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FEATURE

# Building a cognitive digital supply network

## Augmenting automation in an AI world

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Cognitive technologies can profoundly transform the digital supply network, not just changing the nature of work, but also augmenting the role of the worker and the entire ecosystem.

AUTOMATION IN THE supply chain is nothing new. From the earliest days of industrialization through the present time, increasingly sophisticated automation technologies serve to drive new levels of efficiencies. Historically, automation has focused on physical tasks, making them more efficient. As technologies continue to advance, however, they may offer new ways for supply chain organizations to achieve efficiencies within areas of business operations where automation was previously considered to be impossible—areas such as thought and reason.

Enter cognitive technologies. At one level, cognitive technologies, also known as artificial intelligence (AI), continue the tradition of automating physical tasks that previous generations of automation technologies offered. But they can also go further, taking the concept of automation to the next level by automating jobs that we ordinarily associate with mental processing, learning and self-correction, sensing, and judgment—in other words, the very things that we consider to be higher-level "human" thought. And so human thought now exists along the spectrum of automation: from repeatable, predictable tasks that replicate physical labor to reasoning and decision-making.

The implications of these capabilities for digital supply networks (DSNs) can be profound in the way work gets done and decisions are made. But just as profoundly, they could take the longstanding idea of the augmented worker to a new level. In one sense, workers can use cognitive tools to augment their supply chain capabilities, going from simply sensing a scenario to understanding it with far greater precision. In a deeper sense, workers could now have the opportunity to take on new, value-added roles, including those that add more *human* elements to the supply chain: qualities such as the formation of relationships, coaching, and nuanced thought. The result of all of this could be continually optimized, more efficient, and more productive DSNs.[1]

In this article, we will examine how cognitively enabled automation of DSNs can extend the historical arc of automation in new and transformational ways. We will offer examples of how some organizations have used AI technologies in increasingly sophisticated approaches in a supply chain context and consider how they may affect DSNs' talent and ecosystem relationships. Finally, we'll offer some steps to consider as you proceed in your cognitive journey.

## Enter cognitive technologies: Automating thinking across the supply chain

A key component of the digital technologies of the Fourth Industrial Revolution, cognitive technologies can create a step-change in what it means to make data-driven decisions—and what it means to automate. Supply chain leaders can pick and choose capabilities that fit their respective, value-focused needs from a broad spectrum of cognitive capabilities, and there are many possibilities at their fingertips—many of which may redefine what automation means.

At one level, *cognitive assistance* technologies can replace basic repetitive tasks such as in the form of rules-based process automation: shipping notifications, order updating, and others. At the next level, *cognitive insights* capabilities serve to draw meaning from patterns in structured and unstructured

## DRIVING GREATER PRODUCTIVITY IN THE SUPPLY NETWORK: A LOOK AT HOW AUTOMATION HAS EVOLVED

Industrial revolutions do not happen in the abstract. They happen because manufacturers in each era want to leverage the emerging technologies of their time to gain greater efficiencies. And the technologies of each era, from the earliest days of the First Industrial Revolution until the present moment, helped define the contours of just how much advancement in efficiency was possible via automation—and where within the organization that efficiency could be realized. No matter the driver, however, the goal is and has largely always been to achieve greater outputs with fewer inputs, all the while adapting to faster process cycles and increasing appetites for innovation.

In the First Industrial Revolution, steam power led to more efficient, more portable engines that could accommodate varying loads unlike anything characteristic of the pre-Steam era. In the late nineteenth and early twentieth centuries, the Second Industrial Revolution witnessed the introduction of the assembly line and electricity into the factory setting, allowing for mass production. In the latter half of the twentieth century, the Third Industrial Revolution saw disruptive information technology and electronics spark movement toward the truly automated production floor.

Now, in the Fourth Industrial Revolution, digital technologies have made possible the smart factory and intelligent production processes, characterized by information transparency, decentralized production, and autonomous decision-making and self-correction, and a fully-connected DSN. As technological options increase, organizations can seek to apply them across a wider range of areas and functions. The result is automation that is faster and smarter, and that can be used in increasingly diverse ways across ever-broader swaths of the organization.[2]

datasets to help humans make better decisions. *Cognitive engagement* takes automation to an even higher place: emulating human senses and judgments (figure 1). *Each* category of cognitive technologies along this spectrum builds on the one before it, but they can be used in any combination to serve an intended goal.[3]

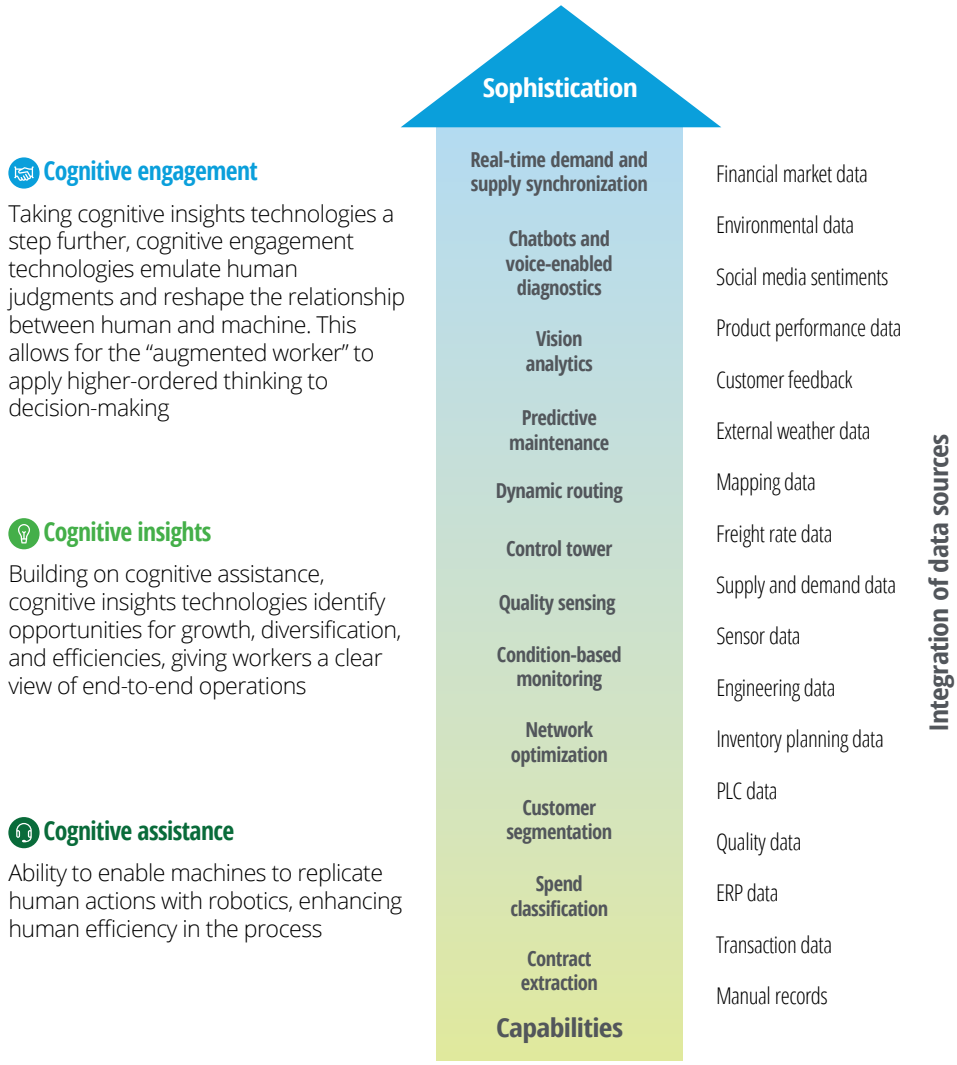
Figure 1 provides a high-level overview of a progression of cognitive technologies along a continuum of sophistication. It also shows *representative* capabilities and data sources that are generally correlative with the technology categories. Below, each of these three categories of cognitive technologies is described in greater detail:

**Cognitive assistance** focuses on automating time-intensive, manual, and repetitive tasks within DSNs, enabling machines to replicate predictable, recurring human actions.[4] Applications in industry today largely center on physical automation, and include examples such as the use of robots for automated welding activities, or picking and stocking inventory within warehouses. On a digital level, they can also include back-office process automation, such as contract management and transaction processing. Here, while cognitively enabled tasks remain repetitive, they can enhance human efficiency, enabling workers to take on the more challenging, thought-related work.

**Cognitive insights** build on the efficiencies offered by cognitive rules-based automation technologies. Cognitive insights tools, such as machine learning (ML), achieve pattern recognition across structured and unstructured datasets to generate insights that are more sophisticated than a human working alone could achieve in the same amount of time. Supply chain companies deploying cognitive insights capabilities can experience broad advances in productivity beyond a discrete task or series of tasks, driven in large part by providing workers

FIGURE 1

## The continuum of cognitive automation within the digital supply network




Source: Deloitte analysis.

and leaders with a clearer view of end-to-end operations and enabling the technology to provide options for critical decisions throughout the supply chain. Examples of cognitive insights capabilities include predictive maintenance, condition-based monitoring, quality sensing, and dynamic routing.

**Cognitive engagement** describes the use of intelligent agents and programs to emulate human sensing and judgment, interact with humans, and make iteratively improving nuanced decisions on their behalf throughout the supply chain. Cognitive engagement applications can not only optimize and execute task-specific roles such as demand planning, but also assess the impact on, and communicate with, other parts of a DSN. At this level, cognitively enabled automation can drive complex tasks such as procurement logistics, procurement chatbots, and voice-enabled diagnostics. As a result of this kind of high-level automation of inherent human qualities, the human worker can be freer to develop new skills and take on new roles

that may become more prominent within cognitively enabled DSNs, while also augmenting their senses and capabilities.

What we describe above is just one cognitive technology classification scheme. Many others are described in the literature.[5]

## Cognitive technologies in action: From repetitive tasks to human sensing and beyond

DSNs are premised on the idea that information throughout the supply chain is both transparent and free flowing. As a DSN grows more interconnected, dynamic, and enriched with more information, cognitively enabled automation can be considered critical to sifting through the vast amounts of data to find insight and drive more intelligent, informed decisions. Humans simply can't extract meaning from those massive data volumes all on their own, nor can they sense information at the same level of precision as sensors and other automated tools.

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Moreover, when we speak of automation within a DSN context, we do not simply refer to the physical act of manufacturing. Rather, automation is a holistic concept that extends throughout a DSN's spectrum, from product development to resource planning to physical production to logistics/distribution to customer feedback. Each of these can be made more efficient by the application of cognitively enabled automation technologies. Further, many kinds of digital technologies that already power DSNs can also be used to power cognitive technologies, including cloud, sensors, edge computing, and others.[6]

So, how do AI technologies find application within DSNs? Below, we examine examples that reflect differing levels of purpose and sophistication to illustrate the various cognitive possibilities in action.

### PHYSICAL AUTOMATION OF ROUTINE TASKS: COGNITIVE ASSISTANCE APPLICATIONS

At the lower end of the spectrum, cognitive assistance technologies such as collaborative robots or "cobots" can execute routine processes at typically minimal cost with high accuracy. For example, cobots can be used as warehouse pickers or for performing some basic repetitive manufacturing operations. Another cognitive assistance example may be the use of a "rules-based" process automation solution to facilitate shipping notifications or order tracking.

The common thread that runs through these types of cognitive automation is that they are based on performing a function to save money and mitigate worker fatigue, and not necessarily to yield insights or to directly assist the human worker to make better decisions—however much they free up the worker to do other things. In that sense, this type of "tactical" automation bears some similarity to "traditional" automation within the supply chain.

## DYNAMIC ROUTING FOR RETAIL: COGNITIVE-DRIVEN INSIGHTS LEADING TO EVER-IMPROVING DECISIONS

At a higher level, cognitive technologies can automate insights to help human workers make more precise, data-driven decisions. For example, a cognitive technology optimizing application was developed for one retail organization to help workers make better decisions about resource allocation by optimizing the flow of goods to retail stores at the lowest cost. The company typically used fixed routes for delivery. While that approach usually worked well for higher-volume deliveries, the volatility in delivery volumes meant that the company often experienced cancellations on lower-volume days, leading to lower responsiveness, underutilized trucks, last-minute scrambles for additional trucks in some instances, and reduced service levels to stores. Additional economic factors—including an estimated nationwide shortage of some 50,000 truck drivers—required that the organization find a smarter, more responsive, and more efficient system.[7]

An application that leveraged cognitive technology heuristics and metaheuristics, in combination with cloud and other digital technologies, was configured to optimize routing alternatives to address this problem. Specifically, the application received and analyzed numerous datasets, such as pallet-count information, real-time demand data, and other more nuanced business constraints, across multiple flexible data formats to produce a set of routing solution choices. The output of the application provides a set of several routing alternatives from which the user may select; each alternative is optimized primarily to reduce cost of delivery, while other secondary objectives include maximized throughput and minimized miles. This approach led to this particular company's 25 percent cost reduction in outbound logistics, 44 percent improvement in asset utilization, better standardization of pallets shipped to stores, and an overall increase in customer service.

While the short-term impact of a cognitive insights application is clear, the opportunity to enhance this solution is large, with ML being the next potential enhancement. As this tool evolves, it can learn from the routes created over a time period, assess the adjustments that were made, and analyze user choices to improve the quality of its recommendations. As it consumes more data and is trained to learn which decisions drive the greatest impact for the overall organization, it is expected to become smarter and more effective—not only providing the user with insights, but also ensuring that those insights continually improve based on prior choices.

## EMULATING AND AUTOMATING HUMAN SENSING: TAKING COGNITIVE TECHNOLOGY AUTOMATION TO A HIGHER LEVEL

As we discussed, cognitive technologies can automate repetitive tasks as well as help optimize a distribution process to allow the human to make better choices about resource allocation. But cognitive technologies can take the concept of automation to an entirely new level when human sensing capabilities enter the picture.

### *Emulating human vision*

Computer vision is a kind of cognitive technology that derives information from visual images, in effect automating the human visual system. In one example, a computer vision application is employed on a factory floor to monitor a factory process for "micro stoppages." Often impractical

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for humans to monitor, micro stoppages occur when an asset malfunctions and faults for a minor, unknown reason that often does not require anything more than a factory worker hitting the reset button to restart the machine. As a single event, a micro stoppage is not costly, but over time their cumulative cost can be significant.

Using ML and analyzing each pixel of an image and comparing it to the dataset on which it was trained, the computer vision application assesses each micro stoppage to determine its cause, and either auto restarts the machine or alerts the floating line operator to do so. Essentially, this cognitive solution automates the human ability to observe and process images in ways far beyond the capabilities of a single human being. And, in so doing, it enables the company to achieve greater efficiencies. Specifically, it is expected to lower costs by quantifying the cost of micro stoppages with a camera as opposed to a costlier IoT platform solution. In this way, the cognitive solution can eliminate the need to employ workers to stand by the machine around the clock, manually collecting data, and thereby freeing them to deploy their skills more effectively to other tasks.

### *Emulating human hearing*

Still another, perhaps even more sophisticated, example of the automation of human sensing is found in a plant in which grinders were used to mix resins into a fine blend. Often, the grinders can remain in operation until the blades become dull and the system fails; such a "run-to-failure" approach is costly and inefficient, as the blend ratio is typically affected long before the machine fails, resulting in excessive wastage of materials. To address this challenge, one manufacturer placed a sensor near the grinder blade to record the sound that the blade makes when it is healthy and when it is not. A speech recognition algorithm then turns the analog waves of the sound into digital data.

This algorithm interprets the sound and leverages ML to identify patterns in the sound data of a new blade and a dull blade until it can effectively analyze blade health. Putting this cognitive solution into operation predicted with 92 percent accuracy when the blade was required to be replaced. This solution offered a unique cost-saving substitute to the previous run-to-fail methodology. In a fashion analogous to the computer vision example, this example serves as an automation of the human ability to hear and process far beyond unaided human capacity.

These latter two examples show how AI technologies—in combination with other digital technologies—can automate intrinsic human capabilities—whether it is vision, hearing, mental processing—within DSNs. And, indeed, other cognitive solutions within DSNs may automate other human sensing capabilities such as touch and taste. In effect, this kind of automation serves to expand human capability well beyond the individual human limitations offering more accurate, comprehensive versions of these intrinsic human qualities. Still other, even more sophisticated kinds of cognitive engagement technology applications in DSNs—using some combination of such technologies as ML, natural language processing, and natural language generation—may be able to make autonomous decisions, thereby automating the capabilities of human judgments.

## WHAT DOES THIS ALL MEAN FOR DSNS AND THOSE WHO WORK WITHIN THEM?

Cognitive technologies extend the arc of what can be automated to include the full range of human thinking—from the kind of thinking that accompanies physical action to human sensing to human judgments. And because the ways in which AI technologies can be used to drive productivity in every part of DSNs are nearly unlimited, so too are the ways in which thinking can be automated within DSNs.

Such vastness in the use of cognitive technologies to automate human thought within DSNs poses a new strategic imperative: How should I manage

thinking in my DSNs? And what thinking is done by whom and how? Any answer should fit the particular circumstances of any given organization and project at any given time. Indeed, what is right today may not be right in the future, and more sophisticated is not always the best choice.

Earlier, we referred to the use of cognitive technology in automating human capability well beyond individual human limitations, whether this refers to senses (such as vision) or human judgment itself. But the larger question remains: What does the automation of human thought by way of cognitive technology mean specifically for the human worker and their role within DSNs? How will they *personally* change in cognitively enabled DSNs?

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## THE INDIVIDUAL, AUGMENTED HUMAN WORKER

While there is no way to know precisely, we can conjecture a few possibilities. First, any cognitive solution that aims to automate human thought should, at a minimum, unburden the worker most affected by that solution to take on different, more value-added activities in the organization. As roles evolve, so could the skills that professionals need to complete them. For example, analysis of data that forms the basis of all cognitive technologies could naturally become a larger part of most roles within DSNs, even roles where there was little application of data analysis in a precognitive era. This can lead to a need for shifting training approaches to address these changing job skill requirements.[8]

Such roles may also require highly nuanced and circumstantial skills of judgment, creativity, communication, and intuition—qualities that are not easily emulated by AI technologies. Other areas of focus may involve the kinds of coaching and training skills that are necessarily a part of any organization and that are also not amenable to automation. As supply networks become more cognitively enabled, these intrinsically human qualities can become even more important.[9]

Indeed, the changes in the roles that humans will likely pursue and the qualities that may emerge as especially important in cognitively enabled DSNs describe a potentially even more powerful kind of change than technological duplication of human qualities. It speaks to an "augmentation" of intrinsic human capability—in essence, a more capable, more flexible human worker.

## BEYOND THE AUGMENTED HUMAN WORKER, ON TO THE LARGER TEAMS AND ECOSYSTEM THAT FORM DSNS

The story of augmentation in cognitively enabled DSNs doesn't end with the individual worker. Just as individual roles and skill sets are expected to evolve and augment in a cognitively enabled DSN, so too should teaming relationships. The removal of silos can help drive changes in personal interactions and, ultimately, teaming architectures, including partnerships among DSN professionals with different skill sets and areas of focus. As these and other kinds of collaborations form, the possibilities for knowledge sharing multiply exponentially.[10] In cognitively enabled DSNs, we

can envision the emergence of the "augmented" team.

The augmentation of individual workers and teams may even inspire larger forms of collaboration throughout the supply chain ecosystem that include partners and customers uncovering new insights and driving additional value in the process. For example, in this context, a procurement specialist in a cognitively enabled DSN may more proactively interact with the organization's vendors based on insights that emerge from the application of AI technologies, building stronger relationships and finding new opportunities to partner on future initiatives. These new ecosystem relationships may also help DSN organizations fill strategic and tactical voids in talent and technology, potentially building even stronger cognitive capabilities. In that way, organizations can use their DSNs to better leverage the "augmented" ecosystem.[11]

Ultimately, as cognitive technology automation is more fully adopted throughout DSNs—and individuals, teams, and the supply chain ecosystem evolve as a result—DSNs will likely become new, more evolved versions of what they are today in how they organize, operate, and collectively think.

## Beginning your cognitive journey

Companies are facing tougher margins, a growing demand for customization, and ever-increasing customer expectations. In alleviating these challenges, companies can leverage AI technologies both to speed repetitive processes and automate their ability to sense, predict, and respond to shifts in the market. As leaders contemplate cognitive automation within DSNs, it might be helpful to think critically about your current state and consider ways to use AI to achieve greater supply network productivities.

Toward that end, here are a few steps that you may consider as you traverse the cognitive journey within a DSN context:

**Never lose sight of the reason you're going cognitive.** The deployment of any disruptive technology should have a basis for its adoption. In this paper, we highlight the very real potential of cognitive technologies as a catalyst for heightened efficiencies and less waste within DSNs. Improved supply chain productivities are not the only benefit of cognitive adoption; there are numerous positive outcomes. Your motivations should inform the choices you make in pursuing cognitively enabled DSNs.

**Develop a strategy that helps define where AI technologies fit into your organization and how you want to implement them.** Haphazard planning or "random acts of digital" will not enable your DSNs; investment in cognitive technologies is typically intentional—and gradual. It is important to first take the time to determine where it may fit best, test it, and then implement it. It may make sense to adopt cognitive technologies in some logical sequence of increasing sophistication; but it may not be necessary to adopt all cognitive capabilities in sequence. Rather, you may prefer to delve into more advanced cognitive insights and engagement technologies earlier than later. It is important to craft a cognitive solution that will best fit the needs of the organization.

**Don't hesitate to take the first step.** You don't have to have everything figured out all at once. The cognitive process is generally iterative and "failure" can be an ally toward greater understanding.[12]

**Lean into your talent.** Your organization's ability to adapt to the adoption of cognitive technologies can be both enabled and hindered by your workers, but ultimately determined by them. Certainly, you will not only require talent to create the tools, but also the talent to use them effectively in day-to-day operations. But most importantly,

you should develop and execute on a well-considered plan that enables legacy and newly hired talent to adapt to these technologies and processes—and, ultimately, embrace them—and consider the new roles and development opportunities that may emerge as cognitive capabilities mature and take on some of the more traditionally human-thinking tasks.

**Lean into the ecosystem.** It will be difficult to achieve cognitively enabled DSNs alone. As you understand your gaps in talent and technology, you should also assess where partners can fill the void and incorporate them into your strategy. More broadly, forge new relationships with your suppliers and customers as part of your emerging cognitive DSN initiative. In so doing, you may unleash new opportunities for insights and business opportunities.

While these steps are important to consider on the journey to achieving cognitively enabled DSNs, there is no proven recipe. Successful adoption will require a full array of considerations, including investment and tolerance to failure. It will also require patience. Organizations that understand this and learn from their experiences, adapt, and evolve along their cognitive journeys are likely to be rewarded with more effective organizations—and more productive DSNs that take full advantage of everything that cognitive technologies make possible.

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