IDC PERSPECTIVE

Making the Case for Machine Learning in Manufacturing

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EXECUTIVE SNAPSHOT

FIGURE 1

Executive Snapshot: Machine Learning Will Be Critical to Digital Transformation

For manufacturing firms, the prospect of transforming business models, initiating new operating paradigms to support those models, and monetizing information for new levels of productivity has made machine learning a top technology priority. This IDC Perspective provides manufacturers with a pro forma business plan when it comes to machine learning – the why, what, who, and how – to help articulate the way forward.

Key Takeaways

- Manufacturing represents $4.5 trillion of the overall $18 trillion digital transformation (DX) opportunity. Machine learning is an essential technology to deploy across the value chain to realize this opportunity.
- Building the financial justification for digital transformation (and machine learning) depends on identifying the payback related to each part of the manufacturing value chain. Machine learning may be the most fundamental element of realizing these gains.
- Machine learning is the use of algorithms and statistical models to effectively perform a specific task without using explicit instructions.

Recommended Actions

- Machine learning will require internal and external resources – the line of business should lead but with the right technology partner.
- Explore DX use cases across the manufacturing value chain where decision making can be optimized.
- Your internal digital transformation organization must transition quickly to one where the digital initiatives are embedded into the ongoing activities of the functional leadership.
- IDC advises to look first to one of the megaplatforms as they can offer the widest range of necessary capabilities, will have the largest external developer communities, and are most likely to enhance their offerings faster.

Source: IDC, 2020

April 2020, IDC #US46179220

SITUATION OVERVIEW

Machine learning/artificial intelligence is not a new technology. Concepts such as heuristic processing, simulation, neural nets, and cognition became mainstream academic disciplines as early as 35 years ago. A paucity of compute power and the ability to handle vast streams of data relegated these concepts to more theory than practice, but as compute capabilities continued the relentless progress of Moore's Law and innovative internet companies such as Google have shown how to handle vast stores of data, machine learning has been brought into the mainstream.

For manufacturers, the prospect of transforming business models, initiating new operating paradigms to support those models, and monetizing information for new levels of productivity has made machine learning a top technology priority. However, building a business case in manufacturing can be illusive as can choosing the right technology partners and organizing for success. The purpose of this document is to provide the reader with a pro forma business plan — the why, what, who, and how — to help articulate the way forward.

Why Is Machine Learning Important to Manufacturing?

The CEO of a large financial institution, speaking at the Mobile World Congress, declared that his/her company was no longer a bank, but a technology company in the financial services industry. This theme is consistently seen across most industry segments and geographies, and manufacturing is no different. Digital transformation (DX) has become the central business strategy in the digital economy.

This new strategic direction begs the question — what do these CEOs see as the opportunity? Consider the healthcare industry, which represents 18% of GDP in the United States. Consider the ability to connect patients to continuously monitor their vital signs and then to use machine learning technologies to improve diagnosis and treatments. Or the fact that 60% of the energy that is generated is never used; the same with food — 60% of what is grown is never eaten. Across all industries, this amounts to an opportunity for an annual economic value add of $18.5 trillion or nearly 25% of global GDP. This value add is what the CEOs recognize and the reason for building a strategy around technology.

The manufacturing industry represents $4.5 trillion of the $18.5 trillion opportunity. Building the financial justification for digital transformation (and machine learning) depends on identifying the payback related to each part of the manufacturing value chain. Machine learning may be the most fundamental element of realizing these gains. As companies come to develop and offer new customer experiences and transform the associated operating models, the ability to collect, refine, and leverage information will be the central distinguishing feature of success in the digital economy. Justifications will align with improving net promoter scores (which correlates strongly to market share gains) and productivity gains.

What Do We Mean by Machine Learning?

Machine learning is the use of algorithms and statistical models to effectively perform a specific task without using explicit instructions. This takes human action out of the decision-making process, instead relying on patterns and inference. In addition, it provides systems the ability to automatically learn and improve from experience without being explicitly programmed. In IDC's ongoing research on digital transformation, we find that companies that are further along in their efforts are organizing their investments along three constructs — modernizing existing systems, deploying digital platforms, and industry clouds.

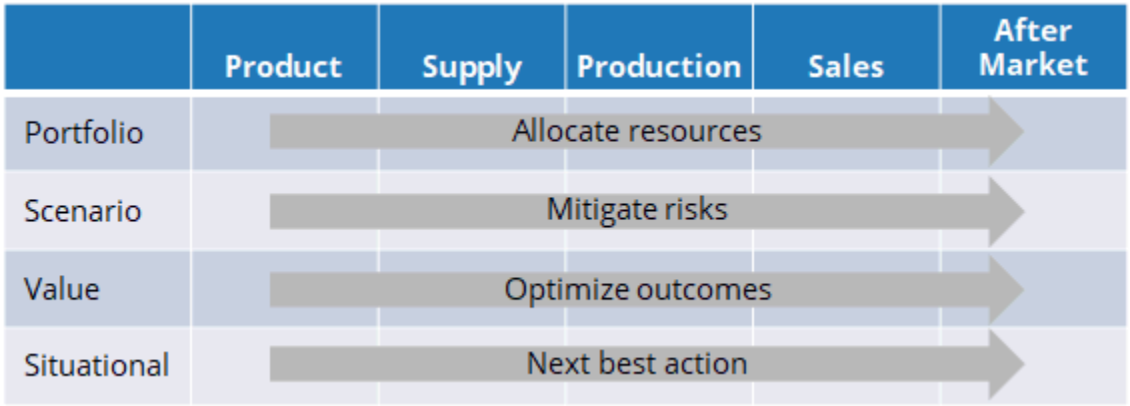
System modernization essentially brings a company's existing application portfolio to a point where those applications can maintain the pace of digital operations. Modernization involves three essential elements. One is portable interfaces that can accommodate new user experiences like mobile, AR/VR, and intelligent agents. Cloud deployment models are also an important part of the modernization so that infrastructure is scalable and flexible. Finally, the convergence of transactional and analytic processing into a single memory space is the element most closely aligned with machine learning. These in-memory architectures provide real-time analysis of a company's financial position.

Industry clouds are being deployed to share technology, process, and information across a value chain. Predix from General Electric or MindSphere from Siemens would be prominent examples. By far the most common and fastest-growing types are those created to exchange information. These information industry clouds will be an important element of machine learning value as a source of critical information to the analytic models that will be built.

The most pivotal and drawing the greatest amount of investment is the digital platform. The digital platform is an architectural construct that marries an analytic model for decision making (the digital twin) with the instrumentation and activation of the operational processes like RPA (the digital thread). The digital twin is an analytic environment that creates a closed-loop decision-making model for any domain in the value chain. The model is built to connect the decisions made at the most strategic level to those being made in real time at the operational level (see Figure 2).

FIGURE 2

Analysis Across the Value Chain



Source: IDC, 2020

In an interesting piece of academic research, more than two-thirds of companies reported not meeting their stretch goals for profitable growth, yet more than 95% of those firms had detailed strategic plans. The message to executives is clear — having a brilliant strategic plan may be necessary, but it is not sufficient in achieving goals. In a separate piece of research investigating companies with Lean Six Sigma programs in place, the number 1 impediment to success was the lack of strategic direction in order to set priorities. The digital twin serves to bridge the strategy to execution gap. There are four types of analysis that are done for every domain within a manufacturing enterprise:

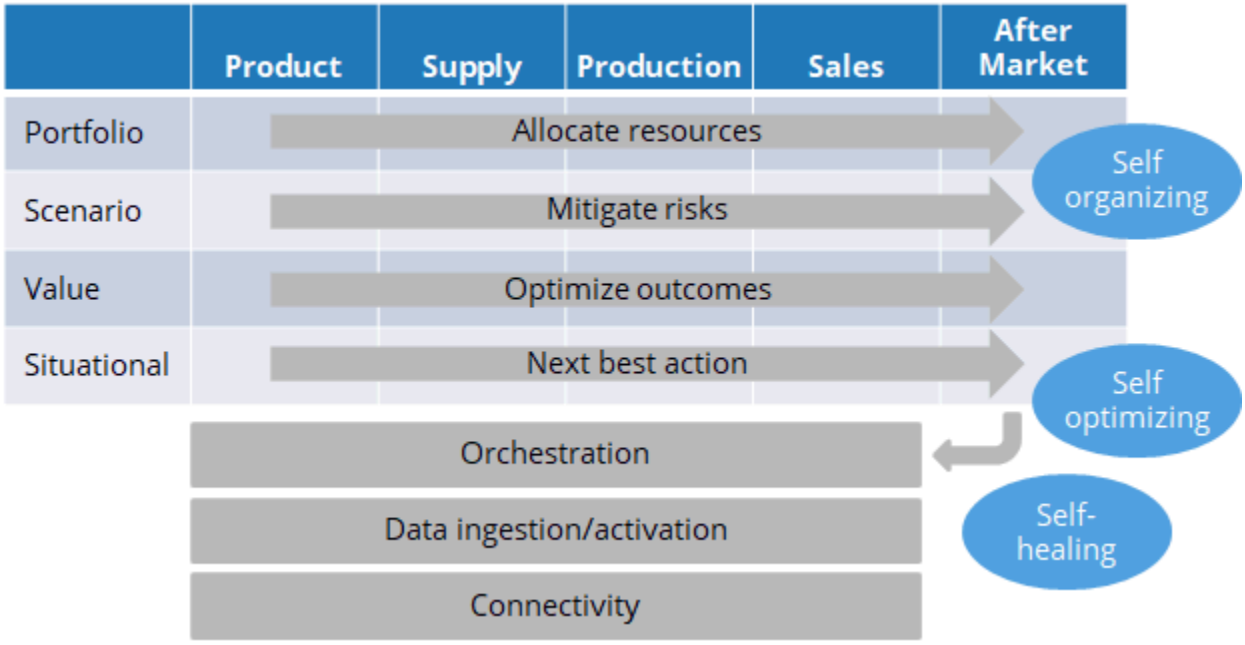
- **Portfolio analysis:** This is done at the highest level of the organization determining the right mix of products, customers, suppliers, assets, people, and so forth. The purpose of this analysis is to allocate resources.
- **Scenario analysis:** This is done at a senior level in the organization looking at possible situational possibilities to identify where the organization is vulnerable with the goal of mitigating risks.
- **Value analysis:** This is normal near-term planning where different countervailing outcomes (e.g., inventory levels versus order fulfillment rates) are evaluated to optimize outcomes.
- **Situational analysis:** This is a real-time evaluation that determines the next best action.

In these models, business policy or rules flow down, while information flows up. The premise is to create a complete closed-loop decision process essential to achieving the promise of digital transformation.

The digital thread is realized at the process level and is often at the center of plans for incorporating IoT technology. There are essentially three layers. At the foundation is the devices and associated connectivity. The next level is the data ingestion and activation layer. This tier serves to both aggregate and organize the data coming from the device and to send instructions back down to those devices. At the top level is process orchestration, which puts the data and action into a process context. The digital twin and digital thread come together when the next best action coming from the situational analysis directly communicates with the process orchestration to instantiate the action (see Figure 3).

FIGURE 3

The Benefits of Digital Platform, Digital Twin, and Digital Thread



Source: IDC, 2020

Having this platform in place will help deliver the self-healing processes that are at the center of digital transformation in manufacturing. As the model is trained, this could be further expanded to the model being capable of self-optimizing plans and self-organizing resources. Japanese manufacturer Denso is a great example of a company that is on this journey. The company is making major IoT investments in its 130 manufacturing sites around the world to improve quality and increase throughput. These efforts are supplemented by the application of advanced analytic approaches to ensure that results are optimized across the whole network of factories.

Who Are the Key Stakeholders?

Achieving digital transformation is an enterprisewide effort, but for machine learning, the magnitude of the change and the need for certain skills dictate a particular approach to how a firm thinks about both its internal and external resources.

Internal — Getting to LOB Lead Initiatives

IDC recently completed a survey of nearly 1,000 digital leaders to determine how transformation efforts were staffed and budgeted. Using cluster analysis, we were able to identify four distinct archetypes of organization:

- The DX special operations team
- The office of digital transformation
- The embedded digital business
- The digital business unit

When we further correlate the relative maturity of these archetypes, a specific journey emerges. Special operations type organizations are seen early in the transformation maturity and tend to do a set of poorly coordinated experiments. The company matures as it adds some corporate oversight to the activity, the office of digital transformation structure. Progress begins to scale as responsibility drives into the line-of-business (LOB) leadership, the embedded structure. The least frequent, the digital business form, represents those companies that set up a separate business unit to compete directly with the existing business. This last archetype is the most mature and is an early representation of what a company might look like once the transformation is complete.

The critical point for manufacturing companies is the move to the embedded structure. This is where the strategic priorities are articulated with an associated set of programs set up to govern investment, and of course, the specific investments or use cases made under those programs. Interestingly, the number 1 technology priority for companies in this archetype is machine learning.

External — Choosing the Right Technology Partners

The technology choices related to digital transformation can be daunting. IDC is tracking well over 150 IoT platforms that could provide the digital thread and almost as many machine learning applications that could power the digital twin. Add to this the broad set of services from the megacloud platform providers like Oracle, Salesforce, SAP, IBM, Google, Microsoft, Amazon, and Alibaba, and it can be very difficult to choose.

One of the important elements of the digital twin is the semantic graph. This is a representation or model of the physical system being replicated. The semantic graph becomes the basis for training the model to learn over time. The actual technology is not very complex, but the knowledge needed to define the model is invaluable. This knowledge is why it is important to move toward a line-of-business organization structure internally and puts a substantial emphasis on industry and process domain knowledge when choosing an external partner.

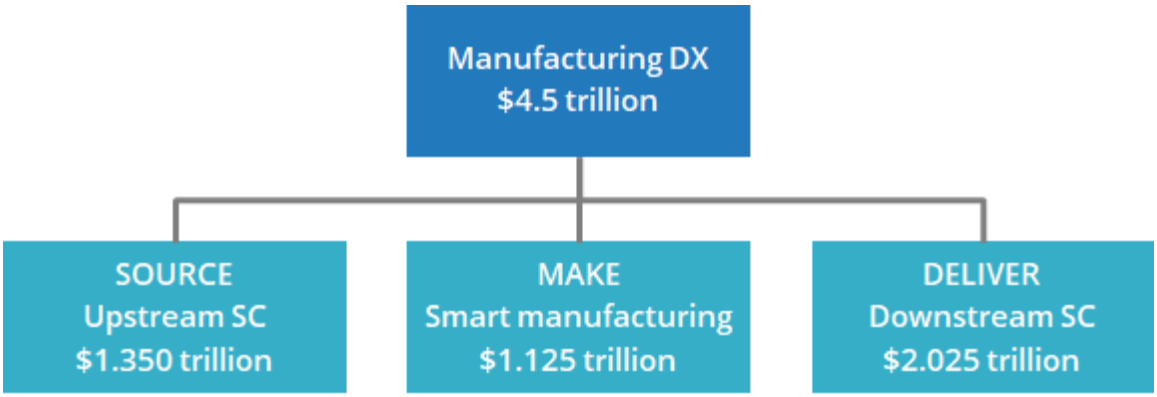
It is unlikely that the requisite domain knowledge will come from one of the software platform providers. Rather, companies will look to partner with services firms that can instantiate machine learning models quickly and provide ongoing support for the specific use cases being implemented.

How Can My Organization Take Advantage of Machine Learning?

When looking at why machine learning is so important to DX for manufacturing, we highlighted the $4.5 trillion annual economic value add opportunity that is present across the value chain. This analysis included upstream (supply chain), production (factory), and downstream (customer experience including product development). The DX opportunity can be broken down further across the source, make, and deliver manufacturing functions (see Figure 4).

FIGURE 4

Breaking Down the $4.5 Trillion Opportunity Across the Manufacturing Value Chain



Source: IDC's Digital Transformation (DX) Study, 2018

Machine learning is a critical technology enabler that will be utilized across most DX use cases for each value chain (for a more in-depth look at each individual use case, refer to the full DX taxonomies that IDC publishes). Overall, the improvements identified are largely driven by improved decision making that can be enabled by machine learning through the digital platform.

Supply Chain Decision Making — $1.35 Trillion of Opportunity

There may be no functional domain that has made more progress in the past 20 years than supply chain. The promulgation of reference models like the Supply Chain Operating Reference (SCOR) combined with widespread continuous improvement models like Lean Six Sigma have yielded a tremendous new set of capabilities. However, the rate of change that is happening in the markets companies serve and the complexity of meeting specific customer needs have left many of these approaches brittle and subject to waste — as much as $1.35 trillion annually.

The opportunity can be further broken out by the specific supply chain area. Improved planning through the use of digital twins is the largest opportunity at $685 billion, with logistics ($340 billion) and procurement ($325 billion) nearly equally split on the remainder. The strategic priority for the senior supply chain executive is the realization of the digital supply chain; one that introduces resiliency to its central purpose while maintaining an ability to adapt to changing market conditions.

It should be noted that machine learning is identified as a key technology in every use case discussed in supply chain. Capturing the $1.35 trillion opportunity will depend on building reliable information repositories and enabling advanced artificial intelligence algorithms to support innovation and improvement based on learning.

Smart Manufacturing — $1.125 Trillion

The factory itself is 25% of the digital opportunity or $1.125 trillion, which can be further broken down into three broad categories:

- **Asset utilization:** It involves application of digital technologies to improve the availability of assets and, in turn, the utilization rate. The $394 billion will flow from lower maintenance costs, higher revenue levels, and avoidance of new capital expenditures.
- **Throughput/efficiency:** New machine, energy, labor, and materials efficiencies will be realized through digital technologies amounting to $504 billion in economic value add.
- **Quality assurance:** Digital technologies can be used to catch defects sooner and to error proof processes to sustain improvements. The estimated potential is $225 billion.

Future factory initiatives will be financially justified along these same lines. While all of the elements are important, different segments may emphasize one over the another. For example, in asset intensive manufacturing segments like chemicals, the returns will flow largely from asset utilization, while fast-moving consumer goods are likely to begin with throughput and engineering-oriented value chains like automotive or aerospace with quality. Regardless, smart manufacturing will be the strategic priority for operations executives and will dictate that three governance programs be formed around strategic asset management, resilient lean, and quality. Again, the smart manufacturing/Industry 4.0 strategic priority shows the use of machine learning across all its use cases.

Connected Customer and Product as a Platform — $2.025 Trillion

When looking downstream in the value chain, manufacturers are focused on how to change the customer experience inclusive of both the marketing (connected customer) and engineering (product as a platform) leadership. We group them together because they are inextricably linked, but each carries its own set of programs and use cases.

Product as a Platform — $935 Billion

Future revenue models that are based on usage and the sale of value-added services turn the perspective of the primary product being offered from a onetime sale to an ongoing source of revenue similar to a gaming system or mobile device. Particularly in engineering-intensive industries, like automotive, aerospace, or medical device, product developers must reorient themselves in their approach to design and make investments in technology-centric tools that support the view. This effort will entail programs around an innovation platform ($415 billion), product line engineering ($285 billion), and life-cycle analytics ($235 billion). Once again, machine learning serves an important role in realizing the benefits.

Connected Customer/Connected Channel — $1.090 Trillion

For marketing and sales, the customer experience priority is to connect to the ultimate user of the product to offer a wide range of services over the ownership life, and there is substantial investment required to achieve that goal. In conjunction with that effort, it must be recognized that most manufacturing segments have tiered distribution channels. There traditional partners as well as new digital partners will have to be connected. The programs that will be formed to govern investment under this strategic priority include advanced channel management ($325 billion), connected services ($410 billion), and responsive experience ($355 billion). Like the other DX priorities, machine learning technology is at the heart of all of connected customer activities.

ADVICE FOR THE TECHNOLOGY BUYER

Capturing a piece of the $4.5 trillion digital opportunity is at the center of manufacturing business strategies. The impact is felt across all functional domains and will change how companies judge success and source talent. The key piece of technology that persists across most of the use cases is machine learning and will be the most prominent technology management success factor. We recommend that companies use this document as a guide to create their own digital transformation plan.

Use the economic value creation data in the document to quantify the opportunity for your company. What are the reasonable expectations for improvements in supply chain, factory operations, product management, and customer engagement? Use this analysis to create a financial justification for investment. Technology investment will revolve around the deployment of a digital platform that includes both advanced process automation and analytic models that support deep learning. Try to avoid selecting different offerings for each domain and gravitate toward a minimum number of suppliers. IDC advises to look first to one of the megaplatforms first as they can offer the widest range of necessary capabilities, will have the largest external developer communities, and are most likely to enhance their offerings faster.

Use the structure outlined in this document to build a road map for investment across the functional domains. The digital mission, as articulated by the highest levels of the organization, should be well understood, and a set of strategic priorities for each functional domain should be identified. The strategic priorities will dictate a set of programs to govern investment, which, in turn, will be divided into manageable projects or use cases. The use cases discussed in this document may not be a perfect fit for your company but should service as a great starting point for establishing your own road map.

Your internal digital transformation organization must transition quickly to one where the digital initiatives are embedded into the ongoing activities of the functional leadership. Expect digital transformation to command investment from 5% and 10% of revenue, drawing from R&D, marketing, factory, and supply chain. Most importantly, don't try to go at it alone. Look for an external service provider with a broad range of services — from design thinking workshops at the front end to process outsourcing on execution. The partner should bring distinctive industry and functional knowledge to the engagement, as the key to success in machine learning is to be able to implement the semantic graphs that are required to train the models to improve decision making.

There will be a big difference between companies that simply survive in the digital economy and those that thrive. The key is the ability to innovate rapidly. The 3M Company has always made a distinction between invention — the new discovery — and innovation, which is more sustainable and comes from continuous organizational learning. To innovate at scale and speed requires broad investment in machine learning.

LEARN MORE

Related Research

- *North American Manufacturing Outlook, 4Q19* (IDC #US45619819, December 2019)
- *Addressing the Industrial Skills Gap* (IDC #US45552019, October 2019)
- *GE Digital Is Delivering on the Operations Performance Management Platform* (IDC #US45213919, June 2019)

- *IDC PlanScape: Digital Transformation for Smart Manufacturing* (IDC #US44529118, December 2018)
- *IDC FutureScape: Worldwide Manufacturing 2019 Predictions* (IDC #US44467118, November 2018)

Synopsis

This IDC Perspective provides manufacturers with a pro forma business plan when it comes to machine learning — the why, what, who, and how — to help articulate the way forward.

"Machine learning is a hot topic within the manufacturing industry. Many are planning out how they can incorporate this technology across their business to drive improvements and transform how they operate. Building a road map for machine learning is an important first step, one where many manufacturers stumble," said Reid Paquin, research director, IT Priorities and Strategies, IDC Manufacturing Insights.

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