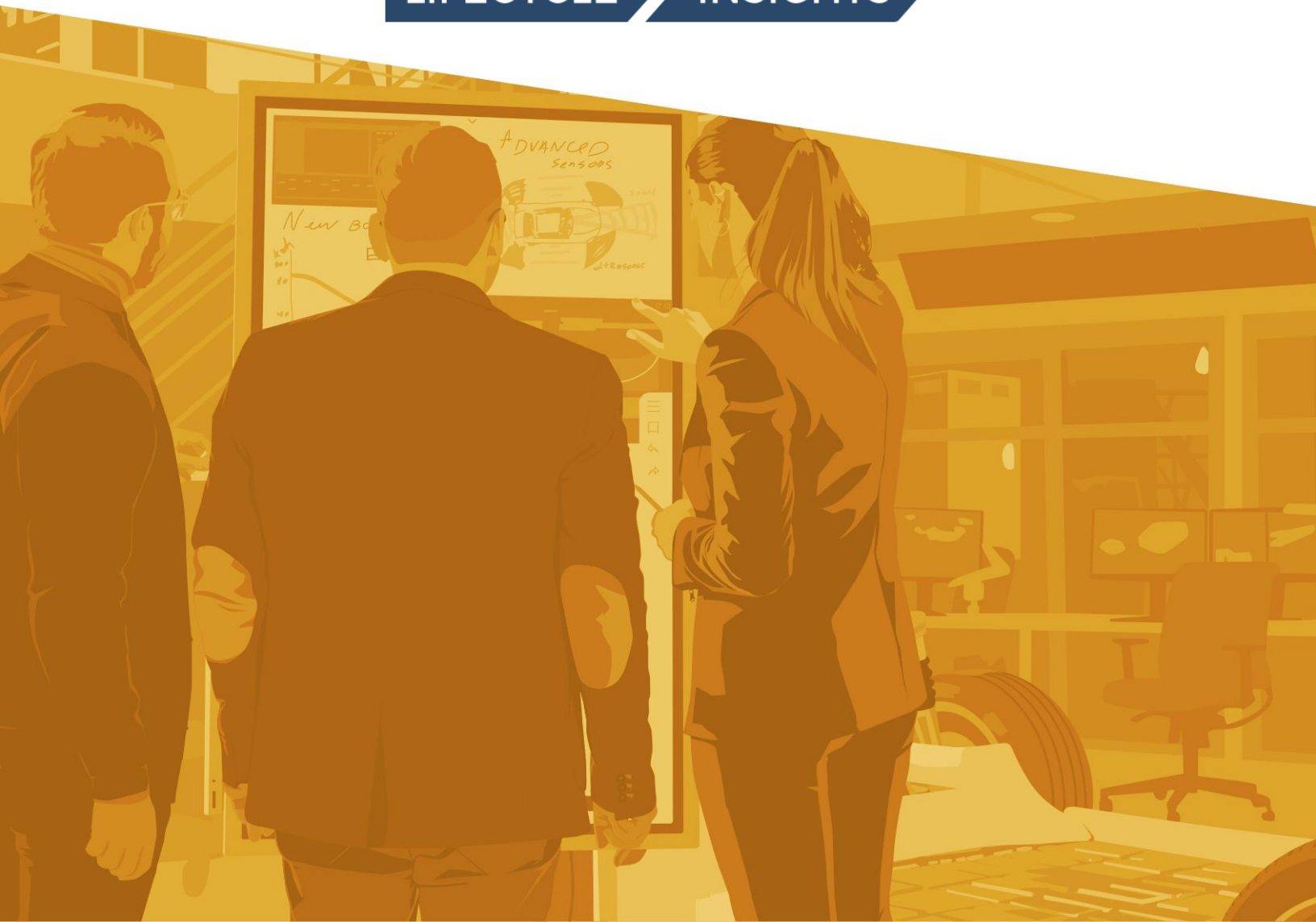# THE ROI OF DIGITAL TRANSFORMATION BENCHMARK REPORT

QUANTIFYING THE IMPACT OF DX INITITATIVES ACROSS PRODUCT DESIGN, MANUFACTURING AND SERVICE

LIFECYCLE > INSIGHTS

EXECUTIVE OVERVIEW

Today's manufacturers have their work more than cut out for them. As noted in Lifecycle Insights' 2020 Engineering Executive's Strategic Agenda study, engineering leaders agree that product, process, and organizational complexity are all rising precipitously. Executives are actively seeking innovative ways to improve the product development process in an effort to manage this complexity. Their digital transformation efforts are greatly changing the way that manufacturers design, fabricate, and service new offerings.

In order to understand how improvement initiatives help companies better manage increasing complexity, Lifecycle Insights conducted a new study, the 2021 Return on Investment (ROI) of Digital Transformation (DX) Study, or ROI of DX Study. The findings were striking. Respondents from the most progressive companies pursued 12.5 investment initiatives compared to a mere 3.5 in the least progressive group. What's more, those investments paid off: Fully 10% more of the most progressive group's product development projects hit or exceeded their margin targets. The overwhelming takeaway from the research is that targeted investments in DX initiatives can and do translate into tangible improvements in organizational performance.

This report shares the findings of Lifecycle Insights' 2021 ROI of DX Study. It offers new insights into the various drivers motivating manufacturers to invest in DX improvements, the benchmarking methodology used to compare companies, and the enablers of DX initiatives that are providing

different manufacturers the ability to better manage the rising complexity demanded in today's market. The publication is broken into three sections:

- **Drivers of Digital Transformation:** The key drivers pushing executives to adopt DX initiatives include increased consumer and industry demands for smart, connected products; eco-friendly requirements, regulations, and incentives; and the disruption of product development norms.

- **Comparing Digital Transformation Efforts:** In order to better understand how companies translated their DX initiatives into tangible improvements, survey respondents were divided into three distinct groups: most progressive, moderately progressive, and least progressive. Lifecycle Insights compared DX investments and correlated performance gains realized by the most progressive.

- **Enablers of Digital Transformation:** The adoption of DX initiatives is powered by a number of processes, practices, and technologies. The findings in this section uncover the enablers that make a difference for the most progressive.

Today's manufacturers must manage an almost overwhelming amount of complexity in products, processes, and organizational partnerships. This study reveals that the most progressive group is harnessing a variety of different DX initiatives, paired with supporting technology investments, to realize tangible savings across the entire product development lifecycle.

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DRIVERS OF DIGITAL TRANSFORMATION

As today's products become more complex, so do the processes and organizations required to support their development. Lifecycle Insights' 2021 ROI of DX Study looked to pinpoint the specific issues companies were attempting to address with their respective investments.

When asked about the issues inspiring changes in their company's development processes in the 2021 ROI of DX Study, manufacturers selected the following key drivers:

- **Demand for smart, connected products:** The transition from traditional, mechanical products to smart, connected ones is forcing companies to either gain new competencies in electronics, electrical systems, and software development, or tightly collaborate with partners or suppliers that have these capabilities. This drives many DX initiatives.

- **Eco-friendly requirements, regulations, and incentives:** Companies must meet a variety of new and evolving environmental requirements that often vary across different countries and regions. DX initiatives can help them to manage these new requirements and take full advantage of any related financial incentives offered by eco-friendly programs.

- **Disruption of product development norms:** Manufacturers that were already grappling with increased organizational complexity found their work norms further disrupted with the onset of the pandemic. DX investments can help different players across geographical and cultural boundaries successfully collaborate on new product development.

It is essential that manufacturers find ways to move beyond their current process and workflows in order to address these pressing drivers for change.

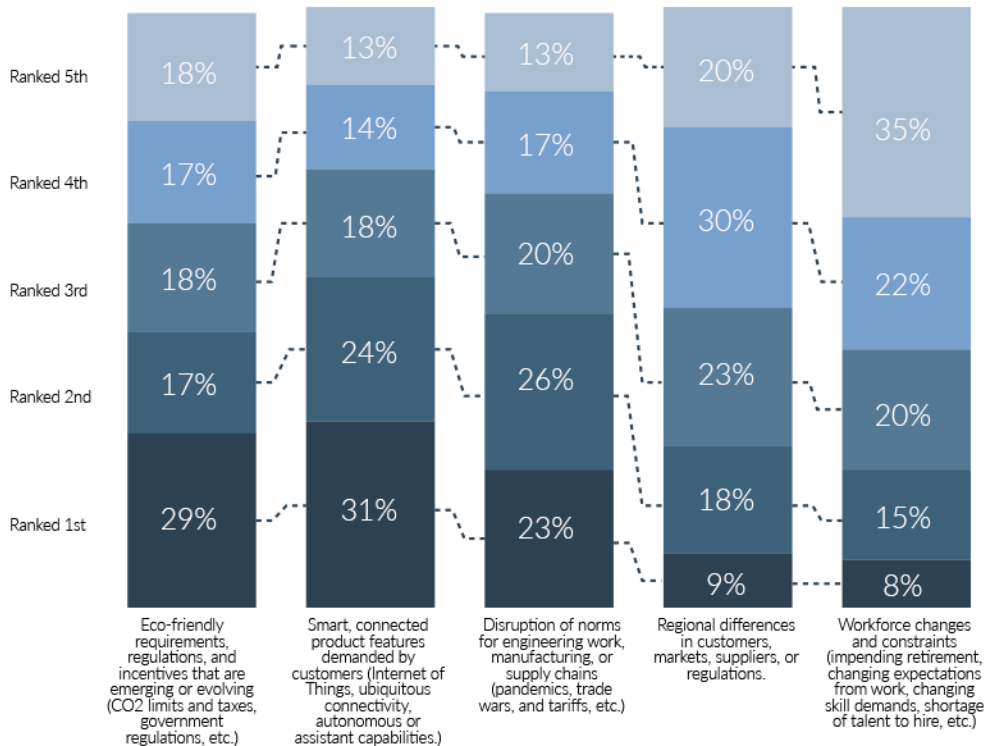## ISSUES THAT DRIVE CHANGE IN A COMPANY'S DEVELOPMENT PROCESSES

Figure 1: Eco-friendly requirements; demand for smart, connected product features; and the disruption of engineering, manufacturing, and supply chain norms are driving companies to pursue digital transformation initiatives per Lifecycle Insights' 2021 ROI of DX Study.

DEMAND FOR SMART, CONNECTED PRODUCTS

Today's consumers want their products—from automobiles to washing machines—to provide smart, connected features. Fully 55% of all respondents in the 2021 ROI of DX Study state that this particular pressure is a top-two driver influencing their DX investments.

This dovetails with the findings from the Lifecycle Insights' 2020 Engineering Executive's Strategic Agenda study. More than half of the responding executives stated that internet-of-things (IoT) connectivity and data complexity were increasing or increasing greatly. In addition, respondents also noted that the complexity of systems (53%), mechanical hardware and materials (43%), electrical distribution (46%), electronics hardware (49%), and onboard or embedded software were also growing.

PRODUCT COMPLEXITY
With Engineering Familiarity

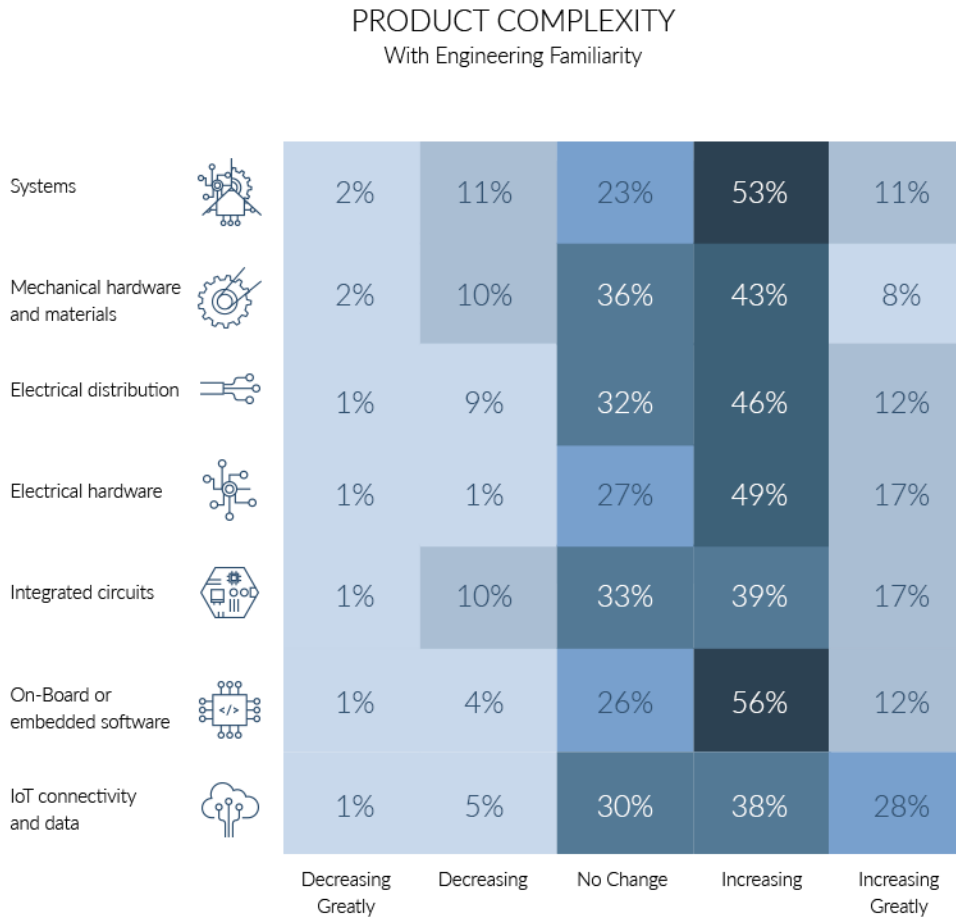|	Decreasing Greatly	Decreasing	No Change	Increasing	Increasing Greatly
Systems	2%	11%	23%	53%	11%
Mechanical hardware and materials	2%	10%	36%	43%	8%
Electrical distribution	1%	9%	32%	46%	12%
Electrical hardware	1%	1%	27%	49%	17%
Integrated circuits	1%	10%	33%	39%	17%
On-Board or embedded software	1%	4%	26%	56%	12%
IoT connectivity and data	1%	5%	30%	38%	28%

Figure 2: Findings from Lifecycle Insights' 2020 Engineering Executive's Strategic Agenda study showed that product complexity is rising across every domain involved in the development of smart, connected products.

It is clear that most executives understand that current product development practices and processes simply cannot support the rising complexity that engineers are now being asked to design into products. Executives are looking to DX initiatives to address these challenges. The initiatives may take the form of a more comprehensive digital twin, the digital definition of a particular product or plant, before any physical items are fabricated. Companies may also execute digital threads or updated processes and workflows to facilitate connected data flow and an integrated view of the development process. In this way, they can support development from start to finish.

As the demand for smart, connected features continues to rise, manufacturers must improve existing processes to help them support these more complex requirements across the product development timeline.

ECO-FRIENDLY REQUIREMENTS, REGULATIONS, AND INCENTIVES

Smart product features aren't the only complicating factor for manufacturers. They also find themselves needing to satisfy a host of eco-friendly requirements, regulations, and incentives. Between increased consumer demands and new policies by various governmental and regulatory bodies around the world, such requirements continue to emerge and evolve. Manufacturers with a global footprint must proactively plan to satisfy these eco-friendly needs, with the understanding that they may vary greatly from country to country and region to region. Furthermore, they are always subject to change based on updated policies and regulations. It can be challenging for manufacturers to meet particular requirements and to make sure they avail themselves of all financial incentives that may help them produce more environmentally friendly products both today and in the future.

The need to comply with environmental standards is another significant driver of DX initiatives, particularly the use of digital threads to improve and digitalize product development processes and practices. The digital thread brings together product data that traditionally sits in separate information silos, creating a connected, integrated view of the product to guide the entire development process. Companies that harness a robust digital thread are in a better position to manage current and future eco-friendly requirements, regulations, and incentives.

DISRUPTION OF PRODUCT DEVELOPMENT NORMS

Thanks to the COVID-19 pandemic, manufacturers of all shapes and sizes have had to make dramatic changes to the way their employees work, regardless of role or functional department. Traditional norms for work were quickly disrupted as companies pivoted to meet various social distancing and stay-at-home mandates. And with entire workforces rapidly transitioning to work-from-home (WFH) environments, companies had to reconsider established and traditional development processes and find new ways to collaborate.

These disruptions occurred just as many processes and organizations were becoming more complex in their own right. Findings from the 2021 ROI of DX Study highlighted that complexity isn't just growing in terms of product features. More than 40% of engineering executives stated in the 2020 Engineering Executive's Strategic Agenda study that organizational complexity was increasing or increasing greatly. This included growing complexity in the number of total participants (45%), the number of remote participants (56%), the number of supplier and partner participants (47%), the number of customer participants (50%), the number of participants from different countries (41%) and the number of participants from different cultures (44%). It couldn't be more clear: More players are becoming involved in the product development process.

Placed within this context, the pandemic-related disruption of work norms was amplified. Companies would have struggled to meet increasingly stringent environmental requirements even if their workplace norms had not been upended by the pandemic. But the sudden shift to working from home and new, remote methods of collaboration was even more onerous because it made it that much more difficult to meet those requirements.

Executives now recognize they cannot work the way they have in the past. Companies are realizing they need to future-proof their processes to minimize any disruptions that may occur in the future. Facilitating easy and effective collaboration is key, and DX initiatives can provide that kind of support.

ORGANIZATIONAL COMPLEXITY

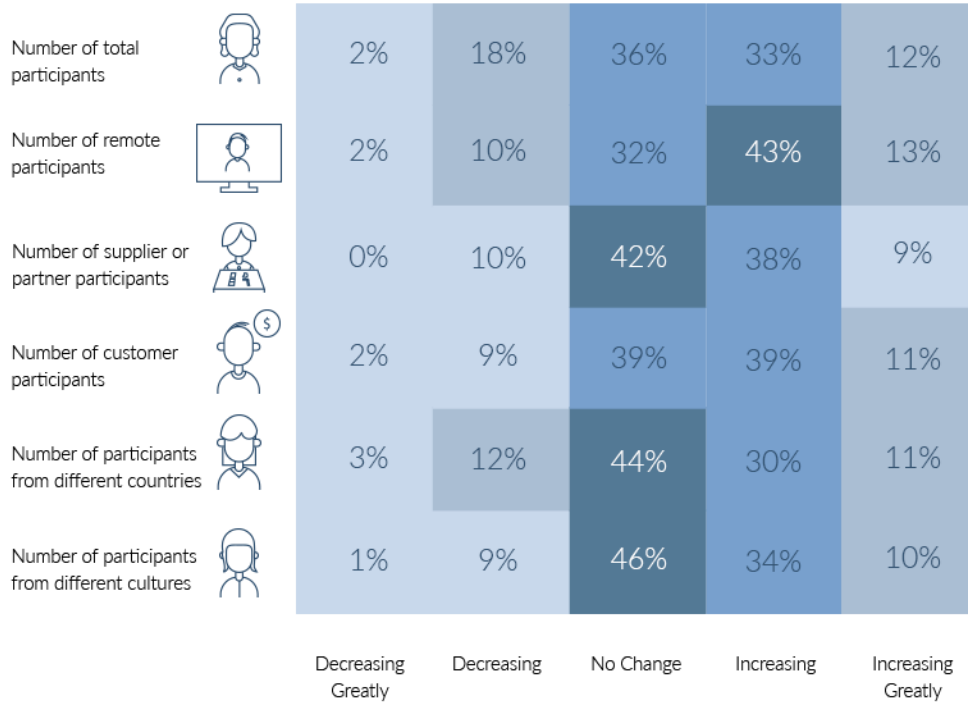|	Decreasing Greatly	Decreasing	No Change	Increasing	Increasing Greatly
Number of total participants	2%	18%	36%	33%	12%
Number of remote participants	2%	10%	32%	43%	13%
Number of supplier or partner participants	0%	10%	42%	38%	9%
Number of customer participants	2%	9%	39%	39%	11%
Number of participants from different countries	3%	12%	44%	30%	11%
Number of participants from different cultures	1%	9%	46%	34%	10%

Figure 3: Findings from Lifecycle Insights' 2020 Engineering Executive's Strategic Agenda study showed that organizational complexity is rising dramatically as more participants from many companies become more involved in product development.

TAKEAWAYS

The drivers highlighted in the 2021 ROI of DX Study are converging in a way that dramatically impacts manufacturers' ability to successfully develop, manufacture, and service products. Rising demand for smart, connected product features translates into growing product complexity. The need to satisfy eco-friendly requirements, regulations, and incentives adds yet another layer to that complexity that must be addressed. And the disruption of norms, both due to the pandemic and other organizational factors, makes it even more challenging for companies to rely on traditional processes and workflows to mitigate these new risks. Overall, these issues demonstrate why so many executives are now pursuing investments in improvement efforts that manifest as DX initiatives.

COMPARING DIGITAL TRANSFORMATION EFFORTS

Findings from the 2021 ROI of DX Study show that many companies are making changes. However, that doesn't mean those companies are guaranteed success. To explore whether DX investments translate to tangible benefits, Lifecycle Insights conducted a benchmark analysis that split the study's respondents into groups to reveal differences in practices and performance. This section details how respondents were divided and what those groups had in common.

SPLITTING RESPONDENTS INTO GROUPS

In order to compare and contrast different companies' strategies, tactics, and performance, Lifecycle Insights divided the respondent pool into three groups. The 2021 ROI of DX Study asked respondents about the status of their improvement efforts in 20 tactical DX initiative areas that span product design, manufacturing, and service. The study also asked respondents about their investments in technology solutions that support, enhance, and empower those respective improvement efforts.

To split respondents into groups, respondents were awarded points for each DX initiative investment. Those points were then summed to create a DX initiative investment score. Separately, respondents were awarded points for each investment in technology solutions that support DX initiatives.

These points were tallied to create a technology investment score. The DX initiative investment score and the technology investment score were then multiplied to give each respondent an overall index score on DX progress.

Lifecycle Insights then segmented the respondents into three groups by index score: least progressive, moderately progressive, and most progressive. The scatterplot below depicts each respondent as a dot and shows their index placement relative to their DX initiative investment and technology investment scores.
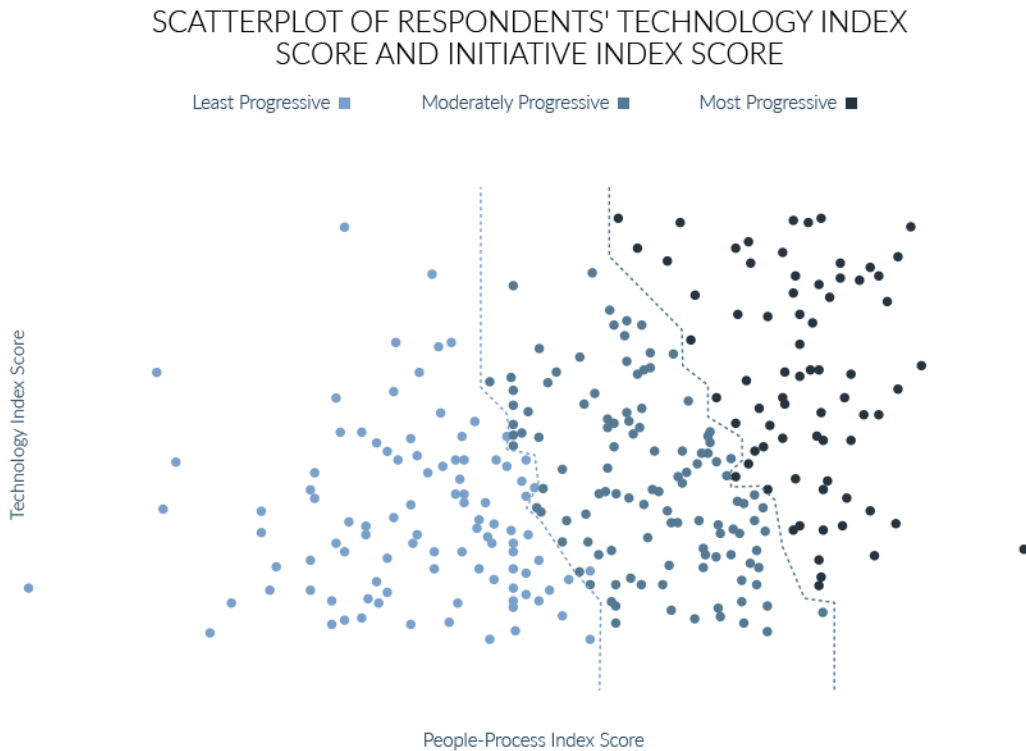

Figure 4: Respondents from Lifecycle Insights' 2021 ROI of DX Study were separated into three groups based on their quantitative scores for investment in DX initiatives and investment in technologies to support those efforts.

COMPARING DX ADOPTION ACROSS GROUPS

The objective of this analysis was to separate respondents into groups of similar traits and characteristics to determine whether the differences between groups revealed insights regarding investments in technology-led

DX initiatives. The results demonstrate a significant difference in the average number of DX initiatives that each group pursued.

On average, the least progressive manufacturers pursued 3.5 DX initiatives. In contrast, the most progressive companies pursued almost four times as many DX initiatives (12.5 initiatives). Clearly, the respondent groups are highly differentiated in terms of the number of DX initiatives pursued.

		Average number of initiative investments (20 max)	Average number of corresponding technology investments (20 max)	Percent of initiatives enabled by technologies
🚶	LEAST PROGRESSIVE	3.5	3.0	85%
🏃	MODERATELY PROGRESSIVE	7.7	3.5	46%
🏃	MOST PROGRESSIVE	12.5	9.9	79%

Figure 5: The most progressive invested in nearly four times as many DX initiatives as the least progressive. Just as importantly, the most progressive group invested in more than three times as many technologies to support and empower those DX efforts.

COMPARING ORGANIZATIONAL PERFORMANCE ACROSS GROUPS

Comparing the groups on the performance of development projects, measured by both revenue and margin, also revealed differences. The most progressive respondents stated that 72% of their product development projects hit or exceeded their revenue targets, and 73% hit or exceeded margin targets. These numbers are fully 10% higher than those of the least progressive groups. They show the kind of ROI companies can achieve when they invest in DX efforts.

The most progressive group also demonstrated the tangible benefits of their DX initiatives with two other metrics: the average number of product-level prototypes and average days of inventory. In terms of prototyping, the most progressive manufacturers averaged 7.6 prototypes per project, compared

to 9.7 prototypes in the least progressive group. Given the time and costs associated with prototyping, especially with more complex products, this metric represents significant savings. The average days in inventory reveals a similar trend. The most progressive group had a mean of 14.1 days, while the least progressive averaged 16.9. The difference in these numbers shows the greater efficiency of sales in the most progressive companies, which can rely on their DX initiatives, particularly digital threads, to help them convert products into sales.
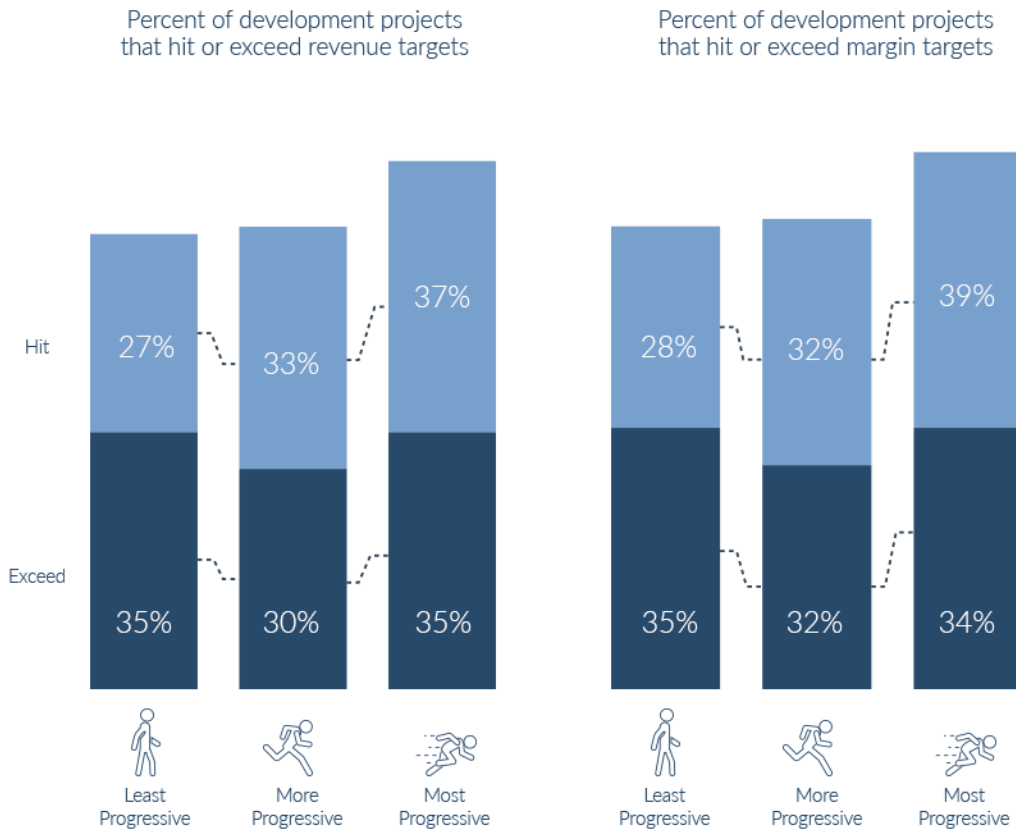

Figure 6: DX investments pay off. Ten percent more of the most progressive's development projects hit or exceeded revenue targets (73% vs. 63%). Nine percent more hit margin targets (71% vs. 62%).

Average number of product-level
prototypes per project

Average days of inventory

9.7   8.7   7.6

16.9   14.9   14.1

Least
Progressive

More
Progressive

Most
Progressive

Least
Progressive

More
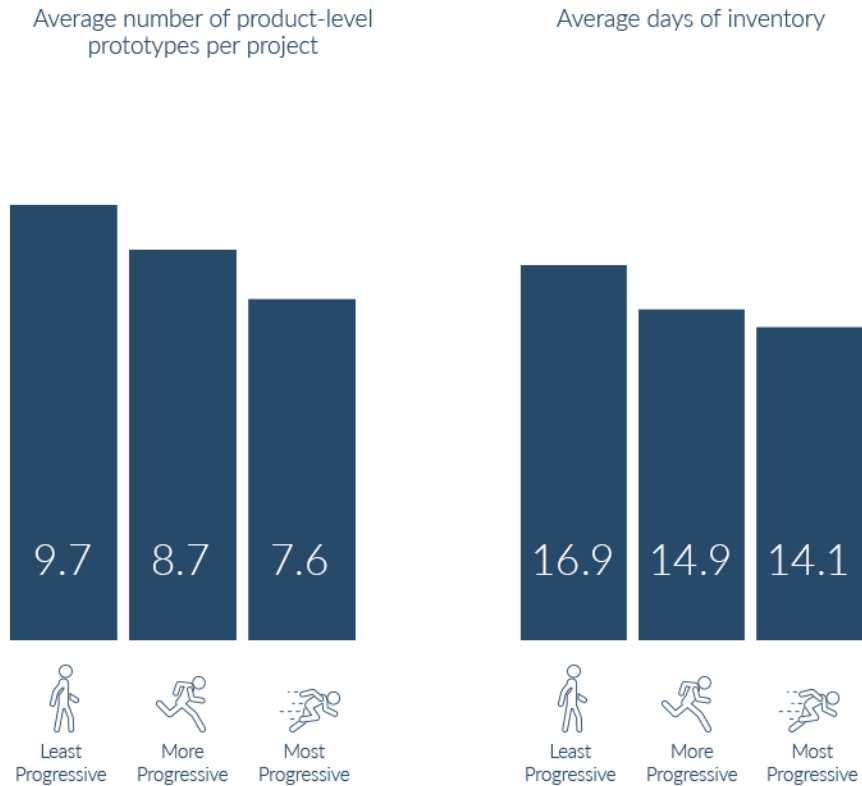Progressive

Most
Progressive

Figure 7: Additionally, the most progressive built 2.1 fewer product-level prototypes per development project and carried 2.8 fewer days of inventory.

THE ROLE OF THE DIGITAL TWIN AND DIGITAL THREAD

How do DX initiatives produce such dramatic results? The data illuminates the role a comprehensive digital twin, a core aspect of almost every DX initiative, can play across the development timeline. When stakeholders have a single, unambiguous definition of the product or a plant, they can easily collaborate and make informed decisions throughout the product development process. They can also use the digital twin to predict and then validate performance across a variety of different design domains and functional departments. This unambiguous source of truth places manufacturers in a better position to manage complex requirements.

Having a digital thread, or processes and practices that are digitally enabled across the product or plant lifecycle, also enhances and expands the comprehensive digital twin over time. This unique communication

framework is a core piece of almost every DX initiative. It permits a connected and integrated view of the product or plant throughout its lifecycle, allowing contributors—both inside and outside of the company—to easily collaborate with the assurance they are working toward a common goal. The digital thread also automates many steps in the product development process, decreasing the likelihood of unintentional human error, and accelerates overall development. Finally, the digital thread connects all the steps in a product's lifecycle—many of which were traditionally siloed off from one another—so engineers and other functional departments can ensure traceability and continuity from start to finish.

TAKEAWAYS

By dividing survey respondents into groups based on similar characteristics, the study analysis gleaned unique insights into the value of DX initiatives. The numbers show that companies are reaping significant ROI in their use of comprehensive digital twins and digital threads supported by the right technology solutions. These tools and technologies helped the most progressive stay on target or exceed performance on both revenue and margin goals more than 70% of the time—a full 10% higher than the least progressive group. In addition, the most progressive were able to reduce the number of prototypes required for each project as well as their average days in inventory. The result is significant savings in both time and overall costs.

ENABLERS OF DIGITAL TRANSFORMATION

While many organizations pursue DX initiatives as a higher-level strategy, success is dependent on translating those efforts into actionable tactics to improve different aspects of product or plant development. In this section, we will discuss how the most progressive companies powered their DX initiatives with specific practices and technologies that support product design, manufacturing and production, and service and maintenance tasks.

PRODUCT DESIGN

To create smart, connected products, manufacturers rely on a variety of different design domains. Companies need to develop mechanical hardware, electronics hardware, electrical systems, onboard software, and streaming data to connect the product to an IoT platform. When asked about these areas, the benchmark groups responded significantly differently. Most notably, the most progressive respondents adopted actionable tactics from their DX initiatives at much higher levels than their least progressive counterparts. The survey responses highlighted the following themes in product design:

PRODUCT DESIGN AND DEVELOPMENT PRACTICES
EMPLOYED BY EACH RESPONDENT GROUP

Practice	Least Progressive	More Progressive	Most Progressive
Develop, explore, and manage system definitions (requirements, functionals, architectures)	23%	33%	64%
Assess, run trade studies on, and improve systems performance or verify integration	15%	29%	52%
Define, explore, and manage mechanical designs	15%	36%	61%
Create, manage, and disseminate documentation of mechanical hardware	22%	35%	48%
Assess, run trade studies on, and improve mechanical hardware performance	22%	30%	59%
Validate manufacturability of mechanical hardware	14%	33%	57%
Define, explore, and manage electronics diagrams, schematics, and layouts	13%	32%	68%
Assess, run trade studies on, and improve electronics performance	19%	34%	56%
Valdate manufacturability of electronics	22%	43%	54%
Define, explore, and manage electrical distribution diagrams, schematics, and routings	23%	33%	53%
Create, manage, and disseminate documentation of electrical distribution systems	19%	42%	47%
Validate manufacturability of electrical distrubition system, including layouts	10%	36%	55%
Asses, run trade studies on, and improve onboard network traffic and power distribution	9%	36%	61%
Code and manage on-product software or embedded systems	19%	35%	52%
Verifty and validate control logic for on-product software or embedded systems	16%	41%	64%

Figure 8: Per Lifecycle Insights' 2021 ROI of DX Study, the most progressive employ a range of practices and processes in design and engineering enabled by DX initiatives. These tactical enablers translate to higher organizational performance.

At a high level, these findings follow a number of themes.

- **Leveraging digital twins:** The most progressive are using virtual definitions of product designs, or digital twins, to develop, explore, and manage different design iterations. By using automation technology to support generative design and generative engineering, engineers gain advantages in mechanical design, electrical design, and electronics design. These initiatives and tools can accelerate the development process while also allowing engineers to more fully explore the design space.

- **Early simulation and analysis:** This additional application of the digital twin allows the engineering team to better integrate different design domains across a single product. Managing structural stress is critical to mechanical hardware. Signal integrity is key to electronics and electronic systems. Yet, too often, engineers wait to use simulation and analysis until much later in the development process, leaving them open to potential errors. Early simulation and analysis allow engineers to verify performance as they explore different design iterations. The result is fewer rounds of testing and respins.

- **Creating, managing, and disseminating documentation:** As product complexity rises, access to good documentation is more important than ever. Many companies are transitioning to the use of a digital model as the unambiguous source of truth for the entire product development process. The right practices and tools are key to authoring documentation, of course, but there are also significant advantages to managing and sharing documentation. Such efforts allow others, regardless of design domain or functional department, to consume design documentation with fewer errors, resulting in savings on scrap and rework.

- **Managing digital definitions:** The most progressive group invested most heavily in managing digital definitions. This effort requires applications and systems that offer capabilities spanning data management, configuration management, and lifecycle management, and that apply equally to hardware and software development. Such capabilities permit everyone in the product development process to track and manage even the most complex configurations.

When organizations that leverage DX initiatives, including comprehensive digital twins and digital threads, can gain key efficiencies during product design. In doing so, they see significant savings in both time and costs throughout the entire product development process.

MANUFACTURING AND PRODUCTION

Once design is complete, the natural next step in the product development process is manufacturing and production. There are many DX initiatives that can help on this front, ranging from the creation of the computer numerical control (CNC) toolpath all the way up to laying out entire production facilities.

MANUFACTURING AND PRODUCTION PRACTICES EMPLOYED
BY EACH RESPONDENT GROUP

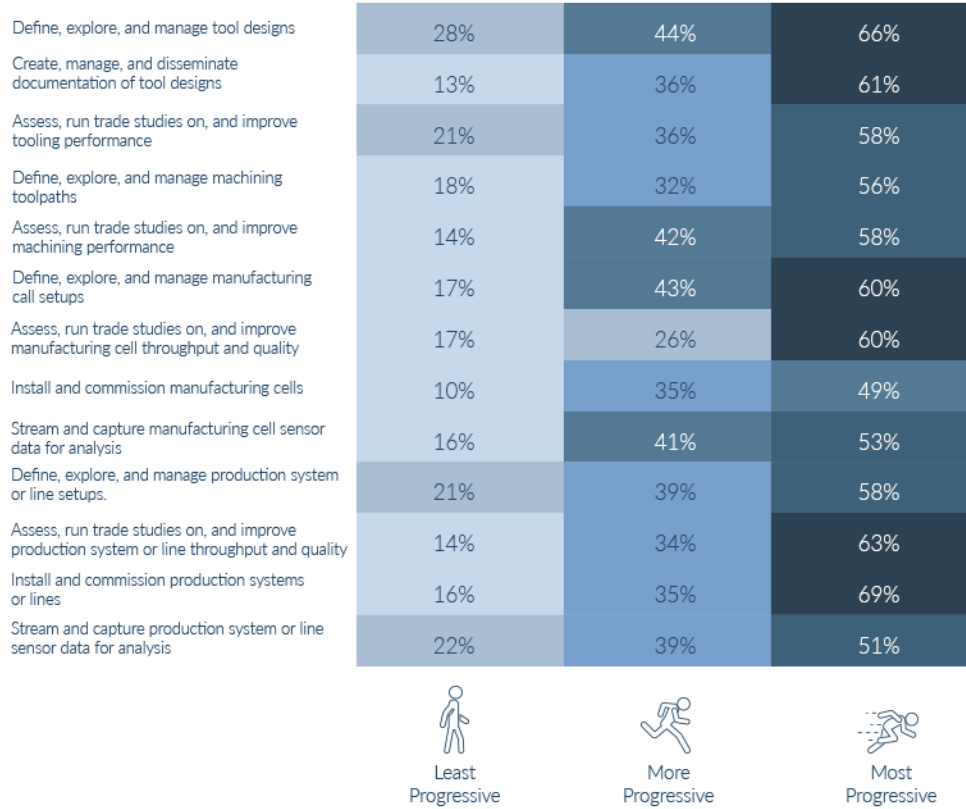|	Least Progressive	More Progressive	Most Progressive
Define, explore, and manage tool designs	28%	44%	66%
Create, manage, and disseminate documentation of tool designs	13%	36%	61%
Assess, run trade studies on, and improve tooling performance	21%	36%	58%
Define, explore, and manage machining toolpaths	18%	32%	56%
Assess, run trade studies on, and improve machining performance	14%	42%	58%
Define, explore, and manage manufacturing call setups	17%	43%	60%
Assess, run trade studies on, and improve manufacturing cell throughput and quality	17%	26%	60%
Install and commission manufacturing cells	10%	35%	49%
Stream and capture manufacturing cell sensor data for analysis	16%	41%	53%
Define, explore, and manage production system or line setups.	21%	39%	58%
Assess, run trade studies on, and improve production system or line throughput and quality	14%	34%	63%
Install and commission production systems or lines	16%	35%	69%
Stream and capture production system or line sensor data for analysis	22%	39%	51%

Figure 9: The most progressive employ a range of practices and processes in manufacturing and production enabled by DX initiatives. These tactical enablers translate to higher organizational performance.

The survey responses highlighted the following themes in manufacturing and production:

- **Managing an unambiguous source of truth:** Having a single digital definition, whether used for tool designs, machining tool paths, cell plans, line layouts, or plans for entire production facilities, was a key differentiator for the most progressive group. The application of the digital twin concept to manufacturing helps those companies keep everyone on the same page at any point during the development process. The end result? Companies can better manage the process, avoiding errors and delays while hitting margin targets.

- **A means to define and explore:** The research also identified the need to define and explore alternative designs and plans during manufacturing and production activities. Iteration allows everyone,

from machinists to production engineers to facility managers, to understand the requirements and find the best options to meet them. Having simulation and analysis capabilities allows stakeholders to understand the impact of any proposed change to requirements and specifications. When combined, these two DX initiatives contribute to the ability to carry fewer days of inventory and, consequently, improve cash flow.

- **The ability to capture and stream sensor data:** As production facilities rely more and more on sensors to support the fabrication of products, the ability to capture and stream sensor data at multiple levels, including production cells and lines, has never been more important. This is commonly referred to as a smart manufacturing initiative, and it, too, falls under the DX umbrella. Capturing and analyzing such data allows production engineers to better understand the state of manufacturing in a cell, line, or facility. When they are armed with this information, they are in a better position to make decisions that can improve production.

DX initiatives can do much more than simply enhance product design. The use of a comprehensive digital twin for plants can help companies create better, faster, and more efficient production environments by giving production engineers a place to explore and iterate. By capturing and integrating sensor data, comprehensive digital twins also provide key stakeholders a bird's eye view of a plant's overall performance. This is yet another area where the most progressive companies' DX investments are translating into savings.

SERVICE AND MAINTENANCE

This discussion would not be complete without touching on the way DX initiatives are influencing service and maintenance. As products and the facilities that produce them become more complex, service and maintenance needs are changing dramatically. DX initiatives play a key role in helping companies evolve to meet those needs.

SERVICE AND MAINTENANCE PRACTICES EMPLOYED BY
EACH RESPONDENT GROUP

	Least Progressive	More Progressive	Most Progressive
Stream and collect data from products	23%	31%	65%
Predict and proactively schedule maintenance	12%	39%	57%
Present product operation data to field agents	22%	38%	52%
Deliver software updates remotely	14%	30%	48%
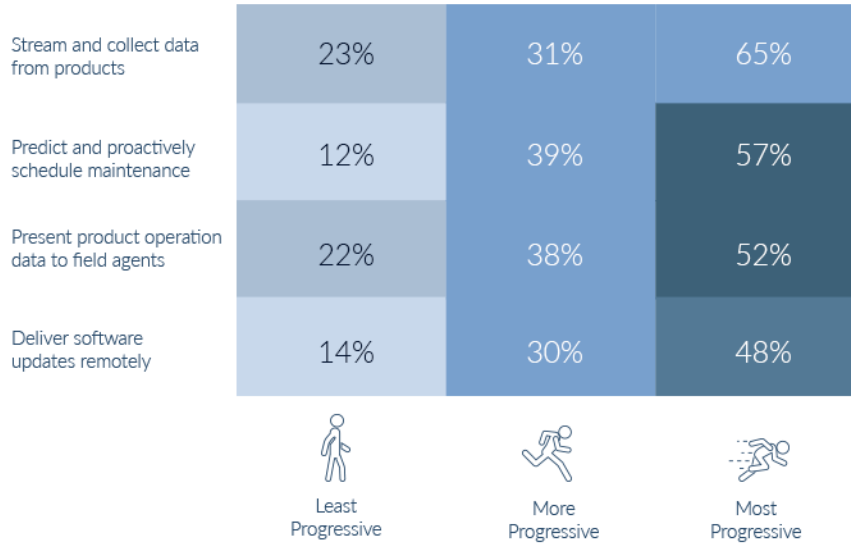
Figure 10: The most progressive employ a range of practices and processes in service and maintenance enabled by DX initiatives. These tactical enablers translate to higher organizational performance.

Thanks to the extension of the IoT movement, manufacturing organizations need to take a new approach to service and maintenance. The survey responses demonstrated that the following themes were important to success in this area:

- **Streaming data for products:** Manufacturers need streaming data to understand how products are performing. Many companies are leveraging this ability as a means of proactively scheduling maintenance and preventing costly problems before they occur. Doing so can help them maximize product uptime, which becomes even more essential for companies moving to service-based offerings.

- **Delivering software updates:** Service-oriented businesses also need an easy way to ensure that onboard software is up-to-date. Having the ability to remotely deliver software updates allows companies to fix issues or enable new functionality without ever having to physically touch products in the field.

- **Delivering operational data:** Another DX initiative that is gaining traction is the ability to deliver operational data to field agents. This

gives those agents the ability to diagnose issues remotely, without having to physically interact with the product.

It is easy to see how all of these DX initiatives directly improve a company's ability to resolve issues during an initial call, or even diagnose problems remotely. The events of the past year have clearly demonstrated the value of such abilities.

SUMMARY AND CONCLUSION

Lifecycle Insights' 2021 ROI of DX Study aimed to understand how different DX efforts were helping manufacturers achieve value as they continue to grapple with increasing complexity across products, processes, and organizations. The survey respondents were clear: Investments in targeted DX initiatives provided significant ROI. The most progressive companies pursued an average of 12.5 investment initiatives—compared to only 3.5 in the least progressive group—and those investments paid off on multiple fronts. The most progressive were more likely to hit or exceed their margin targets for projects, and they required fewer prototypes and fewer days of inventory to do so.

Today's manufacturing executives are being asked to do more with less. Multiple factors—including consumer demands for smart, connected product features; eco-friendly requirements, regulations, and incentives; and disruption of traditional work norms—are converging in ways that dramatically affect companies' abilities to successfully develop, manufacture, and service products. These issues are forcing manufacturing executives to find innovative ways to improve performance across the entire product development lifecycle and minimize risks. It is easy to see why so many companies are pursuing improvement efforts in the form of DX initiatives.

To fully leverage these efforts to glean the most value, however, it's important to think strategically about their use. Lifecycle Insights recommends that companies:

- Develop a strategic plan to pursue DX initiatives.

- Ensure that plan includes investments in technology solutions, which are a key enabler of those DX efforts.

- Consider how a comprehensive digital twin, an unambiguous definition of the product, and the company's digital threads, the digital processes used to execute development, can and should be enhanced over time by various DX initiative investments.

- Identify what measured improvement the company should realize from its DX initiative investments. The approach will vary depending on the objectives. It's up to each company to fully leverage any investments, improving processes in ways that will result in time and cost savings.