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BUILDING THE BIONIC SUPPLY CHAIN

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THE COVID-19 CRISIS HAS brought to the fore supply chain challenges that many companies have long grappled with. Consequently, even though recent investments in digital solutions have helped somewhat, firms are still dealing with many of the performance challenges that they've been dealing with for decades.

To capture the greatest value from their end-to-end (E2E) supply chains, companies need to adopt a bionic operating model. With the help of adaptable key performance indicators (KPIs) that focus on optimizing overall performance in any situation, a platform organization that works cross-functionally, and a data and digital platform (DDP) that enables collaboration, a bionic supply chain leverages the best of what both machines and humans have to offer.

Building a bionic supply chain requires a comprehensive digital transformation where employees as well as leaders play crucial roles. Although the size of the effort is enormous, a bionic supply chain can lead to substantial improvements in performance. It can boost revenue by 4% to 6%, customer service levels by 5 to 30 percentage points (pp), and EBITDA by 2 to 4 pp. Moreover, a bionic supply chain has the potential to reduce manufacturing, warehousing, and distribution costs by 10% to 20% and working capital by 15% to 30%. It's also more able to react swiftly to sudden changes in demand, supply prices, trade policies, and so on—perhaps the most important consideration of all in the current business environment.

The Digital Dilemma

Over the past decade, digitization has helped improve many supply chain functions. Firms have deployed automation, advanced analytics, and artificial intelligence (AI) to optimize the value of supply chain operations for specific use cases, including demand forecasting and production scheduling. Today, supply chain functions such as planning, manufacturing, and distribution are semiautonomous in many companies.

Yet even today's most digitally developed supply chains are far from realizing their promised benefits. Various interrelated challenges stand in the way. For starters, the organization model is still siloed. Demand planners, logistics managers, schedulers, and other employees tend to be more focused on optimizing their own subfunction's performance than the E2E supply chain's. Organization structures and incentive systems that focus on functional performance exacerbate these obstacles. And resistance to change hasn't helped matters.

As a result, collaboration between humans remains underdeveloped. Data has greatly enhanced visibility across the E2E supply chain, and platform organizations have made cross-functional decision making easier. But the KPIs that guide decisions are frequently in conflict with one another. For example, manufacturing's metrics aim for low production costs with large batches and few changeovers, whereas the customer supply chain requires high flexibility and thus small batches and frequent changeovers. Consequently, it can be difficult to make decisions that will optimize overall supply chain performance.

Emerging technologies pose an additional challenge. New analytics solutions have the potential to improve the speed and quality of decision making. But adoption is slow because some of these solutions are seen as black boxes whose inner workings are hard to grasp and as a result are untrustworthy. So it's not surprising that many supply chain operators don't feel comfortable using these technologies.
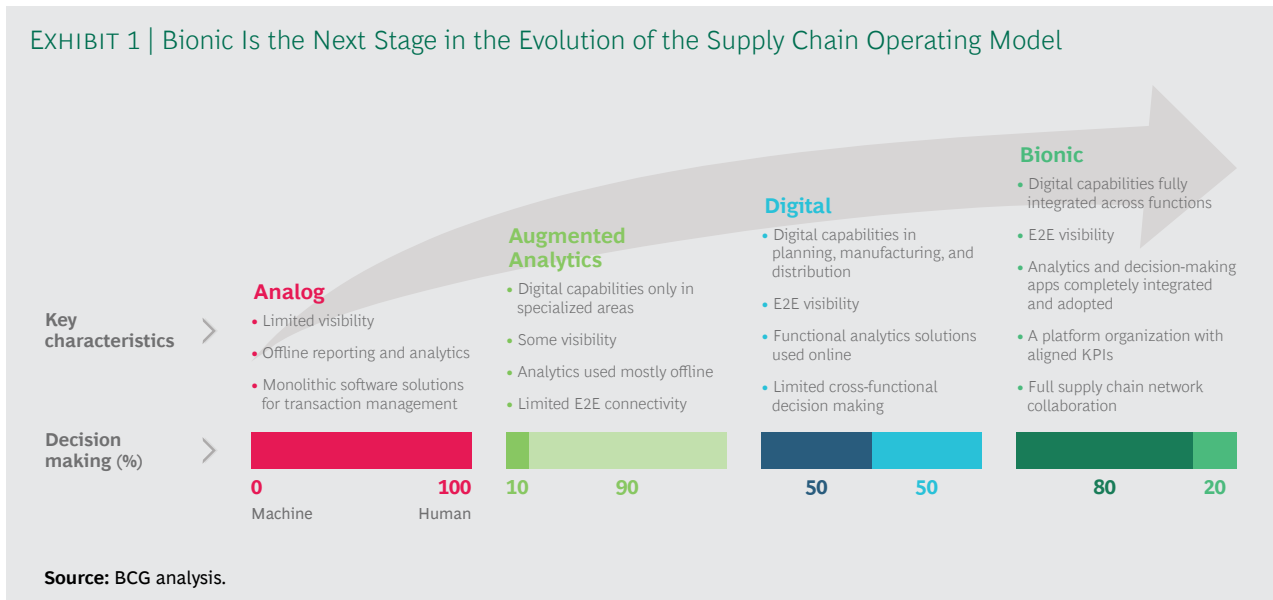
Organizations also must contend with data problems. In many companies, data is trapped in core systems, such as ERPs. This limits the accessibility of the data and therefore the value that can be extracted from it. While data platforms have eased that pain somewhat, firms still have trouble scaling and developing their data assets.

Taking Digital Capabilities to the Next Level

The bionic supply chain operating model, a major step forward from the digital supply chain, addresses these issues. (See Exhibit 1.) Digital capabilities are fully deployed E2E. A platform organization, which consists of a cross-functional team with digital and supply chain capabilities, designs automated E2E processes and manages exceptions. Companies use KPIs to steer E2E supply chain processes while balancing tradeoffs to best support the business strategy.

One key advantage of a bionic supply chain (and, more specifically, a "digital twin") is its ability to simulate the behav-

EXHIBIT 1 | Bionic Is the Next Stage in the Evolution of the Supply Chain Operating Model

Bionic
- Digital capabilities fully integrated across functions
- E2E visibility
- Analytics and decision-making apps completely integrated and adopted
- A platform organization with aligned KPIs
- Full supply chain network collaboration

Digital
- Digital capabilities in planning, manufacturing, and distribution
- E2E visibility
- Functional analytics solutions used online
- Limited cross-functional decision making

Augmented Analytics
- Digital capabilities only in specialized areas
- Some visibility
- Analytics used mostly offline
- Limited E2E connectivity

Analog
- Limited visibility
- Offline reporting and analytics
- Monolithic software solutions for transaction management

Key characteristics

Decision making (%)

Analog	Augmented Analytics	Digital	Bionic
0 ... 100	10 ... 90	50 ... 50	80 ... 20
Machine ... Human			

Source: BCG analysis.

ior of the entire system across different scenarios and provide more accurate predictions. Armed with this information, executives could make better decisions in the face of sudden events. It could also be used to develop more reliable indicators for risk exposure and recovery time.

COLLABORATION: THE SECRET INGREDIENT

The hallmark of the bionic supply chain is the ability of humans and technologies to work together in a seamlessly orchestrated workflow. People and machines make the decisions that they are each best suited to make, which maximizes the supply chain's responsiveness and agility.

Three types of collaboration are involved:

- **Machine-to-Machine.** We estimate that some 80% of day-to-day decisions will be made by machines collaborating with machines. This type of collaboration uses sensors and connectors for full visibility and AI for advanced decision making. Human experts need to carefully design the underlying decision mechanisms and rules.

- **Human-to-Machine.** Another 10% of decisions are likely to require people to work closely with machines. This is where intuitive algorithms, scenario modeling, and impact analysis come into play.

- **Human-to-Human.** The remaining 10% of decisions will depend on people working closely together. This kind of collaboration is needed for addressing urgent and unanticipated issues that are difficult to address in any other way.

BOOSTING COLLABORATIVE CAPABILITIES

Companies eager to "bionicize" their supply chain usually focus on implementing more-advanced digital technologies at the expense of human-to-machine and human-to-human collaboration. To ensure that they leverage each type of collaboration to the fullest extent possible, companies need

to revisit four elements of their supply chain operating model.

KPIs. The first step is to review KPIs across the supply chain, since they are the targets that guide performance. Often, we see that KPIs set for one function undermine or nullify KPIs set for another. The problem lies not so much with the KPIs as with the lack of focus on overall business goals.

Crises like COVID-19 only exacerbate such challenges. The good news is that in these kinds of circumstances, leaders align cross-functionally to manage overall business performance. But it shouldn't be only in times of crisis that the supply chain is wired that way.

For these reasons, companies need to ensure that they align KPIs with the business strategy. Because it's impossible to perform on a world-class level in every dimension, firms must focus on achieving top performance in the dimensions that are most important strategically, whether that's service, cost, or inventory.

Inevitably, this approach forces some tradeoffs in other, less strategic dimensions. Consequently, to help ensure a balance where key strategic objectives for each customer segment can be met without compromising performance elsewhere, companies need to align KPIs across the E2E supply chain and link them to business KPIs. Organizations should also make sure that they embed the KPI framework in the technology they use for daily supply chain execution, since it's the day-to-day decisions that determine supply chain performance.

The Platform Organization. The core vehicle for effective human-to-human collaboration across the E2E supply chain is the platform organization, defined as a learning system of people who work closely together. The employees in the platform organization are responsible for designing the automated processes constituting the bulk of supply chain activities; they also make the decisions that require human input. For this reason, every mem-

ber of the organization should have access to real-time data. Ideally, they should also be collocated and required to participate in agile mechanisms such as daily standups or situation room meetings.

Although not everyone in a large platform organization can be collocated, collocation principles should still apply. Procter & Gamble started this journey 15 years ago when it began forming its regional planning centers all around the world. Enabling all these people with similar skills and responsibilities to sit together in the same place has made collaboration much easier. Not surprisingly, several companies in other industries are now following suit.
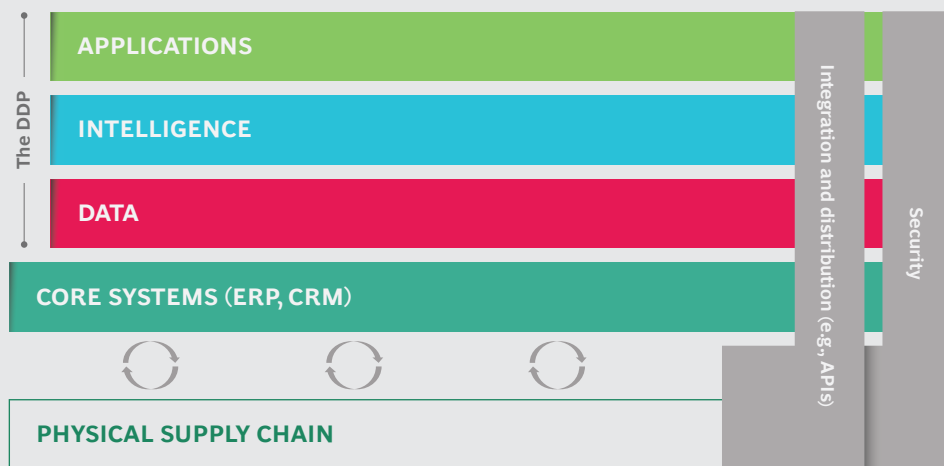
Digital Skill Building and Talent. Sophisticated digital skills are a must for anyone involved in the functioning of the bionic supply chain. These skills vary with the role. Deep supply-chain domain knowledge is essential for the people in the platform organization who design the automated processes. Expertise in data science is required for those who design and train the algorithms. Software engineers are needed to ensure that models are properly coded, able to scale up, and performing at the right level for real-time monitoring and decision making. Operators throughout the supply chain, whether in procurement, demand planning, or logistics, also require

digital skills. Training programs must provide the necessary upskilling for these roles.

The Data and Digital Platform. A cloud-based industrial DDP addresses many of the data and technology challenges that companies face. Built on top of the existing core systems, the DDP has three key layers (Exhibit 2 presents a simplified schematic):

- **Data.** Data is extracted from the core systems and stored in a repository where it can be accessed by applications and analytics models. It's then able to cover the value chain E2E and support critical cross-department decision making—and create a single source of truth.

- **Intelligence.** Advanced analytics and AI engines sit on top of the data layer. Generating insights from the available data, the engines share this information with the user applications by means of microservices and application programming interfaces (APIs). APIs are important because they ensure that the different components across the layers all talk to one another.

- **Applications.** The apps constitute the front-end interface with users. Designed and built with the appropriate, highly

EXHIBIT 2 | The Data and Digital Platform Sits on Top of the Core Systems

The DDP
APPLICATIONS
INTELLIGENCE
DATA

CORE SYSTEMS (ERP, CRM)

PHYSICAL SUPPLY CHAIN

Integration and distribution (e.g., APIs)

Security

Source: BCG analysis.

intuitive user interface, they ensure simplicity and ease of use.

The DDP provides other noteworthy advantages over legacy architectures. It ensures that real-time data is shareable, allowing centralized teams to conduct activities that previously could be done only locally. And the modular architecture of the platforms means they can be built incrementally, an agile approach to value creation that makes it easy to scale and replace outdated solutions as the need arises.

Implementing the Bionic Supply Chain

Many companies have focused their digitization efforts on the technology piece—and many of these efforts have had suboptimal results. BCG research clearly demonstrates that a strong focus on people and processes is key for a major change initiative like digitization. Our analysis of more than 1,000 companies that went through fundamental transformations found that digitization failed when employees were left out of the design initiative, leaders didn't direct the effort, or the change was not explained well. Problems also arose if the undertaking was large and uncoordinated, employees lacked the necessary skill sets, or business was conducted as usual without regard for the additional workload the transformation created.

We've found that five practices are especially important for a successful bionic supply chain implementation.

Put Employees at the Center
While the end result of a digital transformation needs to address the customer's real pain points, the implementation needs to focus on employees to ensure that they adopt the changes. That means, first of all, involving employees in the development of the bionic supply chain solution. They need to provide feedback and be invested if the transformation is to be viable.

It also means ensuring that employees have adequate digital capabilities. Skills like deep learning are quite different from those used in a reorganization or post-merger integration. So companies need to decode their digital talent—they need to understand the digital skills employees currently possess as well as the ones they'll need to acquire in the future. Employees also must be trained on how advanced analytics make their recommendations and the appropriate way to interact with and enrich these tools. This helps shift people's perception of technology from black boxes to collaborative entities that can enhance decision making.

Double Down on Leader Alignment and Enablement
The leaders of a digital transformation wear many hats. They engage employees, address potential fears, clarify issues, and provide guidance on required behaviors and skilling. They also adjust the context—including the transformation agenda, roles, and performance management—to support cross-functional collaboration. Because employees might not yet be sufficiently digitally skilled, leaders help with technical issues as well. Determining how much these decision makers need to know about AI and other technologies is essential.

In addition, leaders need to be on the same page regarding objectives and given the power to realize them. While this holds true of any kind of change initiative, it's even more vital for a digital transformation because of the sheer scope of change involved.

But little will be accomplished unless leaders have purpose. They need to be strategically and emotionally convinced that a bionic supply chain is necessary and must be ready to play a prominent role in making it happen. As the focus shifts from individual silos to a more centralized platform, executive sponsorship is key to managing potentially substantial resistance and creating momentum.

Everyday work needs to continue while the transformation is in progress. This means that leaders must understand the impact that the change initiative has on normal workloads and adjust them accordingly. If

people are very busy, it's not a good time to roll out new tools and processes.

SET UP A TRANSFORMATION MANAGEMENT OFFICE

Not coincidentally, the top 25% of companies in BCG's Global Change Readiness Database have an activist TMO in charge of their digital transformation. As the center of the bionic supply chain change effort, the office should holistically manage the transformation journey of the leaders, people, and program while also making sure that the initiative is integrated with the rest of the company. The TMO is quickly becoming table stakes, so it's important to get it right.

DEVELOP A DDP STRATEGY

Transitioning from the legacy architecture to a DDP is one of the greatest challenges of a digital supply chain transformation. It begins with putting the right cloud-based infrastructure in place and adding the data domains that are needed. These changes are best made incrementally, with an eye on what data is most important from a value perspective. As more and more digital applications and processes are added to the DDP architecture, core business processes can be progressively migrated to the new platform. Eventually, the DDP can become the underlying platform for the entire company.

Implementing a DDP is a long, complex journey. Most companies will likely want to start with a hybrid tech stack consisting of standard core solutions and a bespoke intelligence layer. But given the vital functions that the DDP provides, firms should also determine how they will migrate to a full-fledged DDP over the long term.

CONTINUALLY SCRUTINIZE

Because the transformation effort is unlikely to fully implement all the required changes, leaders need to see which elements should be adjusted after it's over. This is the time to set up a continuous improvement approach to make sure that processes are still working, employees are still upskilling, and so on. We've found that the most successful transformations display this kind of self-scrutiny. Transformations that don't are likely to need a reboot in a couple of years.

N O COMPANY HAS yet completely bionicized its supply chain operating model, though a few have taken great strides in that direction. Companies that want to realize the full benefits of digital need to understand where their current operating models fall short and what steps will help fix them. Going bionic is not an optional exercise—in bad times or in good ones. Your future competitiveness depends on it.

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