economies of scale. At the same time, disruptive technologies are reducing the dependency on cheap, outsourced labor, which diminishes the need to offshore. As disruptive technologies mature and globalization becomes more commonplace, time will tell if automation will render outsourcing obsolete.

Regulatory Pressure and Compliance

In a digital world where manufacturing operations span the globe, a final product is often the result of a worldwide effort. Materials can be sourced from multiple countries, shipped to an assembly plant to be manufactured, and then distributed to any number of other countries. In an industry with no shortage of regulations, where the ramifications for non-compliance can be devastating, the international nature of manufacturing goods and services can make complying with regulations grueling.

As the figure below illustrates, manufacturers must comply with numerous regulations concerning the safety of products, the health and safety of employees, environmental impact, data protection, export controls, anti-corruption, IT safety and security, fair competition, and employment law.¹² To further complicate things most regulations vary by region, and the emergence of new materials, production methods, technologies, political motives, and even scientific research can cause them to change.

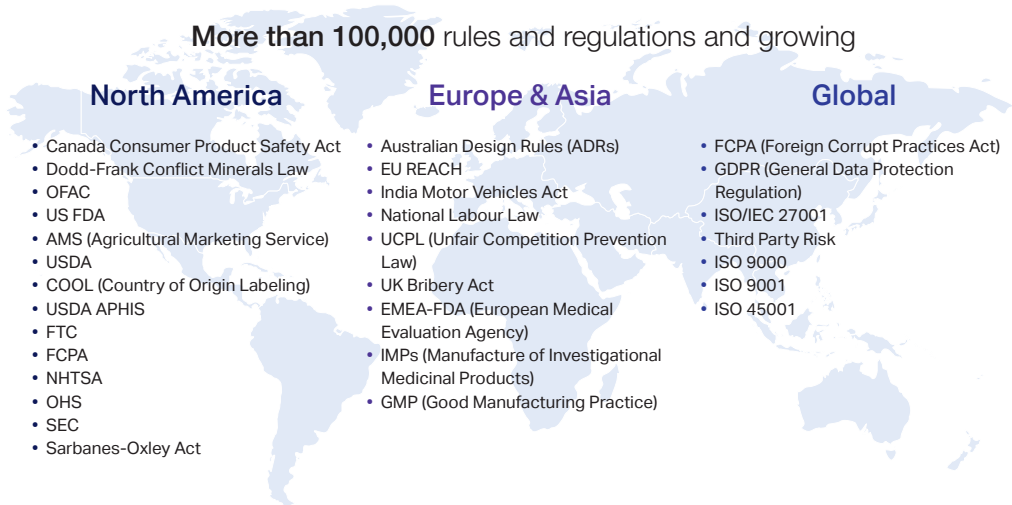


Figure 2.8: A Complex Landscape of Global and Regional Regulatory Pressures

Manufacturers around the world are subject to intense scrutiny by regulatory agencies that monitor compliance all along the product lifecycle. Consider the standard vehicle tire. In the U.S., for example, a tire’s compliance journey begins before the product is even created. Tire manufacturers must ensure the raw materials they source, such as natural and synthetic rubbers, cements and solvents, comply with a variety of environmental regulations as specified by the United States Environmental Protection Agency (US EPA). At various points throughout the manufacturing process, testing and monitoring must be conducted to ensure compliance with Natural Emission Standards for Hazardous Air Pollutants (NESHAP). The finished, road-ready product must meet the requirements as outlined by numerous federal regulatory bodies and standards organizations, including the Department of Transportation (DOT), the National Highway and Traffic Safety Administration (NHTSA), the Uniform Tire Quality Grading System (UTQG), and the Tire and Rim Association (T&RA). The ramifications of non-compliance at any stage in the production process can be severe, including fines, product failure, and costly recalls.

Emerging technologies are impacting the regulatory landscape. New regulations will need to be created to adequately govern and protect everyone, from manufacturers to consumers. The increased adoption of drones, 3D printing, autonomous cars, and robots will be a catalyst for a host of new regulations. In response to the rapid adoption of drones, for example, the U.S. Federal Aviation Administration (FAA) has implemented conditions for use by e-commerce giants like Amazon and Alibaba.¹³ Similarly, 3D printing will introduce opportunities for patent infringement and Intellectual Property (IP) theft, autonomous cars will call into question liability when accidents occur, and robots may present the ethical dilemma of establishing fault in the case of accidental death. To take full advantage of these technologies, manufacturing organizations will require the flexibility and responsiveness to comply with regulations as they are created and revised. Adopting industry standards and ensuring that critical information is governed can make meeting regulatory and compliance requirements more achievable.

Standardization

Industry standards are a set of manufacturing criteria that relate to the standard functions and operations in respective fields of production. They have been designed to help manufacturers meet the established requirements for the safety, quality, and reliability of a manufacturer's products. Both the International Labour Organization (ILO) and the International Organization for Standardization (ISO) are examples of standard-setting bodies that promote worldwide proprietary, industrial, and commercial standards to maintain safe, efficient, and common ways (standard units of measure, for example) to work.

Standards have played a fundamental role in the evolution of manufacturing, creating the foundation for the modern assembly line and supply chain growth.¹⁴ As well as providing common ways to work, they also deliver a common language for business partners, to exchange information electronically. In the current landscape, manufacturers must juggle regional EDI standards (such as EIAJ, VDA, EANCOM, and Tradacoms), vertical industry standards (like OAGi and ebXML), and ERP application formats (including SAP IDoc, Microsoft AIF, and Oracle TIF). Each of these offers a different combination of security, performance, and reliability to satisfy different user requirements. Many of these standards are still based on those established in the 1970s and 1980s. The development of modern standards and architectures will be essential for the integration of physical and digital supply chains into an effective ecosystem and the widespread adoption of the IoT.

B2B integration streamlines business data exchange between business partners, giving manufacturing companies access to standardized transactional solutions that automate and simplify communications. With the complexity and frequency of business transactions, B2B integration involves a heightened degree of coordination, data synchronization, and automation. When combined with standardization, B2B integration helps manufacturers coordinate the flow of commerce and communications across an entire business network.

Consolidation and Modernization

Enterprise infrastructure is becoming more complex. It is expected to support new media, social networking, mobile access, portals, integration with ERP systems, content management solutions, process automation, analytics, connected devices, and much more. A growing reliance on emerging technologies means that enterprise applications must be integrated across a variety of systems. All this adds up to a digital dilemma for manufacturing CIOs: How can they embrace disruptive technologies and new business models, while ensuring a stable enterprise platform that supports business continuity? In the digital world, CIOs are challenged to overcome these obstacles and keep costs low. This is exemplified in the following figure, which shows key barriers to manufacturers adopting the IoT.

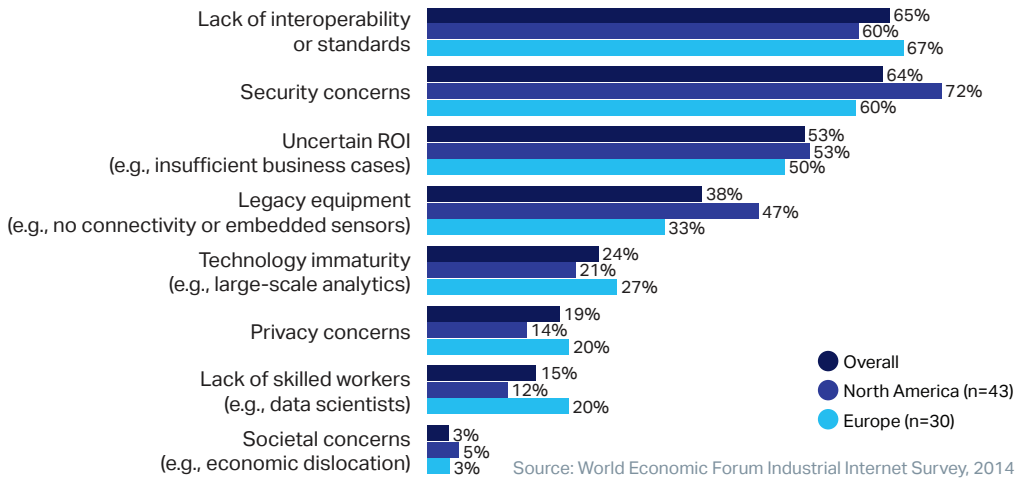


Figure 2.9: Key Barriers to Adopting the Internet of Things¹⁵

Whether supporting Just-in-Time (JIT) production in the automotive industry or reverse logistics process in the high-tech industry, having access to a single, common B2B platform through which standardized information can flow seamlessly is a key objective for digital manufacturing companies. A consolidated infrastructure makes standardization achievable and ensures operational consistency across services, providing the foundation for future business growth, as illustrated in the following interview with Lear Corporation.

Lear Corporation

Lear Corporation was founded in Detroit in 1917 as American Metal Products. More than a century later, Lear is one of the world's leading suppliers of automotive seating systems and electrical distribution systems, ranking 154th on the Fortune 500. Its world-class products are designed, engineered, and manufactured by a diverse team of approximately 150,000 employees located in 37 countries. Serving every major automaker in the world, Lear's content can be found on more than 400 vehicle nameplates.

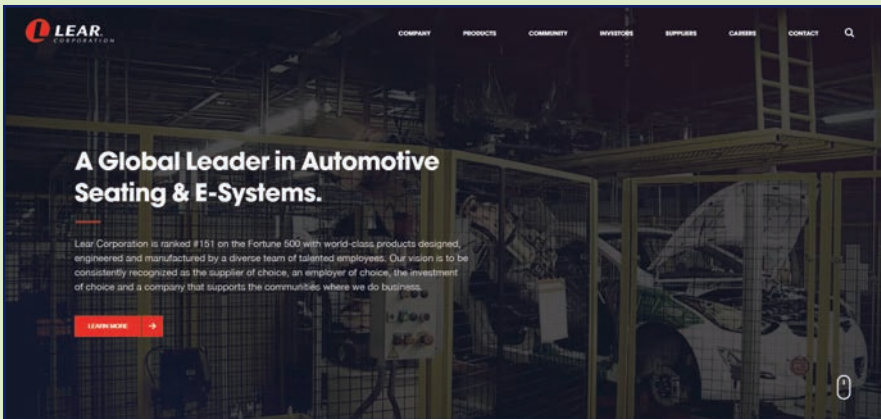


Figure 2.10: Lear Corporation

What follows are excerpts from an interview with Don Guibord, IT Manager, EDI at Lear Corporation.

"Lear is made up of two divisions: E-systems and Seating. We are one of only four suppliers with the global capacity to deliver complete automotive electrical distribution systems for traditional electrical architectures, as well as emerging high-power and hybrid systems. We are also one of the world's only fully integrated manufacturers of the entire seat. With sales exceeding \$18 billion, we are one of the leading tier-one suppliers of automotive seating systems and electrical distribution systems in the industry.

As an industry leader, we have a global business network of over 3,000 unique suppliers and more than 7,500 suppliers that we exchange information with on a regular basis. That's a large supply chain, and exchanging information along it from end to end is challenging. As the IT Manager for Electronic Data Interchange (EDI), it's my job to make sure that all the systems, processes, and contracts are in place to facilitate the seamless exchange of documents that communicate needs and orders from business to business, or more

specifically in our case, between Lear and our partners who are major automakers around the world.

Our key differentiator is that we manufacture and ship our seating products in sequence. In other words, the order in which we build and ship our seats corresponds with the order the cars take in the assembly line at the OEM plant. So rather than building seats months in advance and storing them, we build the seats as they are needed, or Just in Time (JIT). EDI supports JIT manufacturing processes because it provides visibility into inventory levels and can receive broadcast notifications. For example, we'll receive periodic notifications—or triggers—from the OEM plant to let us know where each car is during the manufacturing process. So, if we get a notification that a particular car has just come out of paint, we know that we need to load that seat onto the truck for delivery at that moment in order to get it to the plant "just in time."

Many processes within departments are automated, but different departments are using different systems, so there are gaps in processes that need to be filled. Right now, we rely on people to bridge those gaps, but we're working to correct this so that we can automate processes across the entire enterprise. Within my department, we've successfully digitized the order cycle from start to finish. The order cycle is a little more complicated since Lear acts as not only the supplier, but also as the customer. This means we communicate both with the OEMs as well as our suppliers. We receive orders, query our inventory levels, order required materials, fulfill, ship, bill, and collect payment. This allows us to speed up our order cycles and fulfill orders with greater accuracy. We're able to do this because of standardization.

We've been using EDI in automotive for decades. It's to the point where we've standardized down to a handful of

document standards. As I mentioned, we have more than 7,500 supplier relationships around the world and each month we exchange between three and four million kilocharacters across our business network. In the past, communicating with such a large and diverse partner network was a challenge. There were the obvious hurdles, like language and time zones, but also technical ones—which were often the most challenging to overcome. With standardization, those challenges are behind us. I know, depending on what region my supplier or OEM is, which document format to use.

The Cloud has helped us to further standardize, and even automate EDI. When data is sent via EDI, it needs to be translated into its final proprietary file format—in other words, into the final format that will live in the ERP system. We upload our Intermediate Documents (IDocs) to our cloud-based business network solution, and that's where the magic happens. Based on criteria, or rules that we've established, the solution translates the IDoc into the appropriate format and routes it to the intended recipient. This has eliminated the need for translation software behind our firewall, sped up communications, and significantly improved our supplier relations. We are currently in the process of taking this one step further with canonical maps. This will enable us to outsource the mapping of our B2B program while seamlessly integrating with partner applications. Ultimately, this will reduce costs and speed up partner onboarding. The more we outsource and automate processes, the more efficient we can become.

Cars have come a long way from the Ford Model T. We've moved from mechanically timed ignitions to electronic ignitions to digital ignitions. Cars are evolving from providing a means of transportation to complete software platforms. The more digital- and software-driven they become,

the quicker they will evolve. It's Moore's law in action, and this is forcing automotive companies to transform to keep pace with, or ideally, outpace the competition. Beyond adopting technologies to digitize the enterprise, they're hiring engineers and acquiring software companies and Intellectual Property (IP) to fuel innovation.

Autonomous-driving cars are already being tested on the road. I think it's just a matter of time, a few years really, before they become commonplace. Cars will be designed to be so intelligent, so intuitive and cognitive, and plugged into their surroundings, that it will be safer to have autonomous-driving cars on the road. Intelligent machines will replace humans, they'll be replaced with perfectly accurate and impartial software and sensors.

We're in the middle of another industrial revolution where digital is replacing analog. The shift is already happening. For example, the military is now training more drone operators than pilots. Soon, automotive manufacturers will hire more software engineers than manual laborers, and we'll have more self-driving cars than manned vehicles. The technology already exists; it's the infrastructure that's lagging. Smart cars require smart cities. Roads will have to be able to exchange information with these self-driving cars for everything to run smoothly. So, there's still a fair bit of investment required in the areas of infrastructure, standardization, and innovation that has to happen before technologies like self-driving cars are commonplace, but the automotive industry is transforming, so it won't be too long."

Typical global manufacturers run on mainframe systems with tightly focused technology stacks and siloed information, which makes them slow to respond to change. Legacy platforms are expensive to upgrade and require special skill sets to maintain. Often, the more outmoded they become, the costlier they are to manage. Integrating old systems with new systems can add up to significant long-term investment and operating expenses. Adopting a modern platform results in process efficiencies that reduce IT operating, development, application and infrastructure, and service costs. Platform modernization empowers manufacturers to respond quickly to make changes to products, customize existing ones, or introduce new ones, while reducing time-to-market.

In a highly competitive industry, the solution is to replace legacy systems with investments in digital technologies and channels. Digital strategies based on integration, collaboration, and modernization will be most effective in balancing the mandates to grow the business and reduce costs.



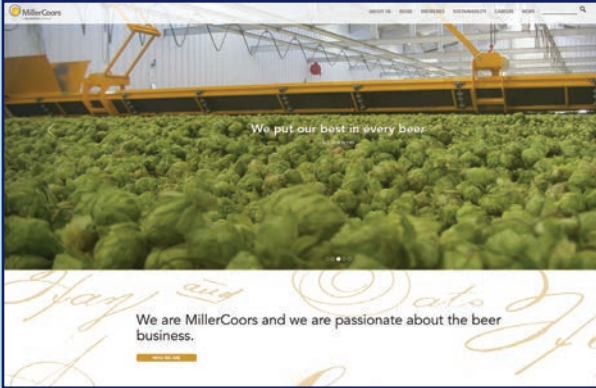
Figure 2.11: Back-office Modernization

Delivering superior responsiveness will depend on tight synchronization of data as well as the movement of information, transactions, and processes between partners, based on modernized systems and infrastructures. As such, manufacturing organizations will need to embrace new types of network infrastructure, new devices connected to these networks, and new forms of digital information generated by these devices. This will allow for improved operations with external partners and enable greater collaboration across the digital supply chain or ecosystem.

Technologies like AI, robotics, sensors, and the IoT have provided the technical backbone for business networks to expand into full-fledged ecosystems that exchange information in real time and transcend geography, industry, and language to create exponentially more opportunities for digital manufacturers. From within the extended manufacturing ecosystem, businesses can assemble new or complementary capabilities from other suppliers and more easily pivot their operations to meet consumer demands.

Back-office modernization not only results in operational efficiencies, it also enables greater collaboration between partners and suppliers through increased digital capabilities as well as substantial cost savings, as shown in the following MillerCoors feature.

MillerCoors



In just one year, OpenText B2B Managed Services has removed 2.5 million labor hours from the distributor-to-retailer supply chain, resulting in an estimated \$50 million in labor savings

Figure 2.12: MillerCoors

MillerCoors is a joint venture of the U.S. operations of SABMiller and Molson Coors. With more than 450 years of combined brewing heritage, MillerCoors boasts an impressive portfolio of industry-leading beers. With nearly 30 percent of U.S. beer sales, MillerCoors is the second-largest beer company in the United States. The company operates eight major breweries, as well as several craft breweries.

Miller Brewing (a legacy company of MillerCoors) found its distributor-to-retail supply chain was falling short of the industry standard and, more importantly, user expectations. The company needed to modernize and standardize their inefficient and document-intensive processes to remain competitive in their complex and consumer-driven market. Using B2B Managed Services, Miller Brewing connected more than 400 distributors with 25 different business systems into a cohesive EDI platform. Doing so enabled their entire distributor network to conduct business with any retailer that required an EDI capability.

Today, B2B Managed Services provides the technical foundation for a seamless, end-to-end EDI platform for all of MillerCoors' supplier and banking connections. Critical documents are received, processed, and seamlessly exchanged to deliver efficiencies, cost savings and, of course, beer. In just one year, the business transformation eliminated 1.2 million hours of labor for distributors and 1.3 million hours for retailers, for a total of 2.5 million labor hours removed from the distributor-to-retailer supply chain. The time savings translates to an estimated re-allocation of 1,200 full-time equivalent (FTE) resources to other tasks, freeing up potentially \$50 million in labor savings.

Digital Consumers

The rapid adoption of digital technologies has created the digital consumer—customers who expect much more from manufacturers than simply products. They want digitally enabled services from any place at any time via the channel of their choice. What used to differentiate the enterprise—economies of scale, distribution strength, and brand—have faded in importance. In their place, manufacturers are developing deeper, direct relationships with customers that exceed a one-time buying experience, giving them access to the potential lifetime value of loyal customers.

As powerful technologies become more widely available, they will change the industry forever. For example, 3D printing will deliver convenience by reducing wait times with onsite manufacturing, customization will transform consumers into co-creators, and drones will fulfill the need for immediacy with same-day (even same-hour) deliveries. These technologies have the power to disrupt entire supply chains and disintermediate manufacturers. Personal 3D printers, for example, are democratizing manufacturing, making it possible for customers to print basic products, such as toy blocks for children, quickly and easily from the comfort of their own home. Customization is providing manufacturers with the opportunity to create deeper, lasting relationships with their customers. With its NIKEiD program, a multi-channel experience that allows consumers to design bespoke footwear, NIKE has successfully established a direct link to its customers while extending engagement into the design, manufacturing, and distribution phases.

Product and services like autonomous vehicles, same-day delivery, wearable technologies, and connected homes all point to the growing consumer demand for immediacy, convenience, and the ability to make real-time, informed decisions. These new demands are pushing manufacturers to re-evaluate traditional design and production processes and leverage information technology to support new levels of flexibility, operational excellence, and engagement. In the quest to satisfy digital consumers, manufacturers will need to find a balance between what is technically possible and what is operationally sustainable. Digital manufactures that can strike this delicate balance and deliver products and services that meet these new demands will succeed in an emerging digital ecosystem.

New Business Models Emerge

“Manufacturers must start thinking about how they can add new pools of value to their customers and then leverage all of the technologies at their disposal to rapidly deliver on that value.”¹⁶

The drivers of digital transformation are rendering well-established business models obsolete. Platforms-as-a-Service (PaaS), a subscription-based services economy, and monetizing data are just a few of the new business models that are enabling manufacturers to transform their operations. In the digital world, success will hinge on a manufacturer’s ability to deliver services-based offerings in place of stand-alone products, to convert one-time transactions into recurring interactions over the lifetime of a product, and to uncover new streams of revenue from their business data.

Platforms-as-a-Service

The combination of disruptive technologies and digital customers has resulted in a growing trend for consumers to seek out more direct relationships with manufacturers. This trend is driving manufacturers to move away from delivering traditional stand-alone products to provide service-based offerings via digital platforms. A good example of this is LG’s SmartThinQ platform, which gives customers added control of their smart appliances.¹⁷ Using it, they can do everything from checking refrigerator inventory to preheating the oven remotely. The service helps customers to monitor, maintain, and even troubleshoot their connected appliances from virtually anywhere.

As illustrated in the following figure, the closer manufacturers move to PaaS offerings, the greater the business potential for customer engagement and revenue expansion. To support digital services, manufacturers need to invest in digital platforms. These platforms will not only provide customers with a way to control a product or service, they also create direct relationships between customers and manufacturers, diminishing the need for the middleman.

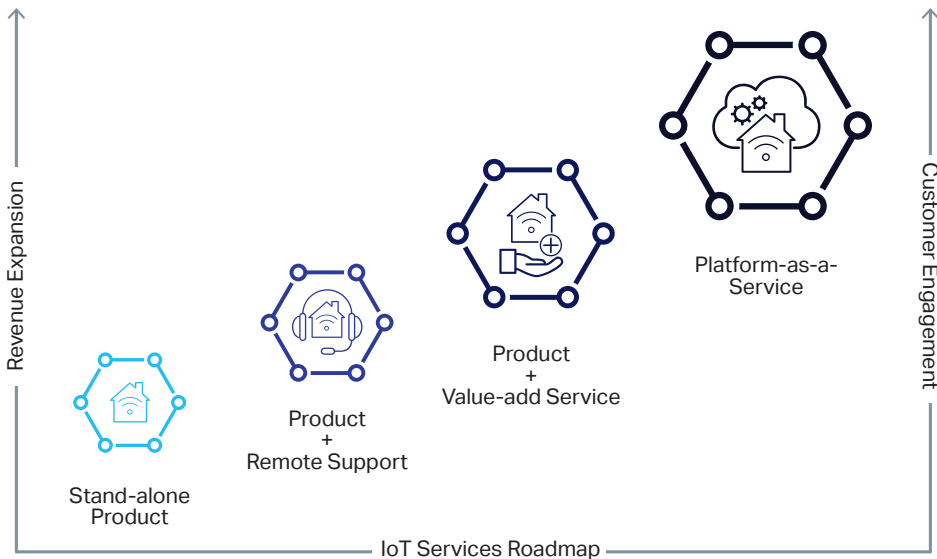


Figure 2.13: New Business Models Emerge

While PaaS offerings deliver added convenience and control for consumers, they can complicate things considerably for manufacturers. Where in the past the middleman—an appliance salesman at a department store, for example—owned the customer relationship; with the new PaaS model, the manufacturer does. Based on this new relationship, manufacturers can sell value-added services to increase customer stickiness. But this new direct-to-consumer relationship also presents a new set of challenges. In addition to modernizing IT infrastructure to support digital service platforms, manufacturing organizations must also update their operations and culture to enable new customer-centric, services-based business models.

A Subscription-based Services Economy

Digital customers are consuming products and services in new and disruptive ways. This behavior is affecting the manufacturing value chain, forcing manufacturers to move from a traditional product-centric business model to a service-centric, subscription-based model.

The need to own a product is declining. Younger generations of consumers, especially Millennials, prefer to access a product rather than own it. This is shown by increasing investments in subscriptions offered by innovative companies like Spotify, Netflix, Zipcar, and Rolls-Royce. Jet engines are costly to purchase outright, so Rolls-Royce gives its customers access to engines via the TotalCare® program, which charges them only for active engine use time. In essence, customers are purchasing engine thrust as a subscription-based service. With this model, convenience is a priority, as consumers subscribe to music, movies, cars, and even jet engines. Organizations that make use of this business model are able to convert one-time transactions into a recurring revenue stream and collect valuable data in the process.

Making the move to a subscription-based model is not as easy as attaching a monthly price to an existing product and calling it a service. The shift will require the adoption of new technologies and practices to support every stage of the product lifecycle—from design through aftermarket products and services—and interactions throughout the supply chain ecosystem to deliver the flexibility and reliability digital customers want.

In the following interview, food-technology company, Local Line, is using an e-commerce platform to disrupt the supply chain and disintermediate the middleman, offering suppliers alternative and direct routes to market.

Local Line

Local Line is a food-technology company that provides an e-commerce platform for local food suppliers and their customers, which includes farmers, wholesalers, vineyards, butchers, bakers, brewers, and more.



Figure 2.14: Local Line

What follows are excerpts from an interview with Cole Jones, Founder and CEO of Local Line.

“Our platform is made up of three products, LocalSell, LocalHub, and LocalMarket. And it’s based on the premise that if you are selling food, you’re one of three things. You could be a seller looking to move products, like a farmer with grass-fed cattle who needs to sell them into the market. Or a buyer and a seller, so a wholesaler with a warehouse, who is buying products from local folks and needs a hub to sell. And finally, you could be a community or farmers’ market organizer that aggregates many suppliers and buyers but does not facilitate purchasing or distribution between those parties. We designed our product line to meet these needs. One for sellers, one for buyers and sellers, and one for markets, as well as broadline distributors, such as big

food businesses, who are looking to create a local market and showcase local products.

We started the company based on research we did on food systems. We were examining supply chains in North America, and we traced the transport of food—in other words, where it was moving to and from. Some interesting stats emerged. One of which was that the average food product travels 4,500 km and changes hands 12 times before it arrives in Ontario—which we thought was crazy. And the same year that we conducted this research (in 2014), Ontario lost just over 4,000 family farms out of a total 51,000 in the province. So that’s approximately eight percent of the total farms in Ontario. While some may have been “lost” to consolidation or other larger

operations, we found that regardless, the only way farmers could operate effectively (and profitably) in the current food system was to work with very big middlemen.

These big middlemen take different forms. Sometimes they are a large processor or distributor that provides the infrastructure needed to move food around. When we looked at the local food suppliers, it was obvious to us that the current model appealed to about one percent of the large producers and manufacturers that could sell into a large distributor and service them very well. But it wasn't a good model for the other 99 percent of family farms, butchers, wholesalers, or vineyards.

So, we spoke to as many farmers as we could—around 200 to be specific. We sat at their kitchen tables and their challenges surfaced very quickly. They wanted to get their products to market while retaining control of their sales, marketing, and brand, but this was hard to do. They could move their products to market, but based on the current model, it was through a massive distributor or processor, and they would have to give up 25 percent of their margin, as well as control over their brand, and become disconnected from their customers.

What we did was disintermediate the middleman, which has happened in every industry. We figured out that the food industry needed an infrastructure to enable this 99 percent of small and medium food suppliers to get their products to market in the best way possible.

For us, the sustainability and the transparency were just a byproduct of building a good system that worked for a range of people. Based on the average order for a food product travelling 4,500 km, we could figure out, per pound of product, how much distance could be saved every

time an order was processed through a new relationship built on Local Line. A significant amount of "food miles" are reduced. First and foremost, though, our goal was to try to help these farmers or producers find their customers and markets—to build their business—and the system we introduced is a very sustainable one.

The big driver for us was increased sales, so that's what we push for when customers enter our program, new customers or increased business from current customers. Our toolset helps our customers do this and then track and support that process. And it gives our customers information they need to know about their products, whether they're in the middle of the field or a driver on the road. They have answers to questions like: "What's in inventory? What's ordered? What's not? Where do I stand with my customers? What product did my customer view and not order?" This information could be important for an upsell opportunity. The system offers a lot of opportunities to improve efficacy.

Many of the local suppliers are concerned about security. They're very protectionist about their information, and with good reason. The decision to use our software is a very important one. They are putting our system between themselves and their most valuable asset—their customer. If they don't have confidence in us, the relationship won't work.

Our platform that connects everyone is how we are improving the industry. Our solution had to be good for everyone in the network—from the big processors to the customers who want to "shop local". It was important that our network benefit everyone—that's really the only way it can be successful. We offer suppliers a direct line to customers and we offer the larger companies access to a big supplier base. It's less about trying to disrupt one side

of an industry and more about a holistic view of an industry and making it better for everyone involved.

We've got customers in four provinces and two states now: B.C., Alberta, Ontario and Nova Scotia in Canada, and Maine and Massachusetts in the U.S. Now that we have built up a good presence, we're trying to target more specific information about a product. So, for example, we might examine what the demand and supply for Ontario potatoes is in the City of Guelph in July. And what's the difference between the two? In other words, is there an oversupply and what impact does that have on the price? Our software gives us a platform that we can run analytics on to discover certain metrics and insights into the industry. This is a long-term play for us, deepening understanding based on a critical mass of customers and data.

Right now, I'm excited about the impact that the IoT will have on every industry. The IoT interests me because it provides marketplaces with the opportunity to build themselves as decentralized networks. This is something that is really important. It's peer-to-peer in every sense of the word. Direct seller to direct buyer, the relationship is direct. Markets need the infrastructure to support this. The e-commerce company Stripe has done this. They've taken a very decentralized model on payments. The IoT and blockchain gives us opportunities to build truly decentralized networks, and this is a very compelling concept that is central to our philosophy. There is a lot of opportunity to do this in the agricultural industry."

Monetizing Data

Technologies like sensors, RFID tags, and IoT-connected devices are continually collecting valuable information from billions of data points. While all of this information can be challenging to manage, it gives manufacturers the opportunity to monetize their data.

As in the abovementioned TotalCare example, Rolls-Royce collects a massive amount of data from the engine services it provides. It uses more than 60 million kilobytes of data generated each year by its 12,500 engines to uncover patterns pertaining to engine health, as well as insights into how customers use the engines.¹⁸ Analyzing this information exposes new ways to improve product design and service delivery and create additional revenue streams. Rolls-Royce sells this data back to customers as add-on services that can predict when engines will need maintenance before issues occur, eliminating unscheduled repair and reducing potential downtime due to breakdowns. Similarly, Italian tire manufacture, Pirelli is successfully monetizing the data it collects on tire pressure with Cyber Fleet, a service that gives drivers and fleet managers the ability to monitor their tires continuously to help detect irregularities and ensure proper maintenance.¹⁹

Applying disruptive technologies to enterprise data delivers numerous benefits, including the ability to monitor performance, mitigate risk, and foster innovation and growth—all of which can benefit manufacturers. It also creates competitive advantage by allowing manufacturers to uncover new streams of revenue by monetizing their data.

EIM: The Digital Backbone for Transformation

Success in the digital world will depend on a manufacturing organization's ability to transform into a digital manufacturing business. To do so, manufacturers will need to re-evaluate (and, in many cases, redesign) existing processes, acquire new skills, adopt new business models, and invest in new technologies.

Digitization is not simply a defensive strategy. Established manufacturers must acknowledge, respond to, and allow digital technologies to transform their operations from the inside-out if they want to remain competitive and relevant in the digital world. EIM and B2B integration will be essential to transforming traditional manufacturers into connected, information-driven manufacturing enterprises.

The disruptive technologies and drivers for digital transformation discussed in this chapter come together to form a comprehensive framework for the digital manufacturing business of the future. This framework, enabled by digitization and the underlying technologies, processes and structures, facilitates the seamless flow of data across traditionally siloed enterprise systems while providing an integrated view of an asset throughout its entire lifecycle. This concept of connecting the "digital thread" from creation through to consumption, and the digitized processes and information involved, will be explored in greater detail in the following chapter.

EIM AND THE DIGITAL THREAD



A digital manufacturing business digitizes activities throughout the complete lifecycle of manufactured products. This chapter describes how EIM provides an integrated, cloud-based platform in new product design and engineering, plant maintenance and asset management, and aftermarket service and support.

EIM and the Digital Thread

“Digital manufacturing technologies will transform every link in the manufacturing value chain, from research and development, supply chain, and factory operations to marketing, sales, and services. Digital connectivity among designers, manufacturers, workers, consumers, and physical industrial assets will unlock enormous value and change the manufacturing landscape forever.”

As discussed in the previous chapter, disruptive applications of technology are enabling manufacturing companies to transform from regional manufacturers into global, connected enterprises that provide better products at lower costs. As the linear value chain is eclipsed by an ecosystem of partners and suppliers, transforming into a connected manufacturing enterprise requires new processes, skills, and investments in technology. The success of a digital manufacturing enterprise depends upon effective coordination across all stages in a product’s development, from design and production through to aftermarket services. This series of data-driven events is commonly referred to as the ‘digital thread’: a single, seamless strand of data that stretches from the initial design concept to the finished product.

Data is the lifeblood of smart business operations. The manufacturing industry generates more data than any other sector of the economy.² To compete in the digital world, manufacturers will be required to manage and analyze their vast stores of information at each stage in the manufacturing process. When information is treated as an asset, it leads to greater insights, higher customer satisfaction, accelerated time-to-market, new opportunities, and competitive advantage. In the Fourth Industrial Revolution, information is a key strategic component for every manufacturer. Future supply chains will rely on Enterprise Information Management (EIM) as the enabling digital backbone and B2B integration platforms to connect information at every juncture, or to interlace the digital thread throughout the manufacturing process.

EIM manages the flow of information across the enterprise—from engagement to insight. It empowers manufacturing organizations to digitize their processes so that they can mitigate strategic risk and uncertainty, while creating new value. Whether process or discrete, food and beverage, Consumer Packaged Goods (CPG), technology companies, or retail organizations, EIM helps organizations anticipate opportunity from disruption, enabling true transformation to occur.

How Much Data?

Manufacturing machinery produces a staggering amount of data. A Boeing 737 aircraft generates 333 gigabytes (GB) of data per minute per engine, so a flight from Los Angeles to New York generates approximately 200 terabytes (TB) of data. A drilling rig produces seven to eight TB of operational data a day. Self-driving cars produce one gigabyte (GB) of information a second. A smart factory might generate over one petabyte (PB) a day, which covers a range of information generated, relating to everything from production lines to processes to machinery to the environment.³

In general, manufacturing plants produce, consume, and exchange volumes of data every day. Connected automobiles, for example, are anticipated to generate more than one petabyte (PB) of operational data every day.⁴ From sensors to machines to software systems, a general range of manufacturing information is illustrated in the figure below.

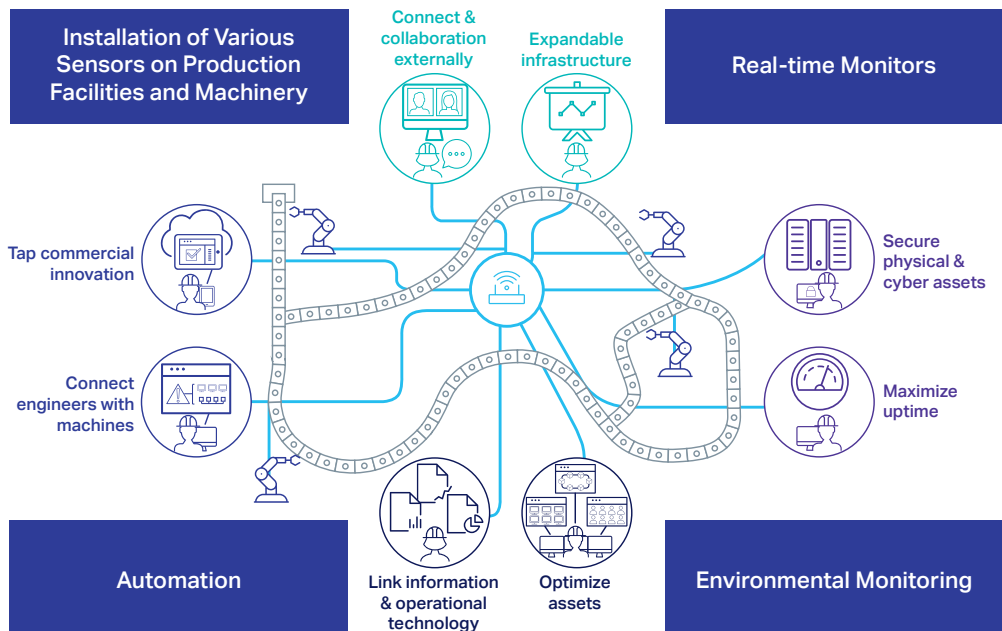


Figure 3.1: Data Generated at a Manufacturing Plant⁵

The proliferation of technology applications used in every aspect of manufacturing—from create to consume—is producing volumes of data. Information comes from many sources, both internal and external. Data is housed in Enterprise Resource Planning (ERP) systems and generated by Manufacturing Execution Systems (MES) on the factory floor, Product Lifecycle Management (PLM) programs, Process Development Execution Systems (PDES), and machine controllers on the assembly line. At the

device level, data is created by motors, pumps, drivers, and robots. Sensor technology is making intelligent products more accessible and these are producing data at exponential rates. When sensors are combined with the IoT, they collect data from machines and equipment and send it to other enterprise systems. At the customer-facing level, Customer Relationship Management (CRM), and Digital Asset Management (DAM) systems house information that must be retained and archived for compliance purposes. All this data needs to be secure and accessible to maximize opportunity and minimize risk.

While manufacturing generates huge volumes of information, few companies are harnessing it. According to a recent survey, only 40 percent of U.S. manufacturers are collecting and using data generated by smart sensors to improve their manufacturing and operating processes. Many are in the early stages of using sensors to gain better transparency into their operations. The same survey also found that 20 percent of manufacturers are using data-driven technologies across their value chains—in the factory, warehouse, along the extended supply chain, and to interact with the customer.

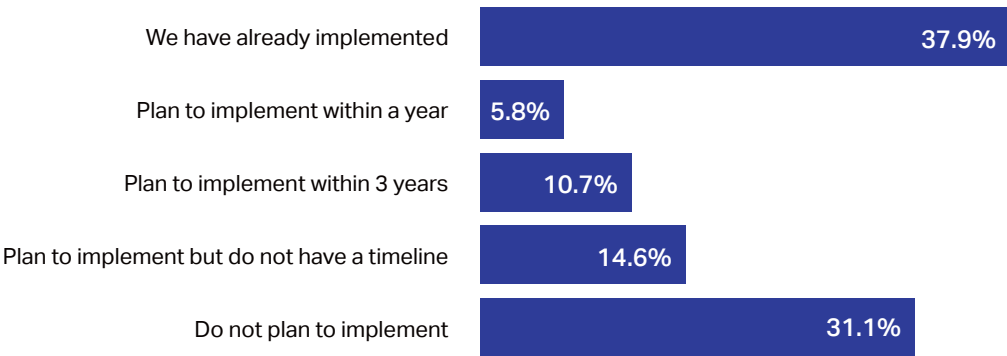


Figure 3.2: Almost Forty Percent of Manufacturers are Embedding Sensors in their Products⁶

By nature, manufacturing is "data rich but information poor," which means that although massive amounts of data are generated, it is short term (or real time) and often, it resides in silos. Take welding images, for example, information that is captured in a factory so that it can be checked for defects. Once a production run is completed and no defects are found, the information is deleted. Increasingly, manufacturers are investing in data-driven technologies to improve productivity, product quality, and even service that is delivered after the product has left the factory. General Electric (GE) has implemented over 20,000 sensors in their wind turbines, which generate 400 data points per second. This information is analyzed in real time to optimize performance and predictive analytics are applied for proactive replacement. As volumes of data in manufacturing grows, so will a focus on implementing cloud-based applications and infrastructure. These implementations are prerequisites for information exchange, analytics, and the development of new products at a scale that is required in the digital world.⁷

Connecting the Digital Thread—From Create to Consume

Manufacturing is complex, involving an array of design, engineering, production, distribution, and service activities. Comprehensive, end-to-end processes are essential for operational efficiency and product quality. This has led to extensive investments in business process reengineering programs and software applications like ERP, PLM, and Supply Chain Management (SCM).

While adopting these systems has resulted in many benefits, it has also reduced organizational agility because the flow of information is interrupted across disparate legacy systems and applications. The digital thread describes this flow of data throughout the manufacturing process, including design, modeling, quality assurance, manufacturing, and post-production sales and services. It is the information that is collected, communicated, and analyzed at each stage in every process. As a body of knowledge around a product grows, gaps in connectivity prevent the manufacturer from gaining full visibility into processes and overall performance. Having the appropriate digital infrastructure—one that can store, access, digitize, and analyze vast amounts of data and interoperate across multiple systems and processes—is critical.

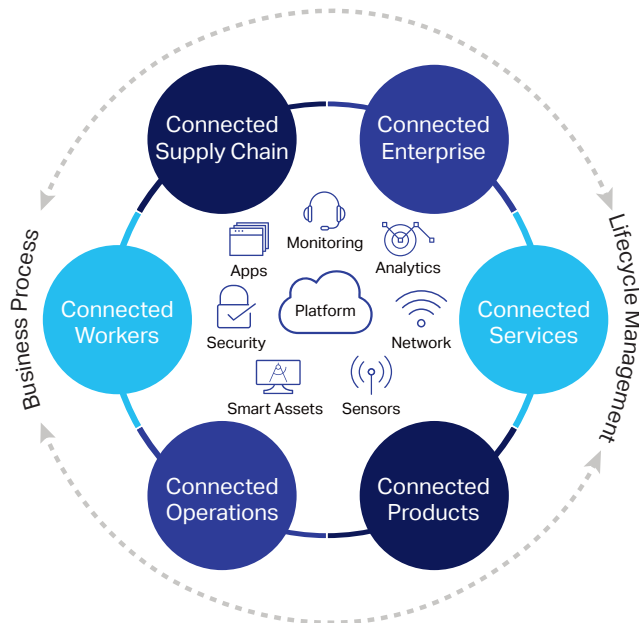


Figure 3.3: The Information-driven, Connected Manufacturing Enterprise

In the following feature, Coca-Cola Refrescos Bandeirantes has extended their reach globally and automated key processes for improved efficiencies using B2B integration.

Coca-Cola Refrescos Bandeirantes



More reliable, global
B2B communications
and integration

Figure 3.4: Coca-Cola Refrescos Bandeirantes

Founded in 1987, Coca-Cola Refrescos Bandeirantes is responsible for the exclusive production, distribution, and sale of Coca-Cola products in Brazil. The company also resells brands such as Heineken and other beverages like teas, energy drinks, isotonic and chocolate milk. Coca-Cola Refrescos Bandeirantes is part of Grupo José Alves based in Goiânia and has more than 2,900 employees and another 5,200 indirect collaborators.

The company needed to improve its EDI processes with its retailers and decided to migrate from their legacy system to a solution that enabled a more global reach and more reliable B2B integration. Refrescos Bandeirantes faced issues relating to orders received from retailers that contained invalid purchase orders (POs) and a lack of overall visibility into the files used throughout the accounts payable process.

With the successful deployment of B2B Managed Services, Refrescos Bandeirantes organized its web-based EDI service to provide better management capabilities for data exchange between the company and its distributors. By restructuring orders and sales, they improved process speeds significantly, giving the company a more competitive internal system. For Refrescos Bandeirantes, EDI processing is now operating under a global platform that provides greater visibility and centralizes mapping infrastructure. An important business rule is now in place to check all POs received from retailers to ensure that it no longer receives invalid invoices. Because the solution is outsourced, the company can avoid issues with software reinstalls and potential strategic data loss.

Manufacturing processes are becoming more sophisticated, and the data inputs and outputs of manufacturing systems, sensors, and technologies will demand more robust information management. This is made more crucial as quality management programs and compliance require real-time monitoring, controls, and archiving. Enterprise Information Management protects and validates parts-related data, enabling each part to have an associated body of knowledge or digital twin.

EIM technologies are helping to ensure greater levels of integrity and traceability. In industries such as food and beverage, for example, regulations require companies to track and analyze products from create to consume. Even in the most traditional industries, manufacturers are burdened with making better use of their data to improve quality and efficiency. The automotive industry, for example, is constantly managing quality control with many of the major companies recalling millions of vehicles any given year. As explored in Chapter 6, information plays an important role in protecting manufacturers against the risks of non-compliance and litigation.

EIM is the platform that enables manufacturers to link together disparate systems. It connects the digital thread across processes, providing a structural backbone that comprises multiple facets, such as security, standards, interoperability, intellectual property and privacy, records management, and analytics. As digital information is used to support the documentation of a product from “cradle to grave,” deploying an effective EIM platform is critical for any manufacturing operation. A comprehensive digital EIM platform unites typically siloed business systems, so that information can flow seamlessly throughout the entire product lifecycle. From engagement to insight, EIM enables digital communication and the exchange of data across the value chain. This end-to-end approach allows for competitive advantage and organizational agility as analytics can be applied to every process and throughout the supply chain, with partners, suppliers, and customers.

In the following interview, Columbia Sportswear emerges as a digital innovator, using digital systems and technologies to manage the lifecycle of their products—from data generated in design, prototyping and sampling stages to portfolio management—in a DAM system to extended supply chain solutions that connect factories, warehouses, and distribution management solutions.

Digitizing Processes

To rise to the challenges of a digital economy, manufacturing and retail companies must digitize their business processes. This goes beyond merely converting paper records to electronic or automating process steps. It requires close examination of key corporate processes, understanding the needs of all stakeholders, determining new outcomes based on these needs, then working back and leveraging digital technology to fundamentally re-invent processes.

Columbia Sportswear

Founded in 1938, Columbia Sportswear Company has grown from a small family-owned hat maker to one of the world's largest outerwear and active wear brands and the leading seller of ski wear in the United States. Today, Columbia Sportswear is a \$2.3 billion company that employs more than 5,300 people around the world and distributes and sells their “tested-tough” family of products to over 13,000 retailers in more than 103 countries. Columbia has become a leading global brand by channeling the company's passion for the outdoors into technologies and performance products that keep people warm, dry, cool and protected year round.

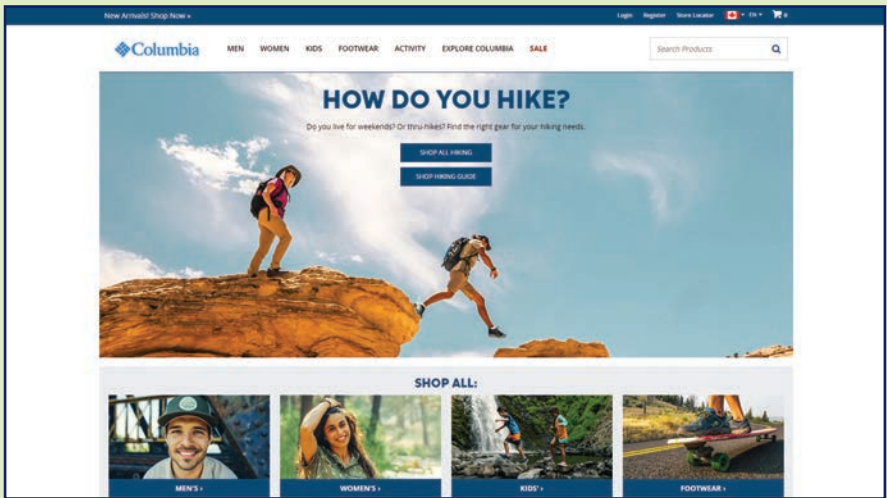


Figure 3.5: Columbia Sportswear

What follows is an excerpt from an interview with Fred Pond, former Vice President and Chief Information Officer at Columbia Sportswear, and Mark Barrenechea, Vice Chair, Chief Executive Officer and Chief Technology Officer of OpenText.

MARK BARRENECHEA: Columbia is a household name. Can you tell me a bit more about the Columbia brand?

FRED POND: Columbia started off as a hat company more than 75 years ago, and has

really evolved since then into a portfolio of brands today. We have Mountain Hardware (our premium line of outdoor ski wear and climbing gear), Sorel (our popular line of fall and winter footwear), prAna (our casual outdoor lifestyle brand focused on yoga,

rock climbing, and swim wear), and of course, the largest, our Columbia brand of outdoor and active wear. So, we've really morphed into an umbrella for multiple brands. We're more a house of brands than a branded house.

Can you give us an idea of the sorts of challenges that come with managing multiple brands?

In addition to supporting our four major brands, we also support multiple channels. We sell wholesale to retailers and distributors around the world, we have traditional standalone retail and outlet stores, we sell to customers online (directly through our websites and through partners like Amazon and Zappos), and we also have what we call a "shop-in-a-shop" (a space within a department store in some markets, mostly in Asia).

Ten years ago, we were 95 percent wholesale, selling mostly through partners like DICK's Sporting Goods, REI, Academy, and all the big retailers in Europe and Asia. But we have morphed into having more of our own direct-to-consumer channels, although we make it very clear that we are not and will not be a pure-play retailer. Globally, we have a little over 500 stores that are branded Columbia, Mountain Hardware, Sorel, or prAna and these are standalone retail stores or shops. Obviously, our web presence has grown over that same period, and today almost ten percent of our global revenue is based on e-commerce. Online is our single fastest-growing channel. We have lots of ways to reach the consumer, and we want to be able to play and succeed in all of them. So, the challenge becomes how to leverage the tools we have across all the brands, channels, and retail formats in a way that delivers a consistent brand experience for the customer.

Are you using any solutions to help manage all the assets that come with multiple brands and the associated products? Give me a sense of your product portfolio.

When I describe our IT environment, I always start at the beginning, where we design and build a product (think of it as CAD/CAM for clothing). We use a product data management system for our designers and developers to work in and hold all the specifications for our products. Once we have a product designed and ready, we build prototypes and samples and then, using digital photography, build our portfolio of digital assets. These are not only shots of all the individual products, but also assortments of products and video of the products being used.

We use a DAM solution to store all of our digital assets associated with our products and their use. We are working towards making the solution the one single place where our digital assets are centrally stored. That way assets can easily be searched and shared internally (across our marketing, advertising, stores, and e-commerce sites). External partners also have access to this solution, so they can conveniently download assets on a self-serve basis for their advertising, catalogs, and marketing. So that is the beginning of our product and digital lifecycle. Product data then flows into our demand and supply solution, our ERP solution, our extended supply chain solutions that connect our outsourced factories, and our warehouse and distribution management solutions. That is our integrated back-office footprint. And that doesn't even touch on reporting and analytics, which is a whole other set of technologies we use to make sense of all the information in these systems, so we can make more accurate and quick decisions.

When it comes to the customer-facing technologies, we use a variety of systems. For e-commerce, for example, we run about 60 global sites in 15 countries and in about six languages, using Software-as-a-Service (SaaS) along with many other partners. For our retail stores, we have five different systems that run in different parts of the world—one set here in North America, one in Europe, and three in different locations across Asia. So, right now, we're not very standardized. But what we lack in standardization, we make up for with great products and customer service—we are currently expanding our mobile information and solutions.

It sounds like you're working towards becoming a digital company. How far along are you on your journey?

We're looking to standardize our global systems. For example, we are consolidating our systems into a standard, global set of back-office and supply chain solutions. To date, we've got 83 countries operating on the same set of systems. It's taken us three and a half years to get to that point. Also, we have made a couple of acquisitions over the past few years (Outdry and prAna) and those businesses are still operating on legacy systems. We still have 20 countries to go to finish our global transformation. Our goal is to have everyone on one set of consolidated technologies within the next few years. We also need to start that same journey to standardized global solutions across all of our direct-to-consumer businesses.

Let's talk about the Cloud. Is Columbia an on-premises, cloud, or hybrid company?

There are good places to outsource and leverage the Cloud and if we don't believe we gain any strategic advantage by keeping a workload in-house, we look to move out to the Cloud. Right now, we probably have 100 to 120 applications that are either

SaaS, Cloud, or managed services; but we still have more than 100 applications in our portfolio that we run on premises. So, right now we are definitely a hybrid company, but looking to move to the Cloud where it makes sense.

In the coming years, are there any particular technologies—from M2M, GPS, IoT, to any platforms—that could really impact your industry?

Something that is really fascinating for us is three-dimensional printing and design work, and the prospect of moving away from having to do prototypes and samples. We could potentially print 3D prototypes. We still complete a lot of drawings manually and then digitize the process. We are playing with some tools that will give us a completely digital delivery of everything 3D into our DAM without building prototypes and samples to photo shoot. We may even have 3D printed samples available and this would move us away from building all sorts of prototypes and samples as part of our product lifecycle.

What does technology "Nirvana" look like for you/for Columbia?

The ideal future is an environment that is digitally integrated from end-to-end, that makes it incredibly easy for customers to get what they want, and that allows us to strengthen our customer relationships, no matter which channel, at each touch point along the customer lifecycle.

Information is delivered across business processes—from supplier engagement, manufacturing, logistics, asset management, to human resources (HR), finance, and sales and marketing—as a part of a larger ecosystem of applications. Ideally, organizations should digitize core business processes from end-to-end, in their entirety. When companies digitize portions of a process, they may achieve improved outcomes but fail to produce an overall seamless experience. A team comprised of external stakeholders and representatives is essential to ensure changes are fully evaluated and cohesive, and to take further action to redefine operating models, organizational structures, and roles.

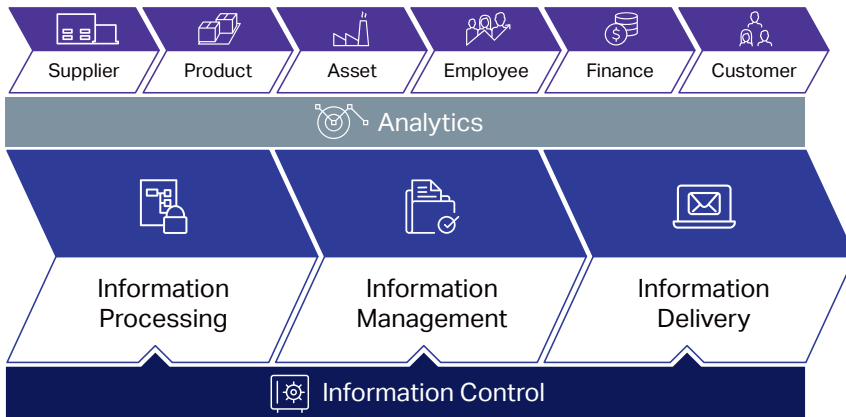


Figure 3.6: Information-fueled Business Processes

In the digital world, technology enables processes to operate seamlessly, efficiently, and rapidly to meet the heightened expectations of customers and drive competitive advantage. The benefits of digitizing information-intensive processes are numerous. Costs can be reduced by up to 90 percent and turnaround times improved by several orders of magnitude.⁸ Errors can be reduced. New channels and new routes to the customer can be leveraged. Replacing manual paper-based processes with digitized processes and documents allows businesses to collect data to better understand process performance, costs, and risk factors.

Digital transformation requires not just integrated processes in a factory, but tight coupling between suppliers, customers, and the manufacturing organization. This provides greater levels of customer engagement and better control over work in progress and raw materials, however the expectation will be towards greater flexibility and agility in the ecosystem. This implies a unified information strategy—across the organization and the supply chain. Once information is created, it can reach multiple audiences. Mixing advanced analytics of enterprise business data with operations technology data is central to delivering better, more powerful business applications.

Embedded Analytics

In the digital economy, information and analytics are the oil fueling every business process. In fact, of all the disruptive technologies, big data analytics, B2B cloud networks, and the Cloud are already mainstream.⁹ Big data analytics is in full use across supply chains in 37 percent of discrete manufacturers and 31 percent of high-tech manufacturers.¹⁰

Analytics will be a mainstay in smart factories of the future. Insights based on analyzing information empowers manufacturers to act on this information in real time and automate their decision-making processes. Applying advanced analytics gives manufacturers a better understanding of their transactions and interactions, and can help improve outcomes. For this reason, 42 percent of manufacturing companies have cited analytics as a top priority moving forward.¹¹ The figure below illustrates where these organizations plan to apply advanced analytics.

Where manufacturing organizations are seeking to leverage advanced analytics:

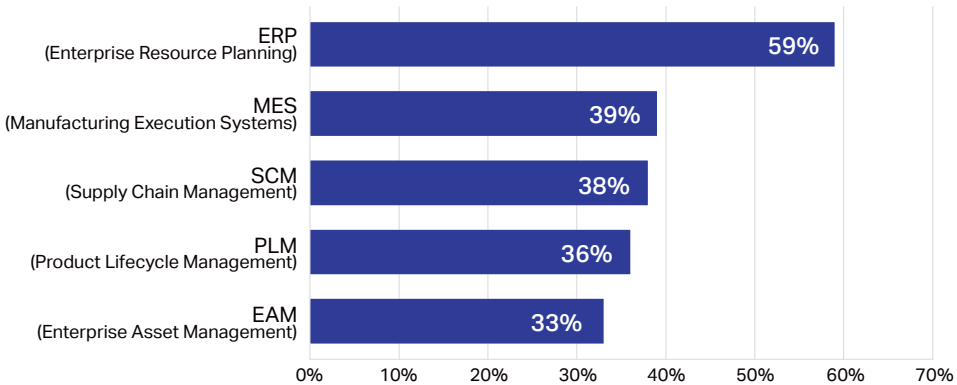


Figure 3.7: Leveraging Data with Analytics in Manufacturing

Revenue from sales of big data and analytics is projected to be \$187 billion in 2019, up from \$122 billion in 2015. One of the sectors that will benefit greatly from this is the manufacturing industry, with revenues projected to reach \$39 billion by 2019.¹² According to one recent report, manufacturers could realize \$4 trillion of value from the IoT by applying analytics to data flows for increased revenues and lower costs.¹³

When information is collected and analyzed, manufacturers can develop more innovative products and services, adopt new business models, improve operational performance, and increase customer satisfaction with after-purchase services and maintenance. As well as dissecting information that is “at rest,” there is also a requirement to track, monitor, and act on dynamic data that is generated by sensors and processes. The IoT offers great potential for streaming data to be analyzed, bringing greater accuracy and real-time decision making.

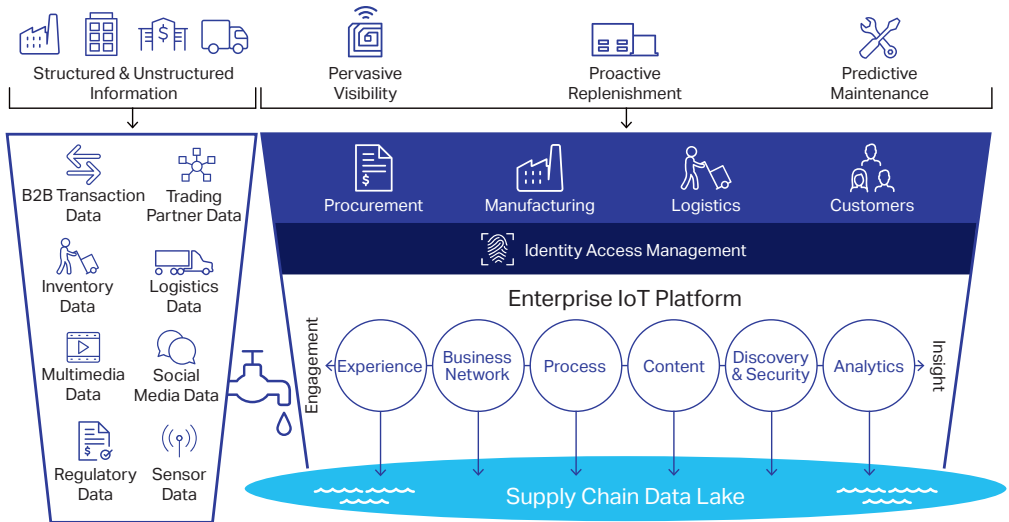


Figure 3.8: Mining the Supply Chain Data Lake for Insights

"The ability to extract meaningful insights about products, processes, production, yield, maintenance, and other manufacturing functions, as well as the ability to make decisions and take proactive action – when it matters – can deliver tremendous growth and profitability results."¹⁴

Some manufacturers have invested in creating the necessary infrastructure to capitalize on their information, creating data lakes rather than storing information in data warehouses. In data warehouses, information is kept in large repository file or folder format, whereas in data lakes, information is maintained in its most raw format. This kind of information will help make analysis quicker and information more actionable as advances are made in computing, chipsets, real-time streaming, and data pipelines. Manufacturers can use these to visualize trends and patterns, and maximize the value of their data.

The figure above illustrates a "supply chain data lake," highlighting the types of information, both structured and unstructured, that comprise the lake. This includes information from every connected device—from the vehicles delivering finished goods to customers to the pallets carrying the goods. All of this information could be remotely connected to an IoT platform. Manufacturers can leverage this information in different ways to help drive IoT-enabled supply chain processes, allowing for a macro level of supply chain visibility to be achieved. Deciding which supply chain assets need to be connected to the IoT platform, what type of information needs to be obtained from the connected device, what B2B transactions need to be accessed, and what to measure will then determine the type of analysis and reporting that is required.

In addition to the data in enterprise resource planning, product lifecycle management, enterprise manufacturing intelligence and manufacturing execution systems, the IoT generates an incredible amount of data. A single sensor monitoring one element of a production line can be producing thousands of datasets every minute. These are stored in massive data pools, which are often siloed by enterprise application, business division or operational process, with analysis conducted for tracking purposes, rather than business improvement. It is unsustainable for an organization to retain vast amounts of data from every connected device over a long period. By deploying edge analytics—analytics conducted at the device or network point level—allied to information governance policies, data with long-term strategic value can be identified.

In the following feature, steel manufacturer North Star BlueScope Steel is using analytics to gain insights into costs, monitor performance based on plant delays and bottlenecks, and ultimately, forecast utility requirements and sales opportunities.

EIM Impacts Every Manufacturing Process

*"Industrial companies are in the information business, whether they want to be or not."*¹⁵

A digital manufacturing enterprise digitizes activities throughout the complete lifecycle of manufactured products and the facilities used for production and distribution—from end to end. Information is critical for every lifecycle activity. The following sections describe how EIM provides an integrated, cloud-based platform for information and process management in product design and engineering, plant maintenance and asset management, and aftermarket service and support.

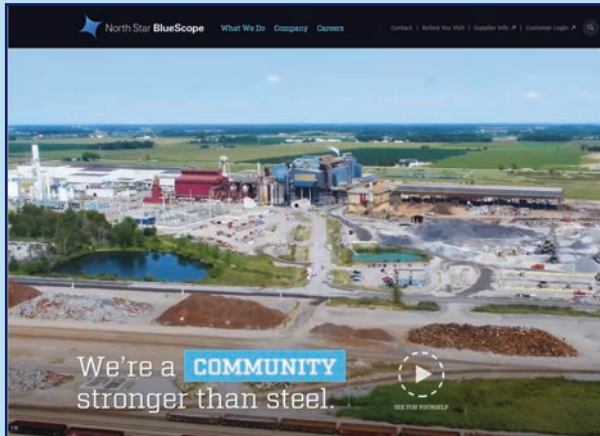


New Product Design and Engineering

The lifecycle of a manufactured product begins with information created in the design and engineering phase. Design departments rely on PLM solutions to build complete digital representations of their products. These are based on 3D digital information that is used by many different departments in the manufacturing enterprise. Providing a centralized digital information hub, a platform that is available and accessible by any type of device, enables convenient access by partners on a worldwide basis.

Modern PLM solutions support information sharing with production groups and the products they use to program machining centers. Some also support the development of prototype models utilizing the latest 3D printing technologies or even virtual prototyping. But today's need for design information has expanded far beyond these traditional production activities.

North Star BlueScope Steel



Steel band manufacturer makes costing clearer through analytics

Figure 3.9: North Star BlueScope Steel

A subsidiary of Australia-based BlueScope, North Star BlueScope Steel produces and supplies hot-rolled steel bands for coil processors, cold-rolled strip producers, pipe and tubers, original equipment manufacturers and steel service centers. Founded in 1997, the company is the largest scrap steel recycler in Ohio, recycling nearly 1.5 million tons of scrap steel every year.

North Star BlueScope Steel needed a more efficient tool to help it more accurately understand its costing data and workflow, so the company could use it to engage with customers, conduct market-based analysis, and build purchasing breakdowns. The technology would have to eliminate the manually intensive process and collect data automatically from a variety of sources—including databases and the company’s electric arc furnaces (EAF)—allowing it to reallocate staff and save on resources, all while better meeting customers’ needs.

The company opted for Big Data Analytics (BDA) to automatically access, blend, explore and analyze data. The solution allows North Star BlueScope Steel to apply algorithms to extracted information to generate a final monthly report, reducing their reliance on manual work. Using BDA, the company can compare month-to-month data to analyze how events such as plant delays and bottlenecking might affect profitability. Embracing the IoT, the company hopes to integrate BDA into data points coming directly from its instruments, to analyze electricity consumption, weather patterns, material usage and steel prices for a better idea of future needs and sales potential.

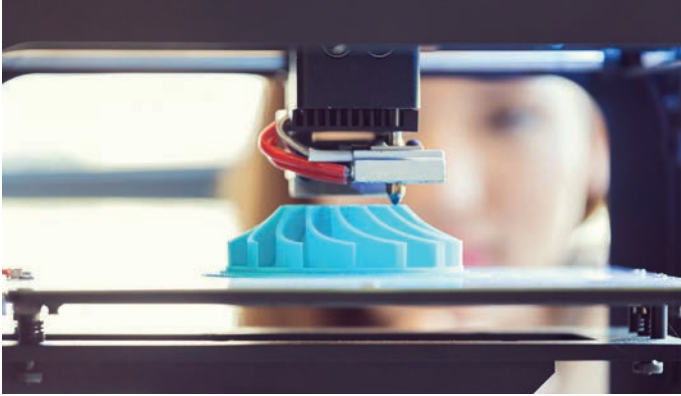


Figure 3.10: Rapid Prototyping with 3D Printing

The design and scan phase describes a product's inception into the digital realm. This process also includes the digital twin. Gartner predicts that by 2020, there will be more than 20 billion connected sensors and devices, and digital twins will exist for billions of things.¹⁶

A digital twin is a dynamic software representation of a piece of equipment or system that emulates the original's materials, measurements, component parts, and behavior. More importantly, a digital twin also includes data that is unique to the asset it represents. Data is incorporated into a unit part's digital twin and records anomalies from the digital reference model that may affect the product's lifecycle. This information can grow by orders of magnitude, and thus it is important for organizations to understand their requirements so they can selectively store, reduce, and analyze data created during the build.

Digital twins are created and maintained to allow simulation, analysis, and control. Sensors can be used to feed data to the digital twin. As more information is acquired, the digital twin gains accuracy. Initially developed by the military for aircraft, digital twins are gaining traction in other industries, such as renewable energy and manufacturing. The GE Digital Twin has created cloud-based computer models of wind farms which connect wind turbines, collecting and analyzing data to make them 20 percent more efficient.¹⁷ Black & Decker has digital twins of assembly lines and materials in one of their factories and has reported labor utilization improvements of 12 percent and a 10 percent increase in throughput.¹⁸

Over the next year, organizations will use digital twins to boost efficiency, optimize design and performance, and improve quality. Over the next five years, billions of objects will be represented by digital twins, including equipment, facilities, environments, processes, and even people. For every physical asset, there will be a virtual copy running in the Cloud. Their potential lies beyond demonstrating proof-of-concept to mirroring an entire supply chain to support globalization and promote economic gain.



Figure 3.11: The Digital Twin of a Wind Turbine

New product development depends upon design information that is accessible from anywhere at any time. This allows everyone within the connected manufacturing enterprise—whether internal to the company, outside suppliers, or third-party contract designers and manufacturers—to have access to information they can trust. This information must be securely archived to support the growing need for full traceability of every component in every product. Manufacturers are required to preserve design information for an extended period of time—often up to 10 or 20 years. As recent events have shown, products that fail or cause harm to a user can create incredibly expensive recall situations for manufacturers. A centralized archiving process for all design-related information can help companies resolve recall issues quickly and maintain consumer confidence. Governance, risk, and compliance initiatives introduced by governments around the world require secure information management and archiving.

EIM systems help meet the needs of product design and engineering by providing a consolidated view of all related information, including 3D CAD/CAM models, 3D visualization models, product bills of materials, testing reports, specifications, videos, renderings, and more. Extensive archive and version control are offered for each of these file types, helping to ensure compliance with regulations and QA requirements. Different groups and departments are able to access and share these documents and collaborate using mark-up capabilities from leading PLM solutions and other business applications. Finally, processes are streamlined as review and approvals can be automated for all design-related information. As with product design and engineering, information accuracy, security, and accessibility are paramount in plant maintenance and asset management.

In the following interview, Enterprise Content Management (ECM) is helping Multiconsult bring together digital and analog—uniting the two worlds of 3D modelling and documents—to keep projects on schedule and on budget, and its clients satisfied.

Multiconsult

Multiconsult is one of the leading firms of consulting engineers and designers in Scandinavia. With roots going back to 1908, the company has played an important role in Norway's development and economic growth. Thanks to its 2,800 highly skilled members of staff, the company is able to provide a range of services including multidisciplinary consulting and design, project engineering and management, verification, inspection, supervision, and architecture—both in Norway and overseas.

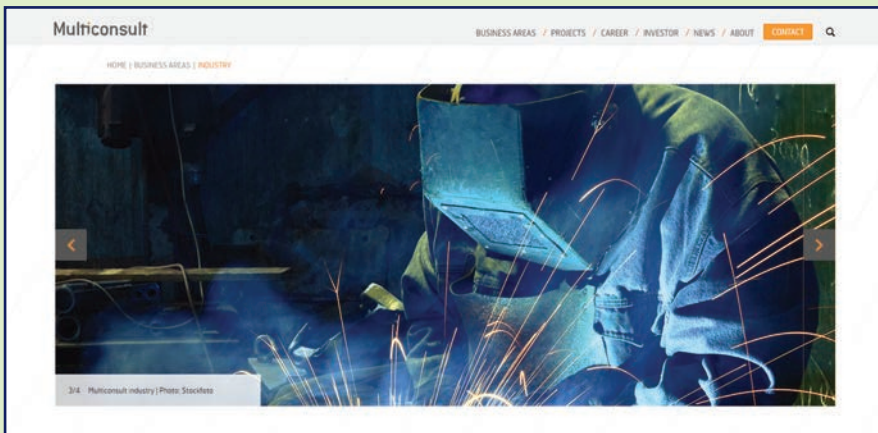


Figure 3.12: Multiconsult

What follows are excerpts from an interview with Ole Meyer-Skjølingstad, Head of Information and Document Management at Multiconsult.

"As the Head of Information and Document Management at Multiconsult, my job is to ensure that we accomplish effective information management in our projects. We manage massive amounts of projects in many industries, including Buildings & Properties, Transportation, Oil & Gas, Industry, Renewable Energy, Water & Environment, and Cities & Society.

Our projects range from small projects that last hours to large ones that last for many

years—like projecting building facilities like hospitals. Engineering documentation is primarily unstructured data comprised of engineering or CAD drawings, 3D models, health and safety procedures, contracts, regulatory rules and regulations, equipment instructions, calculations, geophysical data, analysis results and financial projections. An increasing amount of our projects involve us using virtual 3D models. These models contain a lot of information about specific objects or facilities. One of our biggest

challenges is bringing all this information together. We're continuously developing better methods of how to control the quality, how to manage, and how to connect the two worlds of 3D models and 2D documents.

Three-dimensional modelling gives us a lot of options—we can build structures that would not be possible to produce with two-dimensional methods. It also gives the involved parties a better way to give early input and review of the project when it is modelled in 3D. Our customers are increasingly asking for 3D models to be included as part of the project deliverable. In some infrastructure projects that we've worked on, our customers want to extract the data coordinates housed inside the model and use these directly in production out in the field to create the final product. So, we have to make sure that the quality of this information is good enough and accurate enough to allow them to do this.

We have some drawing-free projects, in which all the information is contained in the 3D model. That's happening a lot these days. In some projects, 3D modelling can be used to replace the CAD drawings or at least a large amount of them. This allows our customers, or entrepreneurs, or any other stakeholder to extract the data from the model, generate a level plan on the fly, take measurements, or click on an object for more information, like specifications. There are a lot of options available because the models are filled with relevant information. CAD drawings are still used because they are very portable and traditional processes are based around these, but we can reduce the number of drawings with 3D modelling.

We use ECM to manage all our documents in projects, mostly office and PDF formats. Engineering departments often operate in silos with specialized applications. Engineering documentation and drawings have special characteristics and complex inter-relationships. In an ideal world, all

the final products produced using these applications would be uploaded to our document management system. We are working hard to increase adoption and establish rules or governance for usage to be as effective as possible in our data flow.

For many of our projects we need to keep the documents for more than 10 or 15 years. In practice, we have a policy of not deleting anything today, which is not a sustainable path because the volume of information just keeps growing. When I started in my position, I wanted to see the number and types of documents I would be managing—and I discovered that we had 1.8 million documents in our content server. If we include all the versions, the number is likely closer to 2 billion, which we are well over today. Plus, we have all of the information on a file share. And, of course, there is duplication between the two. When I discovered all this information and its disparate sources, I spent half a year building a three-year roadmap to help manage this information and to develop our solution and best practices to support our operational needs. At the end of the three years, our goal is to have the building blocks for a robust and user-friendly ECM system in place. After that, we will have to help our engineers become digital engineers—where lifecycle management and automation are part of their processes.

We have a company-wide project for digitization. It runs across all the industries we cover and all areas of the business. This includes our project for automating the process for quality control. But it also goes beyond this to embrace more disruptive technologies and identify the ones that are most important to us or the ones that would give us a competitive advantage. This will be a continuous project for us so we strive to nurture an environment that keeps us on the cutting edge of technology."



Plant Maintenance and Asset Management

Maintaining high availability of production assets has never been more important to manufacturers. The cost of facilities has skyrocketed and manufacturers need to maximize the use of every production line to achieve Return On Investment (ROI) goals. The shift to customized products and new manufacturing strategies like Lean and Just-in-Time (JIT) drastically reduce inventories and increase the importance of predictable production schedules.

The impact of any disruption can ripple through supply chains and undermine customer confidence. For example, JIT production environments across the automotive industry have two basic requirements: first, there must be a steady stream of parts delivered to a plant from outside suppliers and secondly, production equipment, assembly lines, and associated utilities supporting the facility must be highly available. If a key piece of robotic handling equipment suffers a failure or a back-up power generator fails to kick in during a power outage, these can have serious impacts on the production of parts, and more importantly, could negatively affect deliveries and customer satisfaction levels.

There is a direct relationship between asset availability and the quality of asset information. Studies have shown that the cost of poor asset information management can exceed 1.5 percent of a plant's revenues in some industries. This doesn't even consider the impact that poor maintenance could have on safety and environmental compliance.¹⁹

To ensure safe and reliable assets, today's factory-based maintenance teams need access to all digital information associated with machinery, as well as all utilities servicing the plant, such as electricity, gas, and water supplies. There is also a growing need to effectively manage the day-to-day relationships with all on-site contractors and indirect suppliers of spare parts used to repair plant equipment. Maintenance teams must also embrace a growing number of health- and safety-related compliance regulations. Advances in digital technologies, for example, the introduction of lightweight, ruggedized tablets that can remotely connect to centralized maintenance information, are transforming how production facilities are managed and increasing the uptime of production equipment.

Traditionally, plant maintenance windows would be factored into production operations to ensure that key pieces of production machinery are proactively maintained. The aim of this has been to minimize downtime of plant-related assets, such as robots, lathes, milling machines, and assembly handling equipment. However, the introduction of new and disruptive technologies such as the IoT is changing how production equipment is maintained. These new technologies are transforming the plant maintenance sector from one that has traditionally been reactive and preventative to one that is proactive and predictive.

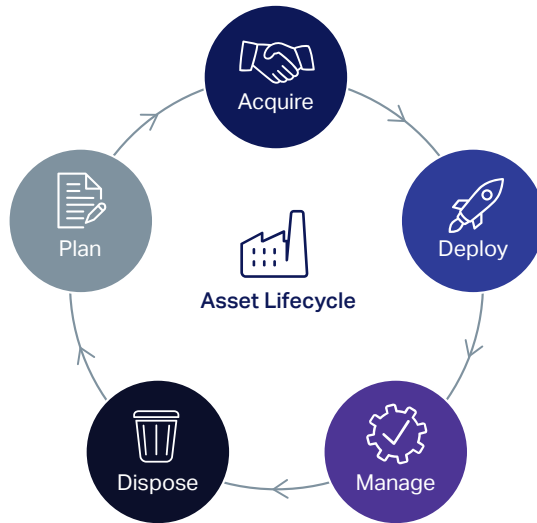


Figure 3.13: Plant Asset Management

An effective EIM solution for asset lifecycle management improves the quality and consistency of asset information and work instructions, provides remote, mobile access to plant-related asset information, and allows for higher asset uptime and reliability through extensive analysis of equipment data. Information can be easily archived to satisfy compliance requirements. As well, predictive maintenance procedures can be implemented to improve equipment availability.

The need for an organized information management strategy will expand in the future as manufacturers adopt new Industrial Internet of Things (IIoT) capabilities for equipment maintenance. This will increase the number of sensors on production equipment and enable organizations to implement more predictive maintenance strategies that identify problems before they occur, as discussed in Chapter 4. Big data and analytics are central to this approach and will lead people to require access to additional data, analysis tools, and alerts. They will also take a more vital role in delivering aftermarket services and support once a product has left the plant floor.



Aftermarket Services and Support

Manufacturers of products, whether aircraft, vehicles, or consumer electronics, need a service and support infrastructure with broad capabilities and high availability. Excellent product service and support helps companies maintain and improve customer satisfaction levels. In many cases, such as the production of jet engines, a manufacturer can make more money through maintenance over the lifetime of the engine than on the original sale.

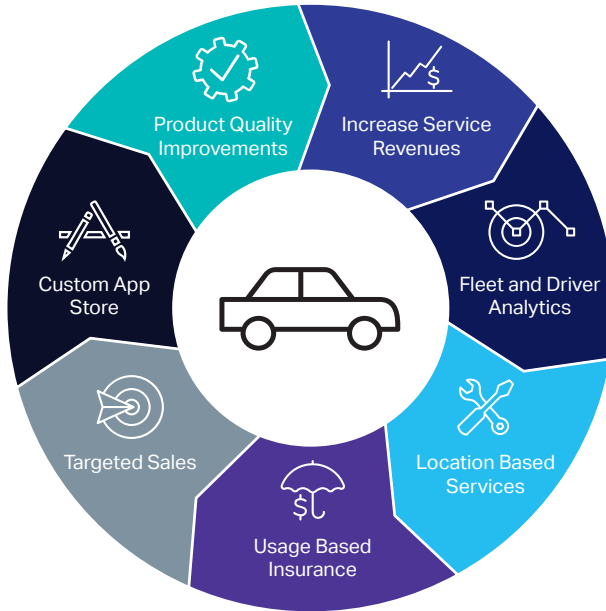


Figure 3.14: Aftermarket Services on an Automobile

Field service engineers, whether working on an aircraft in a maintenance hangar or a vehicle in a garage, must have access to all digital information associated with the product or piece of equipment. Being able to remotely download product or replacement part information, whether images, videos or documents, is becoming a standard requirement in today's aftermarket service sector.

Having the ability to access a complete digital archive or representation of a product is becoming a condition of doing business in the digital world. Archiving all service records and test or compliance certificates is important for transparency, especially if a major recall is initiated at some point during the lifetime of a product.

Field service engineers may also need to place an order for a replacement part and have it shipped to a specific location. The ability to remotely access a web-based spare parts portal is becoming standard in the aftermarket service sector. However, new disruptive technologies, such as the IIoT have the potential to transform the aftermarket service sector for good. As more products are shipped with onboard sensors and Wi-Fi connectivity, it means that a product or piece of equipment can remotely inform a service center of a problem before it becomes an issue. These kinds of advanced developments will drastically increase asset availability and reduce the costs of service calls.

Standard applications like ERP, PLM, and SCM help manufacturers optimize individual business processes within finance, production, design, and distribution. But this is not enough for a successful, connected manufacturing enterprise. Today, manufacturing organizations are as driven by information as they are by processes. They need information access and sharing that is not encumbered by departmental boundaries and static business processes. Implementing manufacturing applications on a common, enterprise-wide EIM platform is essential for digital transformation.

In the following interview, leading chemical manufacturer Solenis is adopting transformational technologies and approaches to digitize processes, as well as its supply chain, from end to end.

EIM Enables the Digital Manufacturing Enterprise

The need for more effective enterprise information management is apparent in light of how manufacturing organizations are struggling to accelerate product lifecycles, digitize global supply chains, offset high offshore labor costs, offer more customized products, and comply with regulations. In the digital world, information is a key differentiator, helping innovative manufacturers scale their operations, restructure their supply chain, evolve their products, and adopt new business models.

To compete in today's global economy and respond rapidly to threats and opportunities, digital manufacturing enterprises need end-to-end business processes and applications that transact across a dynamic, fully-connected ecosystem of global partners. Every partner needs trustworthy information, but access has to be flexible enough to enable a broad base of partners. Partners should be able to share information easily with other entities in the connected manufacturing enterprise. Every exchange should be tracked and stored for overall control, governance, and regulatory compliance.

EIM enables manufacturers to manage their stores of information across their digital supply chain. It binds together the digital thread, allowing multiple, federated systems to interact with one another so that information contained within the enterprise can be shared across every manufacturing process, from create to consume. EIM helps to ensure that each connected stage of the manufacturing process communicates effectively, regardless of protocols and file formats. By connecting data-driven processes, EIM promotes supply chain evolution, enabling effective information exchange between numerous manufacturers, distributors, and designers. This will be discussed in greater detail in the following chapter, "The Digital Supply Chain."

Solenis

Solenis, formerly Ashland Water Technologies, is an American manufacturer of specialty chemicals for the pulp, paper, oil and gas, chemical processing, mining, biorefining, power and municipal markets. Headquartered in Wilmington, Delaware, in the United States, the company operates 30 manufacturing facilities which span 118 countries and five continents and 3,500 employees. Its product portfolio includes a variety of process, functional and water treatment chemistries, as well as monitoring and control systems.

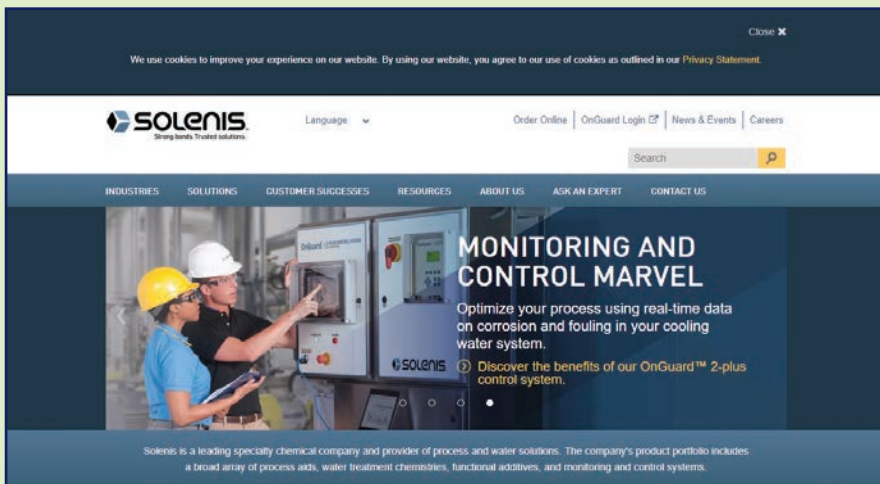


Figure 3.15: Solenis

What follows are excerpts from an interview with Charles Wallace, Senior Vice President (SVP) and Chief Information Officer (CIO) at Solenis.

“Our focus is heavy industry. Solenis is a \$2 billion global chemical processing company, we manufacture specialty chemicals for the pulp and paper and water treatment businesses. As SVP and CIO of the company, I lead the company’s global Information Technology (IT) group.

Before we became Solenis, we belonged to a combined group of many companies

that operated for many years, so we inherited all the legacy systems, platforms, and technologies that belonged to these companies—and the business processes were as disparate at a global level as these systems. We are embarking on the digitization of key processes related to M&A, for example, to make conducting related processes and transactions much more cost-effective.

With digitization, we have the challenge—and the opportunity—to clean up our data house. We want to do business with our customers much more cost-effectively and one way to do this is to implement a B2B portal. We can't do that until we get our house in order. This requires cleaning up our master data and really understanding how our business processes work. It's not efficient to have five different ways to do order-to-cash or purchase-to-pay, which is what we have in place today.

We were lucky at Solenis because, when the merger happened, we were given the opportunity to start with a fresh mindset. We've only been around for a few years. Our approach was to do things differently, so we set up IT differently to how you might find it in other organizations in the same industry. I started with a commitment to using a consumption-based model like Software-as-a-Service (SaaS) and hiring a staff of leaders. As an organization, IT would have scalable versions of our mail and calendaring systems. We wanted to do as much as we possibly could in the Cloud, excluding ERP systems, of course, because we're just not there yet. But we will be.

The transition from ERP to EIM is happening. Up until now, ERP systems have dominated the industry because there hasn't been a reasonable alternative, but those days are gone. We are still reliant on legacy technologies because we house critical information in these systems, but we are decommissioning the ones we can for now.

The business value of technology is understood much more now as it pertains to chemical manufacturing, whereas previously, the value-add was perceived to be more for other industries, especially those dependent on mobile devices like banking and retail. Manufacturing is using technologies like portals, mobile devices, and digital systems and solutions and there is an understanding of value in terms of

responsiveness and agility. The game has changed, significantly. Our commitment to SaaS and Platform-as-a-Service (PaaS) were elements that lit the fire for accelerating that value-add that we're bringing to the business.

Externally facing, a transformational goal is to digitize our supply chain, from end to end. In the chemical manufacturing industry particularly, it's not something that can be accomplished easily. We want to give our supply chain partners visibility into an order, logistics, and invoicing, etc., and this has to happen electronically. Again, we're working on getting our house in order internally and putting a solid foundation in place to build on. We're working on the plans and architectures we need to deliver the same services externally to our customers and suppliers.

Right now, our internal customers are comfortable doing what they've always done because that's what they're used to. Many of the business units need to be brought to the table to have a discussion about digital transformation and its benefits. In some cases, this is going to be easy, depending on where in the world, what region, or what part of the business we're focusing on, like marketing, for example. Technically, transformation is not a challenge, it's the cultural change required that is the challenge. So, we spend a lot of time on that.

We're already achieving some understanding with the low-hanging fruit—processes that we digitized with clear, demonstrable value for internal business users. We have a leadership team in place in our organization that truly understands the value of digital transformation. So, I don't have the challenge of selling the concept or trying to help our leadership team understand the value. When we did have this conversation they said, "Yes, yes. How fast can you do it?" In my experience,

it's unique to have this level of support from the CEO and the rest of the organization. IT is not going to be pulling them along, in fact, in some ways we have set a high level of expectation.

Cognitive technologies are being slated as the next big technology trend. We've put sensors into our manufacturing plants and we're ready for a cognitive platform. We're already taking advantage of the IoT and going forward, it will become part of our business model. Based on its ability to scale and proximity to raw materials, 3D printing has the potential to disrupt manufacturing. This won't happen tomorrow but it's not 15 years away either; it will more likely happen in the next five to seven years.

The advice that I would give to my peers in the industry, and even in others, is to move to a hosted or managed services model. I would share this especially with IT leaders who are managing their own data centers, platforms, and infrastructures. Of course, there's no value in moving to the Cloud just for the sake of moving to the Cloud. From a CIO perspective, if the business needs you to move to the Cloud, that's what you should do. And the conversations should be about what the business needs are.

When SaaS was relatively new, I sat on a panel at Temple University and they were debating the Cloud. I thought to myself, "This is not a debate about what, but when—because it will only be a matter of time until business starts to move there." I realized that technology was going to be much more services-oriented and we would have to change our IT organization to accommodate this. We would have to adopt more hosted services in the Cloud. There's a place for managing internal IT services and networks, but to remain critical to the business and contribute to top-line growth, we would have to disrupt our current IT infrastructure and model. IT has to follow the business to stay relevant."

THE DIGITAL SUPPLY CHAIN



As activities are digitized throughout the lifecycle of a product, several components in this process are streamlined through integrated EIM and B2B services, including the Digital Supply Chain, Digital Manufacturing and Production, Logistics and Distribution—all of which will be explored in this chapter.

The Digital Supply Chain

"It's not the organizations that are competing. It's the supply chains."

New digital technologies are allowing even the smallest supplier to work electronically with their customers. Cloud, mobile, big data, and the Internet of Things (IoT) are the cornerstones of today's efforts to digitally enable global supply chains. If manufacturers want to quickly build flexibility and scalability into their global operations, implementing a digital supply chain strategy is no longer an option—it is essential.

To effectively orchestrate today's outsourced and distributed digital supply chains, organizations must tightly coordinate the flow of goods, communications, and commerce across business partners. With the intricacy and frequency of business transactions, this involves a high degree of coordination, data synchronization, and automated transactions.

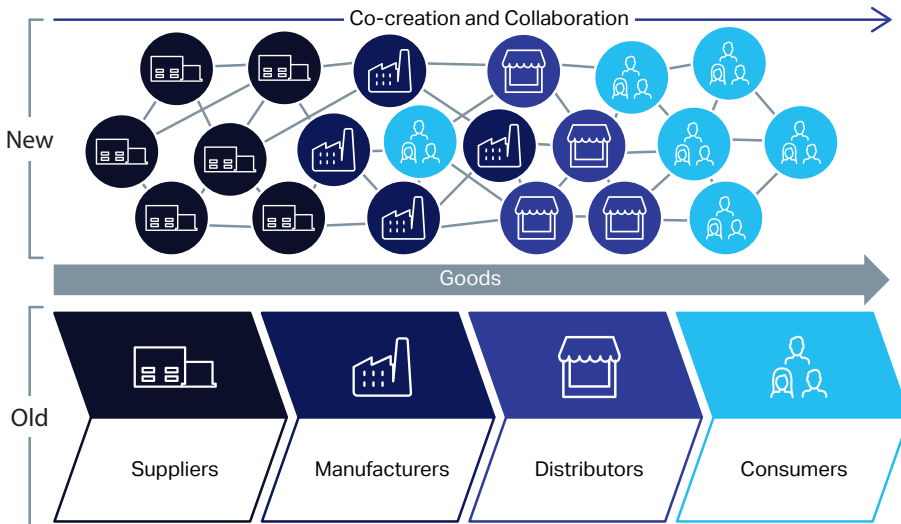


Figure 4.1: The Digital Supply Chain is a Complex, Dynamic Network²

Incredible value can be derived by collecting, managing, and analyzing information from various business applications across the network. Integrating transformative enterprise platforms, such as Enterprise Information Management (EIM), Business-to-Business (B2B) integration, the IoT networks, along with internal systems, allows manufacturers to optimize the flow of information across the digital supply chain. The end result is a comprehensive and automated platform for the management and exchange of digital supply chain information.

Transformational Challenges

Digital's potential for evolving the supply chain is enormous. The proliferation of IoT-connected devices, for example, will significantly alter operations, providing digital enterprises with the opportunity to make or save upwards of \$3 trillion through optimized logistics and next-generation, digital supply chains.³ Eighty percent of manufacturing and supply chain executives believe the digital supply chain will be the predominant model by 2022, while 16 percent recognize that it already is.⁴

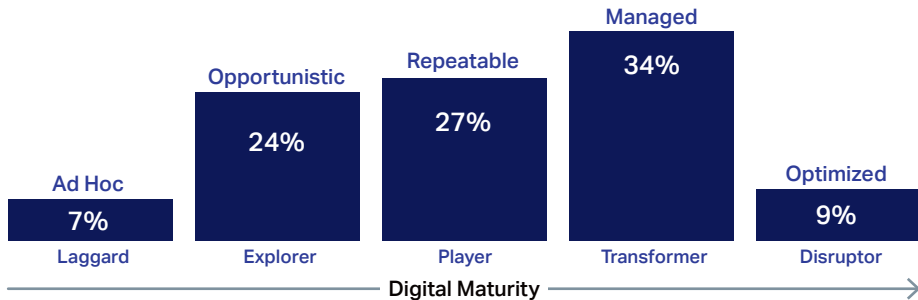


Figure 4.2: The State of Digital Transformation Maturity in the Supply Chain⁵

Despite acknowledging the pivotal role that disruptive technologies play in their overall business success, as illustrated in the figure above, the majority of manufacturers are currently unable to leverage them to enhance existing business models and create new ones for competitive advantage. Typical barriers to adoption include uncertainty about which solution to choose, a culture that is resistant to change, and a lack of skilled employees to adequately use new technologies. In addition, competing IT projects can also slow the adoption of new technologies. These barriers, when combined with the numerous disruptive technologies impacting the industry, can make defining a digital strategy challenging.

To overcome these challenges, manufacturers will need to embark on extensive digital supply chain projects to enable enterprise-wide digital transformation, deliver end-to-end visibility across the supply chain, facilitate information exchange and collaboration across the business network, and simplify expansion into new markets.

The Impact of Globalization

Along with emerging technologies, globalization is another trend that is impacting manufacturers. Over the last decade, manufacturing has expanded into emerging markets, resulting in a truly global industry. As wealth rises, global consumption and cross-border trade is increasing, especially in emerging markets, such as the BRIC (Brazil, Russia, India, and China) and, more recently MINT (Mexico, Indonesia, Nigeria, and Turkey) regions as illustrated in the figure below.

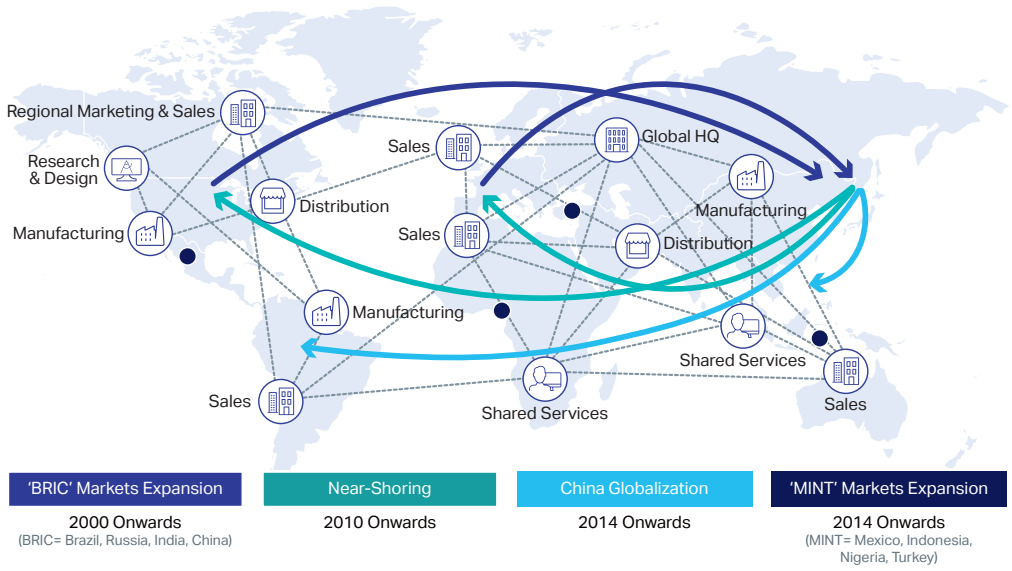


Figure 4.3: Changing Trends in Globalization

As global trade increases, the nature of goods will change. Physical goods will be increasingly digitized into services and there will be more knowledge-based exchanges. These activities involve a high R&D component, highly skilled labor, and the transmission of information, ideas, or expertise among exchanging parties. A key challenge for supply chains will be to support these growing volumes of cross-border transactions while maintaining performance, security, and compliance with both local and international regulations. Only by leveraging digital technologies, such as B2B platforms, will manufacturers achieve the levels of speed, accuracy, and agility required for operational excellence.

Interest in nearshoring remains strong, but overall, the trend may be slowing down. The cost savings of moving production closer to consumers are attractive, but concerns about safety, security, and the availability of skilled labor are making executives think twice before investing. These risks can potentially impede the adoption of B2B technologies like Electronic Data Interchange (EDI) across the entire supply chain. Consequently, for supply chains to operate smoothly, it is imperative that every trading partner has the ability to share their business documents electronically.

In the following feature, Carhartt leverages an integrated EDI solution to support digital information exchange with international supply chain partners.

Carhartt

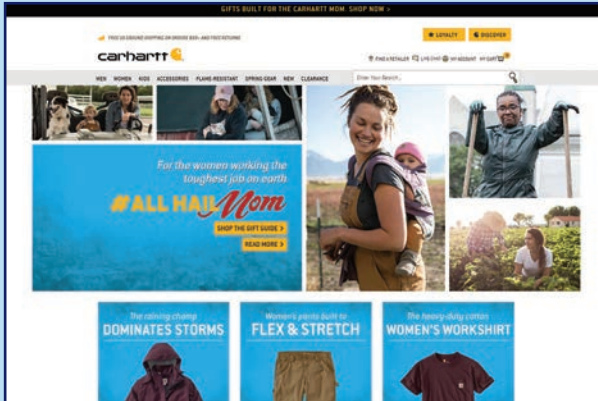


Figure 4.4: Carhartt

“When you increase speed to market, you’re increasing your value-add to partners. We’re onboarding a lot more partners every year, and we’re onboarding them with ease. Our B2B platform, BizManager, makes us a heck of a lot more efficient and so we’re bringing more value to the business as a result.”

– MARK HURT, MANAGER OF ENTERPRISE INTEGRATION, CARHARTT

Weathering the challenges of time, competition, and fluctuating markets, Carhartt has expanded its business; however, the company’s EDI was struggling to keep up. The ability to quickly and easily exchange information with suppliers, distributors, retailers, and other business partners is vital, and documents such as purchase orders, invoices, and advance ship notices are critical to the business. Their EDI process was not streamlined and they used multiple tools to support transactions, which didn’t allow communications and direct connectivity with partners. As a result, the company experienced delays in the process and sometimes, delayed shipment dates.

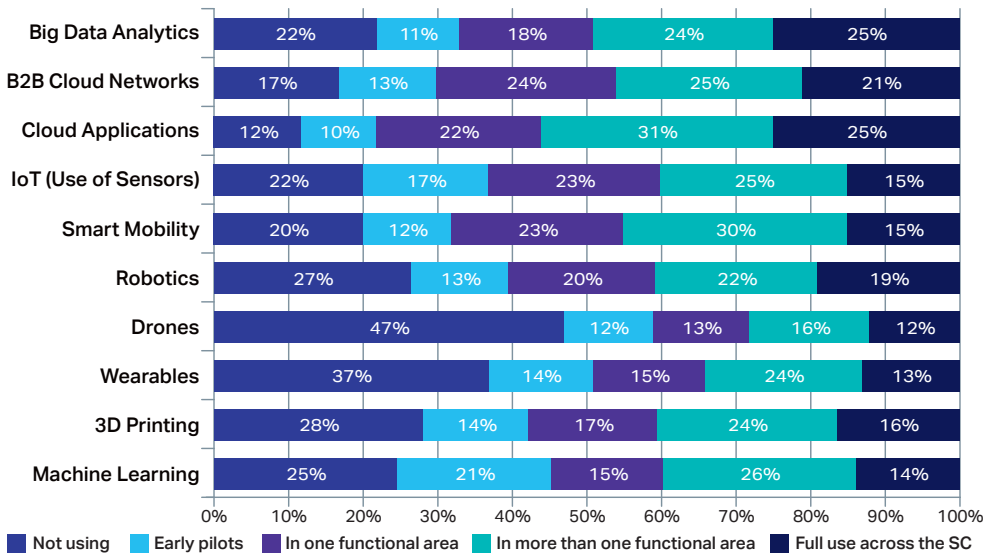
Carhartt sought a comprehensive solution that would provide full EDI value-added network (VAN) services, including communication and mapping functionalities. After evaluating several solutions, the Carhartt team selected BizManager, a comprehensive platform for managed file transfer, messaging, mapping, translation, tracking, and auditing. By sharing technology with the world’s largest B2B network—and incorporating and simplifying industry standards—the solution ensures the uninterrupted flow of information and direct, secure transport of all types of data and documents. With more than 200 trading partners now on the platform, Carhartt can connect and control its information exchange to maximize efficiencies and reduce cycle times. Improved performance has enabled them to support seasonal spikes in transactions, almost doubling their typical total with 725,000 transactions in the month of December.

How Supply Chains are Embracing Digital Disruption

“Businesses cannot unlock the full potential of digital without reinventing their supply chain strategy.”⁶

Efficient supply chain performance ensures customer satisfaction and continued business success. Since the 1990s, lean has been the guiding principle for most manufacturers. Using lean practices, organizations have been able to eliminate excess waste from the supply chain. While lean may have dominated the past three decades, agile will be the way forward.

Agility is achieved when supply chains are built with technologies that support rather than inhibit the flow of information across the business. The figure below highlights the top 10 transformative technologies currently being adopted across supply chains globally and projected growth rates over the next three years. These technologies allow manufacturers to create digital supply chains that are connected, intelligent, scalable, and real time—all of which work together to unlock the power of digital.⁷



N=254 – Source: OpenText Digital Transformation in the Supply Chain Survey, IDC, December, 2016

Figure 4.5: Top Disruptive Supply Chain Technologies⁸

Adidas, for example, has integrated digital technologies into its supply chain, resulting in a double-digit percentage increase in sales in just 24 hours. What started as a trial “click-and-collect” program that allowed customers to pick up online purchases in-store has turned into Adidas Russia’s most-used online shopping method.⁹

Improved supply chain performance is a top business priority, but merely adding digital capabilities to existing supply chains will not be enough. Manufacturers rely on the supply chain to enable new capabilities and business models with digital technologies like the IoT, AI and analytics, and blockchain. These disruptive technologies empower manufacturers to transform their supply chains from vehicles for reducing costs and increasing efficiencies into tools for driving sales, growing profits, delivering value, and improving customer satisfaction.

B2B and EIM Integration: Impacting Every Manufacturing Process

A digital manufacturing business digitizes activities throughout the complete lifecycle of manufactured products and the facilities used for production and distribution—from end to end. Several components in this process are streamlined through integrated EIM and B2B services, including the Digital Supply Chain, Digital Manufacturing and Production, and Logistics and Distribution—which the following sections describe.



Digital Supply Chain

A digital supply chain provides a seamless way for manufacturers to connect with a global network of trading partners. As companies expand into new markets around the world, their suppliers also have to extend their operations to support new markets. To simplify this complexity, automating processes is critical for supply chain efficiency. B2B integration provides the complete network of supply chain partners with a collaborative, secure, and automated solution for dynamically managing business transactions and delivering the “perfect order”—the right product delivered in full, on time, every time.

“Our relationships with our trading partners makes our supply chain operations much more complex than an organization that controls its entire route-to-market. So, making sure that our trading partner processes are tightly aligned is a huge priority for us. It allows us to seamlessly execute complex activities, like limited-time offers. Carrying out these offers requires an incredible amount of coordination and information sharing across all of our partners. Most stores that carry our beverages receive our products from multiple distributors—many of which are not company-owned. In these cases, it’s incredibly important that all of our partners have the right information, especially about a special price over the holidays, for example. Our integrated business model makes getting the right products and information into our customers’ hands much easier.”

– VP IT FOR A LEADING NORTH AMERICAN REFRESHMENT BEVERAGE COMPANY

Today's CIOs must juggle modernizing IT infrastructures while managing complex B2B environments. Forty percent of companies cite competing IT projects (such as ERP) as the primary barrier to B2B integration. As such, two-thirds are considering an outsourced approach, where they rely on B2B managed services to seamlessly integrate external trading partners with internal enterprise systems.¹⁰ Doing so provides additional resources and expertise to manage their B2B environment while freeing up internal resources to focus on strategically managing the business and rolling out new digital initiatives across the extended enterprise.

As the supply chain becomes more digitized, the demand for B2B integration will rise. While large companies continue to mature their B2B integration strategies, small-to-medium businesses (SMBs) are feeling the pressure to connect digitally as well. Increasingly, large businesses prefer to do business with trading partners who can connect digitally. Digital connectivity ensures that B2B communications are easy and secure.

Increasing security concerns across the end-to-end supply chain will escalate the need for Identity and Access Management (IAM) solutions. It is estimated that the IAM market will grow by nearly 10 percent in 2018 to \$4.7 billion.¹¹ As more companies start to adopt cloud-based B2B networks and establish a single digital backbone to connect external trading partners to internal enterprise resources, there will be an increasing need to re-evaluate secure access to these resources, especially supply chain assets connected to IoT platforms. Being able to secure IoT endpoints across the supply chain will drive further adoption of IAM solutions as companies look to secure their digital ecosystems.

Connected, Intelligent, and Secure Supply Chains

As the IoT and IoT-connected technologies become more pervasive, they become more powerful. The real value in the IoT is its ability to connect the entire supply chain for end-to-end visibility. An IoT-enabled supply chain has the potential to deliver significant benefits and gains through improved inventory management, supply chain visibility, supply chain responsiveness, logistics order tracking, fleet optimization, energy monitoring, asset utilization, and health and safety.

In the following interview, a North American retailer of pet goods and services is integrating their supply chain to bring the best products and services to their customers.

A North American Specialty Pet Services and Solutions Retailer

What follows are excerpts from an interview with an e-commerce and supply chain director at a leading North American pet services and solutions retailer.

"I am responsible for supply chain and operations on the e-commerce side of the business. Our goal is to provide quality service to our customers through efficient e-commerce operations and a streamlined supply chain. Our supply chain purchases over \$5 billion in inventory and processing. We move more than 1.5 billion units per year to brick-and-mortar locations, so that doesn't include our e-commerce base. The e-commerce side of the business is responsible for 20 to 30 percent of the business per year and is growing.

Our customers have different expectations of our supply chain than they did ten years ago. In many cases, they're driving the supply chain and they expect immediate service. That means you need to have the right inventory in the right place when customers demand it. It's a same-day-delivery model, whether that's in the store or delivered, it's more than just a package arriving in the mail. This has ramped up the pressure on us to offer faster, more efficient services to our customers. What we thought was pushing the boundaries of our supply chain just five years ago is becoming the norm today.

As part of our transformation journey, we're piloting a new service where products are shipped in just a few hours to meet the growing demand for same-day deliveries.

We achieve this by partnering with a managed services provider, which gives us a secure environment for processing and analyzing data as it is exchanged, or as EDI transactions occur. This has enabled us to take our e-commerce business to the next level to support our growth model.

We are also working to digitize our supply chain. The end goal is to digitize the entire supply chain so that processes and partnerships are automated and standardized. This is where we are headed. At this point, we have around 100 vendors out of 600 that are digital. This number will increase as vendors travel to trade shows and introduce their products. When we standardize and digitize our business models, the barriers to entry are lowered and we can do more business with more suppliers or retailers. So, any supplier can sign up using our portal, execute their orders, send the data back—and this all happens through a standard EDI process that looks the same regardless of supplier or retailer. This is particularly valuable for our smaller partners that only have an online presence. We don't have to limit ourselves from these opportunities just because they can't support traditional EDI processes or additional overhead.

B2B managed services provides a clean, efficient digital model that enables us to

exchange information with these suppliers just as easily as we can with our larger retailers. In this way, digital is opening up new opportunities for both us and the vendors we partner with. It not only helps us optimize our processes and make our supply chain more nimble and transparent, it also gives us the chance to work with companies we typically might not work with. It's win-win.

Traditional supply chains are evolving into demand networks. To remain competitive, we need to digitize our entire e-commerce supply chain to support process automation, standardization, and customization. Customization is very important to us because it's important to our customers, and it provides us with so much more opportunity to connect with them. They're using digital channels like Facebook, Twitter, Google, etc. to provide feedback and tell us what they want—from customized dog food to personalized dog beds, collars, and leads. We want to engage with our customers no matter what channel they use, whether they're after a product or a service, and the experience has to be consistent and satisfying. From inventory to shipping to marketing campaigns and forecasting—all of this is contingent on an agile, efficient, and increasingly digital supply chain.

Good customer experience drives our supply chain. So, when we engage with our customers, we want to form a relationship with them. For sure we are retailers, but we want to build trust with our customers so that they trust us for all their pet needs."

An IoT-Enabled Supply Chain

To illustrate how an IoT-enabled digital supply chain delivers value, let's examine three IoT-focused business processes: pervasive visibility, proactive replenishment, and predictive maintenance.

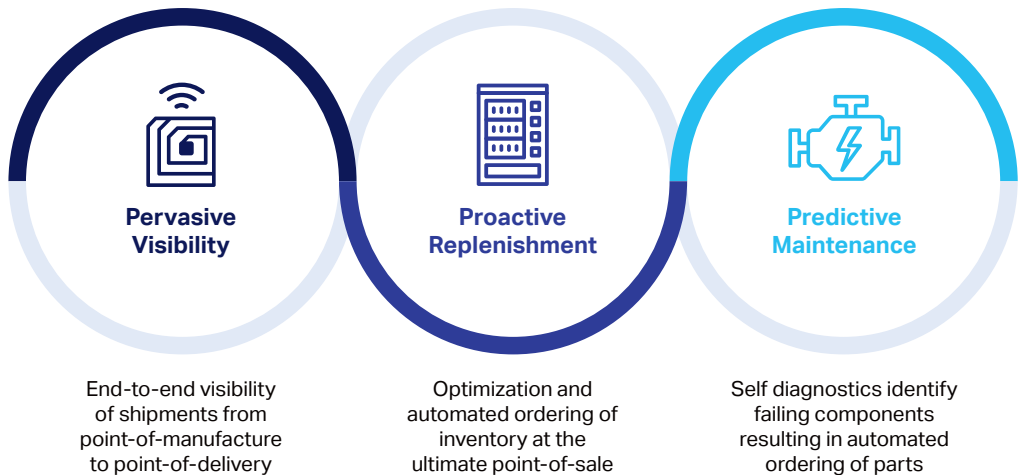


Figure 4.6: IoT-focused Business Processes

“As far as the IoT goes, the potential it presents is limitless. The challenge is to make sure that the timing is right and the business case is there. We are currently exploring how we can apply IoT technologies in our supply chain to make our pull systems more efficient. For example, we are looking at how we can use scan data or point-of-sale information to improve performance. If we can produce items inexpensively and track unique pieces of information, the opportunities for monitoring things like performance, consumption, and forecasting will be plentiful.”

—VP IT FOR A LEADING NORTH AMERICAN REFRESHMENT BEVERAGE COMPANY

Pervasive Visibility

Pervasive visibility provides transparency into and management of information that travels across the supply chain and is related to product orders and shipments. The ultimate goal of pervasive visibility is to enable manufacturing organizations to respond in a timely manner with real-time decision-making and trade-offs for timely order fulfillment, increased profitability, and reduced risk. If a parts shortage is identified, for example, parts can be replenished but existing supply can also be allocated, and/or customer demand steered away from products containing that part—all according to an automated process.

Bosch, for example, is using the IoT to support its virtual supply chain. The environment takes the output from various Radio Frequency Identifications (RFIDs) and other sensors located across both their factories and their third-party logistics (3PL) providers for a complete view of shipments as they move from point-of-manufacture to point-of-delivery. Bosch is using the IoT to invigorate RFID technology, since a barrier to adoption has been the lack of a global RFID reader infrastructure. The IoT, with billions of connected devices, could potentially change this.

Proactive Replenishment

Improved real-time monitoring of inventory levels and consumption trends helps to optimize the replenishment process. The IoT can automate replenishment via connected devices with the ability to initiate procurement processes and order goods directly from suppliers. Recently, a vending machine was developed that could recognize a customer, make suggestions for their next purchase, and highlight out-of-stock situations that prompt an order for replenishment. Information from the vending machine was stored, allowing a supplier to monitor consumer buying patterns and trends across a network of connected vending machines. In the context of a manufacturer, this could be applied to aftermarket parts replenishment or monitoring stock in a warehouse that is part of a production process.

Predictive Maintenance

Applying IoT technologies such as sensors and analytics to industrial equipment, and being able to process the information coming from the sensors in real time, helps to identify trends in data and predict when a component is likely to fail. If a faulty component is replaced as part of a predictive maintenance routine, the piece of equipment is less likely to experience any unexpected downtime. For many organizations, a one percent reduction in equipment downtime could translate into million-dollar returns.¹²

For example, let's assume a bracket on an airplane's wing flap mechanism is going to fail due to a hairline crack. If a sensor was able to detect the crack as it develops (or even predict that it will develop), this information could be transmitted to the airplane's destination airport. In the digital world, a new 3D printed part would be manufactured onsite in the maintenance hangar, and, once heat-treated, could be fitted to the aircraft when it lands.

This scenario describes a zero-length supply chain, in which a part is manufactured without requiring a logistics infrastructure. Alternately, an automated process could be initiated to order a replacement part. Reducing the time it takes for a part to be shipped to a maintenance hangar, which could be located anywhere in the world, would save the airline a considerable amount of money. A similar process could be applied to repair a car, military vehicle, or any serviceable asset that needs to be maintained to maximize uptime and use.

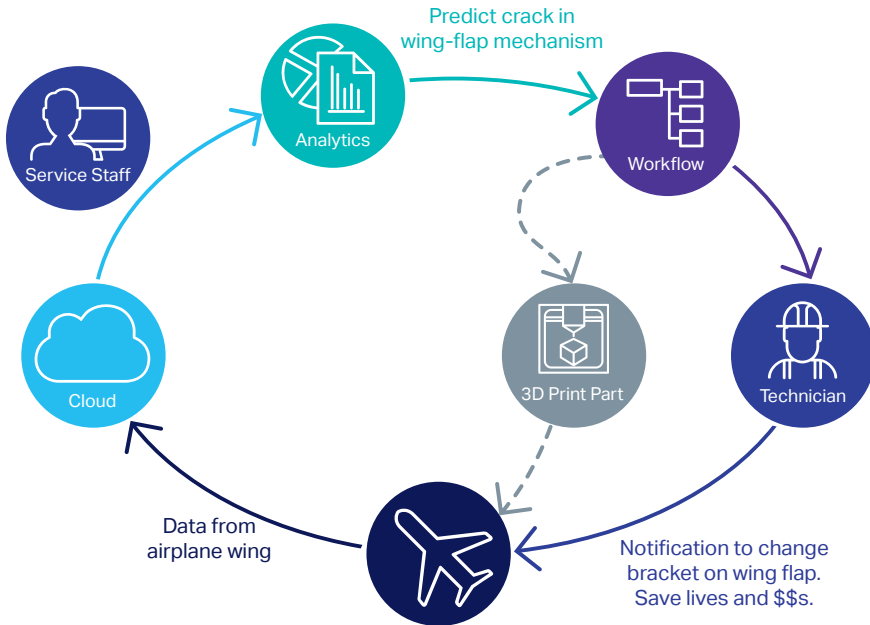


Figure 4.7: Predictive Maintenance

The AI and Analytics Infused Supply Chain

Manufacturers in all industries are shifting their focus to improving decision making based on better business intelligence through AI and analytics. AI technologies allow manufacturers to explore data lakes for sophisticated insights and help ensure that procurement activities align more tightly with customer and market demand. Examples of other AI applications include automating purchasing/replenishment of certain types of goods, detecting fraud in the supply chain to reduce costs and risk, increasing forecast accuracy for use of goods in manufacturing or for the sales of goods in retail.

Like AI, analytics are a top priority for supply chain organizations to ensure their ability to support digital business. Manufacturers in all sectors are leveraging analytics to deliver powerful intelligence to optimize supply chain efficiencies, identify opportunities, and mitigate risks before they disrupt business.

From a supply chain analytics point of view, the most useful information is either operational based or business specific. Manufacturers can apply analytics to operational data, including purchase orders, invoices, Advanced Ship Notices (ASNs) and order acknowledgements, to help forecast potential order volumes, allowing them to be better prepared for seasonal, market, or regulatory fluctuations.

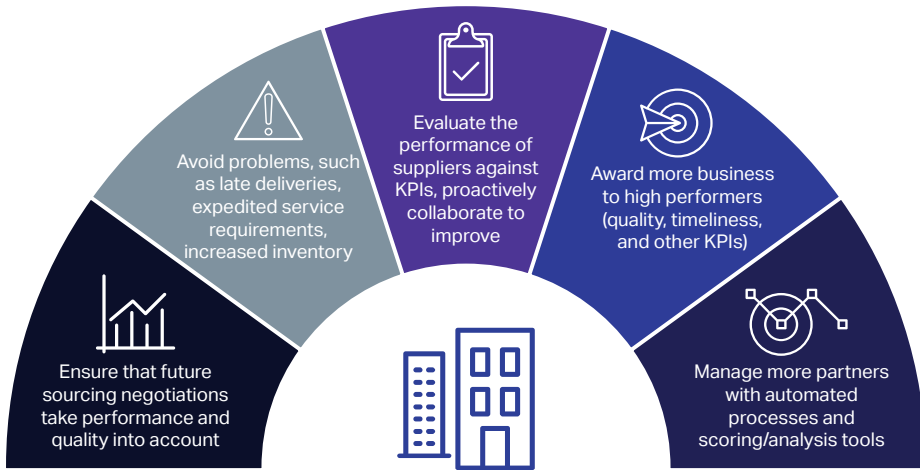


Figure 4.8: Embedded Analytics Allows Manufacturers to Make More Informed Decisions

Applying analytics to business-specific information, such as the delivery address, shipment details, quantity, sender details, etc., contained in an ASN, provides indirect insight into consumer demand in different markets around the world, which can potentially help a business to determine “ASN timeliness,” invoice accuracy, price variance, and so on. If there are any exceptions or errors then the business can take corrective action and resolve problems much sooner. Automotive manufacturers are using analytics for everything from monitoring trends and exceptions to keeping JIT production lines running smoothly based on ASN timeliness.

Applying AI and analytics to the information flowing across a business network provides a complete 360-degree view of supply chain activities, offers deeper insights into transaction-based trading partner activities, provides earlier identification of exceptions, and allows for more-informed business decisions to be made. It also increases responsiveness to consumer demands, helping manufacturers to ensure that inventory levels are aligned with expected demand levels. When coupled with other disruptive technologies like blockchain, the fully digitized supply chain is becoming a reality.

Leveraging Blockchain Technologies

Blockchain is an open, distributed ledger that records transactions between two parties or “blocks” in a verifiable and permanent way, based on requirements for transactions and collaboration. Companies today are looking for ways to apply blockchain technology to the supply chain. Good fits include supply chain finance, food track-and-trace (for both authenticity and food safety), shipping container tracking (most blockchains for tracking also include using IoT technology to help automate tracking) and tracking raw materials from point-of-origin to prove the absence of conflict minerals.

The distributed and secure nature of blockchain makes it ideal for managing the end-to-end supply chain finance process as every participant in a supply chain involved with the movement of goods can append the block with information. More importantly, it introduces a whole new level of transparency to supply chain processes and information flows. The movement of goods can be registered on a global ledger of transactions, along with all relevant information. Each link in the chain ensures that the goods are received by recording their movement across the supply chain, where they are stored, and how they are distributed.

Blockchain and the IoT will lay the foundation for the "Autonomous Supply Chain." The ability for a supply chain to become self-governing and able to respond to situations based on real-time inputs from connected IoT devices will transform how companies optimize their supply chains. Taken individually, the IoT, AI and analytics, and Blockchain are interesting technologies but when combined, they stand to radically transform how supply chains will operate in the future.



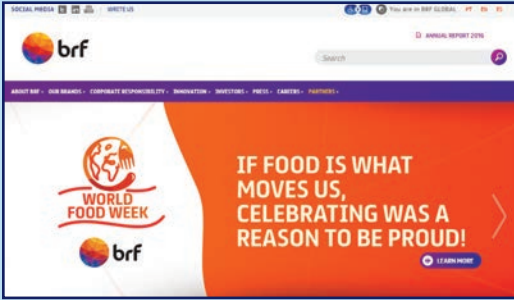
Digital Manufacturing and Production

More and more companies are forming partnerships that complement or enhance their capabilities to bring innovative products to market. This is perhaps most pronounced in the automotive sector where carmakers are partnering with technology companies, ride-sharing firms, and even each other to revolutionize the industry. For example, Toyota has recently expanded its telematics partnership with technology giant, Microsoft. General Motors has invested \$500 million in the ride-sharing firm, Lyft. And the Daimler-Renault-Nissan alliance of automakers has expanded to explore autonomous vehicle-related technologies.¹³

For partnerships like these to be effective, all parties involved must be able to synchronize their master data, gain visibility into each other's supply chain operations, and coordinate efforts to fulfill orders. While these activities have historically occurred via B2B integration on private EDI networks, many manufacturing organizations are decidedly shifting their operations to the Cloud.

Collaborating in the Cloud ensures all business partners have access to a common source of master data. Currently, 70 percent of companies are using B2B cloud networks across their supply chains.¹⁴ Despite this high adoption rate, the majority of manufacturers are still in the early stages of defining their cloud strategy. In the coming years, we will see a continuous increase in the number of manufacturers relying on B2B cloud platforms to streamline business process and enhance supplier connectivity, like BRF in the following feature.

BRF



“The most amazing part is that the business doesn’t really need IT to bring new clients on anymore, which gives them more flexibility and autonomy to bring new partners to the system.”

– DANIEL KELLER, REGIONAL IT MANAGER, BRF

Figure 4.9: BRF

Listed among Forbes’ top 100 innovative companies in 2012 and 2013, BRF produces foods that reach five continents. With more than 115,000 employees working in plants and distribution centers in South America, Europe, Southeast Asia, and The United Arab Emirates, BRF strives for efficient, sustainable operations to support its supply chain network across more than 150 countries and multiple languages.

Partway through implementing an Electronic Data Interchange (EDI) project in Europe, the BRF technology team realized that the finished product would fail to meet the complex business needs of an international company. The new EDI solution would only be able to support two standards of connection, communications lacked the sophistication required by clients and partners, and the onboarding of new partners was still a cumbersome process. What the company really needed was an innovative service that could support a wide variety of standards, as well as the secure exchange of data with partners and suppliers in multiple languages and geographies, both of which would make it easier to onboard and collaborate with new partners around the world. To meet these complex and demanding business requirements, the company sought out a B2B managed services provider.

Working with a B2B Managed Services provider, BRF has been able to offload tedious daily activities like mapping, testing, and onboarding, enabling the company to focus on adding partners to the EDI network rather than managing it. In less than one year, BRF has established EDI connections with 35 trading partners and plans to expand to 130 in the near future. Other benefits include access to reliable tools and expertise that enhance the real-time exchange of information and collaboration. Multi-language support around-the-clock links BRF teams and trading partners across the globe—regardless of language, industry, or time zone. Finally, streamlined integration tools and services provide end-to-end visibility into EDI flows, resulting in improved service levels and satisfaction. With a reliable B2B managed services partnership, a connected business network, and an empowered workforce, BRF is well-positioned to scale for future growth.

Supply Chain Orchestration

As digital technology continues to evolve, manufacturers will pursue supply chain orchestration. This involves outsourcing end-to-end supply chain activities to a single entity for intensified levels of automation and synchronization. The shift from collaboration to orchestration occurs in various phases. Historically, supply chain processes have been performed by core business applications executed within a corporate function or silo which provide enterprise visibility into specific functional processes for production and logistics.

The first phase of transformation involves an “integration” phase in which ERP is deployed for additional functionality to connect data within the silos and allow multi-directional interactions within the enterprise.

Next, to enable multi-enterprise collaboration across the supply chain, tools such as a collaboration hub or control tower technology for logistics allow every partner across the supply chain access to a “single source of the truth.” An EIM platform provides the secure repository with rules-based access required to enable collaboration between all partners in the supply chain.

Orchestration occurs above and beyond collaboration. When a digital business ecosystem can provide tight tracking, synchronization, and the secure exchange of goods, communications, and commerce, all partners involved can make more informed decisions and better satisfy their customers. As described in the following interview, DistributionNOW, a global distributor, is using B2B managed services for improved supply chain orchestration.



Logistics and Distribution

Getting products from a transportation hub to their final destination, or the “last mile,” consumes over 50 percent of a manufacturer’s total delivery costs.¹⁵ Digital technologies that connect logistics teams to back-end systems and customers to order information such as delivery confirmation, provide the visibility manufacturers need to optimize their logistics and distribution processes.

For example, GPS devices can map out the quickest routes, electronic signatures can speed up time-to-cash, and apps that relay real-time updates to consumers can enhance customer satisfaction. These digital technologies are transforming logistics and distribution into a competitive advantage.

Amazon is using drone technology to improve last-mile delivery, and ultimately increase customer satisfaction and lower returns.¹⁶ Like drones, AI and the adoption of autonomous vehicle technology is expected to revolutionize supply chain operations as companies continue to look for ways to improve end-to-end visibility of shipments across the supply chain.

DistributionNOW

DistributionNOW (NYSE: DNOW) is one of the largest distributors and supply chain solution providers to the energy and industrial sectors. With approximately 4,600 employees and more than 285 locations across more than 20 countries, the company stocks and sells a comprehensive offering of products for the upstream, midstream, downstream, and industrial market segments. They offer more than 300,000 stock keeping units, including pipe, valves and valve automation, fittings, instrumentation, mill and industrial supplies, tools, safety supplies, electrical products, drilling and production equipment, artificial lift, pumps, fabricated equipment, and industrial paints and coatings. DNOW also provides supply chain solutions such as procurement, inventory and warehouse management, logistics, industrial vending technology, safety and turnaround support services, project management, and business process and performance metrics reporting.

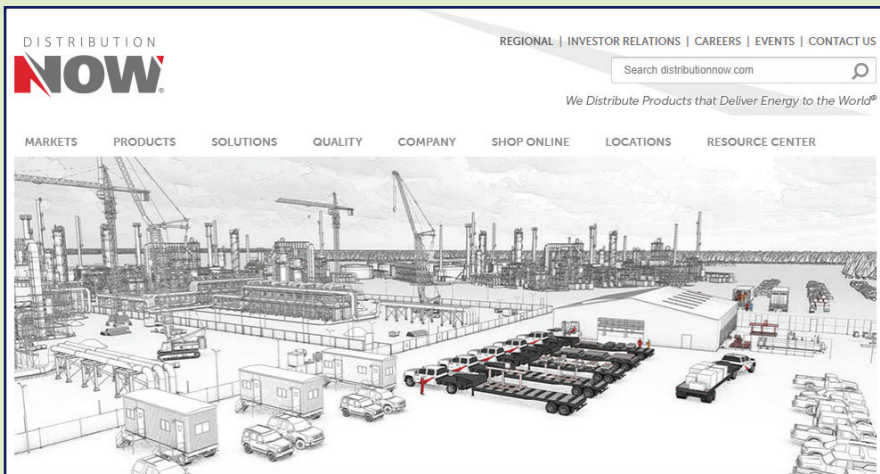


Figure 4.10: DistributionNOW

What follows are excerpts from an interview with Calvin Leong, Director, Business Technology and eBusiness at DistributionNOW.

“My role is to oversee DistributionNOW (DNOw) core technologies, including SAP technical teams, eBusiness (such as B2B electronic transaction systems), e-commerce, and all application development for branch locations and corporate functions.

Our current focus is on digital transformation and creating new opportunities, from market and revenue growth to operational excellence. We also bring cost-saving opportunities for both DNOw and DNOw’s customers through innovation and process automation. One of our digital initiatives is to broaden our electronic connections rapidly and enable customers to more easily do business with us.

We partnered with a B2B integration and B2B Managed Services partner for the technology, scalability, and cost savings necessary to meet our specific requirements and IT goals. The Managed Services partnership takes care of repetitive tasks like onboarding, mapping, testing, and deployment, which in turn allows us to remain focused on B2B strategy and prioritization with our trading partners.

Our B2B-related technologies were originally hosted in-house and required frequent upgrades. Most are now hosted in a third-party B2B integration cloud, allowing us to shift the investment to other areas as part of our overall cloud strategy.

From a B2B perspective, we continue to reduce paper invoicing and eliminate manual processes wherever possible. We encourage our more than 300 trading partners, via Direct-connected or Marketplaces, to embrace digitization and electronic transaction business models.

We are challenging and transforming the traditional oil and gas industry service model through easier, more

efficient transaction processes and new technologies. For example, on our e-commerce front, we created a platform to enable users in the field to easily place an order and monitor its status via their mobile devices. Giving employees and customers the ability to place and track orders from anywhere we deliver materials allows our branches to more effectively manage operations and fulfill customer orders.

Global distributors face the common challenges of managing millions of SKUs and fulfilling orders in the right time at the right locations. In our digital transformation, we are improving the inventory visibility and financial matrix for our global locations to have better accuracy and predictability. We are excited to explore the future of a new set of processes and tools—like big data, the Industrial Internet of Things (IIoT), and analytics technologies—to improve how our branches and distribution centers will operate in a robust and scalable manner.

For more than 150 years, the oil and gas industry has had a nature of disconnected and tough environments, taking considerable time to embrace any new supply chain technologies. We are starting to see the trend of applying new technologies like the IIoT on equipment to monitor performance and allow for preventative maintenance. Yet on the supply chain side, we see lots of opportunities for digital disruption to apply new processes and technologies and enable new ways of design thinking. At DistributionNOW, we stay ahead of the digital disruption curve and provide end-to-end solutions that prepare our customers for the adoption of digital technologies.

On the digital front, I believe many of the processes used today can be digitized—any of the predictive maintenance or demand and forecast planning of materials and services, at both offshore and land rigs can be optimized. Digitization would also

make collaboration much easier if everyone could access sensors, equipment, and data remotely. User experience continues to be challenging, though. Field workers could not use a touchpad effectively on the job—they use a pencil, and it doesn't matter if they drop it or get it dirty—so we're still trying to figure out a safe way to digitize the related processes.

Every procurement process could be unique. For example, a fully efficient online catalog for centralized buyers in an office would be the best way to place an order, but not for contractors on drilling rigs. We understand these challenges and design our capabilities to solve unique problems. Our ultimate goal is to enable our customers to reduce cost and time. The faster anyone can order, the faster our suppliers or merchants can help them match their workload, and the more cost efficient they'll be.

Adopting what we see from Business-to-Consumer (B2C), our objective is to provide omni-channel experience to mobilize everything—access to information, catalogs, ordering, transactions, etc. Business-to-Business (B2B) has a whole other set of objectives. Our customers still need omni-channel experiences, but each customer has very distinct requirements, and that makes it more complex. That's where digital EIM technologies can help to revolutionize the B2B industry, including analytics.

DistributionNOW has been using a traditional Business Intelligence (BI) solution; there's a lot of room for us to grow in terms of mashing up data in the public domain and structured information in our ERP systems. Predictive analytics has great potential to help us manage our inventory and customer demand. We help our customers manage thousands of suppliers, so the information we collect could provide great value—from known product issues, to shortages, to

market trends. We want to make more data-driven decisions by creating more analytics and intelligent capabilities.

We always treat information security as a priority. In our managed cloud strategy, all our partners must provide sufficient capability to protect our data and access. At DistributionNOW, we desire transparency in a secure way. We focus a lot on cybersecurity and end-user education with measurable controls. We often conduct assessments around improving our security to help ensure that our customers feel safe storing their data with us. EIM gives us the ability to maintain this level of trust based on its high number of certifications.

I've been in IT for 30 years now, and my advice to any executive when it comes to digital transformation is to keep an open mind and focus on the customer experience. You need to have a reverse engineering mindset. There also needs to be a balance between disruptive technology and executable solutions that are a good fit for your culture. When you're designing a new business model, the technology should support an agile, fail-fast, iterative approach."

Reverse Logistics

While customer expectations like next-day, same-day, and even same-hour delivery are prompting manufacturers to make significant investments in logistics and distribution, reverse logistics (or returns) is often overlooked—despite being one of the most important aspects of a good supply chain strategy.

With more than half of global consumers preferring to buy online, digital has become the dominant retail channel. As digital sales surge, so too does the volumes of returns. At a staggering \$642.6 billion annually, the value of returned goods worldwide would rank as the world's 21st largest economy.¹⁷ Yet, only 33 percent of retailers have the infrastructure in place to deal with the increasing volume of returns.¹⁸

Traditional supply chains (even those implemented as recently as 10 years ago) that focus on the forward flow of products are not equipped to support the high volumes of returns that e-commerce generates today. As a result, supply chains that support the movement of a product from its point-of-consumption to the point-of-origin (referred to as reverse logistics) are rapidly becoming a business requirement—especially in retail, where returns can account for up to 10 percent of total sales.¹⁹

A digital supply chain provides the flexibility and end-to-end visibility to intelligently support reverse logistics, enabling manufacturers to accommodate multichannel “buy anywhere, return anywhere” consumer behavior while minimizing the costs associated with returns.²⁰

These last-mile expectations are creating opportunities for new entrants to apply digital technologies in innovative ways. In the following interview, Envoi is using analytics and AI to provide competitive, demand-based delivery solutions and services.

Bringing it All Together

In the digital world, EIM, B2B integration, and the IoT are the fundamental infrastructure building blocks required to support digital manufacturing operations.

The IoT presents an opportunity to connect digital and physical supply chains together to develop more closed-loop business systems that are responsive to changing business environments. But in order for an IoT platform to successfully support supply chain business processes, manufacturers must have the following crucial IT competencies, or cornerstones, in place: device management, information management, analytics, integration, and security.

Envoi

Envoi was founded in August 2017, as a successor to the founders' first company Citius Solutions—a B2B logistics optimization company that serviced transportation companies, using routing and scheduling software that has been shown to improve operational efficiency by up to 32 percent.

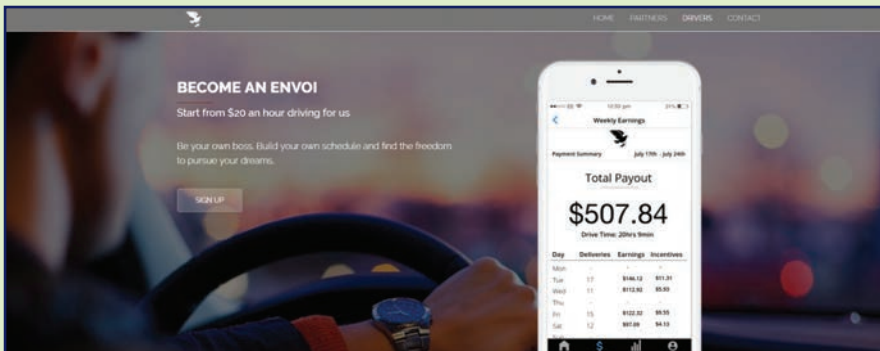


Figure 4.11: Envoi

Below, Maarij Rehman, Co-Founder of both Citius Solutions and Envoi, describes how they adapted and evolved their business model based on market responses to become Envoi.

"We were focused on route optimization, but our suite addressed the entire "last mile," which is everything that happens to a package, from the time it arrives at a local postal warehouse to the time it gets delivered to your door. It might arrive at a warehouse on a trailer where a team of people sort the packages. This includes manually matching postal codes to see who should deliver the package and loading the package on to a specific driver's truck. This happens for every package that comes in every day. When you do this for more than 5,000 packages, it can take more than six hours to complete.

Once the package is placed on a truck, drivers must complete the same process, looking at all the packages, putting the

addresses down on a physical map, and then eyeballing the best delivery route. This process, called routing, takes about an hour. But the last mile doesn't end with routing. There is also something called "pickups on the fly," which involves customers needing a package picked up. Throughout the day, when drivers are out on their deliveries, the dispatcher doesn't know which driver is closest to pick up an order or if they have enough space to accommodate a pickup. Citius Solutions addressed all three of these: sorting, routing, and pickups.

We applied analytics in two ways to help with the route optimization. One was through real-time optimization. If there was a pickup, for example, the driver's route would get recalculated based not only on the new

pickup, but also on factors like construction, accidents, and road closures. The second way was to analyze the manpower required, or how many drivers should be assigned to a given shift.

Citius was founded based on the inefficiencies in the current industry. We started out working to digitize the existing pen-and-paper system for the last mile—the sorting, routing, and pickups—which was a fairly disruptive move for the courier industry. We spoke to executives at multi-million-dollar trucking companies and discovered this manual system was costing them millions (in some cases, even hundreds of millions) of dollars. But they were hesitant to implement a new solution because the change required was of such a magnitude, it would take a lot of time and effort to roll out. So, there was market pushback in the beginning, even from drivers and dispatchers. Our software, in a way, implied that they were not doing their jobs efficiently. Even though we had data to back up our claims, they were reluctant to adopt any kind of automated solution because their jobs were on the line. We were trying to influence market behavior and it wasn't working. After trying to license the software to this market for about a year without much success, we realized we had to change our business model.

We decided to address the problem another way. We knew we were good at solving the last mile, so instead of offering it to courier or trucking companies, we brought the technology in-house so that we could serve their clients more directly and efficiently. We shifted our business model, which meant that our former customers were now our competitors.

Based on the infrastructure of courier companies being ill-equipped to manage the last mile effectively, we followed the demand online. People are becoming more accustomed to shopping online and have

come to expect same-day delivery. Globally, 41 percent of consumers demand same-day delivery, but only 14 percent of retailers offer it. Capitalizing on this opportunity, Envoi was born.

That opportunity was based on providing our services outside of the typical operating hours (between 9 a.m. and 5 p.m.) that most courier companies offer. So, we focused on optimizing last-mile delivery after 5 p.m. Doing this allowed us to eliminate UPS and Canada Post as competitors. We also democratized the process of courier pickup and delivery by cutting out the middleman, essentially, we are enabling direct retail-to-consumer.

Like Uber, our employees are regular people with their own cars. When a bundle is ready to be picked up from a retailer and delivered to a customer, they receive a notification via an app. Our software does all the sorting and routing, and we deliver goods without requiring any overhead for trucks or warehouses. From here, we can easily update customers by text regarding when they can expect their package. Instead of between 9 a.m. and 5 p.m., it's between 7:15 p.m. and 7:30 p.m. It's in real time and far more efficient—especially if we consider the manual processes involved with larger, traditional couriers, which is why, with Canada Post, for example, there can be a 24-hour delay between when something is physically picked up and delivered and when the company says it can be delivered.

Our key customers went from being couriers to retailers. This model works really well as brick-and-mortar stores closing and more retailers are looking to use their stores as small distribution centers. We service retailers who want to meet consumer demand for same-day delivery, at a price point that either matches or beats what they currently pay for standard shipping. That's our key differentiator—affordable, same-day delivery based on consumer demand."

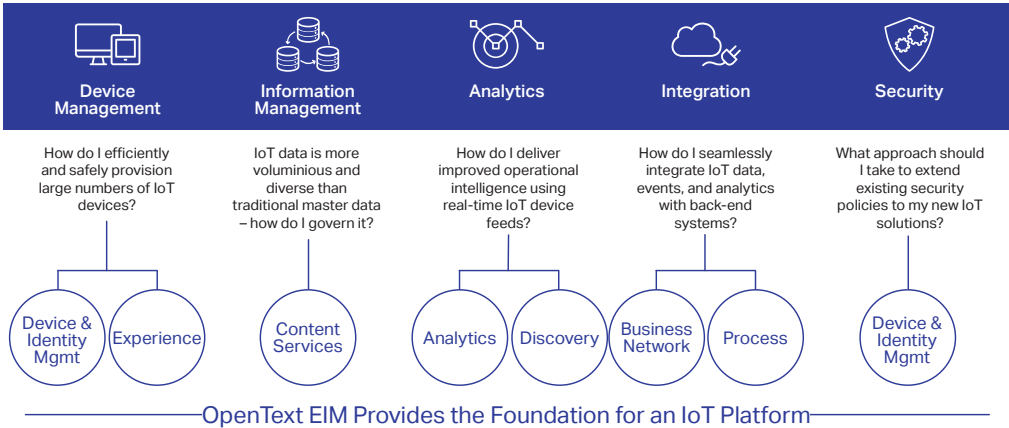


Figure 4.12: The Five Cornerstones of an IoT Platform²¹

With these five cornerstones in place, digital enterprises can layer the following EIM capabilities for added value:

- Experience solutions deliver **device management** via web portals and mobile apps, allowing manufacturers to remotely configure and manage IoT-connected devices (such as sensors) for added control.
- Content solutions provide a centralized hub for **information management**, enabling companies to manage and archive the volumes of information collected and generated by IoT-connected devices.
- **Analytics** can be applied to mine sensor data and identify trends to trigger event-based supply chain processes and uncover insights.
- **B2B integration** provides a secure, digital platform to exchange trading partner information and seamlessly integrate with enterprise systems, devices, and apps.
- Process solutions can be applied to ensure sensor-based information aligns with and supports key supply chain processes, such as a Vendor Managed Inventory (VMI) process. Additionally, process solutions can enhance **security** by ensuring information is getting to the right person, in the right place, at the right time. Identity and Access Management solutions help to “wrap” a security layer around connected devices.

As this chapter demonstrates, EIM provides the technical backbone manufacturers need to reinvent their supply chains. When enterprise systems, B2B platforms, and IoT networks are integrated to control the flow of information across the entire supply chain with partners, suppliers and customers, manufacturers can unlock the full potential of digital.

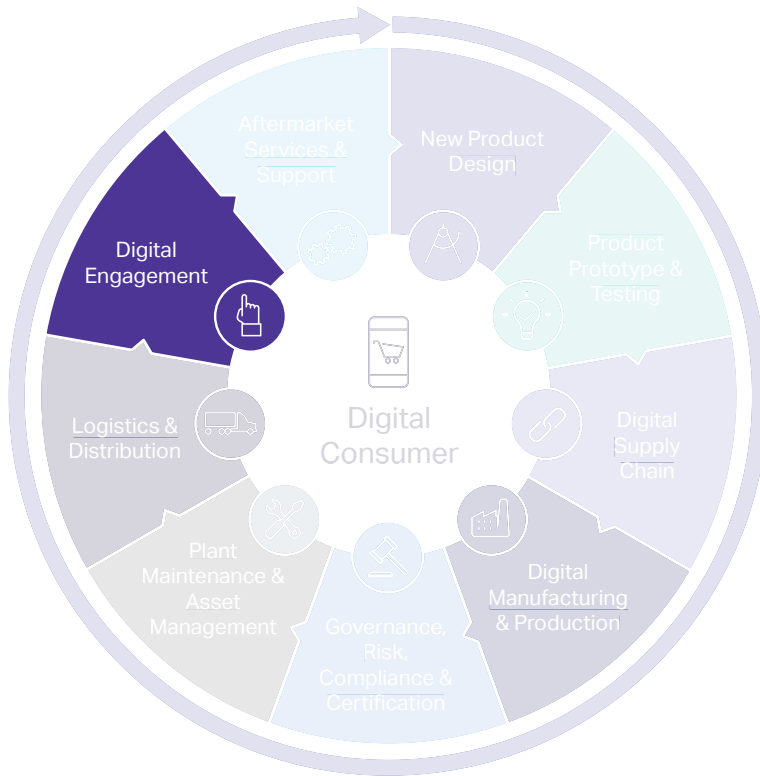
The Digital Supply Chain: A Strategic Imperative

The manufacturing industry is experiencing a significant period of transformation. International expansion, changing consumer needs, and new forms of digital technologies are forcing manufacturers to restructure supply chains and IT infrastructures so that new technologies and consumer-driven market conditions can be embraced with ease.

To ensure they have the flexibility and scalability to succeed in the digital world, manufacturers will need to re-imagine their traditional supply chain and implement an integrated enterprise information strategy that embraces cloud, mobile, and other disruptive technologies. Combining enterprise, B2B, and IoT platforms with disruptive technologies gives manufacturers the insight they need to compete in a digital world.

A digital supply chain delivers the intelligence and agility required to effectively scale operations, support global collaboration across the extended enterprise ecosystem, provide end-to-end visibility for supply chain optimization, and rapidly respond to ever-changing market and customer demands. A manufacturer's ability to meet—and, ideally exceed—customer expectations is wholly dependent upon its supply chain. Infusing the supply chain with digital technologies will enable manufacturers to continually improve performance and outpace their peers while creating customer experiences that delight, resulting in significant competitive advantage. This, along with distributor engagement, is the focus of the next chapter on Digital Engagement.

DIGITAL ENGAGEMENT



This chapter describes how EIM supports the exchange of information between manufacturers, distributors, and retailers, while providing the controls needed to maintain a consistent customer experience.

Digital Engagement

*"Not only are intelligent machines on the verge of taking over, but consumers want them to. Indeed... by 2025, AI will power 95 percent of all customer interactions, including live telephone and online conversations that will leave customers unable to 'spot the bot'."*¹

Disruptive technologies are triggering the convergence of physical and digital worlds. In addition to mobile and social channels, IoT-related technologies like sensors, beacons, and wearable devices will add hundreds of ways for organizations to engage with their employees, partners, and customers. According to the above quote, in the future, only five percent of all customer interactions will require human contact.² Customer experience will expand to include augmented and virtual reality, holograms, digital wallets, virtual shopping assistants, digital mirrors, algorithmic retailing, 3D printing, and more. These technologies and channels will make the customer journey much more complex.

Today's fast-moving consumer market is putting pressure on manufacturers to be able to share digital product information seamlessly and quickly across retail and distribution channels. The challenge for manufacturers and retailers will be to integrate all communications across multiple channels.

To deliver a seamless experience for distributors, retailers, and customers, manufacturers need to take a holistic view, bringing communication channels, information, and technologies together in a single, unified "hub." A winning approach requires a comprehensive EIM solution—one that incorporates all aspects of digital engagement, from processes and information exchange with distributors to the automated delivery of personalized content to consumers. Only EIM securely integrates Customer Experience Management (CEM) solutions like Digital Asset Management (DAM) with process management, real-time data platforms, and analytics for true digital transformation and business agility.



Distributor Engagement

Today's global manufacturers are developing channel partnerships with local retailers and distributors to get their products to consumers. This strategy has been extremely effective helping manufacturers in emerging markets capture up to 35 percent more available market share.³ While partnering with retailers and distributors is proving to be a profitable strategy, it is not without its challenges. Many global manufacturers struggle to efficiently exchange information, such as product specifications, promotional videos and brochures to support a product launch, for instance, across the extended enterprise.

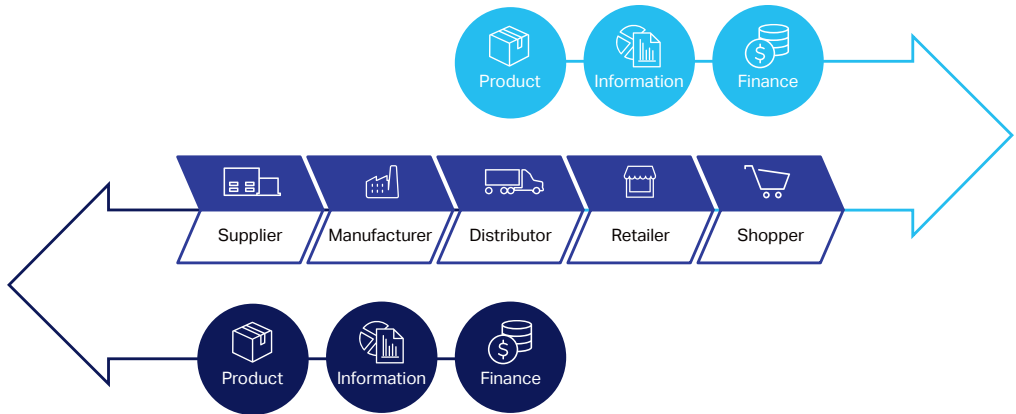


Figure 5.1: EIM Supports the Two-way Exchange of Business Information

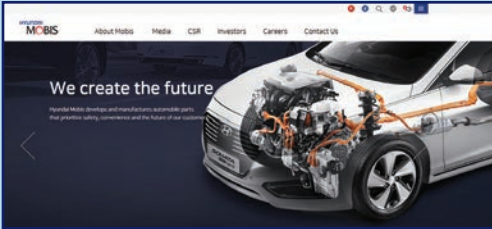
An integrated, digital EIM platform addresses this challenge by establishing a centralized approach to managing the exchange of enterprise information, enabling product-related data to become pervasive across channel partners. EIM supports the two-way exchange of information between manufacturers and local retailers and distributors, while providing the controls needed to maintain a consistent customer experience. When information can flow freely in both directions, manufacturers can extract added value by gaining insights, such as local market trends, performance, consumer preferences, and customer feedback. In the following feature, automotive supplier MOBIS is applying analytics to deepen distributor engagement.

Supporting the Omni-Channel Experience

Omni-channel excellence is supported by a centralized DAM platform that helps to simplify the distribution of information across the enterprise. In the digital world, a manufacturer's ability to penetrate new markets depends in part on its ability to effectively exchange information with channel partners. When combined with other transformative enterprise platforms like B2B, the IoT and the Cloud, EIM provides the digital platform required to seamlessly engage with a global network of channel partners.

Today's market is heavily consumer driven and new technologies, such as mobile smart devices are allowing product information to be accessed in many different ways. This means that all web-related assets need to have a consistent look and feel and must be accessible by any device, any time or anywhere. In addition to managing all product information through a centralized archive, web-related assets should ideally be centrally managed as well.

MOBIS



“From a logistics side, we are able to get clear visibility on business operations by integrating information from the back end to the front end of the BI system, allowing us to analyze the information coming from the back-end system.”

– SUBODH PATIL, IT MANAGER, MPAU

Figure 5.2: MOBIS

Headquartered in Seoul, South Korea, with subsidiaries in approximately 40 countries worldwide, MOBIS manages the supply chain for automobile industry heavyweights Hyundai Motor Company and Kia Motors. The company created a parts production system designed to ensure quality and savings throughout the supply chain—from purchasing and inventory to sales and logistics—helping its clients stand out in the competitive automobile industry. MOBIS Parts Australia Pty Ltd (MPAU) is the automotive supplier’s Australian subsidiary.

The automotive industry has ongoing competitive challenges, with other brands coming up with new products, new sales strategies, and new pricing methodologies. As a result, MPAU has to ensure that they have adequate systems and technologies in place to keep products competitive and operations agile. To react responsively to changing demands or competitors’ offerings, the company needed a new business intelligence system that would support real-time inventory and dealer network reporting, monitor sales performance and pricing offers from vendors, and offer analytical capabilities to predict future sales and inventory requirements.

After testing several systems, MPAU ultimately chose an Analytics Suite based on its robust functionality, as well as its ease of use. The latter was a key factor to ensure end users would take to the system naturally to deepen distributor engagement by integrating seamlessly and intuitively into the day-to-day operations of approximately 140 to 160 users and dealers. The solution was able to integrate with data sources throughout the MPAU operations and dealer network with dashboards that offered each department, from inventory and warehousing through to sales and logistics, a snapshot into their daily activities. Analytics capabilities give the company competitive advantage, with the ability to not only view historical sales and inventory but to forecast future needs as well. Now, instead of relying on a cumbersome reporting process and inaccurate predictions, users can compare historical data to current sales information in close to real time and project future sales. The result is a more efficient business environment with informed decision-making that allows users to access and interact with data more reliably and the company to operate with greater agility in a competitive market.

Manufacturing products is becoming increasingly complex. This is not just in the number of parts they may contain, but also based on the sheer volume of digital information supporting each component part of a manufactured product. Associated content could include a concept sketch, 3D CAD Model, 3D printing model, high resolution photo realistic image, 3D animation or an assembly/disassembly video. This information needs to be managed and archived in a centralized DAM environment, where multiple versions can be controlled to ensure that the very latest digital asset is being used. As illustrated in the figure below (step number 10), if a car manufacturer is launching a new model to market, they need to ensure that their dealer network has all digital assets in place. From a centralized and secure hub, each dealer can download related content as part of a dealership marketing campaign.

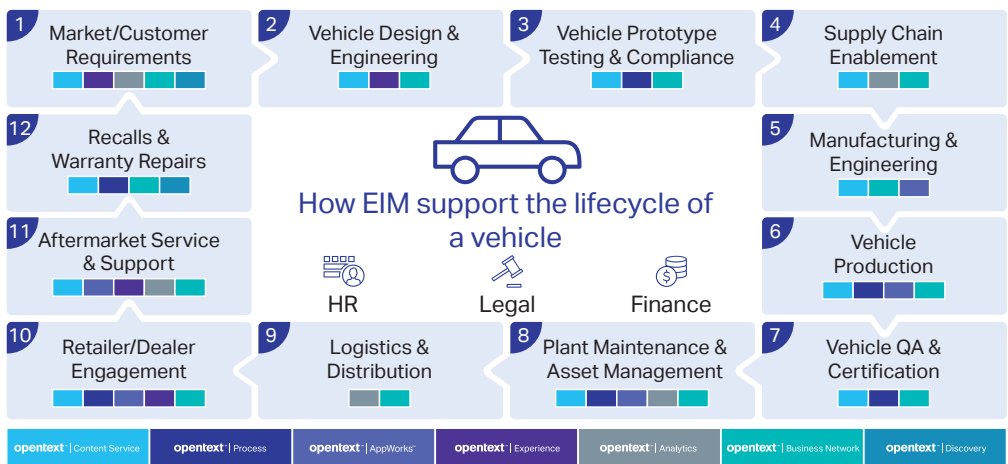


Figure 5.3: Retailer/Distributor Engagement

Along with distributor networks, some consumer packaged goods companies like Nike, Adidas, or Columbia also support retail networks. Columbia headquarters, for example, could be introducing new sportswear and would need to ensure that outside parties (their own retail network, third-party retailers such as DICK'S Sporting Goods, and online retailers) have access to the appropriate photos, specs, or videos, so that the product could be properly promoted.

Sharing Assets Across the Digital Media Supply Chain

Due to sheer size of certain digital assets, such as video files for example, organizations need a secure and efficient way to exchange these files across what can best be described as the Digital Media Supply Chain. Many companies are using cloud-based file transfer solutions to exchange large files between different stakeholders in the digital media supply chain. These Managed File Transfer (MFT) solutions are ideal as they help to ensure that files are secure as they are being exchanged.

Digital product information can be created in a multitude of different software or cloud-based applications. Users across the extended enterprise may need to gain access to these files to view and mark up information, perhaps as part of a design review or product launch process. Ensuring that all digital assets associated with external websites and aftermarket services and support portals are managed effectively is equally as important as managing supply chain processes. Leveraging a centralized information management platform can help manage web-based digital assets and improve the customer experience.

The simplest application available on every desktop PC, laptop, or mobile device is the web browser—a common window into a digital information hub that helps drive consistency in terms of accessing, viewing and collaborating on product-related information. Using responsive design, organizations can manage a single site that caters to all device platforms, sizes, and resolutions. Consistently branded content creates a more satisfying end-user experience and enables organizations to positively impact the customer journey. This is illustrated in the following interview with the CIO of a leading energy drink producer.



Consumer Engagement

Over the past two decades, Internet shopping and mobile phones have shaped the digital consumer. Technically savvy and always connected, these consumers expect convenience, flexibility, and choice in their shopping experiences. Millennials (those born between 1980 and 1995) are overtaking Baby Boomers as the world's largest group of shoppers. By 2025, they will comprise 75 percent of the workforce.⁴ These so-called “digital natives” are defined by their familiarity with technology and their lifestyle, bringing together the physical and digital worlds.

Current Technology Uses for Shopping

How do you use technology to help with your shopping?”

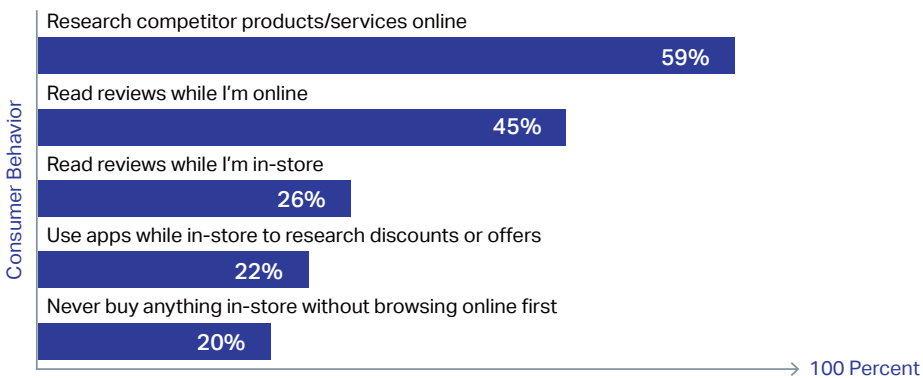


Figure 5.4: Current Technology Uses for Shopping⁵

Leading Energy Drink Company

What follows is an excerpt from an interview with the Chief Information Officer at a leading energy drink company.

“Our philosophy is that we’re a lifestyle first and a product second. That’s been our guiding principle since our launch and it’s worked well for us. We’ve been on an upward trajectory for growth, both in terms of sales and content.

As we grew, our volumes of content grew, and it was becoming harder to find assets and repurpose this content in a timely manner. When we partnered with a global soft drink company and incorporated their energy brands, we realized that to be able to carry those brands forward and to continue to manage ours, we would need to migrate and manage our combined assets in a Digital Asset Management (DAM) system.

We needed to come up with a solution to better manage our collective assets—one that included supporting historical content. As an organization accumulates assets, these assets become the rings of a tree that show the history of a brand and how it has evolved into current marketing and positioning. Porting these assets into the DAM system as soon as possible was one of our key objectives.

The energy/alternative beverage space is leading edge. There are so many players, it’s very competitive. We’re always trying to catch somebody’s tail and somebody is trying to catch ours. Because we have to be agile and stay one step ahead of the curve, innovation is part of our lifeblood, and disruptive technologies play a big part in enabling that. But even in a company

like ours, one that seems very edgy, very Millennial, at our core, we’re still a very conservative company. We have to run our business in the best interest of our shareholders and other stakeholders.

My role as CIO is all about change, innovation, and disruption. Getting people to accept the change that comes with disruption and adopt new solutions can be extremely difficult. I’ve been pleasantly surprised at how well people have adopted the DAM solution. Early on in the project, we had people ask if they could be part of the design team so they could help shape the solution. Their participation was critical to its success. Phase one of the DAM rollout was so successful that we can’t move fast enough for phase two. People are so excited to have this solution in place.

The impact of the system has been profound. It touches more people inside and outside our organization than our ERP ever will. So, when people think about implementing a DAM solution—it’s not just a graphic support solution, it’s not just an asset solution—it’s a solution that will impact pretty much everybody in the organization and allow them to work smarter, not harder.

Every creative project and asset created since the DAM solution’s release has been managed through the system. This gives us better control of our content, not only in terms of accessing and storing but also in terms of brand equity and

consistency. As we grow, one of the things that's very important to us is to ensure that proper logo treatment and the rules of usage are maintained. The system gives us consistency around the globe. We can even automate brand usage and guidelines. Our Legal teams on the IP side and brand protection are thrilled that we're implementing a solution and working on strategies to engage them in the approval process. As you can imagine, we sponsor a lot of athletes and promote a lot of events. If whatever we use comes out of the DAM system, we can be confident that all the checks and balances are in place and that we're using those assets correctly.

Right now, the mobile user is our key demographic. Our digital media group is doing a lot of creative work in that space, like gamification, for example, to digitize the customer journey. Our demographic doesn't really sit at a PC to consume content, so the mobile experience is hugely important. We've got great traction there, but we're like everybody else. We're moving as fast as we can, and we've got a lot of great technology in place, but every time you think you've made it, a new disruptive technology emerges. It's kind of like painting the Golden Gate Bridge: by the time you get to one end, you have to start repainting the other. This is just a reality for us.

Change doesn't come easily. People get comfortable with what they know. In order to ensure that implementation of new technologies is successful, I have to be more than just a CIO. I have to be a sponsor, an advocate, and a cheerleader. It's important to get out and communicate the benefits that transformation will have on the organization as a whole—not just the impact it will have on the individual. I think when people understand that adding a few steps to a process on their end will save 50 steps across the organization, and how saving 50 steps will benefit the organization, they're much more willing to embrace change."

Disruptive technologies like mobile and wearable technologies are revolutionizing the customer experience. Mobile functionality is combining with mobile payments to deliver a convenient end-to-end shopping experience. With options to complete a transaction using Apple Pay® and digital wallets, today's consumers want deeper experiences across many channels, digital or otherwise.⁶

Consumers are driving transformation in retail. Along with mobile devices, wearables have great potential to enhance the overall shopping experience. They provide new ways to engage; consumers will eventually search for products using voice, image, and gesture. Along with communicating promotional offers or events, wearables such as smart watches help consumers save time, alerting them about busy times or long lineups.

As consumer expectations change and technology progresses, the global retail industry is in the midst of a significant shift in operations. New technologies are forcing manufacturers and retailers to re-engineer business processes, and these include the Internet of Things (IoT), automation, and robotics. By 2021, 70 percent of U.S. retailers are expected to invest in the IoT, 68 percent in machine-to-machine (M2M) learning or cognitive computing, and 57 percent in automation.⁷ These technologies will enable organizations to deliver more compelling customer experiences with the end goal being to completely customize the experience.

The IoT and related location-based technologies like sensors and beacons will be used to deliver targeted information, products, and services in the customer's moment of need. Connecting with consumers using M2M technologies like beacons allows retailers to know when a customer is near a store location, where they are in the store, track their movements (and items of interest) in the store, and optimize the visit with targeted products and promotions. By combining customer data with location-based information, M2M technologies ultimately help retailers and manufacturers better understand, engage, and satisfy their consumers.

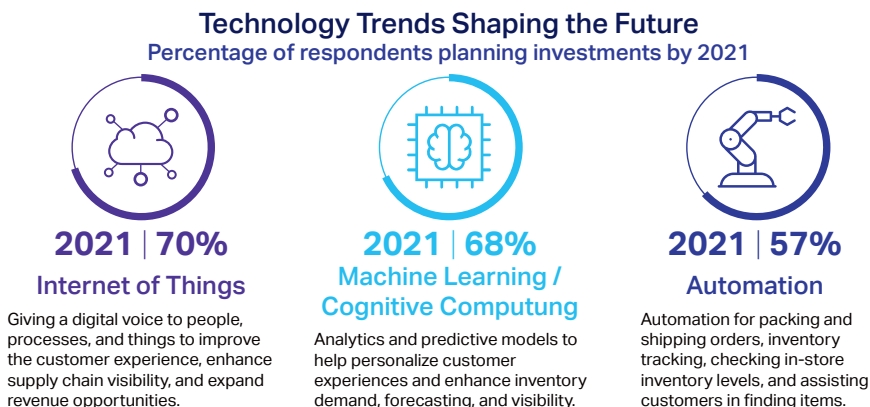


Figure 5.5: Technology Trends Shaping the Future of Shopping⁸

When analytics are applied to the data collected by disruptive technologies, organizations can transform business intelligence into actionable insights to deepen engagement. As shopping becomes more automated and AI-driven, customer loyalty and repeat purchases may be harder to secure. Algorithms will be able to comparatively (and objectively) shop online for the lowest prices available. Sensors in an appliance, for example, will locate replacement parts based on the best price and availability without consideration for brand loyalty. To differentiate themselves, manufacturers and retailers will need to apply analytics and AI in order to tap into consumer habits, behavior, and need—ultimately giving them the ability to create experiences that delight.

The following interview with Tata Consultancy Services Ltd. below examines how digital consumers are forcing organizations to deliver simplified, yet compelling experiences to meet their evolving and sophisticated expectations.

Combining Physical and Digital Worlds

As the digital revolution advances, customer centricity is eclipsing the decades-old, traditional product-centric approach to merchandising. Consumer behavior is evolving, and to stay competitive, manufacturers will be increasingly required to put the consumer at the center of all their operations—from design through to marketing, distribution, and support.

CIOs will be required to deploy a modernized technology foundation to bring together physical and digital experiences and create new value streams for competitive advantage. Although the physical store will remain at the center of multi-channel operations, top manufacturers and retailers will strategically blend physical and digital operations, creating an ambient, immersive user experience in what has been called the “digital mesh.” Virtual Reality (VR), Augmented Reality (AR), wearables, the IoT, and sensor-rich devices will create connected rooms and spaces to enhance the shopping experience.

As consumers push the demand for a more digital sales experience, brick-and-mortar stores are closing their doors. In early 2017, over 8,600 physical store locations shut down in the U.S., including retailers Bebe, JCPenny (JCP), and Payless ShoeSource.⁹ Macy’s announced plans to close 68 stores at the expense of 10,000 jobs.¹⁰ Hudson’s Bay, owner of Saks Fifth Avenue and Lord & Taylor, plans to reduce its workforce by 2,000 jobs.¹¹ In the U.S. alone, physical store traffic and sales are declining in the wake of increasing competition from online sellers like Amazon and Zara.

Tata Consultancy Services Limited

Tata Consultancy Services (TCS) is an IT services, consulting and business solutions organization that delivers real results to global businesses, ensuring a level of certainty no other firm can match. TCS offers a consulting-led, integrated portfolio of IT, BPS, Infrastructure, Engineering and Digital services. This is delivered through its unique Global Network Delivery Model™, recognized as the benchmark of excellence in software development. A part of the Tata group, India's largest industrial conglomerate, TCS is listed on the BSE (formerly Bombay Stock Exchange) and the NSE (National Stock Exchange) in India.



Figure 5.6: Tata Consultancy Services

What follows are excerpts of an interview with Vipul Mohile, ECM Consultant at Tata Consultancy Services.

"At TCS, we believe that customer experience defines the brand, analytics overrule instincts, and innovation, insight, and agility—not size—defines winners.

As an ECM Consultant, I handle the Documentum Center of Excellence. I work closely with our customers, making recommendations around ECM roadmaps and blueprints to provide them with

architecture solutions. I also support our presales and delivery teams.

In my role, I collaborate with colleagues, partners, and customers across all industries. Meeting ever-changing customer expectations, cost reduction, and speed-to-market are the driving forces for any digital transformation journey.

Customer expectations are changing daily. There's a bit of a dichotomy at play here because, while customer needs are becoming more sophisticated, customers also desire simplification. Consider mobile technologies. Mobility has completely changed expectations around customer experience. Customers want to be able to access systems and information from any device, from anywhere, and at any time. But, they also want the experience to be intuitive and seamless. This means that organizations must figure out how to deliver simplified, yet compelling experiences that meet sophisticated expectations. And this is causing business models to change. Omni-channel is a great example of this. When done right, omni-channel experiences can be used to deliver a consistent customer experience across different channels—regardless of whether a customer starts a transaction on a laptop and then switches to a mobile device.

As I mentioned, cost optimization and speed-to-market are also drivers of transformation. Customers want more for less. So, organizations must juggle meeting ever-changing customer expectations with optimizing costs. To complicate things, they must also try to find innovative ways to bring products and services to market faster than their competitors. All of this can be very difficult to do—and this is where customers turn to TCS for help.

The Cloud is also helping organizations to simplify operations and reduce costs. We are seeing a shift in customer mindset

when it comes to the Cloud, with more and more companies embracing cloud services. The Cloud is quickly becoming a business requirement. This is because the byproduct of many new technologies, such as machine-to-machine communications and IoT-connected devices, is data. The more ubiquitous these technologies become, the more data organizations will be required to manage. Cloud solutions and cloud managed services deliver the flexibility and control organizations need to store, manage, and mine this data. For this reason, analytics is also becoming increasingly important to business.

Earlier, organizations would store enterprise information into repositories. So, they were collecting the data, but they weren't extracting any intelligence, or value, from it. Organizations are realizing that applying analytics to this data can help them to resolve certain issues and make better, data-driven decisions faster—both of which can help them stay ahead of their competition. We are seeing a lot of traction in analytics. Our customers, especially those in the retail industry, are integrating intelligence capabilities that certain products provide with their ECM repositories so that they can present actionable insights to senior-level decision makers.”



Figure 5.7: Combining Physical and Virtual Worlds

The largest Internet retailer in the world, Amazon, has led the charge in reshaping the industry. Convenience, cost, and satisfaction define their brand experience—they sell everything from A to Z, shopping is fast and easy, prices are competitive, and consumers can opt for same-day delivery in 35 global cities. Having surpassed major retailers in market cap, the company is now setting its sights on brick-and-mortar. In June of 2017, Amazon acquired high-end grocery store chain Whole Foods, giving them access to a network of distribution hubs across North America.¹² On January 22, 2018, Amazon announced the opening of its first physical grocery store, AI-powered “Amazon Go” in downtown Seattle. Shoppers scan their smartphone at a turnstile, cameras and sensors track the items they purchase, and they are billed after leaving the store.¹³ As a disruptor, the company is recognized for embracing new technologies to enable new business models, such as drones for delivery and 3D printing on-demand to transform its delivery trucks into mobile manufacturing centers.¹⁴

Like Amazon, Zara is reshaping the retail industry. As the world’s largest fashion retailer, the key to their success is their unique business model—or what they call “fast fashion.” A slick logistics operation moves clothes from design to shops in three weeks, less than half the average time it takes most retailers.¹⁵ Global stores experience stock turnover twice a week and orders arrive in just 48 hours. Zara effectively combines the physical with the digital through features like a smart mirror that allows customers to “try on” clothes without actually putting them on. Despite these innovations, it is the connections between stores, designers, and factories that are the true secret to its success.¹⁶

The retail model is being further disrupted by innovations like Moby Mart, an autonomous mobile supermarket that brings the shopping experience right to the consumer's front door. Developed by Wheelys Inc., a Swedish start-up company, Moby Mart is run entirely using AI and sensors, features a hologram cashier, and enables shoppers to scan items using mobile phones. This futuristic grocery store demonstrates just how seamless and convenient consumers expect the shopping experience to be.¹⁷

While the physical store will play its part in the omni-channel experience, making shopping convenient, real time, and relevant is the goal. Consumers today have ultimate control over the customer experience—what channels they use, how they pay, and how items are shipped. Manufacturers and consumer packaged goods companies that have adopted direct-to-consumer models offer their customers flexible options for browsing, payment, shipping, and aftermarket service. As consumers use more channels to complete these processes, they expect the entire experience to be convenient and seamless—across a myriad of channels and at every touchpoint with the brand.

A seamless customer experience requires that underlying operations and processes be aligned. This is incredibly complex to achieve. As explored in Chapter 4, digital capabilities must align with physical supply chain execution. Customer centricity is key to achieving this, along with implementing the right technologies—from the warehouse through to the storefront—all capable of supporting shoppers, fulfilling orders, completing shipments, and delivering highly personalized and satisfying customer experiences.

Creating Consistent Omni-channel Experiences

Reaching consumers today requires a complex, multifaceted approach across many channels. Disruptive technologies have given consumers so many different ways to connect with sellers that the path to purchase has become more complex. Customer engagement has transitioned from a multi-channel experience to an omni-channel experience. Multi-channel engagement pushes content to consumers regardless of their device or location. Omni-channel delivery takes this one step further by focusing on consumer need and behavior in the moment (or in real time), pulling together programs to provide a consistent brand experience across channels, platforms, and devices.

As consumers become more mobile, a uniform experience becomes more critical for success. If a customer visits a retail website on a computer at home but switches to a mobile device at the time of purchase, the brand experience should maintain the same look, functionality, and content. Customers do not see individual devices or channels; they look for a consistent and familiar brand experience. This is dependent on marketing program alignment, consolidated information and systems, and an effective Business-to-Business (B2B) platform to ensure the timely fulfillment and delivery of both online and in-store purchases.

Omni-channel Excellence Starts with the Supply Chain

Omni-channel retailing has been one of the main trends to impact retailers in recent years. The adoption of online mobile retail has changed the dynamics of consumer buying patterns and retail distribution. Retailers need to be able to source goods at competitive prices as well as ensure they are working with responsive suppliers that can meet consumer demand.

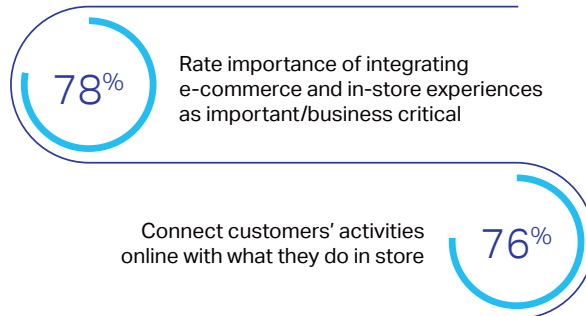


Figure 5.8: Integrating Operations is Critical to Achieving Omni-channel Excellence¹⁸

With a keen focus on optimizing customer experience, manufacturers are streamlining their siloed supply chain processes on top of B2B platforms to unite the factory with the showroom. Omni-channel excellence depends on more than just combining digital and physical channels. A digitized supply chain enables omni-channel execution, especially at the store level.

Superior omni-channel support requires 90 percent inventory accuracy.¹⁹ If merchandise is out of stock, digital consumers can find availability and competitive pricing in just a few clicks. Many manufacturers and retailers are investing in technologies like sensors on shelves, automated inventory verification, cameras and video analytics, and RFID for greater inventory control. Winning strategies make inventory available using as many channels as possible, regardless of the physical location of merchandise.

As well as inventory accuracy, giving consumers convenience and choice in order fulfillment and delivery processes are also key. According to the "UPS Pulse of the Online Shopper" report, more than half of global consumers prefer to buy online. Online shopping and the direct-to-consumer model has introduced buying patterns like "click-and-collect," which entails purchasing online with the ability to pick-up or return goods in-store. Brick-and-mortar store locations are expanding to serve as distribution centers. Alongside shipping direct or to a consumer's workplace, click-and-collect models continue to expand to include retrieval of online or mobile orders at a store locker or drive through, click-and-collect remotely from the store, and reserve-and-collect instore. Over 65 percent of retailers today are experimenting with different delivery models.²⁰

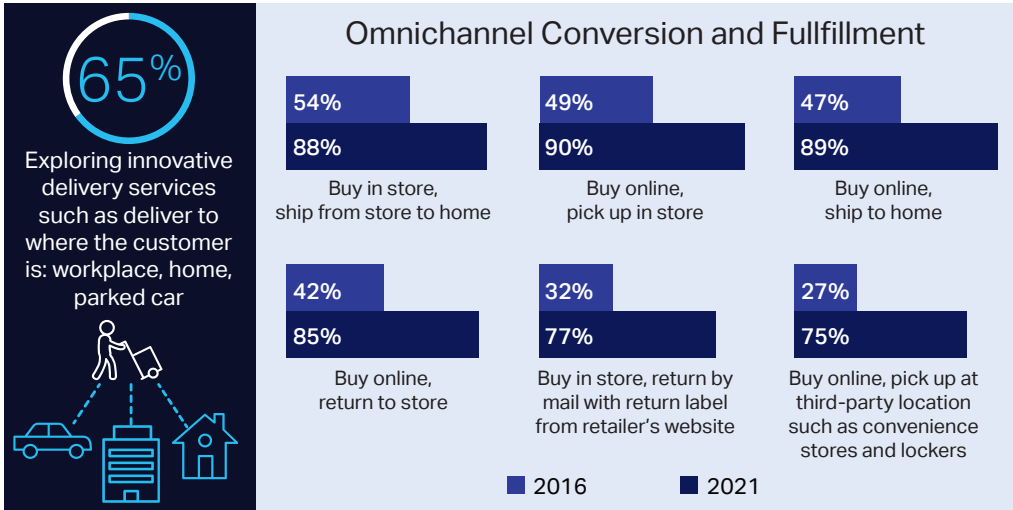


Figure 5.9: Omni-channel Conversion and Fulfillment²¹

The Home Depot uses its store locations as mini-warehouses to fulfill approximately 35 percent of its online orders.²² With online competitors like Amazon and Whole Foods, Walmart plans to run pilots in the U.S. with ride-sharing services Lyft and Uber delivering online grocery orders to customers' homes on the same day that they're ordered.²³ In addition to their mobile pre-order and pay feature, Starbucks has partnered with Postmates to deliver coffee. Using the Starbucks mobile app, consumers can pay using a credit card, Apple Pay, or their Starbucks card and then request to have the coffee delivered.²⁴

Manufacturers and retailers must satisfy customers who purchase from one channel and receive fulfillment from another while supporting returns back into the supply chain. On the back end, as discussed in Chapter 4, supply chains must be flexible, agile, and support digitized processes from end to end.

In the following feature, Argos is embracing different delivery models, including "Check & Reserve" to help attain their digital transformation goals.

Argos

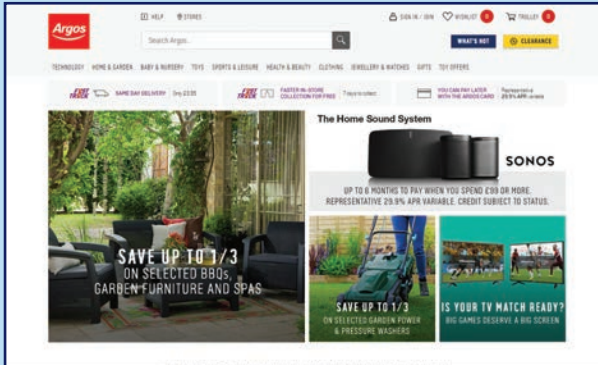


Figure 5.10: Argos

“With Media Management, we will see our digital transformation vision become a reality. Indications are that the solution will provide a full return within two to three years.”

– **ANDREA MILLERS, DIGITAL ASSET MANAGER, ARGOS LIMITED**

Argos is the U.K.’s leading multi-channel retailer, selling a range of more than 53,000 products through 840 stores, by phone, and via its website and mobile apps, for collection or delivery. The Argos website—argos.co.uk—is the U.K.’s second most visited retail website, with more than 900 million visits last year. Customers can use the highly successful “Check & Reserve” service to reserve products online and collect them the same day from a store of their choice. Ninety percent of the U.K. population lives within 10 miles of an Argos store. Same-day delivery services are also available.

Since 1973, Argos has been well known for its printed catalog of products. However, in 2012, Argos began a five-year business journey to reinvent itself as a digital retail leader, the largest retail transformation in the U.K. The aim was to make its in-store, online, and mobile experiences work together, with digital at the heart of the business, to better serve its customers’ needs with more choice and faster availability. Planned growth in the number of products, plus new requirements for channels such as kiosks, and the shortest possible lead times for click-and-collect and same-day delivery services, meant a new DAM solution was a must.

The new DAM solution integrates seamlessly with existing Product Information Management (PIM) and dynamic imaging services to provide a single source of the truth for digital assets—including the nearly 300,000 assets migrated from the old system. It allows more than 1,000 suppliers to upload between 300 and 400 assets a day directly into the system. Argos is looking to expand the solution’s capabilities to accommodate a growing number of products from 50,000 to more than 100,000, each with an average of six or seven assets. By automating the process, DAM is helping Argos realize its digital transformation vision by ensuring that the right asset makes it to the customer’s chosen channel and device in a consistent, convenient, and streamlined manner.

Digitizing the Customer Journey

The customer journey describes the experience a customer has from initial desire through to fulfillment. All of the touchpoints encountered constitute the brand experience. Over the next five years, we will witness a “radical integration” of the customer journey across physical and digital environments.²⁵ It is already being impacted by the IoT, web technologies, and analytics.

In the digital world, companies that succeed will implement digital end-to-end strategies to create breakthrough customer experiences. The focus is on engaging the customer with relevant information, served up on the right channel, at the right time on their journey.

Customer journeys are based on data collected across various touchpoints—transactions, interactions, social media sites, devices, sensors, videos, and more. Analyzing this data leads to customer insights, and these can be tied back to actions that drive automated, internal processes and the delivery of content and services. This should all happen on the fly, in response to customer needs, to influence their buying decisions.

Every touchpoint provides the opportunity for an organization to engage. For ideal customer experiences, organizations need to engage customers at every stage of their purchasing journey because two-thirds of the decisions that customers make are formed based on their experiences.²⁶

The figure below illustrates possible touchpoints on a customer journey for the purchase of a car. A prospect conducts research online before setting foot in the dealership—potentially watching a commercial on the dealer’s site or reading car reviews that link to the manufacturer’s website. This might be followed by a virtual road-test and finally, a trip to the showroom as a GPS system on their mobile device finds the closest location. Analytics along the journey help manufacturers and sellers determine car buyer preference and habits. As part of a larger, digital ecosystem, banks and insurance companies can be incorporated to provide pre-approved loans or insurance rates based on driving habits. Post-purchase, sensors might alert the driver when service is due. The entire journey should be orchestrated to capture preferences and facilitate a seamless experience. The value of the information collected at each touchpoint can be used to deepen the experience and provide insight.

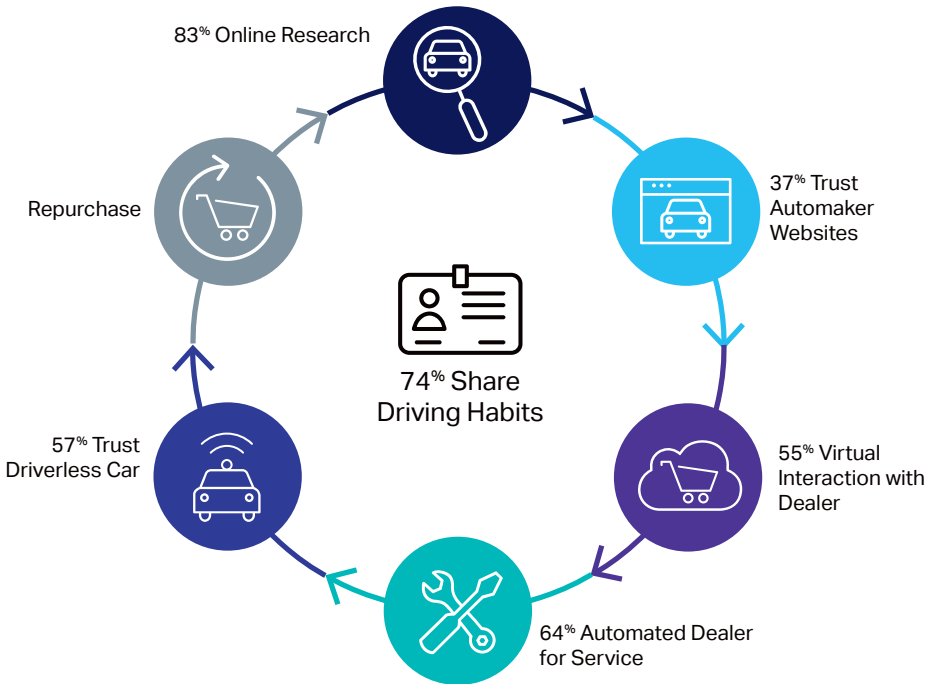


Figure 5.11: Touchpoints in a Car Buyer's Journey²⁷

Effectively managing customer data is critical to optimizing a customer journey. If a manufacturer or retailer can predict customer behavior, it has a better chance at delivering what a customer expects. To deliver a contextual experience, organizations rely on technologies that combine historical (buying behavior including barcodes or click-throughs on a website), situational (geo-location), and demographic (profile-based) data. Content is targeted and personalized, anticipating the needs and buying behavior of each consumer to offer location-based products or services at the most opportune moments to buy. Sellers that digitize customer journeys can apply analytics to gain a true, 360-degree view of the customer.

Analytics: A 360-degree View of the Customer

Consumers now control the shopping process. As more disruptive technologies push the limits on current business models, organizations will turn to advanced analytics to differentiate and deliver winning customer experiences. By applying analytics to data, manufacturers and retailers will gain better insights into their customers' buying behavior, sentiments, and needs. In a time of dwindling brand loyalty and heightened competition, analytics will be a game changer in securing competitive advantage.

While consumers may sit in the driver’s seat, organizations are looking to make investments in technology to gain back some power in the purchasing process. The figure below shows that retailers plan to invest heavily in IoT-related sensors by 2021. IoT-related technologies will give organizations even greater volumes of customer data, based on inventory tracking, customer footpaths, transactions, sentiments, and more. When this data is added to demographics, transaction histories, social media comments and likes, ratings and reviews—organizations will have access to richer information to allow for deeper engagement and greater satisfaction.

Percentage of Retailers Planning to Invest in Analytics

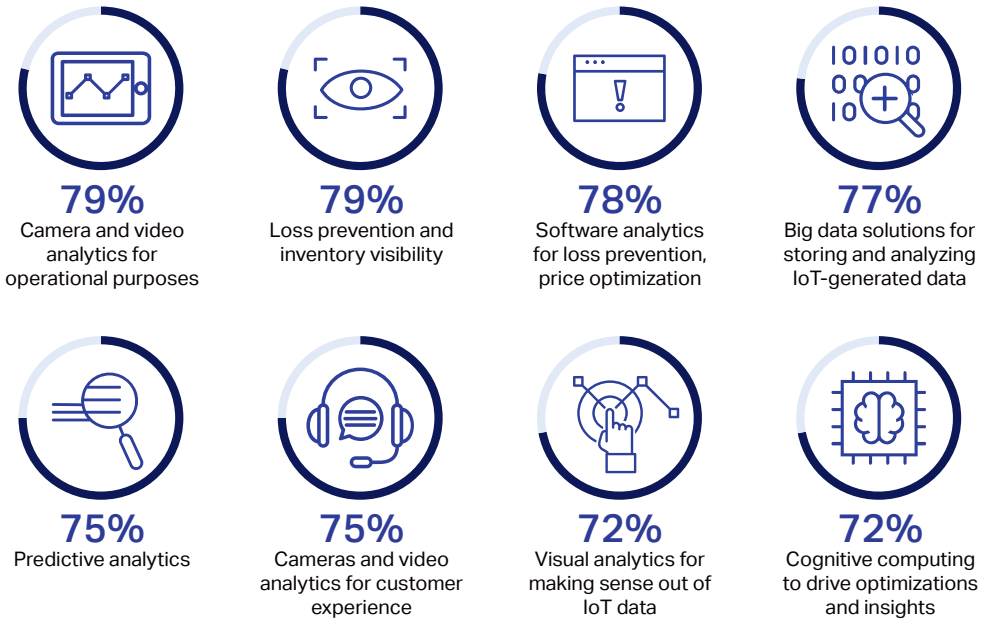


Figure 5.12: Future Analytics Investments²⁸

Having more granular information about how consumers behave will enable retailers to provide more targeted communications and bespoke products and services. Location-based marketing will satisfy customer desires in their moment of need. If a retailer’s website knows the consumer has clicked on more information and reviews about a dishwasher and detects that they are close to a store location, targeted promotions or notifications can be sent out via an app, alerting the consumer that the same item is on sale in a nearby store.

Advanced analytics can effectively comb through data using sophisticated quantitative methods, such as statistics, descriptive and predictive data mining, simulation, and optimization. The insights produced move beyond traditional Business Intelligence (BI) to analyze the data, glean insights, and recommend a course of action. Analytics brings together interactive data visualization, pattern matching, and machine learning. For example, a large U.S.-based retailer applied smart-pattern matching and machine learning to an inventory program to quickly identify a performance issue related to a new product. As a result, the company was able to avoid customer dissatisfaction and reduce returns. Based on their findings, the retailer cited a quality issue and returned the merchandise to the manufacturer.

The need to improve real-time business decision making will force retailers to acquire self-service and big data discovery capabilities. In fact, managing big data is recognized as being business critical by 73 percent of global retailers.²⁹ When asked where analytics would impact their strategic goals, they ranked market-based insights, customer segmentation, and centralizing their customer information as top initiatives.

In the digital world, a deeper understanding of the customer has become a strategic objective for organizations in the manufacturing, retail, and consumer packaged goods industries. Sophisticated analytics platforms can transform volumes of data into advanced intelligence that forms the basis of marketing strategies, new business models and revenue streams, and new product and service development. As consumers depend increasingly on technology to augment their shopping experience, manufactures and retailers will integrate information management and advanced analytics into their operations. Those that do will benefit from productivity and profit gains that are five percent higher than competitors that do not.³⁰

In the retail sector, consumer buying patterns and supply chain operations are intrinsically linked. The use of big data analytics in the retail sector will continue to grow exponentially as retailers look for different ways to mine consumer information and align with transaction-based shipping information from supply chain operations. From analyzing consumer buying patterns based on loyalty cards to monitoring the end-to-end performance of a "last mile" third-party logistics provider, having a complete 360-degree view of the customer can literally make or break a retail business.

Targeted Customer Communications

Streamlined communications give retail and consumer packaged goods companies the opportunity to engage with their customers using the right channel at exactly the right moment in their buying journey. The most effective way to do this is to target different audiences with different messages and focus on products and services with the greatest appeal for each segment.

Dynamically generated customer communications give marketers direct, hands-on capabilities for creating and launching marketing campaigns as well as ongoing promotions. Information is consolidated from multiple back-end systems to create a single portfolio view of each customer. This information is then combined with the context of the customer's current situation to automatically produce targeted communications. When correspondence is part of a digitized process, manual handling and human error are significantly reduced, increasing overall efficiency and customer satisfaction.

Every customer wants to be treated as a known individual. This is dependent on making sure that recommendations are relevant to a person's profile and history—their data, preferences, and past shopping behavior. Streamlined communications based on accurate data helps organizations produce more timely exposure to offers.

Seamless Information Flows

As digital engagement progresses beyond point and click, organizations can streamline communications based on integrated information flows across the business. In order to deliver a consistent end-to-end experience across many touchpoints, they need to integrate front- and back-office technologies and processes with a complete information strategy that delivers individualized customer experiences at each point of engagement.

Within many manufacturers and retailers, the current technology layers that support customer engagement are numerous and disjointed, often consisting of different applications from a variety of vendors. At the customer interface, rich digital solutions are required to support the evolution of a brand's publishing points—from tablets to displays to mobile devices. Behind the customer-facing applications are the systems ranging from Web Content Management (WCM) to Customer Relationship Management (CRM) and various BI and analytics tools. Ideally, each technology should work to optimize digital engagement and extend to the virtual business network. The connections between these systems should be relatively easy to track, but how does the digital enterprise bring this all together for accuracy and consistency?

A Customer Experience Management (CEM) platform combines software applications that help organizations create richer, more interactive digital engagement across devices and channels without sacrificing information governance and compliance. CEM empowers the digital enterprise to capture audience expectations, process requests, search for relevant content, curate user-generated content, assess consumer data for analysis, and present actionable data to create exceptional digital experiences. Video, rich media, and personalized content can be created collaboratively, published seamlessly, and shared ubiquitously to surprise and delight customers at every turn.



Figure 5.13: Disjointed Digital Engagement

EIM Drives Engagement

Exceptional customer experience is the key differentiator that delivers competitive advantage. Manufacturers and retailers must engage in transformation that is built on a foundation of customer insight to create experiences that are relevant, personalized, consistent, and exceed expectation. Customers who are fully engaged bring additional revenue, greater market share, and the potential to deliver a lifetime of value.

Improved customer experience relies on an effective CEM solution and an underlying EIM strategy. Armed with these solutions, an organization can transform unstructured data sources into levers of competitive advantage and profitability. When CEM solutions are consolidated on a single engagement platform, manufacturers are empowered to maximize the potential of their information to reach new markets. By taking this approach, organizations can effectively manage the customer experience, whether it involves human interaction or relies solely on automation or AI. Ultimately, it results in more fulfilling customer experiences and a business that is ready to embrace true digital transformation.

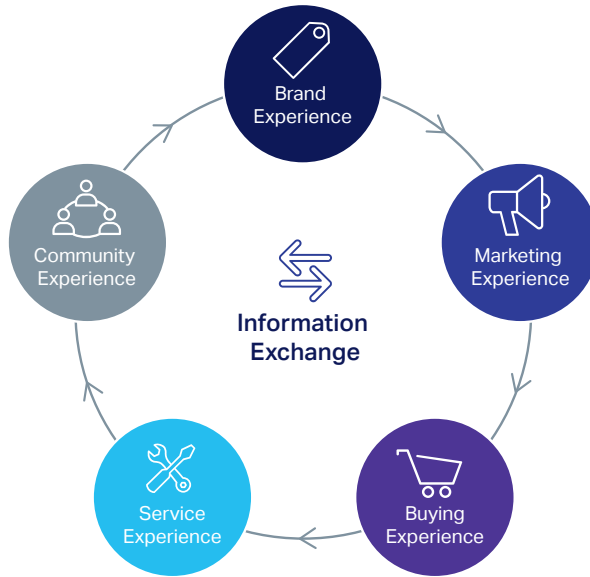


Figure 5.14: CEM Creates Value across the Customer Lifecycle

In the digital world, manufacturers and retailers have to work harder to engage and satisfy their distributors and consumers with an end-to-end digital strategy. They need to be able to extract value from their information, optimize and personalize the delivery of this information, and manage it securely. To transform and drive growth, organizations in the manufacturing and retail industries must deliver compelling experiences while adhering to established information governance policies and standards to guarantee security and privacy. The following chapter on Digital Governance, Risk, Compliance, and Certification describes how to achieve this in greater detail.

DIGITAL GOVERNANCE, RISK, COMPLIANCE AND CERTIFICATION



Manufacturers in every sector need to carefully manage and protect their information, at every stage of the product lifecycle. This chapter examines how Enterprise Information Management (EIM) enables a unified approach to Governance, Risk, Compliance and Certification, helping digital manufacturers operate more efficiently, safely, and cost effectively for competitive advantage.

Digital Governance, Risk, Compliance and Certification

*“Every company is just one bad decision or one ‘bad employee’ away from scandal, one scandal away from a salacious headline, and one headline away from a flood of lawsuits.”*¹ – William Lytton, former EVP and General Counsel of Tyco International

Manufacturing organizations are operating in a new environment—one in which old-world challenges like systems integration and consolidation are colliding with the new-world challenges of globalization, digital disruption, and constantly evolving regulatory compliance requirements. In short, today’s manufacturers must function in an environment that is inherently complex.

Globalization, for example, has exposed the growing intricacies of the extended enterprise ecosystem to an ever-more sophisticated set of security risks. Digital assets and resources once secure behind firewalls now need to be made accessible to employees in globally distributed facilities, as well as to a changing group of suppliers, partners, distributors, logistics providers, and other ecosystem partners.

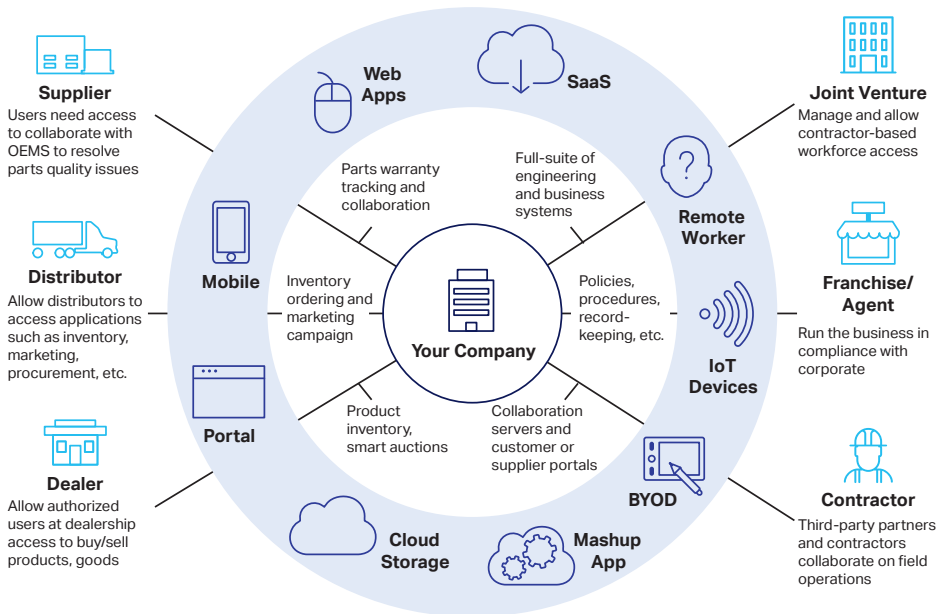


Figure 6.1: Access to Information in the Extended Enterprise is Highly Distributed

Along with globalization and other factors, manufacturers are undertaking significant digital transformation initiatives to automate processes in a bid to increase both productivity and the pace of innovation. These involve the integration of Information Technology (IT) with Operational Technology (OT) to facilitate the seamless exchange of business information, which can bridge security domains through direct connections with value chain partners, as illustrated above. While digital transformation initiatives deliver significant value, more enterprise information is generated by IoT-connected devices or global supply chain partner data, for example, which increases an organization's security threat surface.

In an industry where non-compliance can have devastating consequences—ranging from the erosion of brand equity, crippling fines, unsafe products, recalls, lawsuits, and even loss of life—digital manufacturers cannot afford to overlook the integral role that a Governance, Risk, and Compliance (GRC) program plays in shaping the enterprise. For this reason, analysts predict that the GRC market will more than double in the next few years, with the majority of spending occurring in the Americas.¹

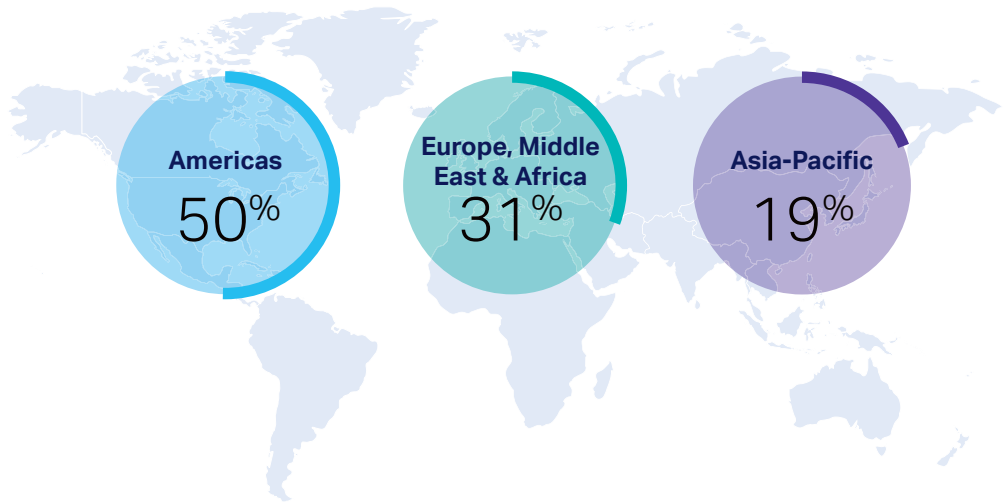


Figure 6.2: GRC Spending by Region²

As a sustainable platform for GRC, EIM empowers the digital enterprise to put policies and controls in place that address compliance issues, while making critical information available to improve performance and deliver competitive advantage.

A Complex and Evolving Landscape

The nature of business has evolved dramatically in the past few years. Disruptive technologies have introduced systems integration, information management, and security concerns to the enterprise. At the same time, new business models (including PaaS, a subscription economy, and data monetization) are forcing manufacturers to adopt new practices and leverage digital technologies to connect with partners and customers in new ways.

As business evolves, so must the internal policies and external regulations that govern how an organization operates. In the digital world, manufacturing enterprises are under increasing pressure to control the acquisition, management, retention and disposal of all enterprise information, both structured and unstructured, to mitigate risk and help to ensure compliance. The expectation is that manufacturers follow GRC best practices, while enhancing performance, keeping pace with competitors, and meeting growing expectations from a variety of sources, including consumers, partners, and business stakeholders.

As the following figure illustrates, compliance is a multi-faceted concept that encompasses a number of broader areas, including product safety, health, environmental safety, data protection, employment law, export controls, fair competition, IT security, and anti-corruption. Together, compliance activities across these areas help to guarantee the quality of an organization's products and services, the safety of its employees and consumers, and the security of its data.



Figure 6.3: Compliance is Multi-faceted

To further complicate matters, compliance requirements in any of these key areas can change at any time. As such, manufacturing organizations must build agility and flexibility into their enterprise systems and processes to be able to quickly respond to sweeping changes. For example, the 2014 introduction of the Dodd-Frank Conflict Minerals Law impacted export controls requirements, making end-to-end supply chain transparency a necessity. In 2017, Sapin II (the French anti-corruption law addressing transparency, anti-corruption, and economic modernization), mandated companies to establish an anti-corruption program to identify and mitigate the risk of corruption.

Manufacturers must be resolute in their GRC practices. Once they have addressed the intricacies of Conflict Minerals reporting and Sapin II, new regulations like the General Data Protection Regulation (GDPR), and geo-political influences, such as Brexit pose a whole new set of business challenges.

The General Data Protection Regulation

"52.8 percent of companies consider data security and breach notification standards to be the most important component of GDPR."³

In 2016, the European Union (EU) introduced the General Data Protection Regulation (GDPR) to bring personal data protection into the digital age. While this new legislation imposes stringent requirements for how companies store and handle the personal data of European citizens, its legal reach isn't defined by geography, but by the use of the personal data of European residents—which means that the GDPR applies to any organization anywhere in the world. Compliance mandates will be far reaching and impact everything from how organizations obtain consent to how they use cookies on their website to the "right to be forgotten." The GDPR will essentially affect every part of an organization.

The ability to locate personal information is the first piece of the GDPR puzzle. Sophisticated file management solutions can help organizations find the proverbial needle in the haystack by searching, identifying, and reporting on personal information that is dispersed among many sources. This allows manufacturers to manage enterprise information based on value and risk, and apply retention and disposition policies as mandated by the GDPR and other compliance regulations.

Data minimization, or collecting the smallest amount of personal data for the shortest period of time and deleting it quickly after it has been used, is the second piece of the puzzle. The less data that manufacturers hold on to, the less data they have to protect and govern. As a facet of EIM, Enterprise Content Management (ECM) provides the digital platform required to manage and govern personal information securely in a central, repository. Records Management (RM) capabilities further support data minimization by identifying and eliminating unnecessary information, even if it is generated and stored in a separate ERP system or application.

Compliant preservation and access is the final piece of the GDPR puzzle. Consolidating static information that contains personal data into a single repository for a “single source of the truth” delivers tighter security and control and easier access and retrieval, which enables organizations to fulfill “privacy by design” requirements and reduce the risk of GDPR violations.

Brexit

While updating policies and practices to comply with the GDPR will be an elaborate undertaking, it helps that the rules and requirements are clearly outlined. For many global manufacturers, the U.K. vote to leave the European Union—referred to as “Brexit”—will pose an even bigger challenge.

At this point, Brexit raises more questions than answers and, for many manufacturers, represents the unknown. What is certain is that this geopolitical event will usher in significant legal and regulatory change across all industries, including manufacturing.

While, at first blush, Brexit might not appear to have much to do with information governance, it is, in fact, an area that stands to be significantly affected. Brexit promises to impact records retention, data protection and privacy (with laws, like the GDPR), contract governance, HR process, and customer communications. Fortunately, these are all areas that organizations can proactively tackle in preparation for the uncertain future.

Take records management, for example. The majority of U.K. recordkeeping requirements are mandated or heavily influenced by EU directives, including those in the manufacturing industry. However, after Brexit, the U.K. will have the potential to create different rules. Affected organizations will need to diligently follow any changes in laws to assess and update their records retention schedules accordingly to ensure compliance with new laws.

With regards to contracts, specific country requirements for business and revised U.K. laws based on trade relations may have a massive impact on how manufacturers relate with suppliers, third parties, and partners—both in and outside the U.K. Organizations will need to negotiate and update contracts and the processes that govern them. A centralized contract management system that stores, manages, tracks, shares, and reports on contracts will give organizations the power to make decisions as changes happen.

Brexit may impact HR processes such as hiring and recruiting. For instance, manufacturers that employ EU citizens to work in the U.K. will, in effect, be employing foreign citizens. Global manufacturers will need to ensure that their HR policies, processes, and documentation comply with the reporting requirements that are introduced by regulatory changes.

Customer communications—such as bills and statements—may need to be modified to reflect any potential regulatory changes. This can mean creating an additional version of communication, further increasing the complexity of generating and maintaining documents, introducing excessive labor, cost, and risk. Smart organizations will leverage automation to help streamline the production of critical customer documents. Manufacturers that employ agile and adaptable business processes, such as country-compliant invoicing documents, will have the upper hand—smoothing the transition with Brexit while continuing to foster positive customer relationships.

These are just two recent examples of how regulatory reform and geopolitical events can disrupt global manufacturing operations. As a platform for GRC, EIM delivers the flexibility that organizations need to manage occurrences like these. In the following interview, a world leader in titanium technologies, fluoroproducts, and chemical solutions discusses how process automation, consolidation, and records management deliver the agility required to balance regulatory compliance with continuous innovation in a highly regulated industry.

Drivers for GRC

“The average cost of non-compliance runs organizations around \$9 million a year.”⁴

There are many reasons for manufacturing organizations to adopt a GRC program. Regulatory compliance is the top-cited business driver for obvious reasons. Non-compliance can lead to poor performance, financial penalties, and even criminal charges.

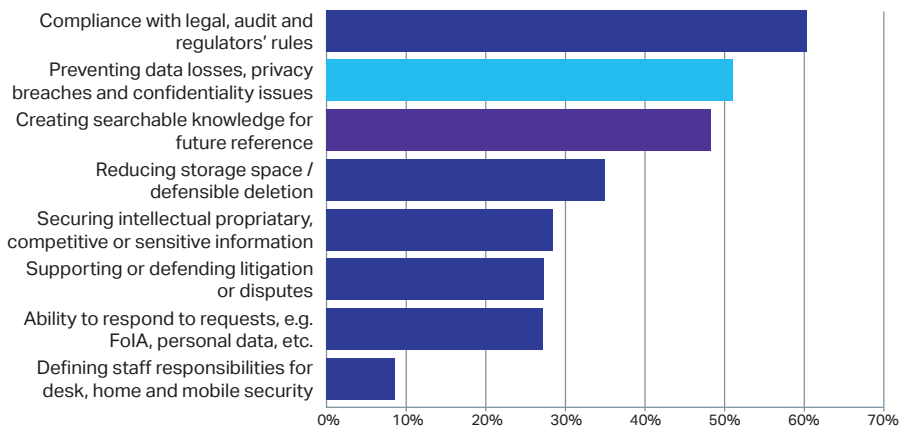


Figure 6.4: Top Drivers to Create and Enforce GRC Policies⁵

While compliance is arguably the biggest driver for GRC, it isn't the only one. As the figure above shows, preventing data loss, knowledge sharing, managing storage through defensible deletion, process efficiency, and productivity are also drivers.

The Chemours Company

The Chemours Company is a world leader in titanium technologies, fluoroproducts, and chemical solutions. The company is focused on its differentiated portfolio of premium products positioned to help its customers respond to developed and developing market needs. Chemours is a new company with over 200 years of history, created from DuPont's performance chemicals businesses.

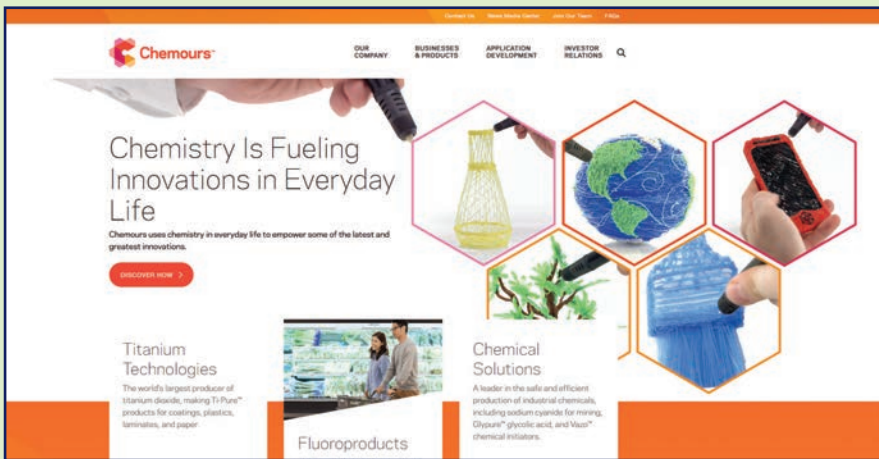


Figure 6.5: The Chemours Company

What follows are excerpts from an interview with Robert Siegel, Solution Portfolio Manager at The Chemours Company.

"Chemours has a rich history that goes back over 200 years in an industry that is almost 300 years old. As a portfolio manager at Chemours, I have strategic oversight for all of the systems and applications we use to manage information—anything from engineering information to SharePoint to records management and retention. We also have legacy systems, architecture, and information from the Dupont days (Chemours was a spin-off from Dupont). A portion of this involves how to integrate processes into our ERP systems, for example.

Our industry is very highly regulated. Not only do we have to comply with regulations, we have to make sure all related information is accessible to regulatory agencies upon request. We follow processes to protect our information, such as records control schedules based on data types, like invoices, customer correspondence, research, or plant maintenance. For example, any information that is related to a manufacturing location or piece of equipment has to be managed for the life of the facility, so this might be anywhere from 50 to even 100 years. There is a regulation

in Europe, the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), that requires companies to share information about a regulated chemical throughout the entire industrial supply chain, and to keep any information related to a chemical a company manufactures for 10 years after its last manufacture, sale, or use. Obviously, this too could be for many years. Some countries like Germany have financial audit requirements for immediate access to data by auditors, who will use our systems to recreate how we came up with specific data. Technology helps us digitize and manage these information-based processes.

As a global leader in titanium technologies, fluoroproducts and chemical solutions, when Chemours manufactures chemical components, our processes produce paper trails that stem from scientific research. We have to manage volumes of information related to the lifecycle of a product, from research and testing, and so on. To do this, we use a separate data system that records electronic laboratory notebooks. As materials are tested, data is produced. All of this information is extremely confidential, and much of it is already in digital format.

Product data is a whole other set of data that is generated and needs to be managed for compliance purposes. We have to register the material(s) we're going to sell, and in Europe for example, what product it's going to be used in, how it's going to be used, etc. We couldn't sell a product to another company that is going to manufacture or repurpose it as a cleaning product without that new use being registered. The volume of a regulated product sold in Europe under the REACH regulations is also part of the registration, so once a certain threshold is reached, the registration needs to be updated to meet the next tier of requirements. We have to have the processes in place to monitor the volumes of materials that are regulated in not only every country in the European

Union but by region and individually determined sectors as well. Before we ship or sell a product, it has to go through many different kinds of regulatory reviews and this can be a lengthy process.

We are bringing structured and unstructured data together, and we are looking to analytics to get more insights from this information. As a first step, though, and this is the tricky part, we have to decide what data we want to mine. Dashboards were popular a couple of years ago to show data points, but not everyone understood them. The next challenge will be how to use artificial intelligence to analyze volumes of information to look for patterns, similarities, or anomalies. Even to tell us what we should be measuring. This will help us create and innovate—to make new products that meet customer demands or markets. It's a challenge because you need to be creative to model what you can't see. What we'd like to do is run analytical reports directly from our central ERP system. We're exploring how to open up our reporting right now, to move beyond the limits of data extracted from one system to analyzing data from the source system for real-time insights.

I'm not convinced that consolidating enterprise information into a single system will ever happen. Different applications have separate databases and regulations dictate that we treat HR-based information differently from financial data, for example. As far as security goes, a centralized, single database can be more vulnerable to a catastrophic attack. There are many information security threats today. One is from hackers accessing information, another from people leaking confidential data. Sometimes stolen information is used to extort money from a corporation in order to prevent its publication. Another threat, emerging quickly, is ransomware attacks, which use malicious software to encrypt a corporation's data to block access to it. Again, corporations are then prey to

extortionist hackers who demand money to decrypt the data. Employee education is critical to effective security, as well as securing and monitoring our systems to make sure breaches aren't happening.

We don't store or manage our highly sensitive information in the Cloud. We have a hybrid solution—partly in the Cloud and partially on premises. We do put in a number of access requirements if there is confidential data in the Cloud—it's a layered security approach. We can still use our information to innovate and create new products, but access is tightly controlled, and we ensure that we protect our information as it is generated.

True digital transformation is based on addressing a business issue with key business stakeholders, a desired business outcome, and a vision of the future state. IT can often operationalize this vision and make it real, but the drive for transformation needs to come from management as strategic insight, with an eye towards its benefits. It's most effective when the originator of a digitization project is a business leader. And in the end, they represent the users as well, so if they're behind the project, adoption will be easier."

Recent hacks, information leaks, and security breaches have raised the profile of GRC. According to a recent survey, GRC ranks very high on the agenda of more than one-quarter of senior managers, and more than half of organizations are undertaking new initiatives to build out their programs. Despite the growing awareness around the importance of governance programs, 57 percent of respondents say senior management is only interested in GRC when things go wrong.⁶

GRC is a means to manage risk, ensure compliance, and achieve operational excellence. Taking a reactive approach, or waiting until “things go wrong” is ill advised. Governance is about leveraging information to conduct business. As such, a critical part of GRC is ensuring that the right information is presented to the right people at the right time. It follows that governance starts with understanding the organization’s information needs, what structured and unstructured information an organization has, where it is, and why it’s needed.

The relationship between compliance and governance is reciprocal. Compliance serves as a driver for information governance, and information governance, in turn, can simplify compliance. This is why more and more manufacturers are realizing the benefits that a strategic GRC program can deliver and are starting to view it as a means to boost operational effectiveness, rather than a burden.

Not Just a Necessary Evil

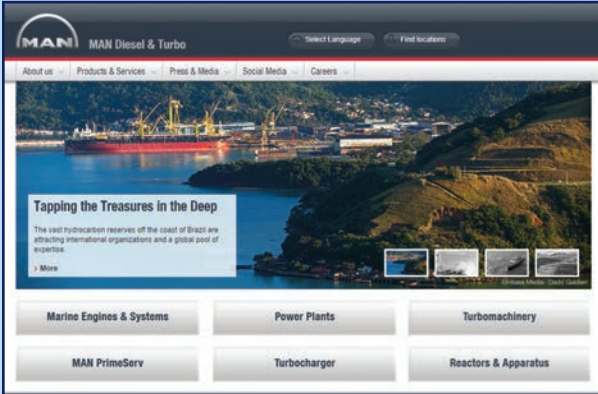
In a recent survey, 69 percent of organizations said that they expected an increase in their total compliance budget over the next year.⁷ While many organizations bemoan the effort and investment required to establish a solid information governance program, research shows that it is well worth the effort. It is estimated that non-compliance costs 2.65 times what compliance costs (or \$3.5 million versus \$9.4 million).⁸ And in today’s competitive and highly regulated business environment where just one non-compliance penalty or one breach made public can sink a business, manufacturers cannot afford not to invest in a GRC program.

In the face of growing volumes of data, there is a strong need for programs to help transform organizations to enable them to benefit from the better management of their information. Manufacturers that have implemented GRC are realizing the opportunities it gives them to drive business transformation efficiently and successfully.

In the following feature, leading global manufacturer MAN Diesel & Turbo is using records management and ECM to apply governance and achieve compliance.



MAN Diesel & Turbo



Digitized processes provide legal security

Figure 6.6: MAN Diesel & Turbo

MAN Diesel & Turbo, headquartered in Augsburg, Germany, is the world’s leading manufacturer of large-bore diesel engines and turbomachinery. The company employs around 14,900 staff at more than 100 international sites, primarily in Germany, Denmark, France, Switzerland, the Czech Republic, India, and China.

Diesel engines in container freighters or luxury liners are some of the largest products in the world and among those with the longest lifespan. They have to function for decades and be regularly maintained. One of the world’s leading manufacturers in this field, MAN Diesel & Turbo, needs to keep important technical documents for a minimum of 30 years and sometimes indefinitely. The company was looking for an information management solution to ensure high-quality maintenance and successfully refute any claims for liability arising from alleged construction faults.

To help achieve compliance, MAN Diesel & Turbo turned to records management capabilities contained within an Extended ECM solution, along with Application Governance & Archiving (AGA). The combined solutions bring together diverse applications to preserve information in context. Approximately 1,000 service staff in Germany and Denmark use it to archive over 4,000 process-related transaction files every day. In many service processes, paper-based transactions are now a thing of the past as existing paper files are being digitized. MAN Diesel & Turbo is saving valuable time spent on searches and maintaining paper archives along with the large number of their digital archives. The integrated solution is also reducing maintenance requirements through the replacement of legacy systems, enabling the company to modernize its infrastructure, digitally transform key processes, and comply with regulations.

Total Quality Management and Certification

To compete in a global economy, an organization's products, systems, and services must be of a higher quality than the competition's. Total Quality Management (TQM) is part of the GRC equation. As a complex, ongoing manufacturing imperative, there are many degrees of quality which must be prioritized, from the implementation of best practices to adherence to regulatory policies and standards, such as the International Standardization Organization (ISO), Federal Drug Approval (FDA), Standards Council Canada (SCC), and the Institute of Electrical and Electronics Engineers (IEEE).



Figure 6.7: Total Quality Management

The success of a TQM strategy relies upon corporate consensus and tight control over the implementation and management of a quality program. Processes need to be put in place and procedural guidelines created, documented, approved, and disseminated. Each time a procedural change occurs, all related documents must be modified, and the changes distributed and communicated globally.

Leveraging existing IT infrastructures, a TQM system ensures that Quality Control becomes fundamental to all business processes, resulting in reduced wastage and increased profits. Furthermore, seamless and transparent visibility into critical Quality Control and Quality Assurance processes allows organizations to proactively monitor manufacturing variability, track product quality trends, and manage non-conformance across the supply chain to bring the enterprise one step closer to achieving Predictable Output.

New business models like PaaS and disruptive technologies that create a direct connection between manufacturers and consumers are causing the line between products and services to blur. This presents manufacturing organizations with the opportunity to provide better aftermarket support for products and services. For example, manufacturers can issue over-the-air updates to improve the quality and performance of a product, such as a refrigerator. Similarly, service centers could be informed of a problem with a vehicle before the driver becomes aware, which could revolutionize the way in which car manufacturers conduct vehicle recalls.

A connected, cloud-based service environment allows manufacturers to use TQM as a means to deliver improved product development and customer services. It also enables them to reduce defects, avoid non-compliance, and even prevent product recalls.

Product Recalls

The direct costs of non-compliance are steep. But they pale in comparison to the cost of product recalls. Research shows that, in the food industry, 52 percent of recalls average more than \$10 million in direct costs and are one of the biggest threats to profitability.⁹ While the direct costs can be staggering, the indirect costs—such as litigation fees, government fines, lost sales, and damage to brand or reputation—are often far more detrimental.

Recalls can range from bio-contamination of food to accidental toxic contamination of pills to flaws in engineering designs, such as wiring problems that cause airbags to deploy or faulty cellphone batteries that spontaneously combust. Regardless of the issue, the ability to trace, audit, and alert is paramount. In the event of recalls, a highly trusted single source of the truth enables manufacturers to isolate the origin of the issue. In some cases, it may be a particular facility or a single supplier, as was the case with a recent pet food recall where the presence of a drug used to euthanize animals was discovered in canned dog food. Fortunately, the pet food manufacturer was able to trace the introduction of the drug into its food back to one manufacturing facility and a single supplier in its supply chain.

A GRC program helps keep employees up-to-date regarding safety and quality standards and the enterprise compliant with regulations to minimize recalls and mitigate risks. Given the penalties and perils associated with recalls and non-compliance, GRC programs are increasing in importance, as is the role of the Compliance Officer (CO). Compliance Officers have never had a higher profile than they do now. Pressure on the compliance function has been steadily increasing. For example, in a recent survey, 60 percent of organizations say they expect the personal liability of compliance officers to increase in the next year.¹⁰

Compliance Officers don't need to be technology experts but they do need to know how to leverage GRC solutions to streamline associated processes. Critical steps include ensuring enterprise policy frameworks are up-to-date and that employees and partners understand and are trained on their compliance responsibilities. The CO strives to put airtight policies and controls in place to ensure that compliance, centralized policy management, discovery and holds, early case assessment, and defensible disposition of content are all working in harmony to reduce and prevent risk.

Information Security in Manufacturing

"The cost of a data breach is \$3.62 million—money you could invest back in your business. So why take the risk?"¹¹

There is a systematic correlation between investing in compliance and enforcing information security. In many sectors, the ever-present threat of security breaches is driving investments in information governance. Digital technologies are introducing concerns about fraud, ethical behavior, and data security. As mobile technologies and IoT-connected devices become ubiquitous, many manufacturing organizations have lagged in implementing security safeguards to counter mobile threats.

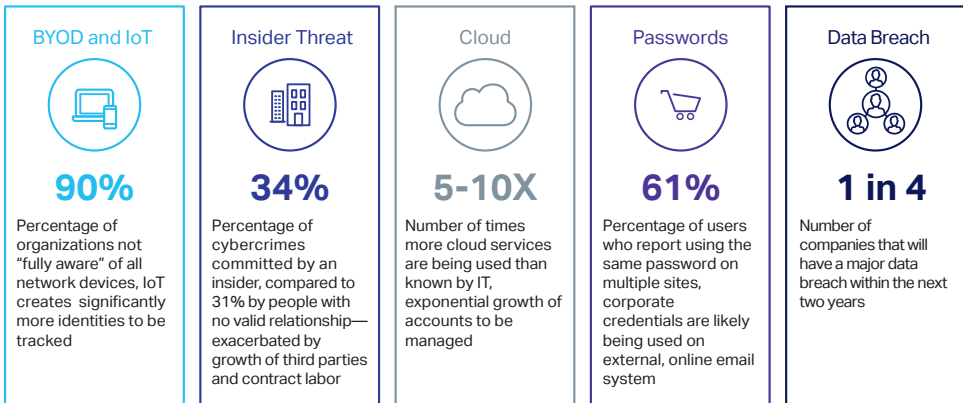


Figure 6.8: The Security Threat Landscape¹²

With the evolution of digital technologies comes evolving information security threats. Attacks today are multi-stage, hard to discover, and highly targeted. Some security threats can be accidental, stemming from unauthorized employee access, for example. Others can be malicious and sophisticated, like "Operation Ghoul"—a cybercrime operation that targeted manufacturing and pharmaceutical companies in over 30 countries using email phishing tactics.¹³ Vulnerabilities permeate all levels of enterprise IT systems, and manufacturers must be prepared to deal with both internal and external security threats.

The extended manufacturing ecosystem continues to grow, adding suppliers, partners, customers, and connected equipment and products. This means more endpoints, identities, and data that must be handled in a compliant manner. Manufacturing is now one of the most frequently hacked industries.¹⁴ Cyberespionage is by far the most common type of breach in manufacturing, with attacks typically originating from competitors or nation-states trying to steal business plans, trade secrets, and Intellectual Property (IP).

Each year, the number of data breaches increases. But not all breaches are a result of cyberespionage and hacking. Many are inadvertent and the result of insider privilege and misuse. As discussed later in this chapter, Identity and Access Management (IAM) and Identity and Access Management as a Service (IDaaS) will play an important role in enabling organizations to securely manage the growing number of digital identities and data associated with connected technologies.

AI, quantum computing, and quantum cryptography are particularly promising countermeasures against cyberattacks and breaches. AI (in the form of machine learning) is being used to monitor networks and associated devices for anomalies, and report deviations in real time. Quantum computing can sift through the more than 150,000 daily threats an organization’s network generates to identify which events are the riskiest.¹⁵ And quantum cryptography can ensure secure communication. These emerging technologies are redefining cybersecurity and, moving forward, will be the best line of defense against sophisticated cyberattacks.

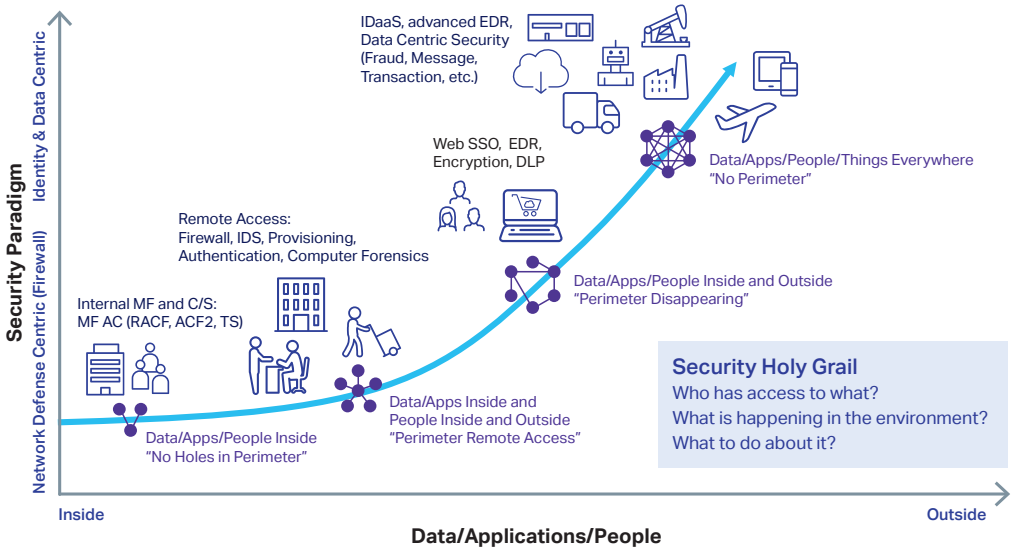


Figure 6.9: The Security Paradigm Shift–From Network Centric to Identity and Data Centric

In addition to redefining cybersecurity, emerging technologies coupled with new business models are causing the network perimeter to vanish. As illustrated in the figure above, the result is a paradigm shift where the focus is moving from a network-centric defense strategy (that protects data, apps, and users behind the firewall) to an identity and data-centric strategy (that protects data, apps, people, and connected things everywhere). As the number of endpoints in the extended enterprise ecosystem grow, and data moves outside the firewall to the Cloud, the more vital next-generation technologies like AI-driven automation, quantum computing, IAM, and cloud security will become.

Information security challenges vary from company to company and region to region. In the following interview, Africa's biggest sugar producer highlights the unique information security challenges it faces operating in sub-Saharan terrain.

Identity and Access Management

"Effective IAM can save organizations up to \$1 billion in compliance penalties and reduce excessive privileges by up to 60 percent."¹⁶

Over the past decade, manufacturers have become more global and have decentralized non-core business functions, transitioning them to an ecosystem of suppliers, factories, warehouses, and other stakeholders. As a result, the value chain has become more complex and vulnerable.

Digital manufacturing companies are pursuing multiple strategies to maximize the value of the distributed functions across multiple external businesses. Most frequently, value is maximized by increasing supply chain efficiency through digital transformation projects, such as application integration between the OEM and suppliers, as well as direct access by external users to OEM applications. Regardless of whether the applications are Product Lifecycle Management (PLM), engineering, ERP or any other function, each integration or access grant bridges multiple security domains. These can present potential points of access for unauthorized users looking to exploit security flaws with malicious intent—or simply accidental information access by unknowing users.

The number of endpoints and digital identities is only going to increase, especially with the explosion of connected devices from the IoT. Manufacturers must figure out how to manage all the identities that access information across the extended enterprise, how to give users access to the information they need for only as long as they need it, and how to keep all interactions compliant and secure, regardless of access channel. For most organizations, this is much easier said than done.

Illovo Sugar Group

Illovo Sugar Group is Africa’s biggest sugar producer and has extensive agricultural and manufacturing operations in six African countries. The group produces raw and refined sugar for local, regional African, European Union (EU), United States of America (USA) and world markets from sugarcane supplied by its own agricultural operations and independent outgrowers who supply cane to Illovo’s factories. High-value products manufactured downstream of the sugar production process are sold internationally into niche markets. The group is a wholly-owned subsidiary of Associated British Foods plc (ABF), a diversified international food, ingredients, and retail group operating in 48 countries.



Figure 6.10: Illovo Sugar Group

What follows are excerpts from an interview with David Schaller, Group CIO, Illovo Sugar Group.

“Illovo Sugar Group is the largest sugar-from-cane manufacturing company in Africa, producing close to two million tons of sugar per year. We operate in six countries in Africa, including South Africa, Swaziland, Mozambique, Malawi, Zambia and Tanzania and, in five of the countries, we are the

planter and the miller. We’ve got quite a lot of vertical integration from land preparation through the entire agricultural cycle from harvesting and milling, packaging, sales and distribution, and marketing. At our peak, we employ about 35,000 people.

As Group CIO, I look after IT for all of the operations in all countries. We support over 3,000 users of IT in the Group, including the languages specific to all six countries that we operate in. The company is actually made up of 17 small-to-medium enterprises (SMEs) with between 100 and 300 users. So, I essentially manage 17 decentralized computer rooms. When these numbers are aggregated, the volumes of information from our systems (ERP, mail, documents, etc.) are equal to enterprise-scale.

We've realized huge gains in efficiencies in not sending paper manually around our organization. It's now digitized and mapped to a workflow, where we can measure it, track it, ensure it's consistent, high quality, and complies with regulations. And we interface this result straight into our ERP system, bypassing the need to capture—so it is completely digitized.

We're also planning to automate the lifecycle of our medical records. Our sugar mills operate in villages and we build the houses, supply the electricity, and provide primary healthcare. We own approximately four hospitals and 15 clinics and employ roughly 30 doctors and 150 nurses. So, we end up as the primary healthcare provider of choice for the entire population within about a 100-mile radius of our business. We see a lot of cases of malaria and HIV/AIDS, do lung function tests and audio tests etc., and then, treat everything. We need to be able to manage these medical records in a way that allows us to access them, protect them, and then keep them for the allotted amount of time to comply with regulations. So, if someone leaves the company, for example, we have to keep these records for ten years.

We've been on an information security journey for some time now. All of the sites (even the remote sites) are connected by a Wide Area Network (WAN) but the lines are very thin and expensive. Taking geography into account, they are spanning

sub-Saharan terrain in Africa, they can be unreliable. A lot of our factories don't even have an Internet broker, so they connect to our WAN. We've got layers and layers of security starting at the very bottom. We have a separate service monitoring for intrusion-type activity and external agencies like Deloitte come and perform security audits. As a result, we've never had a real incident of any consequence. And none of these outbreaks that hit the firewall have ever affected us. The only real issue we might have would be user-dependent, so a breach from the inside out.

We're looking to get insights from our agricultural database on how the agricultural operations are performing. We have a project called a "Group Reporting Layer," which is essentially a light version of a data warehouse. We put data into an application layer, we then aggregate data at the mill-level into what we call a mill layer, and these are then aggregated into a reporting layer. We can access a single view across these groups using analytics tools. When we have a more mature view of this reporting layer, we'll use data scientists to analyze it. At the moment, we're harvesting a lot of data based on our factories and their digital control systems.

We've identified dozens or hundreds of potential applications for the Internet of Things (IoT). The IoT would give us the ability to expand vertically. In other words, we can't expand horizontally or laterally because we're confined to farm the land we own. But we could increase our yield of cane per hectare. If we're currently getting 100 tons of cane per hectare per annum and we increase this to 125, we can add 25 percent to our revenue line without expanding the area of the cane or increasing our fixed costs, and multiply this by all of our operations. Increasing the yields is a sustainability and survival imperative and leveraging the IoT and information can help us achieve this.

My advice to any executive who is embarking on this journey of digitization would be twofold. First of all, if it's not a business project, don't bother doing it. There really is no such thing as just an IT project. As soon as something becomes an IT project, the business disowns it or fails to engage. If you can't find an enthusiastic and committed business champion who is going to own the project and its outcomes, then move on until you find one. And the second piece of advice I would give is to understand where the value is in your value chain. Start with your high-priority projects and demonstrate the value to the business. Once you get traction, then you gain momentum. Then, more and more business people will climb on board. It's not really about the technology, it's about solving a business problem."

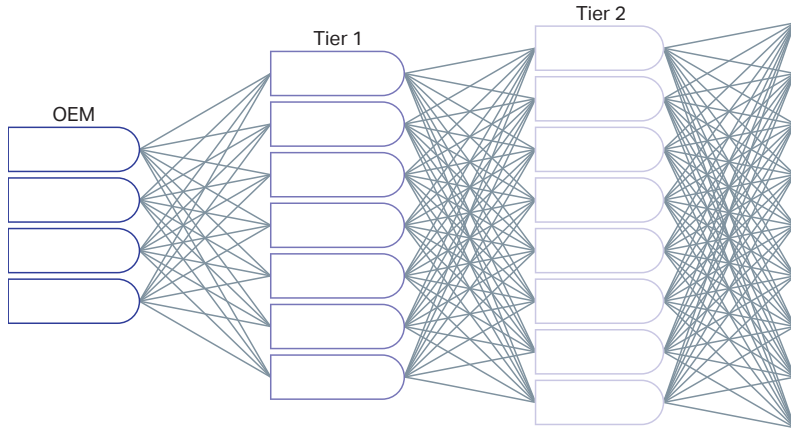


Figure 6.11: The Digital Manufacturing Enterprise is Highly Complex, with Multi-tiered Partners and User Relationships

Identity and Access Management (IAM) is a technology framework consisting of a set of policies and processes. Manufacturers can implement the framework to help ensure that the right people in an enterprise have the appropriate level of access to resources at the right time for improved security, efficiency, and visibility. As companies move more of their workloads and data storage to the Cloud, Identity and Access Management as a Service (IDaaS) will allow organizations to simply and securely manage digital identities across virtually any combination of internal or external systems and end user groups, regardless of where they are within the enterprise value chain.

Cloud Security and Information Privacy

"By 2020, 75 percent of all manufacturers will participate in industry clouds."¹⁷

The Cloud in its varied forms, be it private, public, virtual, or hybrid, is quickly becoming a business imperative. It can help manufacturers more efficiently pursue strategic goals, such as addressing key areas of the user experience, M2M integration, automation and other aspects of a productive work cycle. Cloud computing helps manufacturers reach new markets faster. As manufacturing organizations continue to migrate infrastructure, applications, and information to the Cloud, they will need a sound strategy for privacy and data security.

Securing data is critical, and cloud computing itself can be an efficient way to protect digital data. Cloud computing programs that include provisions for data-breach protection and data location help to ensure that enterprise data is secure, its location is known, and it is easily accessed when needed. Whether data is stored in an offshore or onshore cloud repository, in a known but outsourced data center, or on premises, defensible standards of security protection need to be applied to ensure private data is protected as per legislation and regulations.

For example, data sovereignty laws, such as those in Germany, France, and Russia, mandate that citizen data be stored within the country's physical borders and on physical servers. Growing regulatory and competitive pressures will require manufacturers to rethink and reprioritize security and governance strategies for enterprise information. These requirements will be driven by emerging global regulations (such as the GDPR), increasing amounts of Internet users and privacy-related issues, big data, and the IoT.

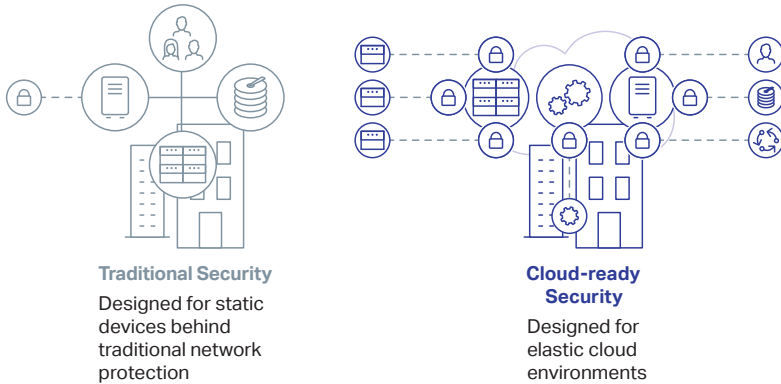


Figure 6.12: Is Your Enterprise Security Cloud Ready?

The IoT has the potential to increase the number of devices on an enterprise's network by an order of magnitude. In many cases, information is currently exchanged over a network without requiring human-to-human or human-to-computer interaction, based on M2M communications. With almost half of manufacturers using mobile apps for their connected products, and three-quarters using Wi-Fi networks to transmit data to and from those connected products, digital manufacturers have a considerably vulnerable—and sizable—threat surface to monitor.¹⁸ Many of these devices will be used in manufacturing facilities, on factory floors and production lines, while others will find their way into the consumer marketplace in the form of connected products.

In the coming years, manufacturers will increasingly rely on the Cloud. Experts predict that by 2019, 50 percent of manufacturers will be collaborating directly with consumers regarding new and improved product designs through cloud-based crowdsourcing, virtual reality, and product virtualization. And, by 2020, 80 percent of supply chain interactions will happen across cloud-based commerce networks.¹⁹

The retail industry is expected to experience the highest growth rate in the cloud security market over the next five years due to the need to protect customer-sensitive data and the digital identities associated with each customer record stored in the Cloud.²⁰ With more partner and consumer engagement taking place in the Cloud, manufacturers will need to store and analyze valuable information flowing in through various sources.

The Cloud can be very secure and very compliant if it is well managed. Developing a cloud strategy is an exercise in understanding an organization's business processes, workloads, security rules, compliance requirements, and user adoption. A cloud-based EIM platform empowers enterprises to maximize the value of their data, provide cloud security, and automate business processes—from customer engagement to business insight.

Top manufacturers are already formalizing their cloud strategies and leveraging cloud infrastructure to manage critical business processes, increase efficiencies, achieve compliance, mitigate risk, and improve their bottom line. In the following feature, a leading French food distributor uses a secure, cloud-based e-billing solution to overcome international compliance challenges and better serve its customers.

Removing Risk via Information Management and Analytics

The volume of digital data will surge to a trillion gigabytes by 2025. That's 10 times the 16.1 zettabytes of data generated in 2016.²¹ While keeping everything may seem like a prudent approach, this "hoard-everything" mentality can lead to over retention, which can increase storage, infrastructure, and eDiscovery costs.

As part of a GRC program, manufacturers should instead create or redefine clear policies on defensible deletion, which defines when content is governed, understood, classified, and managed consistently, as well as policies around retention and privacy. An added benefit of a defensible deletion program is that it makes organizations more efficient by reducing the amount of irrelevant information that users have to sift through to get work done.

An effective strategy for digital manufacturers is to apply analytics to data from their risk management systems to get a "big picture" view of the state of their operations. This can help manufacturers identify where the biggest risks lie. In terms of impact on the business, critical asset failure is a top operational risk for manufacturers. By applying analytics to connected-asset data, a digital manufacturer can detect and remediate vendor-related risks, like a materials shortage, to avoid supply chain disruptions.

While information presents great opportunity, it can also bring risk. Data breaches, privacy concerns, and growing eDiscovery costs continue to force organizations to rethink their approach to controlling their business data while balancing worker productivity. Deploying a risk management solution allows manufacturers to implement data-driven information governance to improve business intelligence and manage risk and compliance.

Davigel



Figure 6.13: Davigel

Davigel SAS, owned by SYSCO, is a leading producer, importer, and distributor of branded frozen and chilled food products across the commercial, social, and airline catering sectors. The company provides an innovative range of products and solutions for more than 65,000 customers around the world.

Shortly after being acquired, Davigel partnered with a Managed Services provider to migrate its trading partner community of customers and logistics providers to its own B2B trading platform. Building on the success of the B2B migration, Davigel expanded its Managed Services relationship to include an integrated e-billing solution.

A key factor in electronic billing is ensuring that each invoice is compliant with local regulations. Every country in the world has legislation to regulate electronic invoicing, and while regulations are often similar in purpose, the specific requirements can vary significantly by country. For example, data archiving requirements can vary from 6 to 11 years depending on which countries are involved. In addition, having to manage the country-specific value-added tax (VAT), security, and archiving requirements for every customer significantly complicated the billing process.

To address this challenge, Davigel deployed a secure, cloud-based e-billing solution with the capability to automate invoicing and compliance in more than 45 countries. Compatibility with the company's recently migrated B2B trading platform enabled Davigel to establish an e-invoicing program that could support data validation, data signatures, archiving, and delivery—all while providing employees and auditors with access to the archive via a simple, intuitive web portal. Thanks to the e-invoicing program, Davigel can now confidently issue over 120,000 invoices to more than 65,000 global customers securely and in accordance with regional regulations.

Davigel automates secure and regionally compliant e-invoicing for more than 65,000 global customers

Effectively safeguarding enterprise data and mitigating risk requires a strategic combination of technologies, processes, and people. The protection of enterprise information should be unified, covering all bases to avoid risks that might violate legislation, cause non-compliance, or adversely impact the organization's ability to perform. Protecting sensitive data in an enterprise IT environment is a continual challenge. EIM permits access to information on a "need to know" basis while preserving an overall integrated archive of information.

EIM: A Unified Approach to GRC

As illustrated in the figure below, governance, risk, and compliance should be regarded as three gears working in unison to power a machine—the intelligent and connected enterprise. The best GRC programs work in the background, seamlessly integrating with operational processes and enabling employees to work how and where they want to without disruption while achieving compliance with internal organizational policies and external regulations.

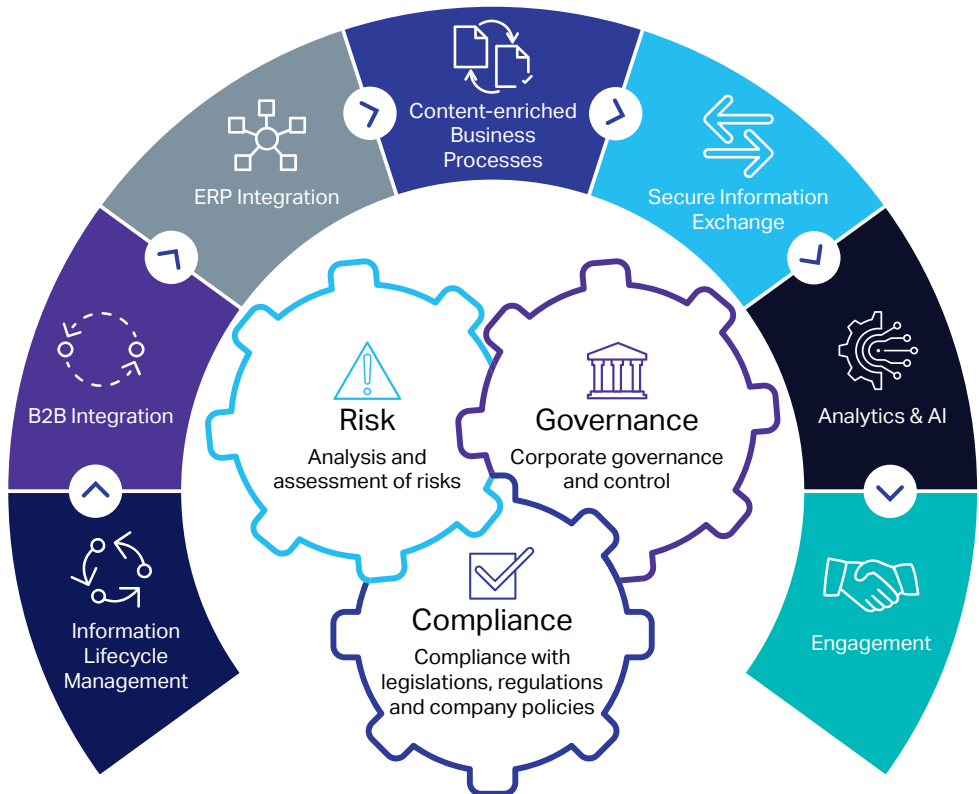


Figure 6.14: A Unified GRC Powers the Digital Enterprise

EIM delivers a seamless GRC solution that connects procedural guidance with documentation, process execution tools, reporting and audits, and integration with ERP systems. It acts as a central nervous system to capture, track, and report on regulatory requirements. EIM brings consistency and scale to the management and preservation of information by incorporating records management with solutions for archiving, email management, search, and eDiscovery.

Many GRC procedures are centered on documents and document processes. For this reason, Records Management (RM) plays a strong role in addressing GRC issues. Effective records management is not just about information preservation; it is also about adding value to manufacturing activities throughout the entire product lifecycle. Content such as emails, documents, and paper files can be classified as business records and managed—from capture to archive—to comply with governance and regulatory requirements.

When corporate information sources are brought under central information governance, there is a level of consistency that is not possible with disparate systems. Structured data, unstructured content and emerging data types, such as social media, can all be managed across multiple sources to establish a single source of the truth. Policy can be consistently set and enforced across all the content sources. By providing a structured and transparent way to maintain records from creation through to eventual disposition, records management enhances corporate accountability, ensures regulatory compliance, and minimizes the risks associated with audit and litigation.

In the event of an audit, eDiscovery solutions can enhance an organization's capacity to both "find" and "remember." eDiscovery incorporates information and records management with solutions for archiving, email management, auto-classification, and search to help manufacturers reduce litigation, risk, and storage costs. By linking enterprise information across multiple formats and sources—eDiscovery lays the foundation for analyzing large volumes of information in real time with superior accuracy. At the same time, organizations benefit from security, user productivity, time-savings in addressing the need to classify huge volumes of legacy content, as well as compliance—which is one of the most significant challenges for manufacturers.

As the volume and variety of enterprise information increases and regulations continue to evolve, digital manufacturers will be required to ensure information systems, and the records they store, are protected and individual rights are respected. Organizations that can get this right will keep a step ahead of their competitors.



Figure 6.15: Complete Lifecycle Management of Records

Corporate Social Responsibility and Supply Chain Sustainability

There is a growing emphasis among leading manufacturers to become more socially and environmentally responsible. In fact, approximately 95 percent of the world's 250 largest corporations currently produce Corporate Social Responsibility (CSR) reports and improving corporate environmental sustainability ranks as a high-to-critical business priority.²²

Digitizing paper-based supply chain processes and transactions, exchanging information via integrated B2B networks, and conducting business in the Cloud are all vital steps in developing greener, more sustainable supply chains. For example, automating one million paper-based transactions can save up to 9 metric tons of paper (or 228 trees), save 186,117 gallons of water, and defer 22,215 pounds of solid waste.* Automating and digitizing paper-based processes offer savings and efficiencies that can exceed sustainability investments. Plus, more efficient and digital operations drive growth and reduce risk.

In addition to better positioning organizations to fulfill CSR initiatives, digital supply chains can deliver increased resilience. Regardless of where the disaster may be occurring, having a single global B2B network that connects all trading partners can allow manufacturers to quickly identify points of weakness across the supply chain and take action as required.

Balance Matters

EIM helps digital manufacturing enterprises manage compliance, risk, and governance through established controls for information policies, procedures, business rules, roles, and responsibilities. Internal controls are typically based on processes designed to manage industry consolidation, capitalize on the opportunities globalization and disruptive technology present, promote employee and product safety, ensure information security, and adhere to applicable laws and regulations throughout the entire manufacturing product lifecycle.

* Calculations were made using Environmental Paper Network's paper calculator

While most manufacturers recognize the need for improved technologies for better innovation and differentiation, impending timelines and uncertainty surrounding regulatory developments like GDPR and Brexit can make it difficult for many to balance compliance spending with customer acquisition, digital transformation, and developing new products and services. A unified approach to governance, risk, and compliance can accelerate compliance with new regulations while offsetting operational and information risk.

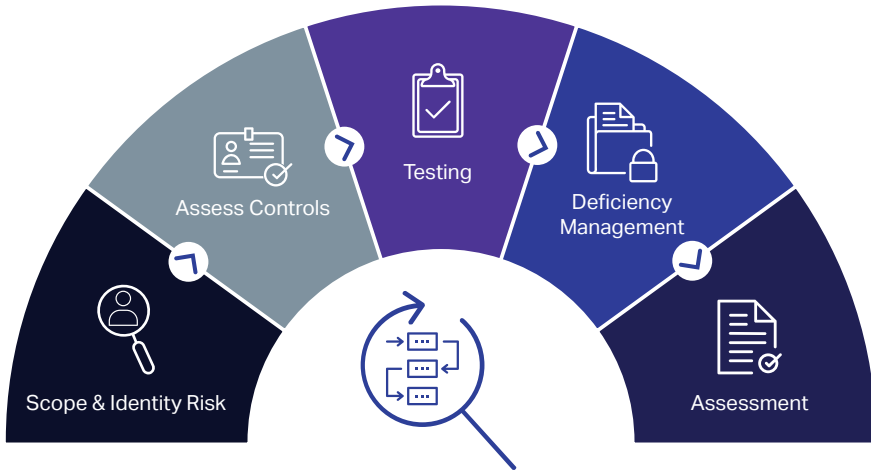


Figure 6.16: Internal Process Controls

The following chapter explores how EIM technologies are part of an overall strategic approach for digital transformation and how its component technologies work together to balance innovation and opportunity with risk and compliance in the creation of the intelligent and connected enterprise.

EIM – BUILDING THE INTELLIGENT AND CONNECTED ENTERPRISE



EIM is the digital platform for transformation. This chapter illustrates how each EIM product suite enables the digitization of processes, information, transactions, and interactions that occur throughout the lifecycle of manufactured products and the facilities used for production and distribution.

EIM – Building the Intelligent and Connected Enterprise

“Digital transformation is not a quick-fix solution within rigid manufacturing processes and resources, but a long-term commitment and imperative.”¹

Computing has changed

- Always on, connected, real time
- Visual and has sensors
- Workforce is fluid and global
- Takes one finger to use
- Users are changing the way IT works
- Wicked smart

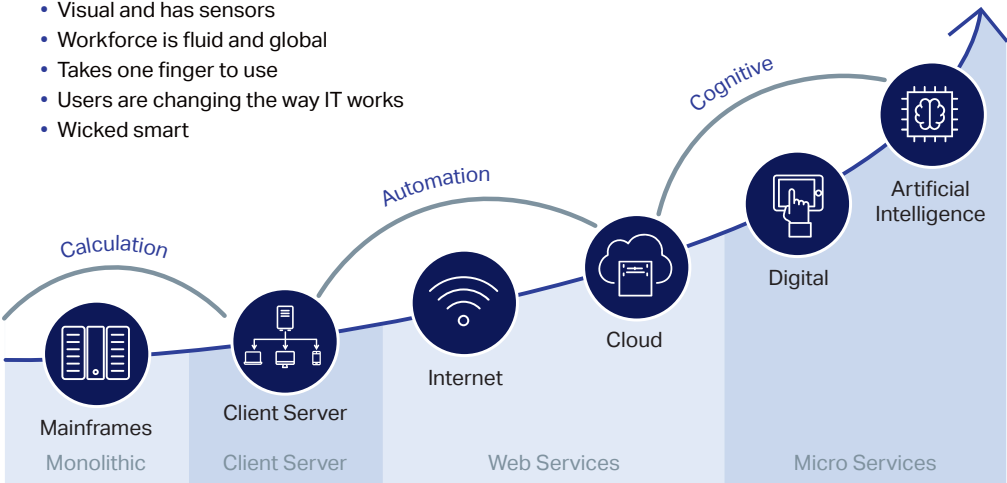


Figure 7.1: The Nature of Computing Has Changed

We are in the Cognitive Era of computing. Recent innovations in technologies that range from Artificial Intelligence (AI) to mobile apps to the Internet of Things (IoT) are challenging the established rules of business.

For the intelligent and connected enterprise, information is a strategic asset. It has replaced size, scale, access to resources, and geographic presence as a key driver of competitive advantage. Manufacturers that leverage their information to innovate and grow will be the ones that succeed. Throughout this book, we have illustrated how digital information lies at the core of interactions, processes, transactions, and experiences. When information is harnessed and protected, manufacturers are empowered to reach their maximum levels of efficiency, impact, and value while reducing security, compliance, and litigation risks.

The goal for every modern manufacturing organization is to leverage their information and disruptive digital technologies in order to transform into an intelligent and connected enterprise. But how can they unlock the power of their information without compromising productivity and security? Enterprise Information Management (EIM) helps manufacturers innovate and thrive in the digital world. This chapter explores EIM as an integrated set of technologies and outlines an agenda for digital transformation.

EIM: The Digital Platform for Transformation

EIM is a set of methods and technologies that help customers to maximize the value of their information while minimizing its risks.

Most manufacturers keep their information in vast repositories. These repositories house information of significant volume that compounds daily. Information and data, and often the processes that underpin them, are fragmented. Information flows across the enterprise are interrupted and disconnected, their paths are not clear, vulnerabilities lay hidden, and opportunities are lost. In the digital world, many organizations are unable to realize the strategic significance of their information.

An intelligent and connected enterprise is one in which digital technology is both pervasive and central to its overall success. It is a business that manages its information across its extended network to drive value and competitive advantage. The intelligent manufacturing enterprise adopts EIM as its foundational digital platform for change.

EIM enables manufacturers to secure their information across the diverse and complex landscapes of organizational departments, legacy systems, corporate and regulatory policies, business content, and unstructured big data. As an integrated platform of suites, EIM assembles information flows and expands them beyond simple tasks to add value as information moves through the enterprise.

The core technologies of EIM work together to create an end-to-end platform for sharing, collaboration, analysis, and decision-making, based on the effective management of information, enabling manufacturers to harness its potential while mitigating its risk.

OpenText EIM bundles the following core technologies together:

OpenText™ Content Suite is an integrated group of Enterprise Content Management (ECM) solutions that work together to create a centralized, unified information grid that connects information across the enterprise. Fully integrated with 187, 204, , Oracle, Salesforce, and Microsoft applications, it improves content control with governance and security functionality.

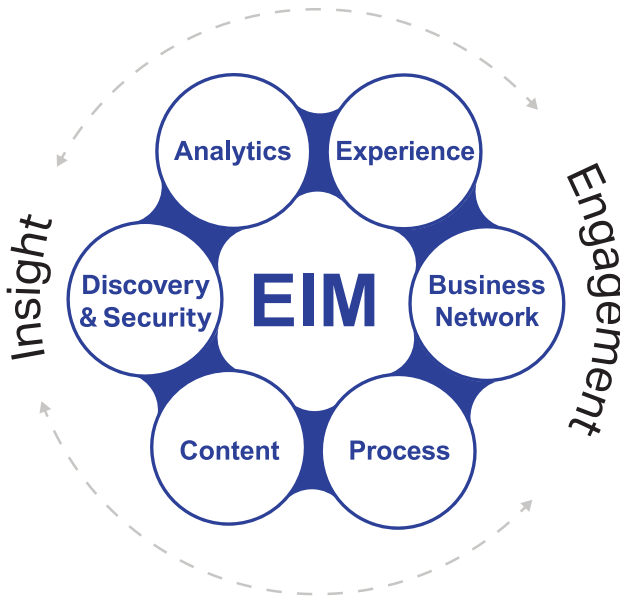


Figure 7.2: EIM – The Digital Platform of the Future

OpenText™ Discovery Suite introduces discovery analytics to enterprise content for fast access to key documents, contract terms, personnel with expertise, and early insights. Using unstructured data analytics, machine learning, and interactive visualizations, organizations use this platform to support litigation, investigations, due diligence, compliance, and better decision-making.

OpenText™ Analytics Suite helps organizations improve decision-making, gain operational efficiency, and increase visibility using interactive dashboards, reports, and data visualizations. Leveraging all data—whether structured or unstructured, internal, Customer Relationship Management (CRM), big data, IoT, or social media—in relevant, interactive visualizations, increases opportunities for growth.

OpenText™ Experience Suite delivers personalized content and engaging interactions along a continuous customer journey. As an integrated set of applications, it brings together critical capabilities such as Customer Communications Management (CCM), Digital Asset Management (DAM), Workforce Optimization, and Web Content Management (WCM) to drive higher customer satisfaction and better customer engagement.

OpenText™ Process Suite combines digital process automation with powerful, flexible process orchestration, content-rich execution, and low-code development. Manufacturers can take advantage of customizable and extensible business applications or quickly build custom, natively mobile business applications using a low-code application development platform and pre-defined building blocks.

OpenText™ Business Network delivers a comprehensive product set that accelerates time-to-transaction. It integrates messaging and B2B integration services such as secure mail, large file transfer, fax, and Electronic Data Interchange (EDI) within a single platform—enabling any-to-any transactions. Cloud or on premises, Business Network enables businesses to streamline and control how information is delivered—increasing the security and reliability of sensitive or complex communications.

In addition, a development platform called **OpenText AppWorks™** helps users to create purpose-built applications across all EIM suites. These include departmental applications like invoice management, industry-specific applications, such as regulated documents, as well as active applications for supply chains, such as Active Community, Active Orders, Active Catalogue, and more.

The **OpenText Cloud** is a purpose-built cloud environment that spans information management, compliance, and B2B integration. Each suite is available in the Cloud, on premises, or as a hybrid of both. Our cloud-based IoT platform helps manufacturers dynamically integrate multi-tiered supply chain communities and build enterprise IoT solutions for greater efficiency, agility, and new value-added services.

This chapter describes how these core component EIM technologies work together to support the complete manufacturing lifecycle. It includes stories about how organizations in the industry have embraced EIM to address key business challenges and capitalize on the potential of their information.

In the following interview, a leading, global chemicals company describes how ECM—as a combination of process and information management—is central to their digital transformation strategy, along with ensuring compliance in a highly regulated industry.

EIM Technologies Support the Product Lifecycle

A digital manufacturing enterprise supports activities throughout the lifecycle of manufactured products and the facilities used for production and distribution. Information is critical for every lifecycle activity.

Across every stage in a product's lifecycle, EIM transforms the manufacturing organization into an intelligent and connected enterprise—from capturing customer needs and wants in new product design to manufacturing, logistics, and aftermarket service. Every transaction, every process, and all of the data that flows in between is digital—from internal ERP and Manufacturing Execution Systems (MES) to external partner and supply systems in an extended ecosystem in the Cloud. Its underlying systems are fast and configurable. It supports technologies that enhance automation, like sensors, M2M communications, and AI. When processes and data are fully integrated, predictive analytics can be applied to add value all across the enterprise and its supply network—for insights into better performance, customer behavior, and product innovation.

LANXESS

LANXESS is a leading specialty chemicals company with sales of €7.7 billion in 2016 and close to 20,000 employees in 25 countries. The company is currently represented at 75 production sites worldwide, including 24 in North America after the acquisition of Chemtura. The core business of LANXESS is the development, manufacturing, and marketing of chemical intermediates, additives, specialty chemicals, and plastics. Through ARLANXEO, the joint venture with Saudi Aramco, LANXESS is also a leading supplier of synthetic rubber. LANXESS is listed in the leading sustainability indices Dow Jones Sustainability Index (DJSI World) and FTSE4Good.

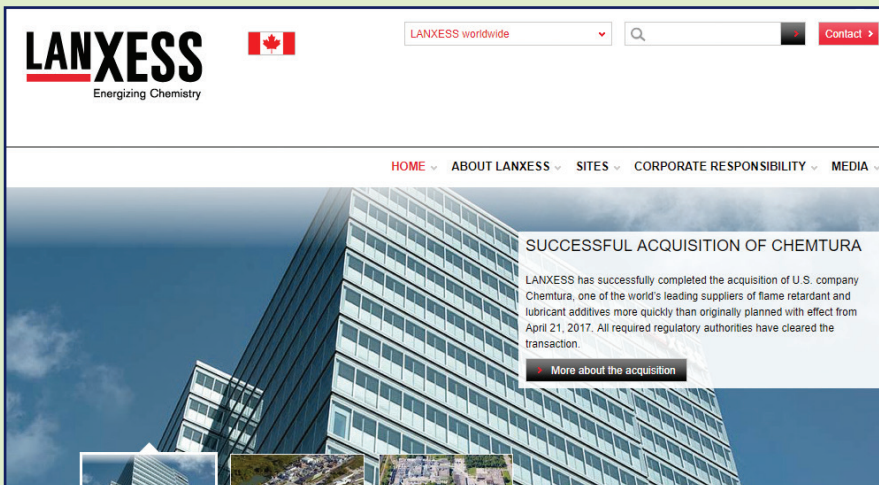


Figure 7.3: LANXESS

What follows are excerpts of an interview with Stefan Linke, Process Expert Documentum at LANXESS.

"I am responsible for Document Management at LANXESS and this involves the coordination and implementation of infrastructure projects, as well as business-driven projects. We work closely with other departments in the company, like IT.

As a chemical company, we don't compete with the larger players like DOW because our market focus is a niche one, but, given our expansive areas of focus, we have a lot of Intellectual Property (IP) that we have to manage. It is critical to the company and a key differentiator.

Our aim is to explore opportunities for digitization where they make sense and to streamline processes internally to help reshape the transformation of the chemical industry as a whole. To this end, we are working on a global digitization strategy that is geared to the specific requirements of the company, our customers, and our employees. Our understanding is that The Fourth Industrial Revolution, also called Industry 4.0, calls for independent and fresh access to business processes. At the moment, we are examining projects that we believe are good candidates for transformation, with a focus on the quick wins. Many of the projects impact other projects and schedules, so they have to be considered very carefully. Overall, the chemical industry is not an early adopter of digital business models or technologies, so we are in the early stages of digitization.

Process improvement is a central theme of our digitization strategy, and this includes process standardization. A few years ago, for example, we established the "Commercial & Supply Chain" initiative for excellence in process standardization, master data quality, and the consequent use of the leading IT systems in marketing, sales, and the supply chain. Our objective was to standardize the entire value chain in order to equip us to react quickly to ever-changing requirements from both our customers and suppliers.

Information also plays a key role in our digitization strategy. It needs to be managed and assessed. Without Enterprise Content Management (ECM) any worthwhile transformation is beyond reach. We have been using ECM solutions for nearly 15 years now for lifecycle management, rights management, collaboration, and to help us achieve information governance and compliance. We are using it to help us bring together our structured and unstructured information and automate the processes involved. Standardization

is critical because with 20,000 employees we have to keep everyone on a clear path to a shared end goal. With integration and interoperability, we can reach our objective for a "single source of truth" in our enterprise information.

Given the complexity of our portfolio, when we manufacture products (chemical intermediates, additives, specialty chemicals, and plastics), our processes leave paper trails that stem from scientific research through to sales and marketing. A typical starting point for research occurs when a customer requests a new product feature. Typically, we would then conduct research with an external partner, so there would be requirements around secure access and collaboration.

Because we are a company that manufactures and distributes globally, our products, operations, and paper trails have to comply with global regulations. An ECM platform helps us to ensure that information is compliant—from the research conducted to the procedures that engineers establish to manufacture at scale to the construction and operation of a plant, and finally, through to sales and marketing. We deal with volumes of paper every day. Each step in a process has to be compliant and well documented, especially given that we operate in 25 countries and each one has a different set of regulations. This is so important to us that we have assigned document controllers to oversee and protect specific documents.

Compliance is a benefit as a result of effective information management, along with efficiency and productivity—specifically being able to find information more quickly. To realize these benefits, we have to show our internal customers how using the technology will make their jobs easier. ECM delivers the tools we need to balance compliance and security with usability.

New Product Design

OpenText Content Suite enables manufacturers to manage content throughout its complete lifecycle, from capture to archiving or disposition. The solution delivers concurrent revision control and secure collaboration for all digital product design and engineering process information, including 3D CAD/CAM models, 3D printing files, 3D visualization models, 2D drawings, production information, product bill of materials, materials specifications, product specifications, videos, animations, renderings, and more.

As a complementary system, Content Suite integrates directly with industry-leading Project Lifecycle Management (PLM) solutions, enabling manufacturers to share, collaborate, and mark up design information. Centralized access to all design and engineering information for a new product delivers a single version of the truth for all product design and engineering information. Full traceability of design information helps manufacturers comply with increasing legislation. Design and approval processes can be automated to improve efficiency, reduce costs, and drive digital transformation.

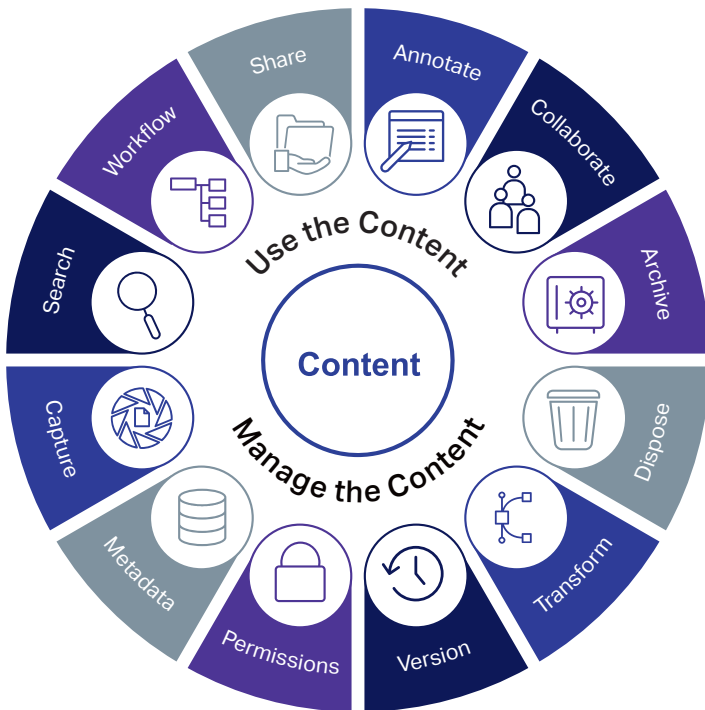


Figure 7.4: Manage and Secure the Complete Lifecycle of Product Content

Due to the volume and velocity of data, content solutions for manufacturing need to be massively scalable and capable of identifying and accessing data—structured and unstructured—from many sources both inside and outside the factory walls. By applying predictive algorithms to this information, manufacturers can generate accurate, forward-looking insights to help them make better decisions.

The **OpenText Analytics Suite** supports both product design and quality management processes when costs are high and the failure rate for new industrial products is more than 50 percent.² During a quality management process, for example, analytics can capture sensor-based information to increase production yield and throughput. Data on how many products are manufactured and at what cost and effort can feed into quality systems to quickly identify problem areas and predict issues in real-time, rather than using root cause analysis to learn what has historically gone wrong. When quality defects in production can cost as much as 30 percent of a manufacturer's revenue, analytics can help improve production while significantly reducing costs.³

OpenText Magellan, the flexible AI and analytics platform, combines open source machine learning with advanced analytics, enterprise-grade Business Intelligence (BI), and the capabilities to acquire, merge, manage, and analyze enterprise information. As drag-and-drop AI, Magellan cost-effectively gives manufacturers access to unparalleled insights by removing the limits of conforming data to a particular schema. Armed with tools like analytics and AI, manufacturers can more precisely address customer demands, predict factors that will impact business continuity, such as weather, and gain insights into product or asset performance.



Product Prototype and Testing

Creating prototypes is a highly practical phase in the manufacturing process, helping to test for design flaws, usability, and overall safety—each of which impacts the bottom line. As physical or digital renderings of a product, prototypes typically undergo rigorous operations and testing. Information gathered from a prototype, such as stress analysis reports, environmental test reports, or materials testing reports, can be used to make improvements to the actual product. Since different types of prototypes can be helpful at different stages of the product development cycle, managing the information associated with each prototype is critical to the overall success of the product.

As well as designing a product and building prototypes or samples, there is also the requirement to manage the complete portfolio of all digital assets related to a product. These assets can range from product specifications to images and videos of prototypes being used. OpenText capture technologies are used to preserve and manage content as the by-product of prototyping. As a required part of digitization, **OpenText Capture Center** uses the most advanced document and character recognition capabilities available to turn documents into machine-readable information.

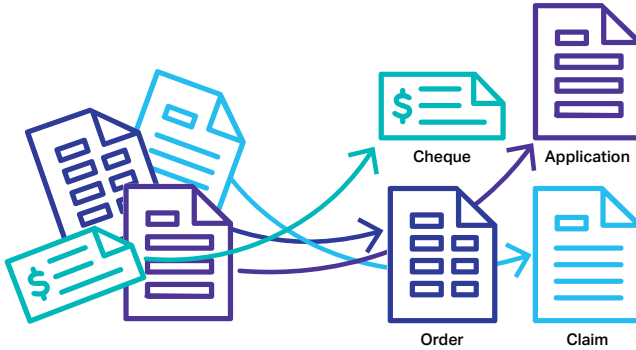


Figure 7.5: Capture - Sophisticated OCR, ICR, IDR, and Adaptive Reading

Once assets have been ingested, a Digital Asset Management (DAM) system stores all digital assets associated with products and their use. **OpenText Digital Asset Management** solutions serve as a centralized, secure and accessible repository, whether cloud-based or on premises. Ingestion and storage mark the beginning of the lifecycle of product information, with data flowing from the DAM system into integrated ERP and extended systems that support outsourced factories, warehouses, and distribution centers. Scalable for the largest organizations, DAM solutions offer capabilities to manage the entire content lifecycle with workflows and features for creative production, collaboration, publishing, and distribution to drive value for manufacturers.

Many manufacturers still complete manual drawings and then digitize the process. In a digital world, manufacturers are moving away from building prototypes to using additive manufacturing approaches like 3D printing or even augmented and virtual reality. As part of this approach, rapid prototyping, or fabricating a scale model of a physical part using 3D-aided design (CAD) data reduces development cycles and improves time-to-market. As discussed in Chapter 3, digital twins can also be used as digital replicas of products, although they are learning systems as well, incorporating AI, machine learning, and analytics with data to alter (or self-assemble) their components or features in relation to their physical counterparts.

In the following interview, the President of a Capture Division at an IT consulting company describes how critical capture is as a first step to implementing a digital transformation strategy.

Digital Supply Chain

Manufacturers can improve communication with global trading partners by exchanging business documents electronically. **OpenText Business Network** solutions enable organizations to control how information is delivered across mission-critical business processes, such as supply chain and logistics.

HMB

HMB is an IT consulting company with offices in Columbus, OH, Washington, DC and Louisville, KY. The company has four lines of business, three of which focus primarily on custom application development for specific market segments. Over 180 developers support customers in these lines of business. HMB's fourth line of business, Capture, focuses on the reselling of hardware and software to help companies throughout North America execute their enterprise content management strategies. HMB also has a managed services division which serves as an outsourced IT department.



Figure 7.6: HMB

What follows are excerpts from an interview with John Paider, President of the Capture Division, HMB.

"I am the President of the Capture Line of Business and oversee all aspects, including sales, marketing, operations, finance, engineering, and support.

The effective management of information is critical to enabling digital transformation. I can give you an example of this by discussing specific projects. For example, we have a current customer who works with us on our ECM 360 program. They ingest a significant amount of paper from both their customers and partners. Using scanning

products, we digitized their documentation. We combined their electronic files and performed data management, extraction, and business workflow through the deployment of software. This means that all of their information is digital. We then deployed another software application to better organize their digital information and to provide enterprise-wide access for those who need to use the information.

As a final step, we implemented a solution that enabled them to distribute their

information outside of the enterprise in a secure and trusted way. We wrapped all of this up with several onsite developers who worked with them to create a custom application to manage, monitor, and communicate the effectiveness of the processes to their stakeholders and shareholders.

Enterprise information exists in many formats that ultimately need to be captured and transformed to be well understood, governed, and leveraged to maximize value. For the role it plays in critical business processes, "Capture" does more than the name suggests. Capture does collect information, but more importantly, it activates it. It brings information that resides in a paper document to life so that it can be used by multiple entities to meet a variety of business objectives. Capture actually collects, enables, and distributes the right information to the right people in the most efficient way possible.

Capture helps organizations achieve better efficiency, accuracy, and security. The sharing of information needs to happen in real time, not at 4 p.m. tomorrow, and so this information needs to be digitized. The information must also be shared securely and in a way that is easy to consume.

Capture also plays a key role in integrating structured data with unstructured information. There are two steps involved. First, we need to allow structured and unstructured data to co-mingle so that search can be performed throughout all data types. Metadata strategies have really improved this capability. Second, we need to provide data visualization. This is significantly more difficult than most people think because this information needs to be active and it needs to be pushed to the right consumers and users of this data at the right time based on specific outcomes. Almost anybody can create a dashboard of pie charts and stacked bar charts but

notifications and messaging components assigned to data are much more beneficial to the business.

Overall, I'm not convinced that there are too many disruptive technologies, there are more disruptive processes. Smart people look at these processes differently and apply technology to address business problems in a new way. I would suggest that we focus on disruptive business leaders. For example, cloud or peer-to-peer technologies are nothing new. It simply required Mark Cuban to create CyberDust to leverage both technologies to solve a problem of having people's confidential information stored somewhere out of their control and thus risk exposure.

For Capture, we will continue to refine our product mix so we can leverage our development culture and expand our professional services offerings around valuable ECM solutions. We are expanding our Managed Services offerings to Chicago and Washington DC, and we look to supplement our organic growth with continued strategic acquisitions. HMB as a whole will continue to build on its award-winning reputation as the best tech company in the markets it serves, as well as the Best Place to Work.

The advice I would give to organizations and peers that are undertaking digital transformation is to approach business problems like a four-year-old would. In other words, keep asking questions that drive to a business outcome. Most people stop talking when a problem has been identified, but I recommend to continue being curious until an understanding about why the problem exists is reached, along with the measurable bad thing that happens because of the problem, and the vision of success and its value. Once this understanding is reached, it's time to get to work, deliver value, and make money."

Exchange technologies facilitate the efficient, secure, and compliant exchange of information across the enterprise and its business network, from faxes and cloud services to EDI and large Managed File Transfers (MFTs). These services generate massive amounts of data, including supplier information and procurement contracts. Through integration services, the OpenText™ Trading Grid™ and B2B Managed Services, the Business Network provides end-to-end visibility into supply chain operations for real-time decision making and the improved orchestration of operations. The Business Network's cloud-based solutions help to onboard 100 percent of the trading partner community. Manufacturers can reduce operational costs and streamline supply chain processes with an outsourced approach to managing a B2B infrastructure. Integration with back-end enterprise systems, such as ERP improves efficiency. The end-to-end visibility of all supply chain transactions helps address regional compliance initiatives, such as electronic invoicing, and the adherence to new industry initiatives, such as conflict minerals compliance.

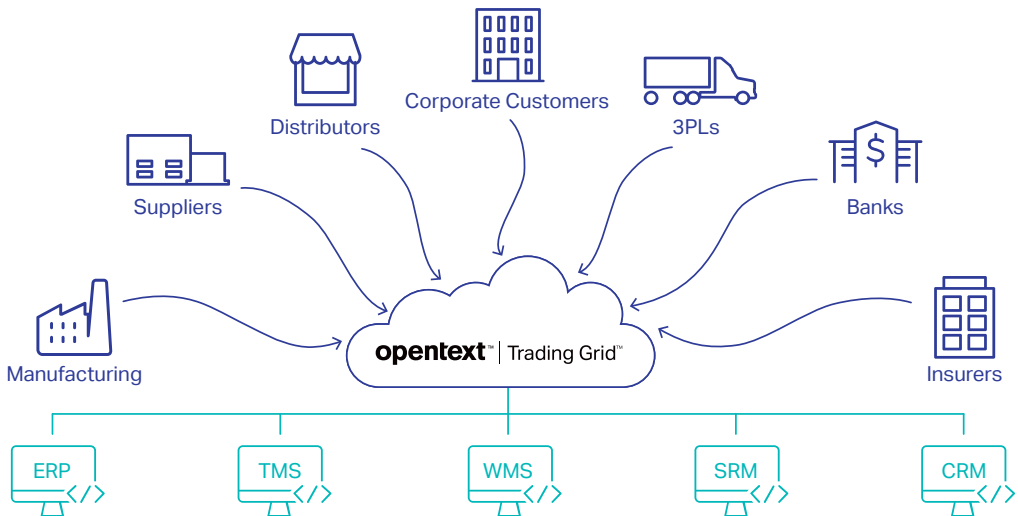


Figure 7.7: Connecting the Extended Manufacturing Ecosystem

With more than 24 billion transactions a year, \$8 trillion in annual commerce, and more than 600,000 trading partners, the OpenText Business Network provides a foundation for digital business and secure e-commerce. It delivers the integration layer manufacturers need to support disruptive technologies such as the IoT, automation, analytics, and AI systems. Global manufacturers are using the Business Network to drive business value through the efficient, secure, and compliant exchange of information—inside the enterprise and across the manufacturing ecosystem.

All across the supply chain, OpenText Analytics Suite includes high-performing, on-premises, and cloud solutions for big data and predictive analytics. It gives manufacturers an easier way to access, blend, explore, and analyze supply chain data to better understand customers, markets, and business operations without requiring data experts or additional IT resources. When analytics are applied to the Business Network, the information flow moves from systems of engagement and systems of record to systems of insight. Business Insight is gained by capturing, combining, and transforming information to identify relationships, risk, and new opportunities for growth.

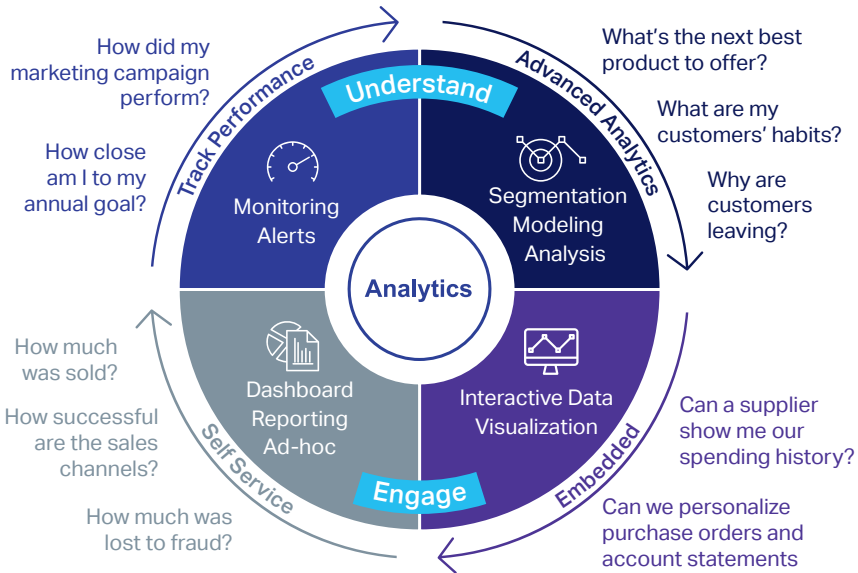


Figure 7.8: Analytics Drive Understanding and Engagement



Digital Manufacturing and Production

To truly transform into intelligent enterprises, manufacturers must develop flexible and highly-scalable IT infrastructures with a centralized hub of digital information. Once information is digitized, organizations can automate processes around this newly created information for greater efficiency and agility.

OpenText Process Suite is a set of components for building process and case management applications. It includes the OpenText Process Platform, out-of-the-box applications, and add-on products that gives manufacturers the ability to build applications that leverage a wide variety of EIM capabilities.

When information is secure, it can be effectively routed through process applications to improve efficiency and performance. OpenText Process Suite offers solutions for flexible, agile business process automation and case management systems that enable employees, customers, and partners to collaborate, streamline operations and work more efficiently.

Review and approval processes can be remotely accessed and expedited using smartphones, wearables, and tablets. From contract to deliver, OpenText solutions help to effectively manage risk, renewals, and scope changes across the entire supply ecosystem. Costly reworks and errors can be all but eliminated. EIM helps to ensure compliance of processes and information with strict Health, Safety and Environment (HSE) and regulatory reporting requirements. Collaboration is simplified and operational excellence improved with rich supply chain analytics and Key Performance Indicators (KPIs) across the extended trading ecosystem with OpenText Business Network.



Figure 7.9: Digitizing Business Processes for Improved Time-to-Results

In the digital world, globally distributed teams are fragmented. The potential to slow down projects is a source of frustration for both manufacturing and production teams. Delayed production slows milestone payments and reduces production revenues, while the complex handover of a project can delay time-to-business value for both contractors and manufacturers.

EIM enables end-to-end digitization, bringing together unstructured and structured information, business process automation, and a digitized supply chain on a single digital platform. **OpenText Collaboration** technologies provide a secure environment where manufacturing processes and projects can be safely archived, moderated, managed, and explored for greater value. The solution helps document control managers, engineers, external collaborators, and subsequent operations personnel efficiently control all manufacturing information, work processes, and risk across the lifecycle of projects and operations to help accelerate production and time-to-revenue.

OpenText Core, the digital platform for next-generation collaboration technologies, combines social communications, channels, intelligent bots, secure file sharing, and project management. Manufacturers can improve ROI and project completion through improved exchange and collaboration, both within projects and through handover to operations. OpenText collaboration technologies like Core enable the efficient exchange of large volumes of content with internal and external parties while providing secure, high-speed transmission, which improves project lifecycles. Costs and environmental impact are reduced, while productivity, reliability, compliance, and worker safety is increased.



Governance, Risk, Compliance and Certification

EIM provides the backbone for an effective Governance, Risk Management, and Compliance (GRC) program. When manufacturers have weak governance enforced across disparate systems, complying with laws and regulations becomes very difficult. Using manual processes to capture and track compliance requirements is time-consuming and error-prone. Many manufacturers have home-grown systems to do this which are not efficient or effective.

Supply chains and sub-contracted operations are becoming increasingly complex, particularly in the manufacturing sector. Extending internal control and visibility into the supply chain may involve a wide range of contractors, suppliers, partners, vendors, and other third parties. Associated vendor information is rarely stored in a centralized location. Many manufacturers are struggling to keep an inventory of their suppliers, and to classify them by risk profile. In some instances, they do not complete formal vendor on-boarding or conduct reliable assessments to ensure that the third parties they work with are compliant.

EIM connects procedural guidance with documentation, process execution tools, reporting and audits, and integration with ERP systems—across the supply chain. It brings consistency and scale to the management and preservation of information by incorporating records management with solutions for archiving, email management, search, and eDiscovery.

Manufacturing content needs to be governed throughout its complete lifecycle, from capture to disposition. OpenText Content Suite enables manufacturers to integrate critical content with business processes, to help ensure the security, integrity, and accessibility of manufacturing data. When an electronic investigation (audit or legal review) is initiated, systems have to be examined, information identified, and policies well understood and documented. When policies are centrally maintained, one central source can be easily understood, documented, and defended.

The expense and time associated with traditional legal or other information discovery is very high. Having a set of Discovery tools available to reduce time spent finding materials and improving the accuracy of data sets retrieved represents immediate savings for manufacturing organizations. By linking structured and unstructured information across multiple formats and sources—**OpenText Discovery Suite** lays the foundation for analyzing large volumes of information in real time with superior accuracy. Incorporating information and records management with solutions for archiving, email management, auto-classification, search, and eDiscovery helps manufacturers to reduce litigation, risk, and storage costs. At the same time, they benefit from improved compliance, security, user productivity, and time-savings in addressing the need to classify huge volumes of legacy content, email, and even, social media.

EIM gives manufacturers the confidence to apply governance across departments, content, application silos, and networks to align operations, meet certain standards, and achieve compliance.



Plant Maintenance and Asset Management

Today's manufacturers need to ensure their production facilities are available 24/7. Ensuring that production lines are operating smoothly, associated utility supplies are maintained correctly, and production stoppages are minimized can significantly reduce the operational costs and boost the profits of manufacturing operations.

For plant assets and equipment to be maintained effectively, it is important to have access to a single source of the truth for all digital information relating to the asset concerned. Careful management and archiving of digital information at the design and engineering phase of a new asset will help transform how the asset is maintained through its life. Many manufacturers of industrial factory equipment are starting to provide their customers with a full "digital model" of their products. For example, an industrial robot manufacturer can provide a full 3D model of a robotic arm, which allows maintenance engineers to become familiar with all aspects of the robot, even before it has been installed on a production line. Ensuring that maintenance teams have the correct versions of all digital information associated with the robot can help to minimize any potential downtime.

EIM provides a complete 360-degree view of factory asset information, process, and performance data. Easy access to all plant-related information like maintenance procedures, assembly and disassembly videos, 3D plant design models, 3D CAD equipment animations, 2D equipment drawings, 2D utilities diagrams, and equipment test procedures helps maintenance teams minimize plant downtimes to avoid production stoppages. The quality and consistency of asset information and work instructions can be improved, and HSE risks minimized as more stringent compliance procedures are archived and more easily managed.

The application of analytics in plant asset management is transforming the process from one that has been reactive to one that can accurately predict future asset performance based on historical data. This helps to increase the uptime and efficiency of robot work cells, machining centres, assembly equipment, and utilities-related infrastructures.



Logistics and Distribution

OpenText EIM solutions enable secure collaboration between employees, partners, and customers, empowering them to add value to information to improve the transportation, warehousing, and packaging of products. By consolidating information in a secure repository, EIM gives manufacturers and their partner's rules-based access to information for secure collaboration. It also integrates with back-end manufacturing programs for streamlined logistics and distribution activities.

B2B integration is a set of technologies that facilitate the real-time, automated transfer of information, money, and goods and services, creating an "information supply chain" for the intelligent and connected enterprise. It empowers a tightly integrated network of employees, suppliers, and partners to exchange communications, products, and commerce in ways that are rapid and accurate.

With supply chains becoming more complex, many organizations are outsourcing B2B integration to a third party. **OpenText B2B Managed Services** is a hosted B2B cloud service that provides the expertise, technical infrastructure, and process support for critical B2B programs to meet current and future business needs. Managed Services covers activities like mapping, connectivity, onboarding, testing, monitoring, and end-user support to quickly connect business partners and resource projects on an as-needed basis. Outsourcing implementation, maintenance, and upgrades help manufacturers overcome skill deficiencies while enhancing agility, increasing efficiency, reducing risk, and improving ROI—all while opening up new, global business opportunities.

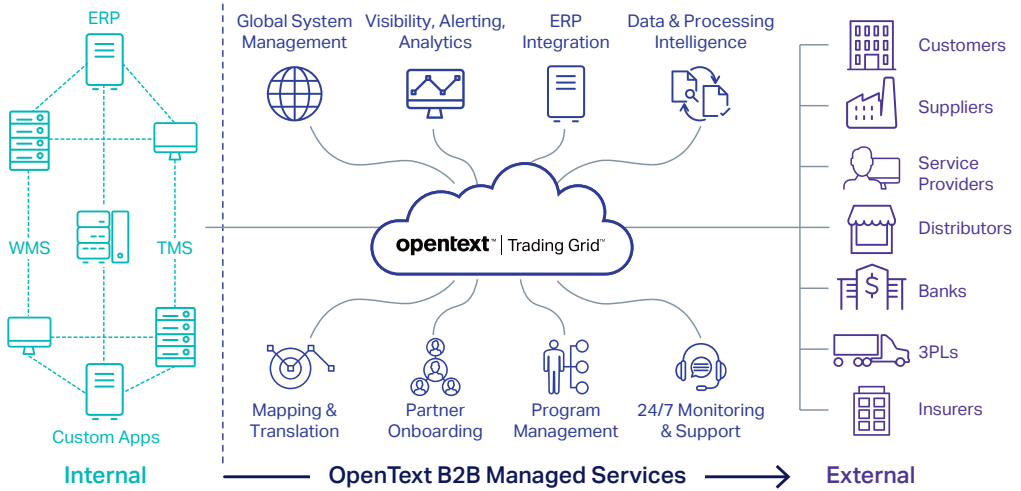


Figure 7.10: Managed Services for Outsourced B2B Integration

B2B Managed Services increases visibility and mobility and reduces delivery times, empowering manufacturers to transform logistics and distribution into a competitive advantage.



Digital Engagement with Retailers, Distributors, and Customers

Fast-moving consumer markets are dictating how quickly and seamlessly information needs to be shared. To meet this need, manufacturers in the automotive, consumer electronics, and consumer packaged goods sectors need to be able to share digital information relating to their products across global retail and distribution networks. Digital assets need to be transferred securely between users and the customer experience must be consistent across all platforms. For example, the marketing department of a consumer electronics manufacturer might need to share many different types of digital assets across a global retail network. This could include product specifications, high-resolution product images, demonstration and promotional videos, complex 3D product animations, along with countless brochures in PDF format.

Over the years, retailers have relied on their suppliers to provide up-to-date digital assets so that goods can be promoted effectively across different retail channels and sold into the consumer market. The challenge for manufacturers has been to find an effective way to distribute digital assets, for example, to support the launch of a new product.

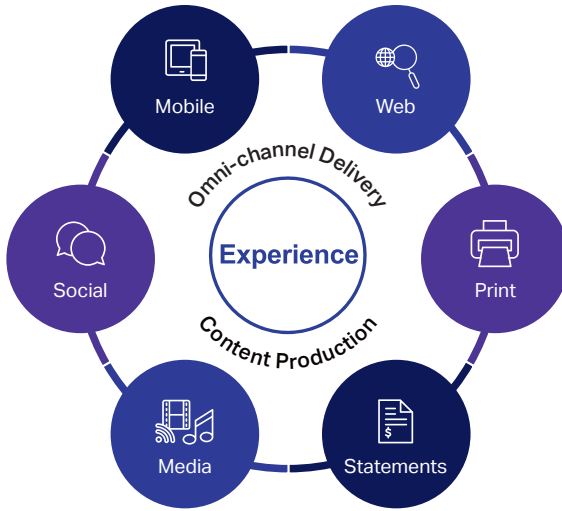


Figure 7.11: Empowering the Intelligent Enterprise with Experience Suite Solutions

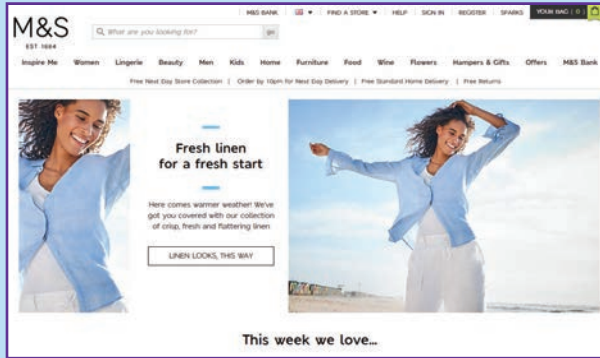
As part of the **OpenText Experience Suite**, a centralized DAM solution helps to simplify the distribution of digital information across the supply chain ecosystem. Ideally, retail or distribution networks need access to digital information stored in a central archive. A centralized hub allows a global network of retailers and distributors to access product information in real time. This becomes important when trying to coordinate global marketing efforts. In addition to retail and distribution networks, other stakeholders need to access product-specific information. This could include video production companies, advertising agencies, graphics companies, and other organizations involved with the product release.

As well as distributing digital assets across a retail or distribution network, digital product information needs to be made available through a variety of go-to-market channels. In the digital world, reaching consumers requires a complex, multi-faceted approach across many channels. New digital technologies have created new customer touchpoints with opportunities to deepen engagement for more satisfying customer experiences.

Manufacturers are using the OpenText Experience Suite to bridge these channels and digitize the entire customer journey. OpenText Experience Suite is a comprehensive, integrated suite of products that includes Web Content Management, DAM, Customer Communications Management (CCM), and social technologies, working together to create compelling and consistent brand experiences, and consolidate information for deeper insights into customer preference and buying behavior.

In the following feature, retail giant Marks and Spencer is using a Digital Asset Management (DAM) system to centralize its assets and deliver more consistent brand experiences.

Marks and Spencer



A centralized DAM system helps Marks and Spencer streamline time-to-production, save money, and meet customer demand for multichannel delivery

Figure 7.12: Marks and Spencer

Founded in 1884, Marks & Spencer (M&S) has grown into an international, multi-channel retailer, with more than 1,000 stores in the U.K. alone. The company sells clothing, home products, and food sourced from 3,000 global suppliers, with 85,000 employees. Its website, [marksandspencer.com](https://www.marksandspencer.com), receives 8.3 million visits each week.

As a large retailer, M&S was looking for a centralized DAM solution for their 20,000 listed products and associated digital assets like videos and images. With disparate systems in place, it was a challenge to locate assets, efforts were being duplicated, and with no reliable, definitive source to establish if an asset was available for use under the terms of a licensing agreement, they were having rights management issues. Working with multiple external agencies and internal departments, M&S sources, reviews, approves, and manages up to 2,500 assets per day—meaning that its DAM needed to provide an efficient, easy-to-use solution for 800 U.K.-based and international users.

The DAM system M&S selected provides a fast, efficient means for submission, review, and approval of digital assets, and ultimately publication and ongoing management. It streamlines and accelerates operations by reducing the amount of manual processing needed. The simplicity of the system helps M&S meet a key objective by ensuring that assets can be approved and put live on the website as quickly as possible. Avoiding unnecessary asset recreation, users can quickly locate assets and make any required changes within the DAM system, without going back to the originator and starting the process again. This speeds up publication significantly and prevents unnecessary expenditure.



Aftermarket Services and Support

Many companies today are looking for ways to improve their aftermarket service and support processes, as this is a key way to help improve customer satisfaction. Ensuring that field service teams have access to a complete digital representation of a product or piece of equipment can significantly improve the uptime and ongoing maintenance of serviceable products.

Maintaining an accurate and up-to-date archive of all information relating to the product at the design and manufacturing stages of a product's lifecycle benefits downstream service and support activities. Centralizing this archive into a single source of truth for all information about a product simplifies all through-life related interactions with digital product information.

OpenText Content Suite helps manufacturers manage and access product-related digital information for aftermarket service and support—from repair and test procedures to warranty recall procedures to fault diagnosis routines to replacement parts ordering. Any type of digital file can be viewed and marked up remotely using mobile devices. All service records, such as certifications and test reports are centrally archived for the entire lifecycle of a product, allowing for traceability and regulatory compliance.

For every manufacturer, equipment performance needs to be proactively monitored and acted upon. OpenText Analytics can be used to provide predictive analytics tools to optimize maintenance procedures and reduce downtime.

EIM: A Digital Business Strategy

EIM is the platform that underpins a deployable digital strategy. The core sets of technologies and services described in this chapter equip manufacturers to digitize key processes at each stage of a product's lifecycle and navigate their digital transformational journeys with success.

In the digital world, the requirements for transformation are complex and consist of the digitization of all processes and information, consolidation of information across many systems, alignment and seamless integration of business networks, creation of wildly exciting customer experiences, compliance with global and regional regulations, and the discovery insights that change the ways that people work with technology to create and innovate.

As they start on a multi-year journey toward digital transformation, manufacturers in all sectors are looking to IT for leadership. To help articulate vision and execute on a plan for digital re-invention, strategic leaders will need to work together to implement change across the enterprise. The next chapter explores change management strategies to help executives transform their organization into an intelligent and connected enterprise to lead and succeed in the digital world.

STRATEGIES FOR CHANGE MANAGEMENT



This chapter discusses how EIM approaches, strategies, and best practices deliver a strategic blueprint for transformational success in digital manufacturing.

Strategies for Change Management

*“Industrial companies that don’t invest in data now will eventually be like consumer companies that missed the Internet: It’s going to be too late.”*¹ – Bill Ruh, Chief Digital Officer of GE and CEO of GE Digital

The world is changing at an incredible pace with new technologies causing upheavals in every industry. In the next few years, as many as one-third of all industry leaders will find themselves disrupted by a third-party platform competitor.² Despite this prediction, only 15 percent of manufacturers are actively planning a digitization strategy.³

While disruption implies risk, the opportunities for businesses to grow, differentiate, and compete have never been greater. As customer requirements change, continuous innovation will be critical for survival. The disruptive mindset puts the customer front and center, and manufacturers will have to shift their focus from engineering new products to customer experience and centrality. Top management will be required to define new business models and follow digital strategies fearlessly and with imagination. And they must be ready for a substantial shift in culture based on openness, innovation, and trust. Visionary leaders will apply the technologies described throughout this book to digitally transform the enterprise.

Managing and harnessing information is essential to driving an agenda for innovation and growth. Stakeholders throughout the supply chain ecosystem will need access to information from a variety of sources, including the Cloud, mobile, IoT, smart meters, 3D printers, and mobile devices. The demand for this information will grow as it expands in format and volume. EIM is a fundamental enabler of digital transformation based on an integrated infrastructure that delivers secure information and services. As outlined in this chapter, a transformational strategy can be effectively guided by EIM processes, principles, standards, and effective leadership.

Transformational Leadership

To achieve a digital advantage, business leaders will be called upon to motivate their companies around a strong, unifying vision articulated through an achievable and well-governed digital strategy. Typically, executives build their visions based on operational effectiveness (inside-out) or superior customer experiences and sales (outside-in). Centralization and digitization are integral to both approaches.

Digital transformation in itself is not disruptive. Many digitization projects are implemented to improve performance or efficiency in the near future. The key is to identify the processes and organizational structures required for long-term success. Different scenarios can be created or explored to deepen understanding of a business problem. Business cases can then be created to drive short-term, measurable outcomes.

A business case should link business challenges to a strategic driver or business goal. Transformational business leaders need to establish a business case for digital transformation. Most projects do not move forward without a scrutinized business case. A business case should be based on existing processes, industry best-practices, and the positive impact an EIM solution can have on performance.

Most organizations have existing performance goals and objectives. These may be defined as Management by Objective (MBO) or as a Balanced Scorecard. Defining goals presents an opportunity to identify the processes that will directly influence objectives and demonstrate how improving the processes can improve overall business success. The ability to align process improvements directly to corporate objectives provides a clear and effective framework for illustrating business value and gaining executive sponsorship. C-level commitment is critical for any transformational project's success.

“Change management is a problem for everybody. We have customers across multiple horizontals and verticals. Each has very different business requirements. Our approach is to provide digitization solutions to meet those customers' specific requirements. We try to engage business stakeholders early and often so that we have buy-in and they have a vested interest in the success of the project that they're undertaking to automate their business processes. To be successful, each software project needs a champion from the business side. That person is responsible for implementing the change that is required—the development and deployment issues of the application. Without that person, the solution might as well be shelf-ware.”

—STEVE MARKMANN, VICE PRESIDENT OF COUNTERPOINT CONSULTING.

The operational goals of any business could not be achieved without strong leadership based on a coherent strategy. A strategy accounts for cultural shift and technology infrastructure challenges while supporting engagement across departments, partners, suppliers, and customers. A transformational leader has to overcome outmoded structures and old management styles to empower employees to self-direct, make decisions, experiment, generate ideas, and take risks.

To build a digital business strategy, executives need to shift their focus away from cost efficiencies and tactical operations to providing value for customers through innovation, developing new products and services, and overall business growth as part of their arsenal of transformational strategies.

Transformational Strategies

The manufacturer of the future will be holistic and expansive to include digital value chains and an extended ecosystem of customers, partners, and suppliers. IT infrastructure will be consolidated and processes streamlined to support superior omni-channel experiences and employee engagement. To implement transformational strategies, manufacturers should:

- Invest in emerging, digital technologies
- Integrate enterprise infrastructure (align IT/OT)
- Obsess about the customer
- Develop agile processes
- Expand the digital ecosystem
- Build capacity
- Focus on information as an asset



Figure 8.1: Transformational Strategies

Invest in Emerging, Digital Technologies

In the digital world, digital technologies will force organizations to explore new ways to engage with customers, create new products and services, and accelerate time-to-market. This moves beyond merely digitizing processes and, in many cases, will require radical shifts in core competencies, especially in IT. Strategic leaders will need to position their IT, support, and marketing organizations in relation to emerging digital technologies.

CIOs will lead their organizations on the digital transformation journey. They will have to meet the challenges of digital disruption by adopting key technologies for growth, especially around information management. CIOs will be forced to make investments as they transition away from legacy apps and toward consolidating on a digital backbone.

According to Forrester, tech spending is on an upward trend and will surpass \$3 trillion globally and \$1.5 trillion in the U.S. next year.⁴ Now more than ever, CIOs in manufacturing companies have the opportunity to invest in agile approaches and unify software development and operations. They can partner with service providers to outsource expertise in technology integration, deploy new architectures based on APIs and microservices, and demonstrate strategic vision based on digital transformation.

There are major technological hurdles to implementing digital transformation. Four out of five manufacturers believe that transformation revolves around major new IT projects. The figure below illustrates the breakdown of investments made when digitally transforming the supply chain. Consolidating multiple IT projects was the top response (for 47 percent of respondents), followed by moving to the Cloud (43 percent), implementing a digital backbone (38 percent), and upgrading ERP systems (31 percent).⁵ These findings point largely to manufacturers creating an IT infrastructure that enables automated processes and better end-to-end flow of information across these processes.

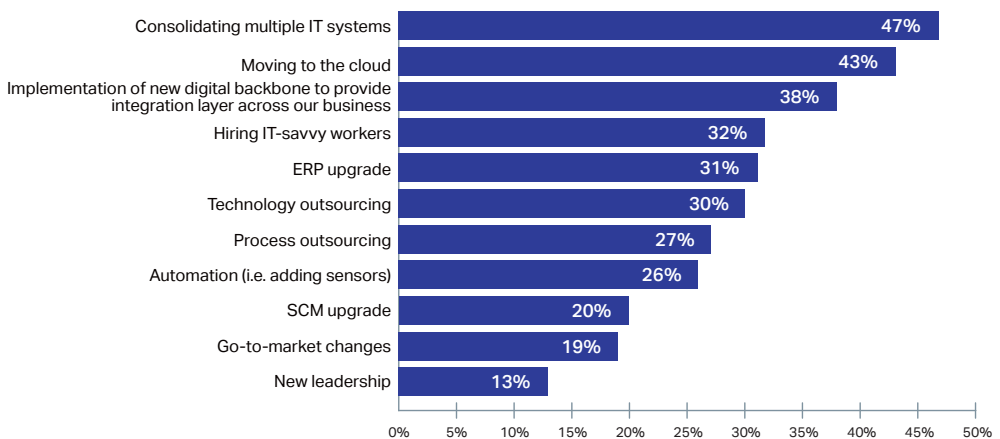


Figure 8.2: Steps Taken to Allow for Digital Transformation⁶

Many manufacturing core processing systems were implemented pre-Internet and before mobile devices became ubiquitous. In the digital world, manufacturers will be transformed through the consolidation of technology onto platforms that allow for rapid application development of next-generation products, replacing development that moves at the speed of “zero-fault” tolerance. Continuous iteration, rapid feature enhancement, and short-term solutions will be developed as cheap, fast, and scalable pilots, replacing longer deployment cycles and the IT backlog that hinders the ability to capitalize on new opportunities.

Front-line and back-office employees will need to be empowered with the technologies to make their jobs easier and more efficient. This will entail monitoring advances in emerging technologies, along with the information required to operationalize the technology. As mobile, smart devices, and AI become standard, processes will have to evolve to support them. Technology will continue to force manufacturers to adopt new business models quickly and partner or outsource capabilities such as non-core business processes or system development and maintenance. One of the most important approaches the CIO can take is to align technology with business operations, or Information Technology (IT) with Operational Technology (OT).

Integrate Enterprise Infrastructure (Align IT/OT)

As the following figure illustrates, over a third of manufacturers have a “segregated” approach to IT and OT integration. This means that many facilities operate in silos, with each making technology decisions based solely on the needs of their facility, rather than the entire enterprise, which results in disconnected systems across the business. While many (42 percent) manufacturers have adopted “coordinated” enterprise integration models based on a common platform to manage operations at an execution level, there is room for improvement. Research suggests that in the next five years, the majority of companies will make the move to an “integrated” IT/OT approach where IT and OT share the control systems.

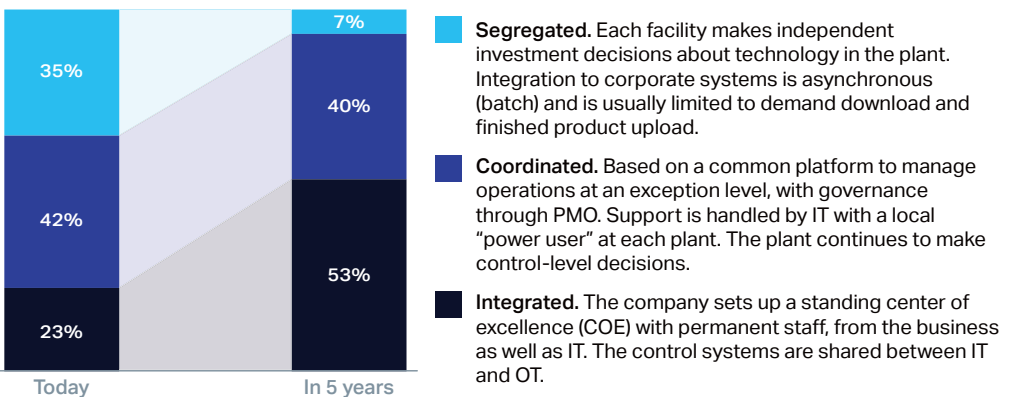


Figure 8.3: The Status of IT/OT Integration⁷

Manufacturers will need to think about how they integrate their B2B platform to back-end ERP, Transport Management, and/or Warehouse Management systems. More than one-third of information that typically enters an ERP environment comes from outside the business.⁸ Therefore, having a highly available, integrated business network that provides seamless connectivity to an outside trading partner community is paramount for today's digital manufacturers. To achieve this, many organizations are opting for an outsourced, Software-as-a-Service (SaaS), or Platform-as-a-Service (PaaS) managed-services approach for their B2B integration activities to reduce the complexities of connecting with partners, supporting multiple information exchange protocols, and dealing with messaging and security standards.

There are many aspects of manufacturing that require highly specialized technologies to gather data from or send information to IT systems. This interconnection between IT and OT goes beyond data transmissions and interacts with a variety of other processes. Any change to IT infrastructure can impact machinery, automation and control networks, specialized equipment, or other manufacturing tools. Ineffective change management in this area can lead to major operational challenges, as issues emerging in areas where IT and OT intersect can derail operations in a number of ways.

For manufacturers to fully embrace an end-to-end digital supply chain strategy, everything—from IoT-connected assets to enterprise systems to globally dispersed partners, suppliers, and employees—must be unified by a secure digital backbone. EIM, along with B2B integration, provides a solid digital backbone for manufacturers, enabling them to leverage the Cloud to access, manage, and exchange information all along the supply chain.

Obsess about the Customer

In the digital world, consumers have come to expect higher levels of service. The traditional product-centric approach to merchandizing and marketing is being revolutionized. The fight for differentiation will be won by excelling at customer experience and this can only be achieved through customer-centricity.

While it is true that technology has given consumers more choice than ever before, technology is only an enabler. The key to success lies in customer-centric approaches, disruptive technologies, and new business models. Over the coming year, digital leaders will shift from marketing digital products and services to embracing customer-centric operations. They will invest in IT to become more responsive. Customer-led self-service will be a requirement, along with AI and predictive analytics, innovation, and the agility needed to adapt to changing customer needs.

In the following interview, Tom Roberts of SAP discusses how customer requirements are disrupting entire industries and driving business transformation.

SAP

As a market leader in enterprise application software, SAP helps companies of all sizes and industries run better. From back office to boardroom, warehouse to storefront, desktop to mobile devices, SAP empowers people and organizations to work together more efficiently and use business insight more effectively to stay ahead of the competition. SAP applications and services enable more than 296,000 customers in 190 countries to operate profitably, adapt continuously, and grow sustainably.

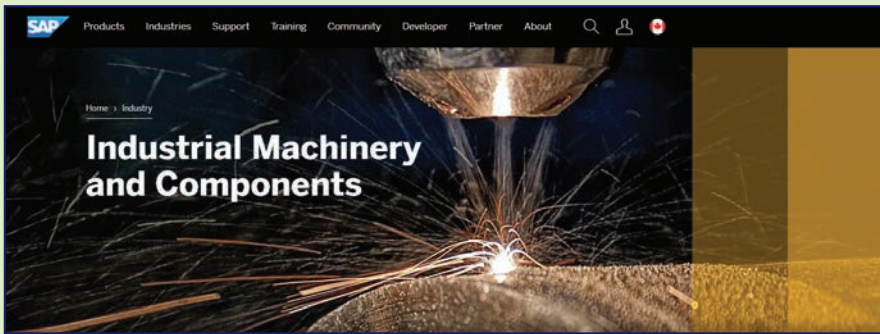


Figure 8.4: SAP

What follows are excerpts from an interview with Tom Roberts, Global Vice President, SAP Third Party Technologies, SAP.

"I am the global VP of third-party solutions for SAP. We take about a dozen EIM products and combine them with SAP's products and we sell them to our customers as a total, end-to-end solution to bring the worlds of structured and unstructured information together. And the volumes of information that this solution manages are vast. In one example, 350 million documents were managed and 112 terabytes archived in just one year.

If we look at an asset-heavy industry, like a manufacturing plant, we know that when there's a problem in the plant, there's still a big piece of paper (a blueprint) that's

used as a reference for a broken pump, for example. In North America, a lot of Baby Boomers are retiring as Millennials enter the workforce. We're seeing these asset-intensive industries make a really big push to digitize and capture what's in their employees' minds and put that into their enterprise asset management systems like SAP. Getting information into the system, like a mental note that there's a higher failure rate on a certain pump due to its position in the plant, prevents it from "walking out the door" and allows people to search on this information and retrieve it at a later date. Taking this one step further, the younger, more digitally savvy workforce

wants to be able to find this information, and then manipulate it with a touch screen for example, and that's the direction we're moving in.

One of the key drivers of transformation is meeting the needs of the digital consumer. An SAP SlideShare called "99 Facts About the Future of Business in the Digital Economy," states that "By 2020, 50 percent of digital transformation initiatives will fail due to lack of an end-to-end customer experience operating system." Systems today are expected to support the customer journey from end-to-end, and support omni-channel delivery for a more fulfilling customer experience.

The retail landscape has shifted. Walmart, who once dominated, is now under pressure from Amazon—and this is all based on the customer experience. Amazon can create great customer experiences based on their search component. An effective search is based on two things: metadata and volume. We tend to forget about volume. Volume is the whole reason that Google became the dominant search engine. The more information you can get, obviously the better the search. Google realized that the most important outcome was the input of information or the act of searching itself. The terms that people search on helps to identify priorities. Selecting something from a search results list can help the next customer. Amazon also understood this early on. But to do all of this, you need a digital infrastructure in place. You have to get the metadata and associated images, essentially a catalogue, right and positioned correctly. Brick-and-mortar retailers have to realize the importance of metadata and images, and learning about your customers based on what they're searching for. These are early indicators of demand.

But it's not only retailers that are wrestling with this. Any company that interfaces with their customer has to take them on a

journey that starts with search and ends with the shopping cart and delivery. The catalogue and images are central, so the relationship between our commerce engine and Digital Asset Management (DAM) is the linchpin. SAP is managing transactions and EIM is managing all of the content.

Let's say you want to buy a new snowboard and you're searching on a retailer's site. You follow your favorite pro to see what gear she has. The site should help you with factors like weight and height, and skill level—and you should be guided throughout an omni-channel experience. If you shop at the physical store and you see that same snowboard, the prices better synch up and the experience better be the same.

Our customers are in the business of brewing beer, making shoes, running a bank, etc., they're not in the business of adopting the latest technologies. Many customers are making do with technologies that should have been retired 5-10 years ago. Some customers, however, are surprisingly cutting edge and ahead of the curve. They have CIOs that are driving the agenda for digital transformation. Others are riding old technology to keep their margins down. For years, retail was an IT backwater. They would hang on to technology forever. Walmart changed that because they exploited technology for competitive advantage. That changed a lot of minds and that trickled throughout the industry and they've become more aggressive about things like state-of-the-art point-of-sale and omni-channel delivery.

When you're undertaking digital transformation projects, it's critical to complete a worst-case scenario. In other words, what would put you out of business or break your back, and then put a strategy in place to do it to yourself and disrupt your own company. It's disrupt or die. Status quo no longer works."

To succeed, manufacturers and retailers must execute across physical and digital channels. As consumer shopping habits and technology continue to evolve, business models will have to keep pace, incorporating sensors, beacons, robots, and more. Putting customers at the center of all decisions will involve continuous collaboration and innovation, development speed and iteration, embracing disruptive technologies and new ideas, along with a reliance on accurate, real-time information.

Customer centricity is enabled by the ability to understand customer behavior and the seamless flow of communication across all channels. To truly transform, manufacturers, retailers, and consumer packaged goods companies will have to create networked environments and implement agile marketing based on new engagement models to empower all stakeholders across the supply chain. This agility depends on using data and analytics to capitalize on opportunities. A North American retailer, for example, was able to increase customer satisfaction by 30 percent through their approach to agile marketing, which involved running hundreds of tests simultaneously and ensuring that the appropriate data was collected to deliver personalized experiences across all channels.⁹

New engagement models often lead to a richer exchange of ideas and opportunities. In the digital world, cross-functional collaboration will be critical. Collaborative EIM technologies arm marketers to engage in innovative ways in order to meet customer needs more effectively. Engagement helps with workflow optimization. Effective collaboration eliminates information and process silos. As a result, other departments are more inclined to engage with IT to adopt new technologies, automate processes, and advance transformation.

Customer centricity is what keeps Tarkett's focus on delivering exceptional customer service, as described in the following feature.

Facilitate Agile Process Development

New business models drive transformational change. As explored in this book, many manufacturers are expanding their value propositions to include services. They are moving from a traditional sales model to a more holistic, ecosystem-driven approach with fully integrated mobile services. This approach is based on underlying processes that are automated, flexible, and align with online and mobile channels to improve productivity and efficiency while reducing costs. Agile development and dynamic processes that are cross-functional and repeatable will help manufacturers stay nimble and focused.

Tarkett



“In the past, locating an asset could take days, now it’s minutes at most.”

– RICHARD BURBAUD, IT FRONT OFFICE SOLUTIONS DIRECTOR, TARKETT

Figure 8.5: Tarkett

Headquartered in France, Tarkett prides itself on providing outstanding customer service. With diverse products, breadth of expertise, and technical support to customize solutions to complex spaces and specific usages, the company sells 1.3 million m² of flooring each day. The company has grown organically and through acquisition and has 34 manufacturing sites in 17 countries, operations throughout Europe, the Middle East, Africa, Asia, Latin America, the Commonwealth of Independent States, and North America, employing 12,000 staff and serving more than 100 countries.

Tarkett’s key objective is to deliver ‘The ultimate customer experience.’ With tens of thousands of product lines, including current and discontinued products, Tarkett maintains technical and marketing descriptions, product certifications, and images for each. In the past, this was handled on multiple systems by region, which led to difficulties in locating the most current version of assets. This was further complicated by products that required documentation in 30 or more languages. Managing multiple documents for a product was time consuming and prone to error, and many duplicates existed. To meet its high standard for customer service, comply with industry regulations, and reduce time-to-market, Tarkett implemented a global Digital Asset Management (DAM) system.

One of the most welcome features of the new DAM solution is the faceted search. Users can quickly narrow down their search by filtering the metadata captured. In the past, locating an asset could take days; with the new system, it takes minutes at most. With all of the assets centralized, users are confident that they have the latest, approved version. The system is eliminating duplication, which has lowered the costs associated with storage requirements. The first phase of the project was foundational, with the next phase expanding usage out to other departments, covering 6,000 staff members, helping to ensure accuracy of information across the company on a global basis.

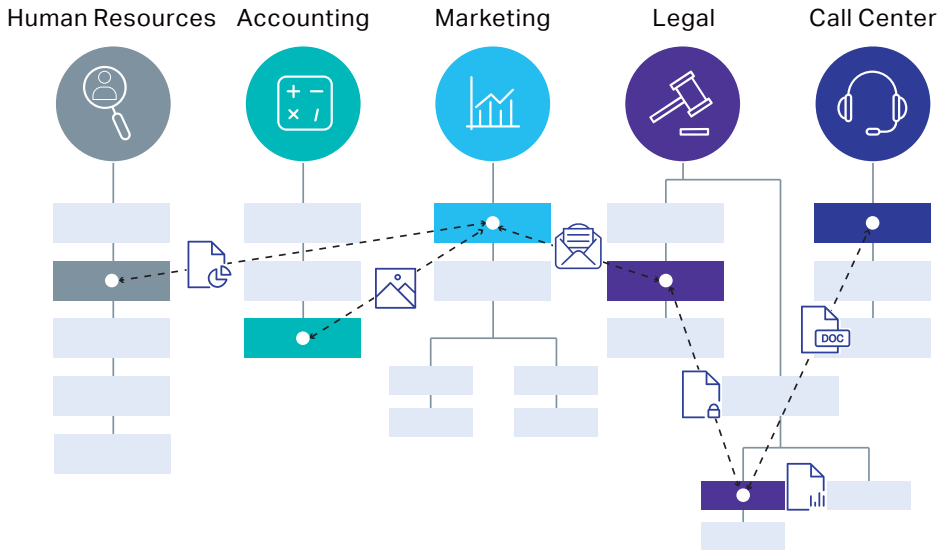


Figure 8.6: End-to-End Process Agility

EIM can be used to rapidly create new processes that support customer service—within hours—without requiring IT support or software development skills. By combining well-structured modules with pre-built components, an application-factory approach allows a line-of-business manager to build new processes easily. Alternately, an existing process can be used as a template and modified to suit business needs. This means that employees can be creative in anticipating service requirements and designing ways to address them. An on-demand environment is supported by a flexible EIM infrastructure, new technologies, and the ability to re-engineer evolving customer processes and services.

In the digital world, the IT landscape will become more multidimensional and complex—based on new business models, shifting corporate strategies, industry transformation, organizational changes, skill shortages, a multi-generational workforce, and digital disruption. To generate value for the business, manufacturers will have to determine if current IT activities and projects contribute to the digital strategy and corporate objectives for growth. To master an infrastructure in flux, business leaders will have to examine current processes, explore new business and engagement models, and embrace digital disruption—while maximizing security and minimizing risk. It's a tall order, but with a sound EIM infrastructure in place, manufacturers are well equipped to digitally transform the enterprise.

In the following feature, Bumble Bee Foods has digitized its procure-to-pay process to fulfill its mandate to deliver customer satisfaction through quality products at comparable prices.

Bumble Bee Foods



Figure 8.7: Bumble Bee Foods

“We decreased invoice processing costs by over 50 percent, driven mainly by headcount redeployment, but also due to instituting a more automated process that reduces errors.”

– **FARRAH GOLDBERG, GENERAL ACCOUNTING MANAGER, BUMBLE BEE FOODS**

Bumble Bee Foods was founded by a handful of dedicated fishermen in 1899. Today, privately held and headquartered in the United States, Bumble Bee Foods, LLC is North America’s largest branded shelf-stable seafood company, offering a full line of canned and pouched tuna, salmon, sardines, and specialty seafood products marketed in the U.S. under leading brands, including Bumble Bee®, Brunswick®, Snow’s®, and Beach Cliff®, and in Canada under the Clover Leaf® brand.

Bumble Bee’s mandate is to be a low-cost operator without sacrificing quality—a goal that requires an ongoing commitment to internal efficiencies and cost reduction. To this end, the company sought to digitize its procure-to-pay process. The AP department was decentralized and different plants in the United States, Canada, and Puerto Rico all managed separate processes. Invoice processing was 100 percent paper-based, resulting in a lack of process visibility and inefficiencies. Invoices often went missing and AP clerks spent about 80 percent of their time searching for invoices and responding to inquiries. Auditor requests took weeks to fulfill.

To address these challenges, Bumble Bee implemented a digital Vendor Invoice Management (VIM) solution that would allow them to eliminate manual processes and standardize and consolidate operations. The solution integrates seamlessly with their ERP and Optical Character Recognition (OCR) systems, offering a streamlined process that enables users to easily manage and route invoices for approval. Within 16 months of deployment, Bumble Bee achieved some remarkable results. They consolidated their global AP processing centers from six to two, invoice processing operations were digitized from end to end, and they reduced staff from 13 full-time equivalents down to five. The solution gives employees full visibility into where invoices are at each stage of the process. They can more easily resolve issues on purchase orders and ensure that items no longer slip through the cracks. The digital solution has helped transform AP from a transactional role to a more value-based one, with its employees looking for ways to continually improve operations.

Expand the Digital Ecosystem

Traditional manufacturing companies are focused on the efficient design, development, and delivery of physical goods. As more manufacturers shift from products to services and customer centricity, they will need to likewise shift their operations and processes to incorporate digital ecosystems. Supply chains will become supply networks.

We have already discussed how critical collaboration and innovation have become for digital manufacturers. Globalization has forced manufacturers to compete on many fronts. Software competence is becoming a key requirement. In the automotive industry, for example, the leading, global manufacturers will partner increasingly with new entrants like Apple and Google, as well as with specialized OEMs (especially for electric cars). This will lead to consolidation of the industry as manufacturers become part of a scalable, ecosystem in order to stay ahead of the disruption curve.

Partnership strategies will include outsourcing in the form of managed services for integration support. This is not just because manufacturers do not have the internal skills needed to understand and implement new technologies, but because the distraction of managing existing IT projects may preclude focusing on new and existing transformative business opportunities, such as the need for consolidating multiple IT systems or the need to move to the Cloud. Part of the transformation process involves knowing core competencies, where the business is in terms of digital transformation, and what can be outsourced.

In some ways, the technology barriers are the easy ones. Barriers such as lack of technological expertise or lack of bandwidth can be remedied with partnerships with external providers to integrate and adopt new technologies. Digital leaders will be required to research and build partnerships with startups, technology vendors, developers, and whole ecosystems. In an intensely competitive landscape, the speed of business will call for faster times to innovate—and this will all be driven by technology.

Build Capacity

Manufacturers are aware of their resource limitations when facing digital transformation projects such as digitizing the supply chain. As illustrated in the figure below, lack of technology skills and expertise is the greatest challenge. For this reason, more than 20 percent of manufacturers surveyed in an IDC report are outsourcing to address this issue.¹⁰

To successfully transform, manufacturers will have to build capacity by bringing together people with highly specific skill sets to collaborate on projects. More effective human capital management will be required, specifically by offering ways for employees to develop the skills required by future business models. Skill sets such as long-term strategic research and development, for example, will also improve overall performance.

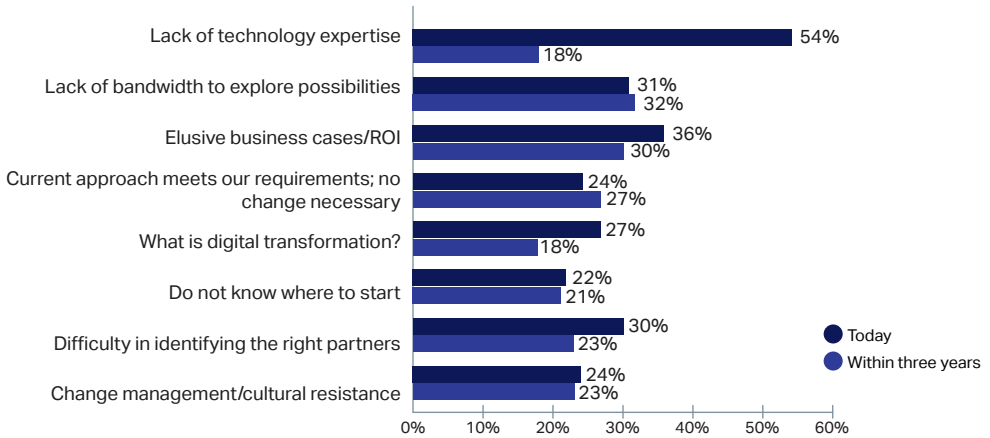


Figure 8.8: Barriers to Digitizing the Supply Chain¹¹

Another effective way to improve capacity is to aggressively recruit and attract those with requisite skill sets. As Millennials and the computer literate generations enter the workforce (displacing the Baby Boomers), this will be achieved by creating and maintaining a culture that mirrors their values of multiculturalism, corporate responsibility, and career development. Building up communities of practice, promoting collaboration using social networks, and allowing employees to have flexible hours and work remotely are ways of creating a workplace that is attractive to an evolving workforce. Manufacturers will have to determine where their skills gaps lie, and either hire to fill these gaps or train and certify current staff to expand capabilities.

As technologies continue to advance at a rapid pace, the workforce will become integrated and machines and humans will work side by side. This new, collaborative blend of labor will combine human characteristics such as contextual decision-making with the precision that belongs to robots for better results. Working alongside humans, collaborative robots are likely to reshape manufacturing processes and workforces. With new applications for automation, robots will help to give manufacturers a competitive edge but organizations will be required to train employees to effectively operate and maintain them.

Using AI and analytics, employers will be able to better train workers based on detailed modeling about how people think and act in different scenarios. Programs will be much more tailored to suit individual needs. In the digital world, manufacturers will rely on these learning techniques to fill skills gaps, matching resources to capability for improved productivity and employee satisfaction. Investment in digital education programs for executives will help to position digital as critical to overall growth and success—and aid in the implementation of a digital strategy as an enterprise-wide directive. New team goals, performance plans, and incentives will be defined and the adoption of digital technologies will help to build capacity.

The impact of digital technologies on the workforce will be profound as entire industries become more entrenched in using disruptive technologies. Manufacturers should act now to prepare for the changes that digital will introduce, especially regarding the mobile workforce, training and education programs, and recruitment strategies to find and retain top talent.

Focus on Information as an Asset

Future enterprise infrastructures will have to expand to support and incorporate the entire business network. Information and process integration will increase the speed of business. New processes will be deployed on premises, in the Cloud, and to support mobile apps. Manufacturers will have to expand their function beyond the firewall to deliver value and business growth. Enterprise architecture will extend to incorporate new business models based on the needs of employees, customers, partners and suppliers.

An enterprise architecture provides a framework for organizational change and includes plans for transitioning to future business models. Before resources are committed to implementing change, an enterprise architecture identifies capability and risk, outlining the ways in which data and information can be integrated with services effectively. Data integration—a critical enabling capability for transformation—must be reliable, secure, and accessible. Data integration connects operations and analytics to unify the enterprise, and it does so in secure and compliant ways. Enterprise architecture helps to ensure the interoperability of systems and the sharing of information resources across departments. As an integrated suite of targeted functions, EIM supports digitization, consolidation, data integration and discovery, customer experience management, secure information exchange, and records and information management.

EIM helps to minimize and control risk. It enables manufacturers to manage disruption caused by a mobile workforce, unstructured data, cloud computing, AI, the IoT, and the proliferation of devices. EIM systems can deliver benefits such as better data access, decision making and insight, consolidation and standardization, security and risk management, cost-effectiveness, and better alignment of IT activities with business objectives. But EIM does more than this—it provides a secure context in which innovation can happen by unlocking the value of information, from engagement to insight.

In the following interview, Michael Carlino of Deloitte Consulting explains the important role information plays in digital transformation.

Deloitte Consulting LLP

Deloitte Digital is an innovative leader in online and mobile strategy, design and development, offering world-class knowledge and resources from the leading global business and technology consultancy. The company works with a wide range of iconic local and global organizations, helping them understand and profit from the online and mobile revolution. Their focus is on the areas of digital strategy, mobile, social/web, content management, and managed services—all underpinned by digital tech architecture, application implementation and development expertise.

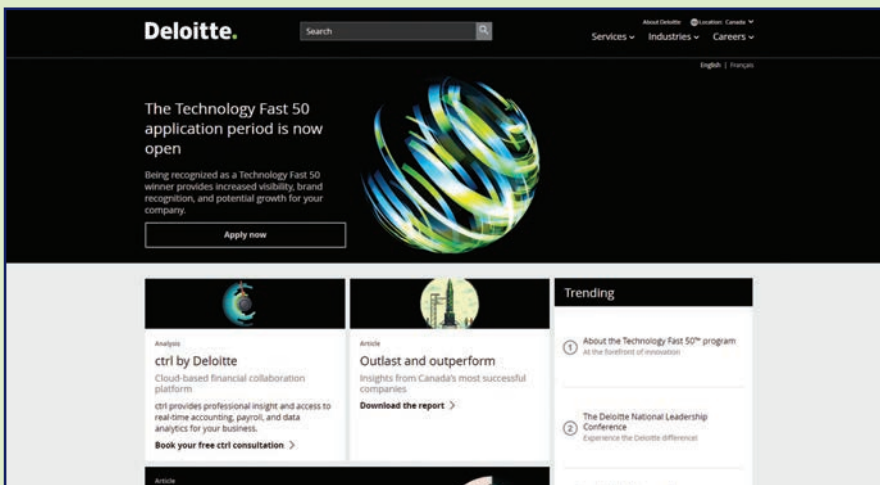


Figure 8.9: Deloitte Consulting LLP

What follows are excerpts from an interview with Michael Carlino, Principal at Deloitte Consulting LLP

"Deloitte as a brand consists of many entities. I'm in the group called Deloitte Digital and we're a part of Deloitte Consulting LLP. Basically, we deal with all things digital. It's a timely organization because right now we're experiencing a confluence of digital technologies, and

these are driving a shift in business models, attitudes, cultures, the workforce, adoption, and much more. We've been through this already about 20 years ago with mobile and even hosted services. Only this time it's based on much more powerful computers and technologies.

Along with this shift, we've seen a change in data. It's expanded beyond transactions to include context. The value of information lies in its context and the channels that we can extract it from. So, the unstructured information around structured data is becoming more important. And it's much more compelling as well, making discoveries based on all the unstructured information.

This is where analytics and cognitive technologies come in. If we combine structured and unstructured data on an information platform that we've never had access to before and then layer this with analytics, the cognitive solution offers much richer potential and its capabilities are exponential.

Digital transformation builds a bridge between structured and unstructured information. We focus on transforming use cases that are very strategic to the business. We examine the process flows, and more importantly, the information related to these flows. Once a process is successfully automated and benefits are realized, we can build momentum and buzz around the project to boost adoption. Then we move on to the next use case. It's an iterative and ongoing process because technologies, attitudes, and cultures are always changing. Where we are today can be a dramatically different place in two years. This case-by-case approach is much more digestible and there's room for failure and learning from mistakes. Once success is achieved, it's much easier to embrace other transformational projects.

From a change management perspective, we bring a diverse approach to each project. Deloitte Digital is made up of different groups with a variety of backgrounds—some individuals on a team might have an agency background, others are more technical, for example. What we often end up with is four or five solutions for one particular use case based on the

different vantage point each participant introduces to the problem we're trying to solve. And not one of these is wrong, per se, specific approaches appeal to specific audiences and we like to take that into account when we're developing a transformational solution.

How we get to our end result is just as important as the end result, and typically, it's from a dynamic gathering of diverse perspectives. This is becoming more the rule than the exception as organizations become more global. A lot of our digital projects are global projects. So, we not only have to take corporate cultures into consideration, we also have to take different nationalities into account. The world is becoming the "global village" that Marshall McLuhan, a media and communication theorist, predicted over 50 years ago. Our culture is both shrinking and expanding based on pervasive technological advances.

One of my key areas of focus is deepening engagement both within the enterprise and with customers. To refer to McLuhan again, he stated that "the medium is the message" and in this instance, the message is equated to the product—and that's what digital content is. The lines are blurring between the medium and the message. The platform, the channels are becoming as much a part of the message. And there's a symbiotic relationship between the two.

Another aspect—and a key part of Deloitte—is a focus on security. Part of Deloitte has a huge security practice. A consistency that we've found is that no matter how much changes in an organization, it needs to have fundamentals around security in place. This includes frameworks, policies, and guidelines. Governance is a big part of security, and compliance is the next big step, no matter what types of technologies a company is using. We can automate some of the compliance processes but when it comes

down to it, most of the security breaches that we read about today are fundamental breaches. These are things that should have been taken care of, or seem obvious from a security perspective.

Security is a big risk that limits the adoption of cloud technologies. Right now, it is a hybrid world. People are looking at content within their own organizations and assessing what is risky to outsource and what is not, in other words, what can be stored safely in the Cloud. And when I say "Cloud," I'm not differentiating between on-premises or off-premises, because many organizations have their own private cloud. But this will change. As businesses experience successful use cases and the potential for benefits of applying analytics in the Cloud, there will be much more momentum and uptake. More organizations will move to the public Cloud. We're not there yet—progress is slow—but in the last year, we've seen acceptance for the Cloud increase across all industries. Even in the past six months, it has changed. There's a growing appetite for the Cloud, and this is not based on just cost savings. When people consider the benefits of applying a broad spectrum of analytics in the Cloud, they are more open-minded to outsourcing. When they realize the benefits can be huge, they are willing to take the risk.

With any digital solution, including cloud adoption, success is based on alignment with corporate objectives. Solutions are developed and implemented based on the specific business or industry challenge. What's keeping business leaders up at night? And trying to address those issues through technologies like analytics and the Cloud. The answer to the why is to ensure that whatever we do, we are making businesses more successful, that we are transforming key aspects of the business.

One of the most disruptive forces that I find compelling is not really a technology, but more a practice that is enabled by technology, and this is crowdsourcing. Disruption happens when we bring thought leaders together to, not just create software, but to find a cure for a disease for example, or for financing some social benefit. So not crowdsourcing for an organization or industry, but crowdsourcing for the public good. That is a big disruption and the power of technology, to connect everyone. It's more than the Cloud or analytics, it's a sharing of knowledge. At the end of the day, if we run analytics against data and come up with a cure for a disease, that's pretty amazing. That's what it's all about. It's that impact, it's those kinds of things which are going to impact the way we live today. It's a sharing of knowledge and how to harness this. The Millennials are marrying this transparency with altruism, they are thinking much broader than we are, but they have a different reality. They won't be concerned with the same issues that we are. Driving, for example, won't require a license, they'll just use an app to locate the closest flying taxi. And they might travel to space. But beyond the Millennials, how will the next generation harness all of this data? That is what I find compelling."

RECOMMENDATION

When implementing a transformational strategy, a good first step is to take inventory of current enterprise information assets. This includes the following:

- Fragmentation - How many disconnected sources, flows, and archives do you have?
- Velocity - Which information processes need to be accelerated?
- Variety - What kind of information, media, documents, and discussions are you most concerned with?
- Volume - How much information are you managing?
- Security - What kind of information security risks are most threatening to your organization?
- Governance - How are you ensuring that your digital efforts are coordinated, efficient, and moving in the right direction?
- Compliance - Which legal or regulatory requirements and risks exist in your company and your industry?

Efforts need to be prioritized and targeted—and linked to an articulated business case. Prioritization should align with the executive team's top business objectives, whether they are productivity, cost reduction, revenue growth, innovation, competitiveness, or governance. The objective that benefits most significantly from improved information management should be identified. These business needs are the pilot projects for effective digital transformation.

As EIM projects or initiatives are successful, they can be expanded to encompass more users, technologies, and processes. The recommended approach is to start small but base your efforts on an encompassing, enterprise vision of transformation. What follows is a collection of 15 best practices to support this approach.

Fifteen Best Practices for Digital Transformation

Digital transformation is an ongoing process. Transformational leaders must be flexible and organizations agile enough to accept this truism. Beyond structural adjustments, a change of attitude is already underway. Many organizations are adopting entrepreneurial, innovative approaches to communicating and collaborating to digitize operations.

To accomplish a foundation for transformational change, manufacturers in all industries must establish a proven methodology and tested methods. Here are 15 best practices for the effective execution of a best-in-class methodology for digital transformation:

- 1 Identify opportunities for transformation.** Explore ways in which digital could disrupt the industry in the next decade. Review current and new business models. Where does the value lie for your company? Focus on core competencies and define how they can be transformed. Assess your current legacy systems and investments in information and process management/automation solutions.
- 2 Define an appropriate strategy based on goals and objectives.** Clearly articulate your vision and strategy to ensure that your organization is committed to and aligned behind a common set of objectives. This means taking a stakeholder view early on to identify what's important company-wide. To know if you're on the right track, consider the following:
 - **Organizational mission.** What's the organization's long-term vision? What does it hope to achieve?
 - **Objectives and goals.** As with the mission, objectives also flow from the top of the organization down to the department level, and can take the form of financial goals (i.e., profits) or departmental goals (e.g., to achieve a certain level of market share). Objectives also help to shape the lower-level metrics and Key Performance Indicators (KPIs) that will become part of their measurable strategy.
 - **Current activities.** Current activities and programs should be reviewed in order to make decisions on how these activities will be measured.
 - **Capabilities required:** Technology, skills, mindsets, and partners. Consider how you will identify, recruit, and retain new talent.
- 3 Evaluate your business case.** Determine costs. Outline benefits and risks to the business. Engage early in discussions on governance, security, risk, and liability. Consider current information-based processes and procedures. Measures should be chosen based on the processes already in place. Eventually it will become evident as to which top-level, operational, or strategic goals these measurement areas impact. Prioritize initiatives and assign KPIs that can be measured. Have a clear understanding of your capabilities and limitations.
- 4 Have a strong champion and dedicated team.** During the initial stages of an implementation, most organizations have a champion included in the planning process, as well as the one or two individuals who act as the system's administrators. The champion provides knowledge of the organization's strategy management history and specifies the overall goals and vision of the transformation program moving forward. The system administrators typically take on the remaining responsibilities: coordinating various meetings with the departments for measure identification, building the actual database into the system, and organizing training. This central team manages all business processes that support the program as a whole.

- 5 **Recognize that transformation is not solely a technological issue.** Culture and organizational challenges will also need to be addressed.
- 6 **Start small, but plan for a journey.** A long-term transformational journey will be based on or impacted by markets, strategies and business objectives, capabilities, and budget.
- 7 **Pilot and assess your progress.** Many organizations want to hit the ground running, taking on as much as they can at once in the hope that it will get them to the finish line faster. Trying to measure everything at the same time is often a setup for failure. For a successful implementation, plan for a realistic pilot—something manageable that will allow you to make sure everything is being done correctly from the start. By choosing a specific starting point—a function, department, or unit within a department—you will be better equipped to fine tune your progress and be positioned well for success. The greatest thing about this approach? Training often becomes easier and results can be achieved more rapidly—allowing implementation to be rolled out to other pilot sites easily and quickly, streamlining the entire approach.
- 8 **Demonstrate incremental progress.** This consists of both strategic value-driver measures (that are often delivered monthly, weekly, or daily) and leading indicators (usually found at the departmental or divisional level). After mapping out what’s already being measured, create an overall structure of metrics, consider what’s been overlooked in the past to see if anything else can help to accomplish defined goals. Those goals can be made up of multiple measures and KPIs, and it’s important to understand the activities that directly contribute to each, in order to discover, analyze, and improve—closing the loop on transformational success.
- 9 **Identify and communicate links between scorecards and dashboards to streamline reporting and analysis.** Identifying and then communicating linkages helps everyone understand how their contribution impacts their peers and the organization as a whole. For example, review details regarding where resources (e.g., department funds) will be directed, but also have immediate access to details regarding the results of those activities and how they impact higher-level goals and objectives. In a real-world context, before spending begins on individual programs, your organization might need to establish a general plan of action that summarizes linkages in terms of what they want to do and what the expected outcomes are.
- 10 **Determine current state of skill competence and establish new competencies.** Ensure that your department or project team has the right skills and competencies to contribute to transformation. You may need to update your current training programs to support a rapidly evolving workplace. Another option is to outsource non-core services to onshore or offshore providers, or to

vendors in the Cloud. When skills gaps are apparent, consider partnering with startups or even developers in your ecosystem.

- 11 **Collaborate and talk to users.** Where do current processes fall short? What works and what does not? As the initiative progresses and your organization begins to understand their overarching needs and where their information is coming from, it's important that the team talk to the end users who will be on the front lines of business improvement efforts. Engage with internal customers to understand their needs and issues for insight into how you can support them to deliver on your strategy.
- 12 **Create a digital sandbox or testing ground.** This will foster the agile and iterative approach that supports continuous innovation experimentation across digital channels.
- 13 **Adopt an entrepreneurial attitude and think like a disruptor.** Transform legacy shackles (e.g., technologies and branches) into strengths or remove them altogether. Be willing to disrupt your business and adapt to a changing environment.
- 14 **Operationalize and measure your success.** Create opportunities to refine.
- 15 **Create a culture of digital innovation and transformation.** This starts with the end user. A key component to making this effort seamless is having the ability to communicate the context around the project in the form of action plans, related decisions, and related knowledge. The right technology will provide users with these capabilities, but will also shorten the timelines associated with traditional troubleshooting. Set up digital units or centers of excellence so that best practices (for process automation, for example) can be shared, tested, and refined.

"The most important thing we can do whenever we introduce new technologies is to work on changing the culture. We can only succeed when we build a solution with users and usability in mind. It takes 10 years to build trust, and five seconds to lose it. When we approach any project in our digitization initiative, we partner with other areas in the company to develop a solution and share our success stories. We aim for low-hanging fruit, and we try not to bite off more than we can chew. Once we share success stories, we can expand and do more, but we have to continually keep our users in the loop."

— OLE MEYER-SKJØLINGSTAD, HEAD OF INFORMATION AND DOCUMENT MANAGEMENT AT MULTICONSULT

The Digital Call to Action

In the current complex, digital landscape, manufacturers that adopt new digital business models will be well positioned for success in the digital world. Given the transformational benefits of deploying a comprehensive EIM solution, future business leaders will make information management a top priority. As champions of a digital agenda, they will demonstrate how technology can facilitate change and investments in EIM technology, integrated B2B services, and automated processes will transform the industry.

In an era where change can happen any moment and disrupt whatever your business is doing right now, change management has become a continuous journey of evolution and adaptation. The journey to digital transformation requires a radical overhaul of culture, organizational structures, technology, and operating models. Since this is a new way forward, visionary leaders will need to figure out how to get there.

EIM provides a strategic blueprint for transformational success. All of the digital innovators featured in this book tell the story of successful digital transformation. This vision of transformation is being defined today and improved upon for future generations. Structures and processes are evolving, and journeys down the path to making the vision a reality will be many and variant. The good news is—as illustrated throughout this book—the technology is available, and many enterprises have already taken their first steps toward implementing a digital strategy with EIM at its foundation.

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Mark J. Barrenechea joined OpenText as President and Chief Executive Officer in January 2012, and also serves as a member of the Board. In January 2016, Mark took on the role of Chief Technology Officer.

Mark oversees the strategic direction of the organization. Under his direction, the Company has grown both organically and through strategic acquisitions into a \$2.3 billion technology company and has successfully transformed into an Enterprise Information Management leader.

Mark has received many accolades recognizing his leadership and innovation over the years including the 2011 Best Large Company CEO from the *San Francisco Business Times* and the 2015 Results-Oriented CEO of the year by the CEO World Awards.

In addition, Mark has authored several books including *The Golden Age of Innovation*, *On Digital*, *Digital Financial Services*, *Digital: Disrupt or Die*, *eGovernment or Out of Government*, *Enterprise Information Management: The Next Generation of Enterprise Software*, *Software Rules*, and *e-Business or out of Business*.



Mark J. Barrenechea

P. Thomas (Tom) Jenkins is Chair of the Board of OpenText Corporation (NASDAQ: OTEX, TSX: OTC) of Waterloo, the largest software company in Canada. Mr. Jenkins is the Chair of the National Research Council of Canada and the tenth Chancellor of the University of Waterloo. He is Chair of the Ontario Global 100 (OG100) and a co-founder of Communitech in Waterloo.

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