The future of supply chain management:
Top trends for the next decade

Abstract
Modern supply chain management is entering the third wave of a multi-decade progression towards greater levels of sophistication in addressing increasing levels of product variety, fulfillment options, and customer engagement, at the lowest possible cost. A nexus of business process and technology forces is ushering in unprecedented change for supply chain and retail operations within all companies across the globe. This paper investigates these forces and the associated implications for the future of supply chain management. It identifies and describes the top trends that companies need to address in order to be relevant and successful in the next decade and beyond. The paper also recommends a business and technology architecture for bridging to the future.

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<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Past, present, and future</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Next generation</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Future business challenge:</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>How to expand profit margin</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Top trends for the next decade</td>
<td>7</td>
</tr>
<tr>
<td>5.1</td>
<td>Customer-centric supply chains of one with profitability</td>
<td>8</td>
</tr>
<tr>
<td>5.2</td>
<td>Convergence</td>
<td>9</td>
</tr>
<tr>
<td>5.3</td>
<td>Self-forming and asset virtualization</td>
<td>10</td>
</tr>
<tr>
<td>5.4</td>
<td>3D printing / additive manufacturing</td>
<td>10</td>
</tr>
<tr>
<td>5.5</td>
<td>Sharing economy and crowdsourcing</td>
<td>10</td>
</tr>
<tr>
<td>5.6</td>
<td>Digitization of everything and internet of everything</td>
<td>11</td>
</tr>
<tr>
<td>5.7</td>
<td>Data science and “math houses”</td>
<td>11</td>
</tr>
<tr>
<td>5.8</td>
<td>Software/strategy-driven value chains</td>
<td>12</td>
</tr>
<tr>
<td>5.9</td>
<td>Adaptive learning software / machine learning</td>
<td>12</td>
</tr>
<tr>
<td>5.10</td>
<td>Digital Hub, Apps, and the “Network of Networks”</td>
<td>13</td>
</tr>
<tr>
<td>5.11</td>
<td>Cloud and web-scale IT</td>
<td>14</td>
</tr>
<tr>
<td>5.12</td>
<td>The two-speed architecture</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Call to action</td>
<td>15</td>
</tr>
</tbody>
</table>
1
Introduction

A third revolution (third wave) in supply chain management is upon us. Modern supply chain management, leveraging engineering, math, and computers, started in the 1970s. Since then, it has gone through two twenty-year periods, each with distinct characteristics, and each driven by supply-side technology paradigms. In the past ten years, demand-side thinking has started to play an increasing role. Now, a confluence of technologies, conspiring with customers and the end-consumer, has established a breakpoint for the advent of the third revolution.

This paper investigates and describes the future of modern supply chain management, including perspectives from the past and present. While supply chains and supply chain management have been around in some form for centuries, this article begins its perspective using the term “modern supply chain management,” which is assumed to start in the mid-1970s, as companies began to leverage computers and information technology in this area of their businesses. The paper describes trends and characteristics that will be prevalent across all functions of supply chain management, including demand, supply, fulfillment, transportation, warehouse management, category management, and retail operations.

2
Past, present, and future

Modern supply chain management, leveraging computers, can be characterized by three significant periods, as shown in Figure 1. The first two of these fall into roughly twenty-year stretches; the next period is just as likely to be on the order of twenty years. It is important to note that there is significant overlap between each period and that they successively build on each other.

In the 1960s, the IBM 360 and its derivatives ushered in a period of widespread use of computers and software for a whole host of business applications, starting with the mechanization of back-office finance and human resource functions. This spread into supply chain management (which was known as “logistics” at the time) in the mid to late 1970s for inventory management and, ultimately, for planning and execution functions. The principal area driving this was materials management, both inbound material requirements planning (MRP), and outbound distribution requirements planning (DRP). These foundational concepts led ultimately to the development and widespread deployment of enterprise resource planning (ERP) systems. (In 1990, Gartner Group coined the term “Enterprise Resource Planning” to describe next-generation MRP/DRP systems).

Figure 1 - Three Periods of Modern Supply Chain Management
Businesses across the globe implemented ERP systems largely to automate mundane business functions that could easily be standardized and described using rules; furthermore, these business functions and rules were characterized as being fairly static. For example, finance functions and associated accounting rules can be easily codified and are not prone to change every week. ERP for manufacturing and supply chain management was based on the MRP/DRP thinking that started in the 1970s. ERP began as bespoke in-house development, followed by commercial off-the-shelf software (COTS) from software vendors. ERP packaged software started to take off in the mid-1990s; many companies spent the next two decades implementing such packages.

Deficiencies of MRP/DRP thinking, coupled with the rapid growth of computing power and memory, gave way to a new paradigm in the mid-1990s. This paradigm was based on real-life business modeling, constraints, and optimization. This approach was still rules-driven, but it was fundamentally based on a modeling paradigm which sought to describe the real-world more accurately than the ERP approach. The ERP approach is good at describing what happened, after-the-fact; the optimization paradigm sought to understand what was going to happen and then prescribe a path that helped achieve a business objective. However, this approach is still fundamentally rules-driven and has a reaction time that may be out-of-phase with the real world. In fact, as time passed and change became more frequent and pervasive, optimization had to be augmented with responsive control tower capabilities, which are prevalent today. These capabilities are precursors to what is needed in the third wave of modern supply chain management.

In many ways, the three stage model of Figure 1 is a continuum based on one simple concept – using a better understanding and knowledge of the world around us to make better decisions within a business objective function. The current digital paradigm is the next generation of this continuum – digital data from things and people, and their interaction, will increasingly be made available for businesses to gain a greater understanding of what is happening and then react to it in their best interests. Digital data will be coupled with digital smarts – intelligent software that learns, adapts, and provides businesses the ability to better serve customers. Those that do this the best will be the winners.

3

Next Generation

Previous-generation supply chain management systems have been characterized by relatively static models codified in rules defined by humans to provide the best-possible representation of the real physical world. Sophisticated software is configured to run against these models to produce plans, execute the plans, and to react to real-world events. Instead of a static model, the next generation will be driven by increasingly dynamic models, made possible by the availability of digital data points from everywhere, the ability to sense this data, the ability to process this data, the ability to react to this data, and the ability to learn from it over time.

Furthermore, these models will provide much more accurate representations of the real world at any given point in time. In other words, computer representation of the supply chain will become time-synchronized with the physical real world; as digital data from the supply chain is processed and as intelligent adjustments are made, the digital and the physical become one. Not only will the models be commingled with physical reality through digital data, but the logic that runs software against these models will transition from a rules-driven paradigm to a learning paradigm. In the digital phase of modern supply chain management, machine learning will enter the mainstream of enterprise software.

Today’s fast-response systems and prescriptive analytics are precursors to this. In the future, fast response and analytics will be necessary, but not sufficient, conditions for success.
The progression of this phenomenon is based on the interaction of three central characters:

- Customer
- Technology
- Structure

The customer is the individual or entity that creates demand. As Peter Drucker said, “all businesses exist for one purpose – to create a customer.” Traditionally, relationships between a customer and business have been thought of in terms of business-to-business (B2B) or business-to-consumer (B2C). In today’s world, much emphasis is placed on end-consumers, who are thought to be creating a lot of the disruption that is ushering in the third wave. However, business customers are increasingly taking on the same characteristics as end-consumers such that lines between B2B and B2C are blurring (see convergence trends later in this paper). Furthermore, many B2B customers who sell end-consumer products through intermediaries must increasingly establish and manage direct relationships with the end-consumer in order to exert stronger control over their brand identity.

Technology encompasses the wide array of microprocessor and computer-based innovations that are changing how people and physical things interact. This includes how customers, smart machines and devices interact with businesses and each other on a global basis through the internet of everything. Technology also includes the hardware and software necessary for businesses to exist and thrive in the future.

As Moore’s Law continues its multi-decade run, its consequences are making possible the digitization of everything. Previously intractable or difficult problems, along with clumsy approaches to solve them, are giving way to elegant solutions. Everything from common everyday devices such as light bulbs, thermostats, wristwatches, and motor vehicles to robots and smartphones are digital devices with some level of increasing intelligence. There is a sense that across a wide swath of industry and society, a technological tipping point has been reached. This occurs when the Moore’s law doubling effect creates such compute power that previous work that seemed to move along an incremental curve suddenly results in breakthroughs. This is expressed in Figure 2, where certain fields and applications move for decades along a continuous improvement curve and then suddenly, within a short period of time, the improvement curve goes asymptotic. There is a sense that this phenomenon is now occurring across virtually every aspect of the supply chain and its interaction with customers.

Structure refers to all aspects of the physical supply chain and the various processes for managing it. Physical assets include factories, warehouses, retail stores, transportation, and human capital. Management processes cover planning and execution functions, including business and financial planning, demand management, category management, sales and operations planning (S&OP), assortment planning, manufacturing planning, inventory deployment planning, transportation planning and management, warehouse management, and store operations, including labor and inventory.

Figure 2 - Technology Improvement Curve
Supply chain structure in the past has been viewed as a fairly “left-to-right” linear set of assets with relatively static inter-relationships. Today’s supply chains are more characterized as a set of assets that “surround the customer” and dynamically assemble to process and fulfill orders. This is shown pictorially in Figure 3.

The ultimate destination of this area might be a dynamic “map of the world’s supply chains.” This will be discussed later.

Together, these three characters act as a flywheel, with technology playing the role of the triggering mechanism. Technology emboldens the customer, who then continuously raises expectations, which then drives further technology change; together the customer and technology force structural changes on the supply chain. These structural changes are driven by the need for changes in the way customers are served, and to do so at a desirable profit margin. In this context, structure is defined as the physical supply chain and all associated management processes (defined as supply chain management).

4 Future business challenge: How to expand profit margins

McKinsey Global Institute predicts that corporate profit margins, which have grown on an after-tax basis by 73% in the past thirty-five years, will shrink significantly over the next decade. They cite for this a host of factors, including increasing consumer demands, global competition, and associated pricing pressure.

A new term – profit-space – is introduced here to describe current and future challenges of supply chain management and retail operations. While the term may be new, the idea is not. Figure 5 is a three-dimensional diagram that shows the challenges for current and future supply chain management and retail operations. Product variety (including SKU count and configurations), fulfillment options, and lead-time demands are all increasing customer expectations. Across this three dimensional space is a fourth dimension – the profit dimension. In the past, the profit dimension was somewhat independent in the sense that it was driven to a large extent by price and by upstream cost-of-goods sold.

In today’s world, it’s necessary to look at profit-space (borrowing an idea from Einsteinian physics), which differs at each intersection point across the three dimensions of Figure 5; these dimensions represent increasing customer requirements that impact supply chain costs. Profit is now almost completely driven by its position in the three dimensional space of Figure 5.

The sections that follow discuss key trends on which companies must capitalize in order to continually optimize their position in this profit-space, in alignment with their business strategies.
5

Top trends for the next decade

A host of factors working together is creating a revolution in supply chain management. While previous technology-led revolutions were the work of a single or a handful of foundational technologies, the revolution that is upon us seems to be driven by a confluence of factors that are all coming together simultaneously. The steam engine, railroads, electricity, motor vehicles, the microprocessor, and the Internet all led to significant societal upheaval, along with significant step functions in productivity. Today, supply chain managers have to focus on a host of significant trends, which, taken together, will lead to broad upheaval in the way supply chains are planned, managed, and operated.

Supply chains and their management are now at a pivot point – the need to pivot to myriad new technologies while leveraging past investments and transitioning them over time.

Within this context and the context of the three central characters previously discussed, the top trends for supply chain management are summarized in Table 1. The trends are grouped into three color-coded categories: blue for one major trend of customer centricity; green for structural trends; and purple for technological trends.

Table 1 - Top Trends for SCM in the Next Decade
Each of these is discussed in the sections that follow. Each key trend is first defined and discussed in a general sense, followed by a specific discussion with examples of how the trend will potentially impact various aspects of supply chains and supply chain management.

- **Customer-centric**, supply chains of one – customers increasingly demand “everything aisle” access with tailored fulfillment at mass produced prices. Customers increasingly value companies based on their supply chains.

- **Convergence** – the physical value chain, business processes, time and function, and digital and physical will increasingly converge.

- **Self-forming and asset virtualization** – the physical value chain will increasingly be a set of assets that “surrounds the customer” and is dynamically brought together through software and advanced decision making.

- **3D printing / additive manufacturing** – digital techniques that transcend time and space will transform the value chain for at least some set of products.

- **Sharing economy and crowdsourcing** – asset and operations sharing across businesses will occur where it is deemed to have no value to the customer. This will be enabled by a “hub of hubs,” or a “network of networks.”

- **Digitization of everything and internet of everything** – physical assets and people will be increasingly digitized and connected to the Internet of Everything (IOE).

- **Data science and “math houses”** – data science will play an increasing role in supply chain management. Internal and external “math houses” will form to solve problems “around the edges” of existing solutions.

- **Software/ strategy-driven value chains** – the value chain is increasingly synchronized to business strategies. These strategies drive policies, which are synchronized from customer through supplier and strategy through execution.

- **Adaptive learning software / machine learning** – machine learning will enter the mainstream of business application software, allowing for automatic configuration changes and decision-making based on outcome learning.

- **Cloud and web-scale IT** – cloud will continue to evolve, providing for continuous upgrades and much lower TCO. Google and other companies will make available to companies services previously only available to consumers.

- **The two-speed architecture** – existing software architectures and new cloud architectures (e.g. Google Cloud Platform) will work together. This will provide new capabilities to existing software assets, while allowing them to migrate over time.
5.1 Customer-centric, supply chains of one, with profitability

The dominant character in the third wave of supply chain management is the customer. This sounds like a trite statement because the customer has always been important. However, in the third wave, the customer transcends importance to become the singular independent variable in supply chain management decision making. This is fundamentally different than what we have seen in the past and leads to the concept of “supply chains of one.”

As stated earlier, supply chains are moving away from a traditional, linear, left-to-right structure with fixed inter-relationships between assets to a structure in which all of the assets of the supply chain surround the customer and dynamically form relationships in order to process and fulfill orders. This is shown in Figure 3 and is known as a supply chain mesh or supply chain grid in which all of the assets in the supply chain – and supply chain management in general – must be flexible and adaptable enough to provide a personalized, tailored response such that the customer perceives that the company is actually providing them with their own personal supply chain. This is what is meant by “supply chains of one.”

In the second wave of modern supply chain management, various companies became known as much for their supply chain prowess as for the products they produced or sold. In these cases, the service became not just an extension of the product, it transcended the product. Customers engaged with the company for the fulfillment experience as much, or more, than for the performance or capabilities of the products they were buying. In other cases, efficiency and scale of the company’s supply chain operations provided a superior cost structure that in turn provided superior pricing. This superior pricing, coupled with superior choice, caused customers to engage in droves. Two of the poster children of this era were Dell and Walmart (each has been on Gartner’s top 25 supply chain list many times). The Dell ordering and fulfillment processes provided a differentiated experience that lasted for approximately ten years and was the main driver behind building a $60B company. Walmart’s efficient buying and replenishment processes, along with enormous scale, helped build the world’s largest company; its efficiency and scale were such that it had significant impact on entire economies.

Amazon started in 1994 as a company focused on selling books through the World Wide Web. Over the course of the next two decades, it became “The Everything Store,” providing an assortment of more than 300 million products in 2015; this will almost surely grow to greater than a billion over the next decade. Sears Roebuck transformed the retail industry over the course of 80 years; Walmart did it over a 40-year period; and now Amazon has done it in fewer than 20 years.

Amazon is a combination of the Dell and Walmart business models of the second wave – online web-based personalization coupled with huge backend scale. The missing ingredient thus far has been profitability; Amazon has not shown an ability to match profit margins of either Dell or Walmart (both of which are not very high to begin with). Amazon’s narrative has been that it can move to a profit model at any moment; it could certainly do this by raising prices (or charging for shipping, which is the same as raising prices). However, raising prices would be counter to its business model; the Amazon business model would have to change to a standard business model – one based on a balance between profitability and growth. Herein lays the foundational thinking for the third wave.
The initial stages of customer centricity have emerged over the course of the past five years, as topics like omni-channel have come to dominate the conversation. In this initial phase, there has been a race to the top when it comes to service and fulfillment, coupled with a corresponding race to the bottom when it comes to price and profitability.

Retailers are on a collision course with zero profitability as their eCommerce sales grow. eCommerce profit margins are negative or zero for the vast majority of retailers. Consider a retailer with 3.5 percent net profit margin and 100 percent of its sales coming from traditional brick and mortar stores. If this retailer shifts its business model to 90 percent in-store sales and 10 percent eCommerce sales and its eCommerce sales have a negative 5 percent margin, its overall margin would erode to 2.65 percent from 3.5 percent (if eCommerce sales were breakeven, margin would erode to 3.15 percent). If the shift suddenly went to 20 percent eCommerce sales and then to 30 percent eCommerce sales, the similar net margin would be 1.8 percent and 0.95 percent, respectively. This dynamic is real; it needs to be taken seriously by all retailers and companies along the end-to-end value chain.

Traditional retailers and value chain participants must adopt an omni-channel strategy that leverages third-wave thinking in order to not go the way of physical bookstores. (See 10 steps on the path to profitable omnichannel growth for details on adopting a profitable end-to-end omni-channel strategy).

5.2 Convergence

Convergence is happening everywhere in the supply chain. For example, B2B companies are increasingly taking on the characteristics of B2C companies, such that these traditional lines of delineation are becoming blurred. Business customers increasingly expect the same level of flexibility, choice, and service that is provided to consumers. In this sense, the solutions that are needed for serving consumers are the same solutions needed for serving businesses.

However, a more general trend is that convergence is occurring across two dimensions: business process and time. For example, in the past, companies may have had a demand process, a supply process, an S&OP process, and a channel management process (in the CPG industry, the channel process may be account teams collaborating with retailers on promotions, replenishments, and inventory). These individual processes were typically supported by separate technologies with integration between them. In the future, this is going to be a single process, converged around a single technology.

Furthermore, on the time dimension, in the past there was strategic planning, tactical planning, operational planning and operational execution. In the future, companies will be able to “telescope” directly from strategic planning down to operational execution and vice versa.

This trend is occurring today and will continue to occur at all intersection points of business process and time along the end-to-end value chain.

Convergence is leading to what JDA calls “the seamless supply chain.”
5.3 Self-forming and asset virtualization
The third wave will accelerate a trend of information, data, and technology replacing traditional physical assets. Warehouses, transportation, factories, and inventory will increasingly be replaced by information and information technology.

Instead of multiple physical supply chains supporting different customer groups, channels, product lines, products, and geographies, the trend will be towards a single physical supply chain and multiple virtual supply chains, enabled by information technology and advanced decision making. Information technology will allow companies to create different segments across their extended physical assets in order to provide the personalized customer experience previously described in the discussion on customer centricity. Furthermore, the various end-to-end assets will no longer be characterized by linear, fixed interrelationships, but will “self-form” relationships based on a specific customer need at a specific point in time. A precursor to this is supply chain segmentation, which has seen a resurgence in recent years. (For a detailed discussion on supply chain segmentation and virtualization concepts, see Supply chain segmentation: 10 steps to greater profits).

5.4 3D printing / additive manufacturing
The thought of taking an order, digitizing it, and then sending it immediately close to the point of consumption for manufacture, thus eliminating time and distance, is irresistible. The promise of eliminating time and distance – if only a possibility – requires additive manufacturing (also known as 3D printing) to be taken seriously as a potential significant disruptor in supply chains. In one sense, distance is the equivalent of time, but it is much more than that – it represents transportation assets, fuel consumption, and CO2 emissions, among other things. In this sense, 3D printing is essentially the digitization of transportation – dispatching digital signals instead of ships, planes, trucks, and associated human resources.

DHL has done studies in the past 18 months that suggest 3D printing could handle 2-3 percent of the goods flow from China to the US. While that may not sound like a lot, it represents $12B - $18B in goods, and it is only the starting point; where it ultimately ends up is dependent on advances in technology. Speed, volume, and cost are still significant hurdles to wider use of 3D printing. As speed and volume of production are increased through technology advances, it will be more widely adopted, causing prices to decline.

3D printing may be particularly effective in emerging economies, allowing them to leapfrog the need for physical infrastructure, much in the same way that cell phone technology allowed them to leapfrog the need for physical land lines, eliminating decades of infrastructure development. For example, in India, where it may take a long time to develop modern highway infrastructure throughout remote regions, the highway can simply be digitized through 3D printing.

As an interesting side note to this discussion, Jay Leno, a classic car aficionado, now owns multiple 3D printers, which allow him to make many of the parts for any car in his vast collection.

5.5 Sharing economy and crowdsourcing
Crowdsourcing leverages technology to employ hundreds or thousands of individuals to perform tasks or help solve problems. The sharing economy refers to leveraging of owned assets across individuals or companies. Together, the sharing economy and crowdsourcing increase efficiency by taking advantage of underutilized assets and people. Ride-sharing services such as Uber bring together, through smartphone apps, drivers and cars with...
people who need to get from one point to another. This matching of a need (travel from point A to point B) with excess capacity (cars and drivers) creates efficiency by driving higher asset utilization. There are many examples of using crowdsourcing to help solve problems; www.kaggle.com is an example of leveraging crowdsourcing to help solve data science problems for companies.

“Uberization” of the supply chain has already occurred for last mile delivery in eCommerce. Deliv (www.deliv.co) is an example of a company built on this premise. Walmart is now testing last mile delivery by leveraging Uber, Lyft, and Deliv.

In the future, uberization and the sharing economy may make their way upstream in the supply chain to direct sharing of manufacturing, warehouse, and transportation assets across enterprises. It is difficult to see how manufacturing assets may be shared across enterprises (due to their product-specific nature), but certain excess warehouse and transportation capacities should be able to be directly shared because there are 3PL models that do that today. McKinsey believes there is a trillion-dollar opportunity for the global economy in sharing of such excess capacity directly across enterprises. This will be enabled by networks that match capacity needs across companies, much in the same way that smartphone apps match demand and supply needs for transportation in the Uber-like business models.

5.6 Digitization of everything and internet of everything

The most exciting, and perhaps most hyped, area of technology associated with supply chain management is the digitization of everything and the internet of everything (IOE). (Some use the term internet of things (IOT), but IOE is used here because it includes both things and people connected to the cloud).

This offers promise in a whole host of areas associated with supply chains, not the least of which is that the computer models against which supply chain decisions are made today may or may not represent the physical reality of what is going on in the supply chain at any given point in time. There is a latency between the physical supply chain and the computer models for decision making, leading to sub-optimal decisions. In the future, computer models will continuously process digital signals – representing the state of capacities, inventory, and movements, essentially causing the physical world to converge with the digital world (the computer models). This will require supply chain software solutions to become increasingly real-time.

For example, today trucks can send digital location and other information in real-time, either via onboard computers or through smartphone apps. This information can be used to provide much more precise synchronization between manufacturing, warehouses, stores, and, ultimately, end consumers.

5.7 Data science and “math houses ”

Data science will be a core competency of the third wave of modern supply chain management, requiring all enterprises to become “math houses.” Big data is a term that has been around for more than five years and refers to the rapid growth in volume, velocity, and variety of the world’s digital data. The process of transforming big data into actionable information is a wealth creation activity – those companies that do it better than others will create competitive differentiation. Today, processing of data such as social, news, events, and weather (SNEW), adding predictive and prescriptive analytics, along with machine learning, can add tremendous value to replenishment planning, inventory deployment, and demand management.

The means by which big data can be leveraged for competitive differentiation is through predictive analytics, prescriptive analytics, and machine learning. This can only be done if a company has a critical mass of data science competency. Further discussion on machine learning is found below.
5.8 Software/strategy-driven value chains

In the third wave of modern supply chain management, supply chains will be increasingly driven by business strategy. In today’s world, supply chain behavior is governed by function-specific operational policies, which are stitched together along the end-to-end chain from customers back through suppliers. These policies are entrenched in software that supports each of the functions.

For example, a supply chain may have ordering policies, replenishment policies, inventory policies, transportation policies, warehouse management policies, manufacturing policies, supplier policies, and procurement policies. These policies may or may not be synchronized with each other at any given point in time; in fact, they may be at odds with each other. Furthermore, they may not be synchronized back to a business strategy the enterprise is trying to accomplish. For example, an ordering policy designed to ship everything together for a diverse set of products may be out of sync with transportation pickup policies or warehouse management picking and packing policies. Lack of synchronization of operational policies can lead to significant value leakage in the supply chain.

The vision for the future is to have a dashboard through which enterprises can enter business strategies and then have those business strategies be automatically translated into operational policies across the various functional domains from customers back through suppliers. Companies will have different business strategies which directly affect their operational policies. For example, some companies may want to run a high-growth, low-margin business strategy while others may want to maximize margin, while still others may want to run a strategy at some point between the two. Companies may want to have a different business strategy by channel, or customer group, or product line, or product, or geography, or a different business strategy for various intersection points across these.

The vision for the future is that these business strategies would be entered into a dashboard and they, in turn, would automatically populate operational policies across each supply chain functional area, synchronizing policies across the functional areas.

5.9 Adaptive learning software / machine learning

Machine learning is an artificial intelligence technique for processing big data. It is based on algorithms that can recognize data patterns, learn from the patterns, offer insights, and become smarter through time, just as humans do. Machine learning has been around for decades, but it was mostly employed for specific research purposes in university and lab environments. In the past decade, and particularly in the past five years, it has begun to be used for all sorts of applications, including predictive analytics, understanding consumer behavior, and establishing risk profiles.

For example, Google’s cloud now consumes more compute power on machine learning algorithms than on search itself. Google search has a good understanding of what a person is going to search for even before they search for it. That is the essence of machine learning. In the second wave of modern supply chain management, manual techniques such as process playbooks, which are based on control theory, emerged to allow systems to learn and grow. These techniques are a precursor to machine learning in the supply chain management context. (For a discussion on process playbooks see A rudder for course correction).

In the third wave of modern supply chain management, machine learning will become a mainstream part of enterprise software; indeed, it and similar techniques will be a cornerstone characteristic of the third wave. JDA is currently employing machine learning for a number of specific supply chain problems, including understanding consumer behavior to develop customer-specific assortments and offers, and analyzing demand patterns to establish inventory policies for slow-moving merchandise.

However, in the third wave a more widespread and general use case for machine learning will emerge. This use case will be one in which enterprise software employs machine learning to adapt and learn by itself. This use case is extremely powerful and will enable enterprise software to make a step function to a new level of cost efficiency and value enablement. This general use case is described below.
As previously discussed, in the second wave of modern supply chain management commercial off-the-shelf software (COTS) emerged and became generally consumable by enterprises. For the past twenty years, the state-of-the-art of COTS supply chain software has been characterized by the following:

1) A company evaluates and buys software to support a set of business processes
2) The software is configured and implemented over some period of time
3) The software is used for some period of time and drives business value for the company and associated business processes. Business value may be expressed in terms of a return on investment equation such as return on assets (ROA), return on invested capital (ROIC) or economic profit (EP).

What happens next is the challenge for all supply chain management (SCM) software. After achieving some level of value, the software and its configuration start to drift and incremental value delivery levels off; the configuration of the software often does not keep up with changes in business strategy, the physical supply chain, and associated operational policies. This divergence between the business and the configuration of the software can manifest itself in replenishment, stockout, and excess inventory surprises.

A common remedy to this problem in the second wave was to engage the software vendor and consultants to evaluate what went wrong and to change the software to once again be synchronized with the company’s business and operational strategies and how they are running their supply chain. In the meantime, there has been value leakage and increasing costs.

In the third wave of modern supply chain management, this problem will gradually go away. SCM software will add machine learning capabilities, thus enabling the software itself to adapt and learn. The software will process digital signals from various sources in real-time and develop a precise understanding of the business and physical supply chain it is supporting. It will automatically notice and predict drift between its configuration and the business processes it supports. Based on this understanding, it will either modify its own configuration itself, or minimally it will raise a flag to a human operator that the configuration must be changed and identify the specific configuration parameters requiring change, along with the reasons. Humans can then take the advice (prescription) through an approval process and institute the changes. Through this process, there will be minimal value leakage and minimal increasing costs.

All of this is part of a general trend – human-designed, human-directed systems are giving way to human-designed, computer-directed systems, which ultimately will give way to computer-designed, computer-directed systems. In this ultimate state, humans will interact with systems in the same way they interact with other humans.

5.10 Digital hub, apps, and the “network of networks”

In the third wave of modern supply chain management, a “network of networks” will evolve. This is part of what JDA call its “digital hub” strategy, and is described here.

One of the persistent problems in managing supply chains is visibility. If one were to survey supply chain professionals in 1995, and then again in 2005, and then again in 2015, and ask them what their top three challenges were in managing their supply chains, visibility would invariably be among the top three challenges. Even today, supply chain managers simply do not have the visibility to make the best decision at any given point in time. Their level of visibility may be too limited, or too high level, or too detailed. One of the reasons visibility is a persistent problem is that the moment a company feels they have the right level of visibility is the moment they lose it because the problem morphs. Supply chains and associated business processes are constantly morphing – for example, inter-store shipments or shipments from stores to homes were not something contemplated ten years ago.
In the second wave, various solutions emerged to provide visibility. Almost all of these solutions are limited to specific problem domains along the value chain from customers back through suppliers. A company buys an order system and it provides order visibility; they buy a replenishment system and it provides replenishment visibility; they buy an inventory system and it provides inventory visibility; a transportation system and it provides transportation visibility; a warehouse system and it provides warehouse visibility; a factory system and it provides factory visibility; a supplier collaboration system and it provides supplier visibility; a procurement system and it provides procurement visibility. No single system provides end-to-end visibility, and furthermore, even within one domain, such as transportation, the company may have to cobble together different data sources across ocean, air, and ground for consolidated visibility.

The answer is not to try to develop a monolithic end-to-end visibility solution; that has been tried before by multiple companies. The answer lies in bringing together a “network of networks.” In the third wave, digital signals will be available from all sorts of sources. Some companies will build hubs around certain domains. The JDA digital strategy is based on pulling together digital signals from multiple sources, including hubs, and add business process context to flexibly solve increasing parts of the end-to-end visibility problem. This digital hub will have an infrastructure that provides supply chain domain knowledge to process digital signals and that allows value-add apps to be developed and downloaded for consumption by companies.

Ultimately, in the third wave, a map of the world’s supply chains will emerge, much in the same way. Similar things are already happening through crowdsourcing, machine learning, and satellite imagery. This will enable not just visibility, but also the ability to share resources across intersecting networks, as previously discussed.

5.11 Cloud and web-scale IT

The cloud has already emerged as a dominant technological force in all aspects of companies, including supply chain management. The third wave will increasingly be characterized by web-scale IT, which means the scale of the web that is available to consumers will increasingly be available to corporations. The tip of this iceberg is mobility and user experience. Enterprise software user experience will have to be completely reimagined in order to drive higher levels of productivity and to move to a self-training paradigm that millennials are accustomed to with their personal apps.

In the past several years, companies have started down the path of web-scale IT through leveraging infrastructure-as-a-service from the likes of Amazon, Microsoft, Google, and IBM. The next phase is to leverage these technologies as a platform-as-a-service. JDA has partnered with Google because it is a technical engineering company built from the ground up for the cloud. It provides a platform of capabilities for building native software-as-a-service (SaaS) capabilities, and also has programmatic access to a host of value-add capabilities, not the least of which is search. For example, a company can understand the most popular attributes that are searched for associated with the products they sell and can then use analytics to add value to replenishment planning, inventory deployment, and demand planning.

5.12 The two-speed architecture

Perhaps the most important discussion associated with the third wave of modern supply chain management is how to get from today’s state to the future state. JDA has adopted an approach called “the two-speed architecture,” which respects the past while allowing for a seamless branch to the future.

The idea is this; most companies have invested heavily in supply chain assets such as warehouses, factories, transportation, suppliers, and stores, and information technology assets including hardware, software, and networks. No company can afford to rip out their existing infrastructure and immediately branch to future technologies. The idea behind the two-speed architectural approach is to squeeze as much as you possibly can out of your existing assets while branching to the future while taking newly developed capabilities and back leveraging them into the existing asset base to drive additional value for shareholders and customers.
JDA is employing the two-speed architectural approach with its own product portfolio. Existing product platform innovation will continue, while new applications will be developed on Google Cloud Platform (GCP). The newly developed applications add value in their own right, but can also be back-leveraged into the existing product portfolio in a hybrid cloud environment.

Call to action
This is the most exciting period of time for supply chain management in the past twenty years. Customer centricity and the need for supply chains of one, along with the need to maintain or increase profit margins, require companies to rapidly adopt the structural and technological trends discussed herein. The interplay between the customer, structural and technological forces discussed in this paper will keep upping the ante. Thus, urgency for action will only increase.

Disruption will cause some companies to succeed and others to fail. It is critical for companies to create a strategy that respects the past while moving as quickly to the future as possible. To paraphrase Jeff Bezos: “Amazon did not happen to bookstores; the future happened to bookstores.”

3. The average net margin for the retail sector of the S&P 500 was 2.8% in Q1, 2016 (source: CSIMarket).