Tech-Clarity

Digitally Transforming the Factory Lifecycle

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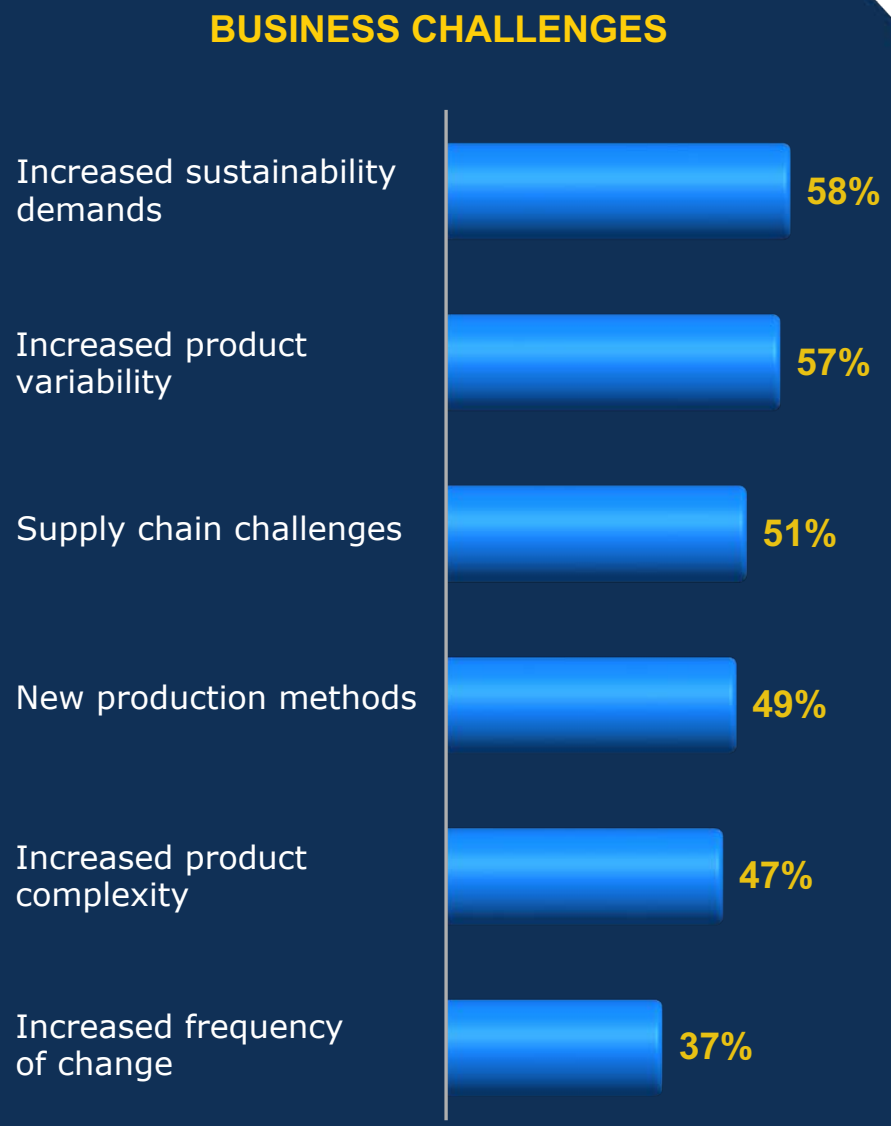
Embrace the Digital Factory

Recognize the Opportunity to Improve Performance

Our recent survey of 180 companies involved in the factory lifecycle shows that manufacturers commonly miss critical targets including program timelines, project spend, quality, and manufacturing agility goals. Missing these targets causes significant business impacts including project delays, budget overruns, higher product cost, and reduced manufacturing flexibility, creating a significant drag on asset utilization, innovation, return on capital, and profitability. The processes manufacturers follow across the lifecycle from facility design through manufacturing operations are ripe for improvement.

Digitally Transform Factory Design and Manufacturing Planning

How can companies improve manufacturing and factory planning across the lifecycle from facility design to operations so they can better hit their targets and drive profitability? Our analysis shows that the companies that best meet their project goals, the Top Performers, have digitally transformed. They have adopted digital tools and take a more collaborative, integrated approach across the factory lifecycle. Let’s see how they do that.



The Pace of Change Demands New Approaches

Recognize New Change Drivers

Before looking at solutions, let's step back and understand why there is a problem in the first place. Part of the reason companies miss their factory design and manufacturing planning targets is increased complexity. Today's business environment, products, supply chains, and manufacturing processes are evolving and are more complex than ever.

Most of the complexity in factory design and manufacturing planning is due to recent industry shifts including increased demand for sustainability, greater product variability, supply chain disruption, new production methods, and increased product complexity. A lot is changing. In fact, over one-third of respondents mention the increased frequency of change as a challenge on its own.

The Pace of Change Demands Innovation and Agility

The pace of change isn't expected to slow down. Manufacturers continue to retool operations to support the shift to improvements like increased automation and further adoption of industrial additive manufacturing. At the same time, they must adapt to continued supply chain disruption and other disruptive forces. These business challenges place a variety of pressures on the factory and the factory lifecycle. Manufacturers must embrace agility and innovation in order to overcome these challenges so they can meet their targets.

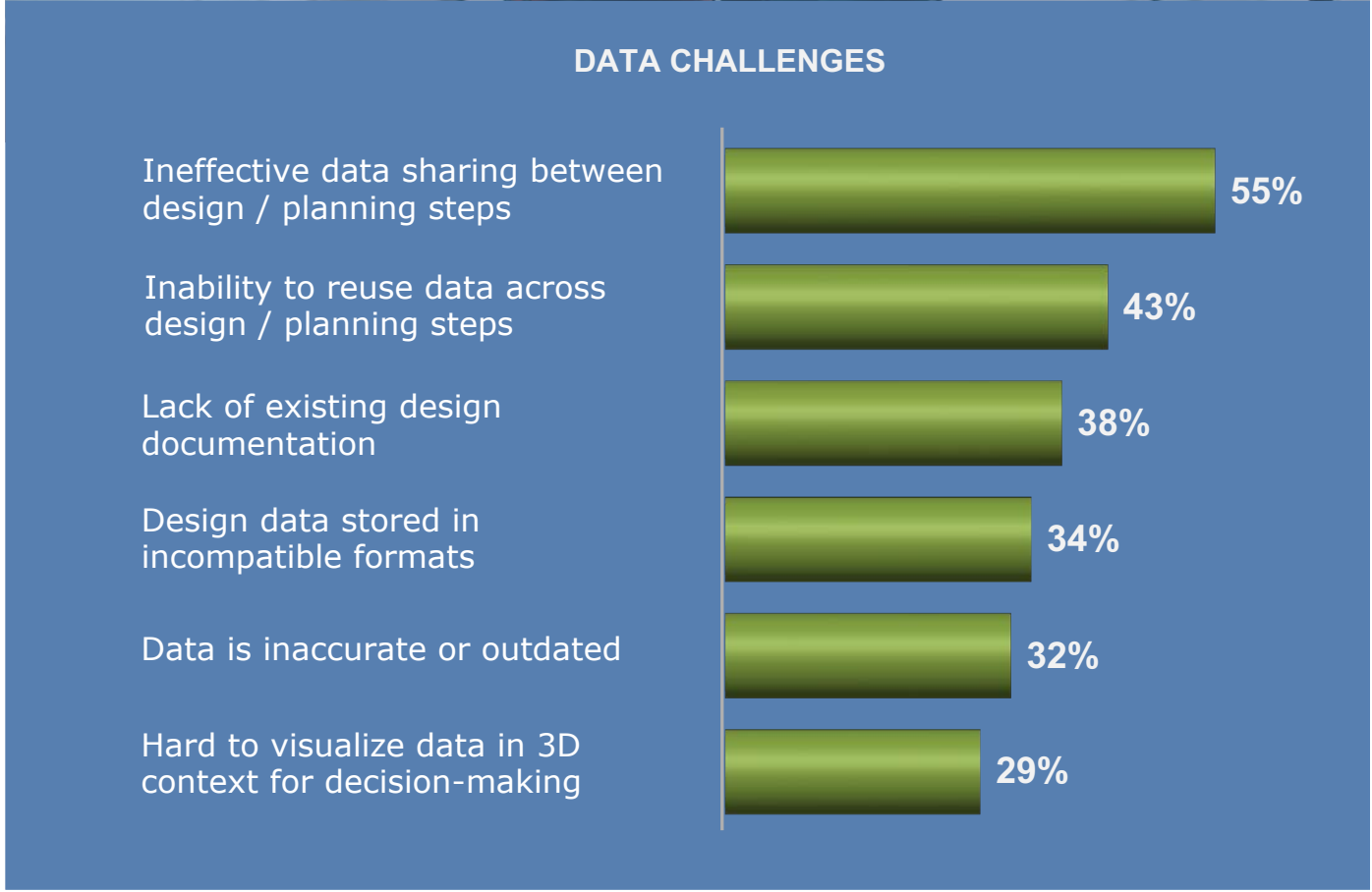
Data Challenges

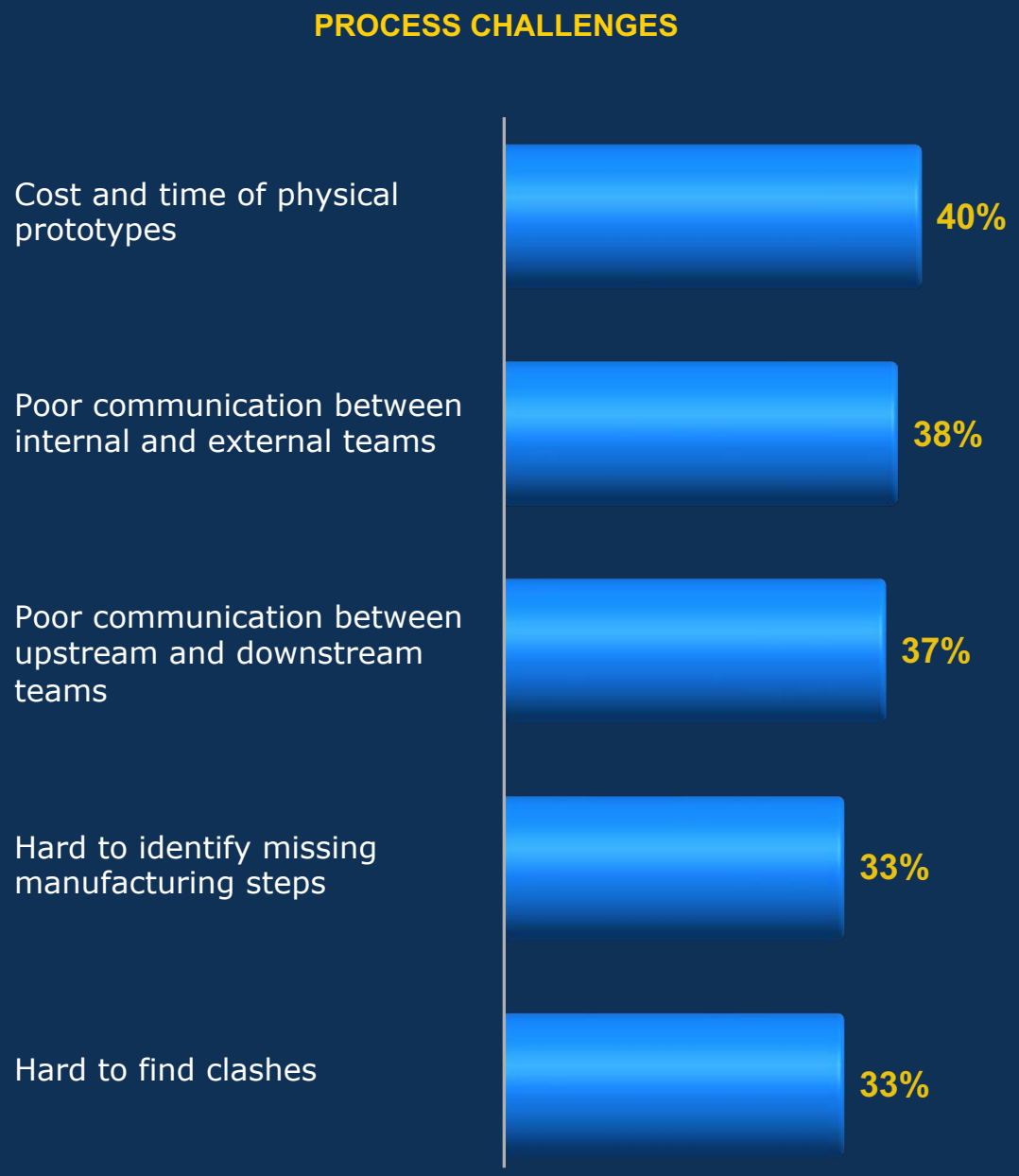
Data Sharing is Hard

To address the frequency of change and other business challenges, manufacturers must improve factory design and manufacturing planning performance. But there are obstacles to overcome. The largest challenge, faced by over one-half of companies, is ineffective data sharing. This is likely due to silos of information common in these processes. Disparate teams often have different design tools and data management approaches. This disjointed environment is likely related to another reported challenge, data shared in incompatible formats. Teams that aren't able to share data are prone to inefficiency and errors that drive up leadtimes, add cost, and negatively impact quality.

Disconnects Hinder Reuse

The second most common challenge is the inability to reuse data between steps. This is also likely related to incompatible formats. For example, a company that manages facility design data in BIM may not be able to share and reuse that information downstream for factory line planning, let alone repurpose it to support plant operations. Manufacturers have many data disconnects of this kind in between their design teams over the phases of their factory lifecycles. The inability to reuse data forces engineers to recreate information, opening up further opportunities for lost time, inefficiency, and errors.





Process Challenges

Design Processes are Challenging

Beyond data challenges, manufacturers face issues with their business processes for factory design and manufacturing planning. The most common process challenge reported is the overhead of creating physical prototypes. Physical prototypes are time-consuming and costly. Companies that have not adopted digital prototyping across their product and factory lifecycles lose valuable time, money, and resources on these processes.

Process Challenges Impede Effective Communication

The next two most commonly reported process challenges involve poor communication between teams, both inside and outside of the organization and upstream and downstream in the lifecycle within the organization. This is clearly related to the underlying data challenges discussed above. Companies need strong communication and collaboration to be agile and innovate.

Process Challenges Lead to Design Problems

Another one-third of companies face problems getting manufacturing planning results right. An equal number report they can't find clashes and say that they can’t identify missing manufacturing steps. These are important capabilities to get factory design and manufacturing planning right the first time. Those that uncover these errors later in the lifecycle suffer from higher costs and lost time due to rework.

The Challenges Impact Business Performance

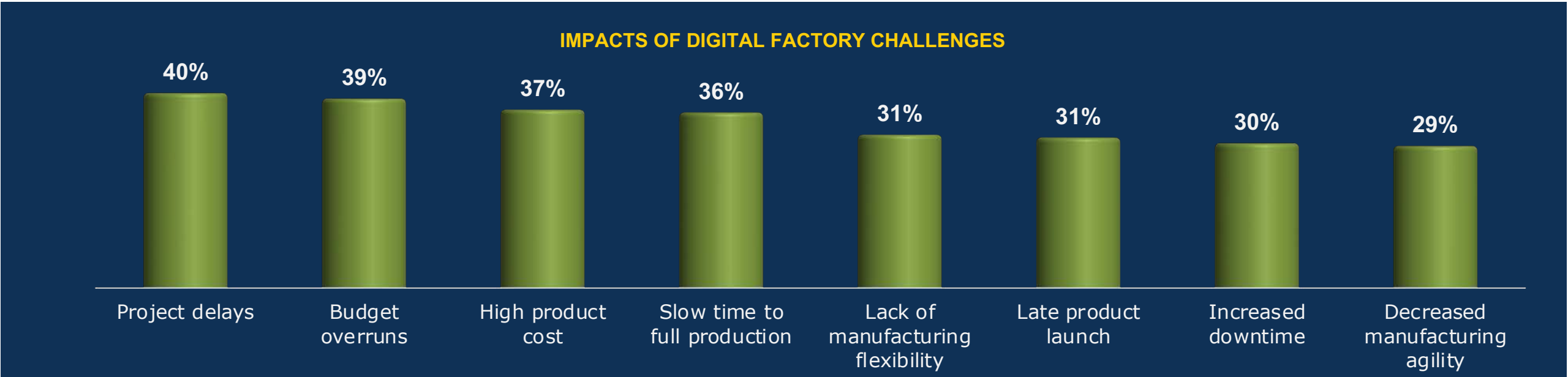
Challenges Lead to Consequences

The challenges identified result in significant, negative business impacts on the metrics that drive profitability and return on assets. The most common impacts relate to time and cost. Time impacts include project delays, slow time to full production, late product launch, and decreased manufacturing agility. These situations can dramatically impact market share and profitability.

Respondents also report cost-related impacts that effect projects and products. These include budget overruns that impact the product development process as well as high product costs that continues to impact profitability over time.

Challenges Derail Flexibility and Agility

On top of time and cost-related impacts, almost one-third of responding companies report a lack of manufacturing flexibility and over one-quarter report a lack of manufacturing agility. Poor flexibility and agility can limit manufacturers from adopting changes to adjust to market opportunities or threats, incorporate new technologies, and continuously improve. These impacts make transforming factory design and manufacturing planning a critical business priority.



Identifying Best Practices

Transformation is Essential

Manufacturers have to address complexity and adapt to shifting business, supply chain, and manufacturing realities. To do this, they have to work across departmental and company boundaries to plan, design, build, and operate their factories despite a variety of challenges with their data and processes. With all of the different parties involved and the complexity, it's a wonder anyone hits their project targets. But there are those that do. Our benchmarks show that not all companies miss their project targets as frequently as others.

Identifying the Top Performers

We benchmarked responding companies on their reported ability to hit the following factory design and manufacturing planning metrics:

- Meeting program timelines
- Project spend versus budget
- Manufacturing quality
- Manufacturing agility

There was a wide variety of performance against these combined metrics. We identified the top 22% and labeled them "Top Performers" and labeled the poorer performing companies as "Others."

Determining Best Practices

After identifying the Top Performers, we analyzed their organizational, process, and technology approaches for factory design and manufacturing planning. We looked to see which approaches are more common to the Top Performers to make recommendations to the Others. Let's review the findings.

Make Manufacturing Planning a Business Priority

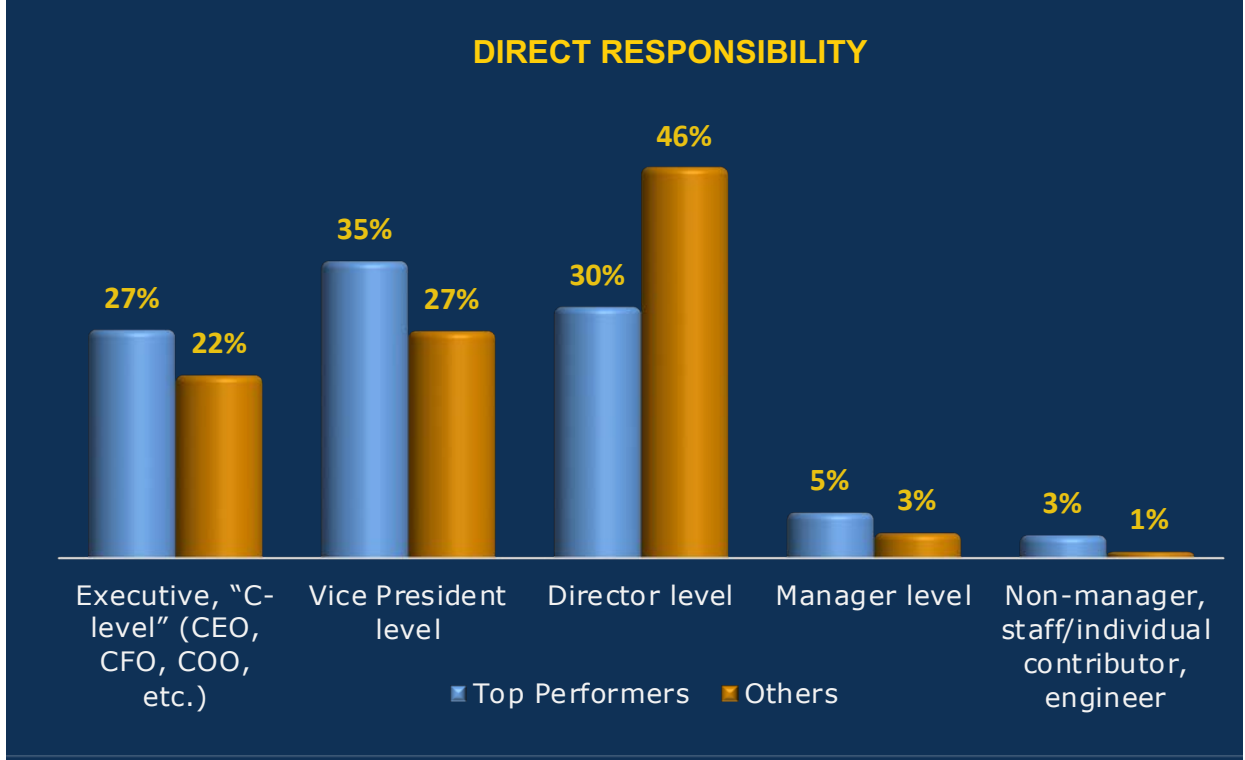
Assign Executive Responsibility

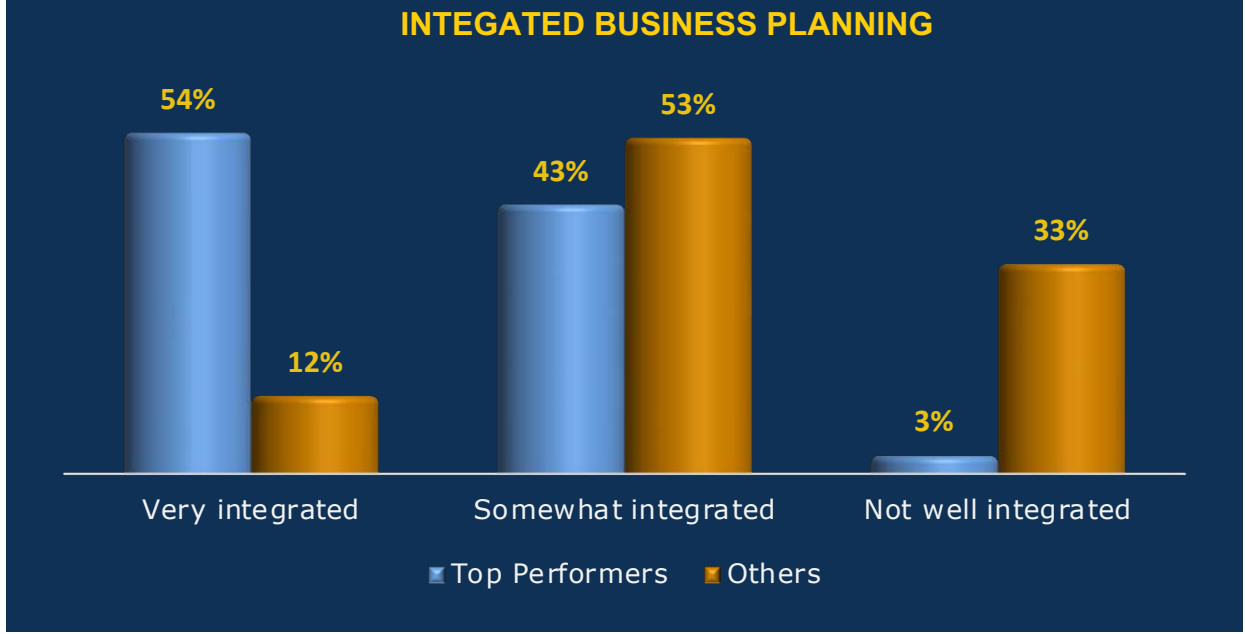
Effective factory design and manufacturing planning requires coordination across a broad variety of resources that report to different departments. Affecting change and improving performance across a disparate organization requires executive oversight.

Top Performers organize for success. They are more likely to have direct responsibility for factory design and manufacturing planning at the executive or VP level as compared to Others. This likely helps Top Performers drive transformation and align objectives across organizational boundaries.

Integrate Business Planning

The Top Performers also plan for success. These leading companies take a different approach from the start. They are over four times as likely to have "very integrated" business planning processes for products, plants, and production. Others, on the other hand, are eleven times as likely as Top Performers to be "not well integrated." Integrated business planning likely helps Top Performers align organizational objectives and metrics toward common goals related to the factory lifecycle.





Improve Collaboration

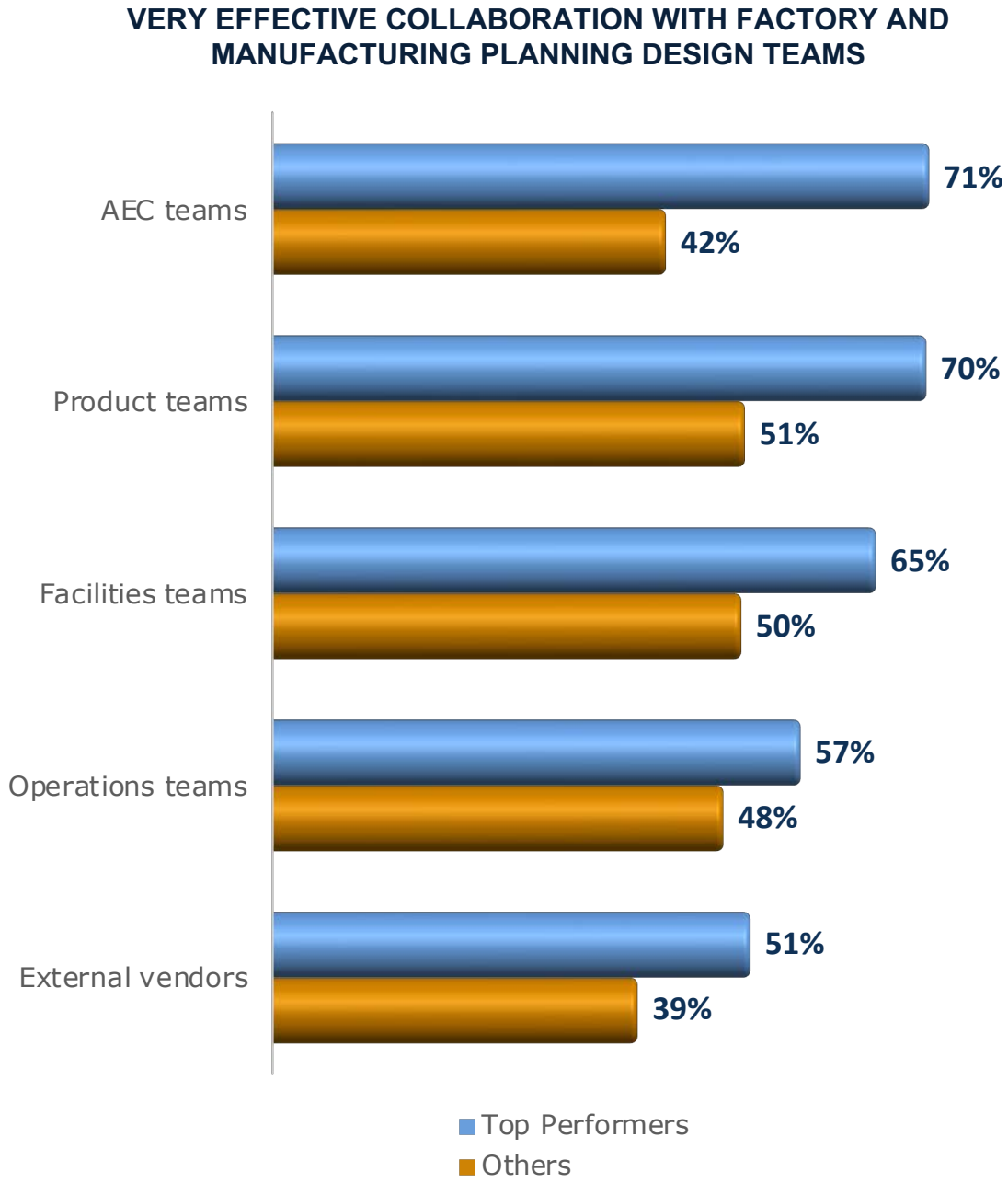
Top Performers Have More Effective Collaboration

Organizing and planning at the executive level is a great start, but teams must work together across the factory lifecycle in order for plans to be effectively fulfilled. Top Performers are more likely to have "very effective" collaboration between factory and manufacturing planning design teams and others that are crucial to the process.

Bridge the Gap to Facility Design

Higher performing companies have better collaboration with other engineers within the manufacturing planning process (not shown). What really sets the Top Performers apart, however, is an even more pronounced likelihood to have very effective collaboration with others upstream and downstream of them in the factory lifecycle. The fact that almost three-quarters of factory and manufacturing planning design teams collaborate so well with AEC and product teams is compelling because it shows collaboration across the product and factory lifecycle.

Solid collaboration between these groups allows them to work in parallel, provide feedback early in the design lifecycle, and catch errors sooner. This translates to lower costs, shorter leadtimes, and better quality. It also allows them to be more agile and flexible so they can more rapidly implement innovation.

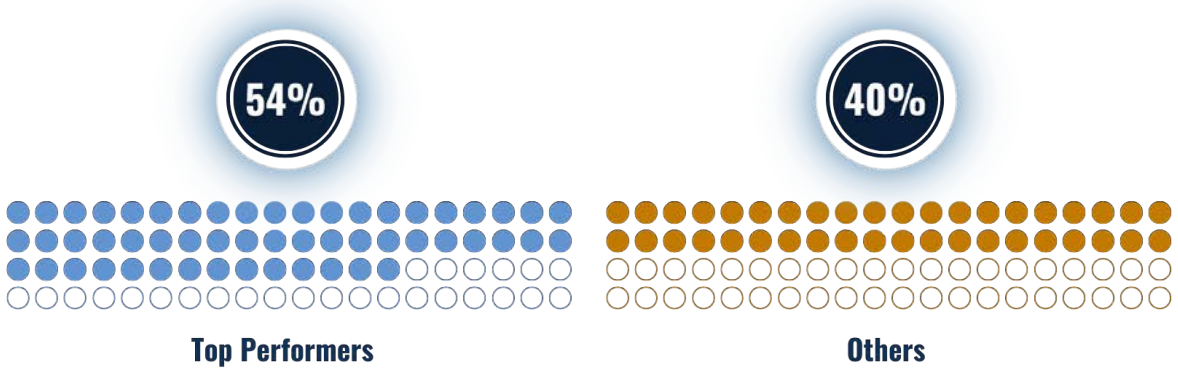


Improve Collaboration

Bridge the Gap to Operations

In a similar way, factory and manufacturing planning design teams collaborate more effectively with downstream organizations including operations teams. This allows them to get real-world feedback from the factory to better optimize designs early in the lifecycle. One example of how Top Performers are better at collaborating downstream is by gathering feedback from operations. Closing the loop with real-world performance data to improve designs is highly valuable for continuous improvement. Beyond current designs, trusted operational data can also be used to validate and optimize new designs based on real-world data and experience. Top Performers are much more likely to share this data upstream than Others.

SHARE DIGITAL OPERATIONS UPSTREAM



Leverage Digital Twins

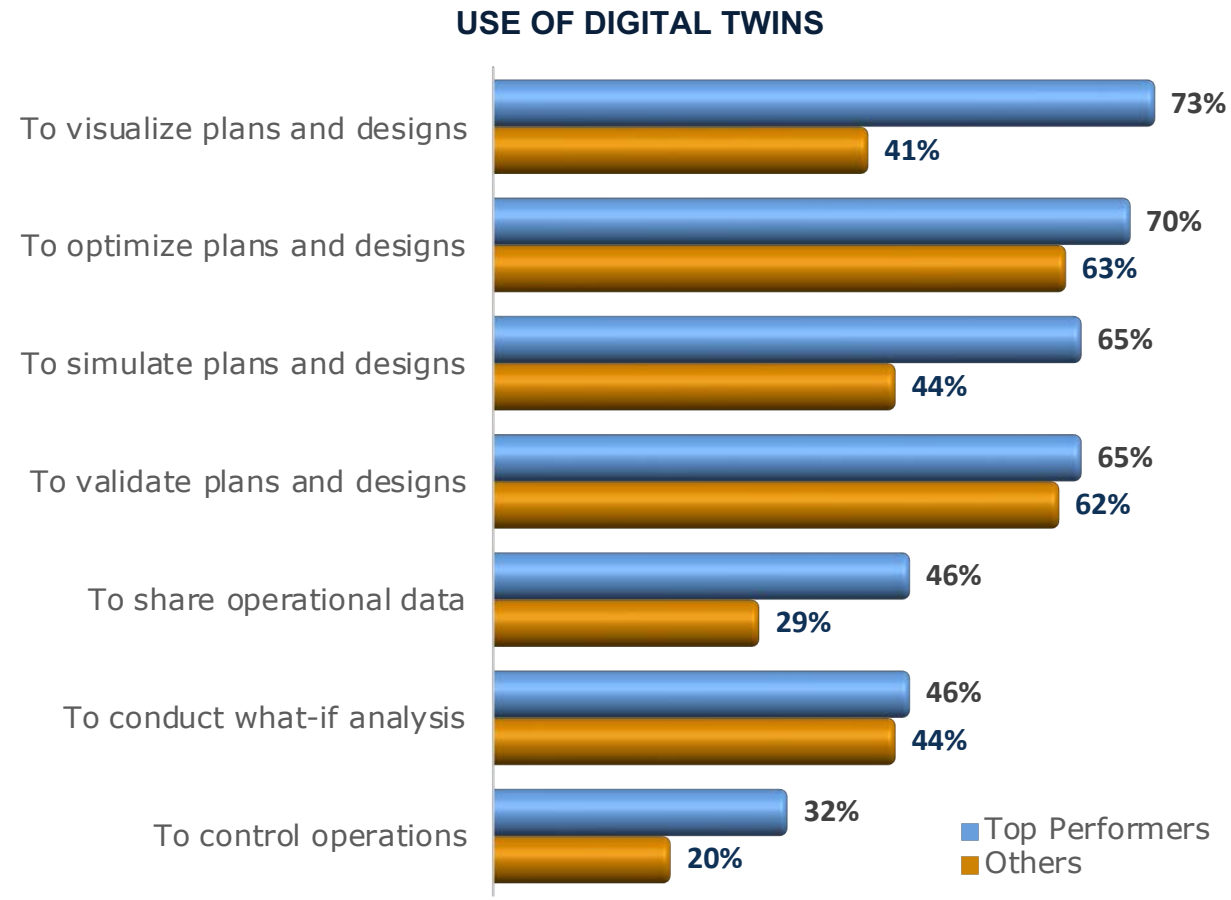
Top Performers Improve Designs

Digital twins are highly valuable for factory design and manufacturing planning because they offer a model of a facility, production line, workcell, product, or combination of these. Digital twins are an effective way to communicate and view designs and are increasingly being used to validate and optimize designs virtually as a digital prototype prior to investing in physical infrastructure. This increases speed, lowers cost, and improves quality. Digital twins are being applied at all levels of the manufacturing planning process.

Top Performers Leverage Digital Twins Extensively

Top Performers are more likely to use digital twins in a variety of ways in factory design and manufacturing planning. The most common ways are to visualize, optimize, simulate, and validate plans. But the most differentiated approach is using digital twins to control manufacturing operations. Top Performers are 66% more likely than Others to use digital twins this way. Leveraging a digital twin for operations furthers the ability to provide digital feedback upstream in addition to improving decision-making on the plant floor.

Digital twins are virtual models of physical items, representing a specific product, configuration, piece of equipment, plant, city, or other physical asset with enough fidelity to predict, validate, and optimize performance and behavior. It's connected and kept in sync with its physical twin over its lifecycle to collect, aggregate, and analyze actual field data to monitor performance, gain intelligence, and close the loop between designs and the real world.

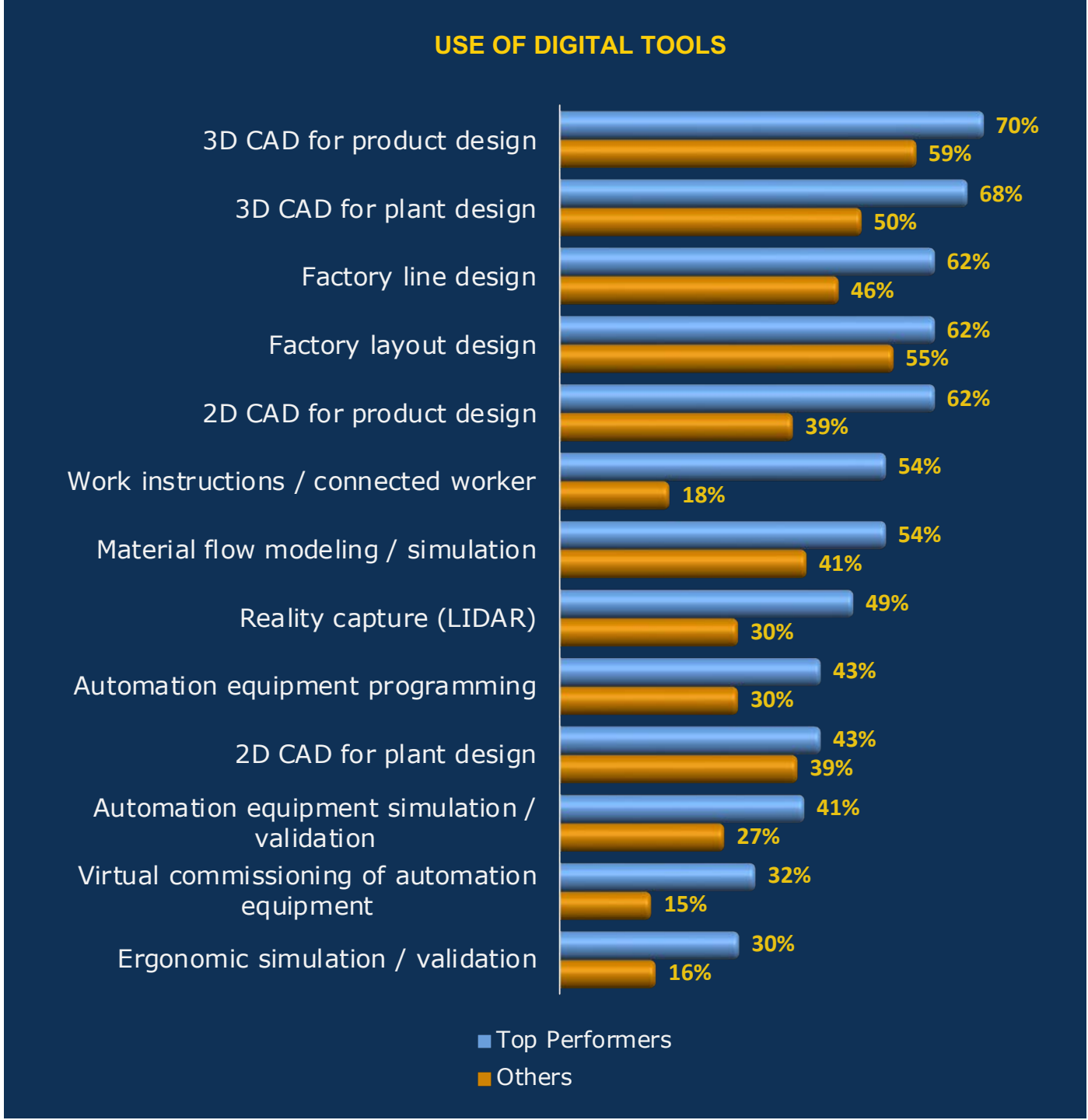


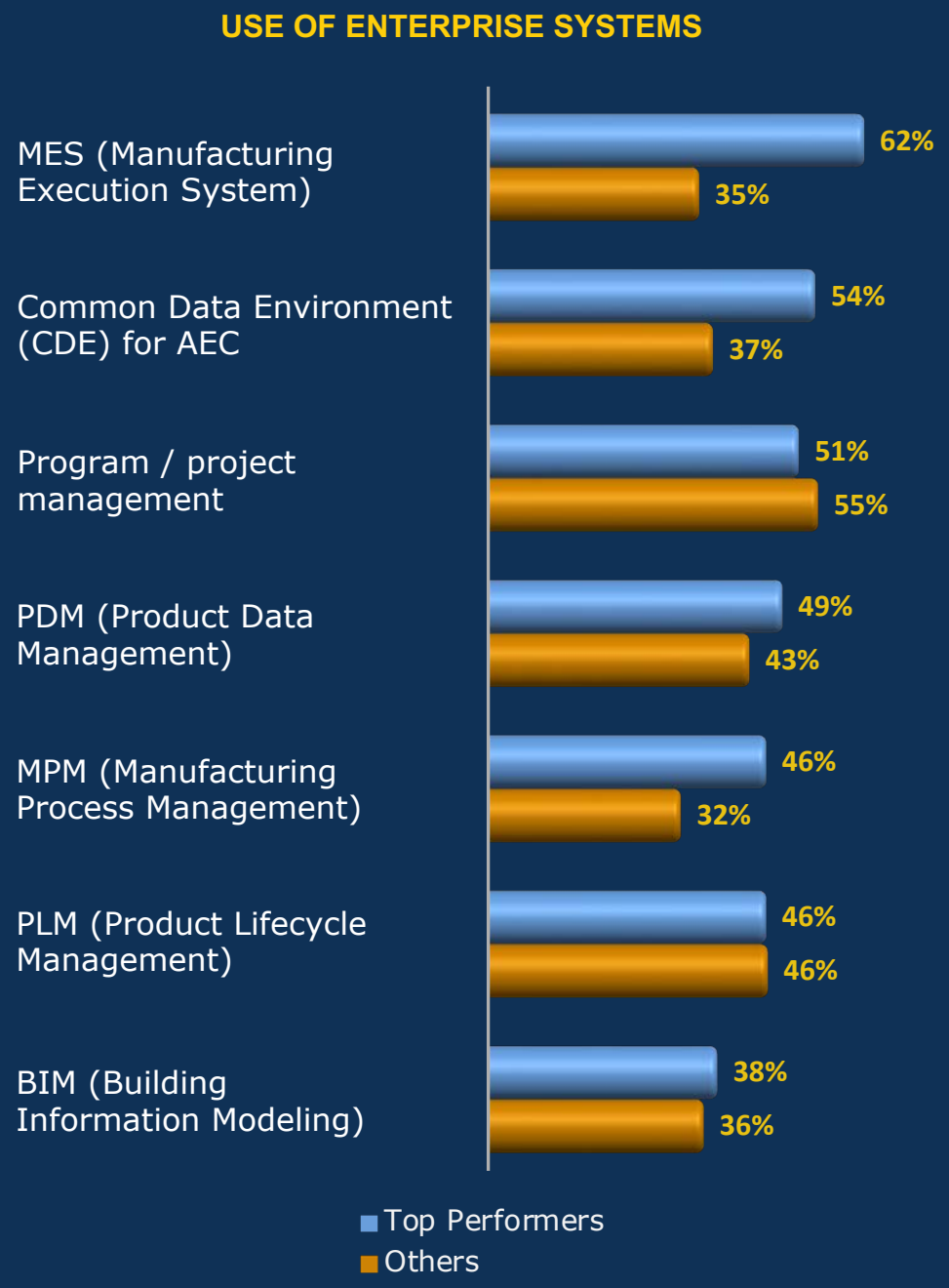
Digitally Transform the Factory Lifecycle

Top Performers are More Digital

Beyond digital twins, Top Performers use more digital tools for factory design and manufacturing planning. For example, they are more likely to design in 3D. In fact, the most commonly used tool for the Top Performers is 3D CAD, used by over two-thirds for both product and plant design. Working in 3D helps engineers better visualize, optimize, and communicate their designs. Further, 3D models are highly valuable for creating digital twins.

Top Performers are pervasively more digital, using digital tools for factory line design, factory layouts, material flow modeling, and more. One interesting note is that not all of the tools that give the Top Performers their advantage are software solutions. Top Performers are also about two-thirds more likely to use reality capture (LIDAR) as a part of the factory design and manufacturing planning processes.





Digitally Transform the Factory Lifecycle

Leverage Digital Tools in the Factory

The most differentiated use of digital tools is in the plant. For example, Top Performers are over three times as likely to have work instructions /connected worker systems and just over twice as likely to use virtual commissioning of automation equipment. This streamlines and creates digital continuity between process design and manufacturing execution. Streamlining this connection reduces the chances to introduce errors in addition to increasing efficiency and better meeting launch dates.

Leverage Enterprise Tools

Top Performers are also more likely to use certain enterprise systems. This is not just in planning. The most common, and the most differentiating, is a manufacturing execution system (MES). MES is used 78% more by Top Performers than Others in the factory lifecycle. The next most common, and also next most differentiating, is using a common data environment (CDE) for AEC.

MES and the CDE solutions are used downstream and upstream in the product lifecycle. The next most differentiating solution, manufacturing process management (MPM), is a platform of specialty tools used directly for manufacturing planning and design. Top Performers are 44% more likely to use MPM tools for manufacturing planning than Others. The combination of these specialty and enterprise tools provides Top Performers with the capabilities they need to more effectively meet their project targets.

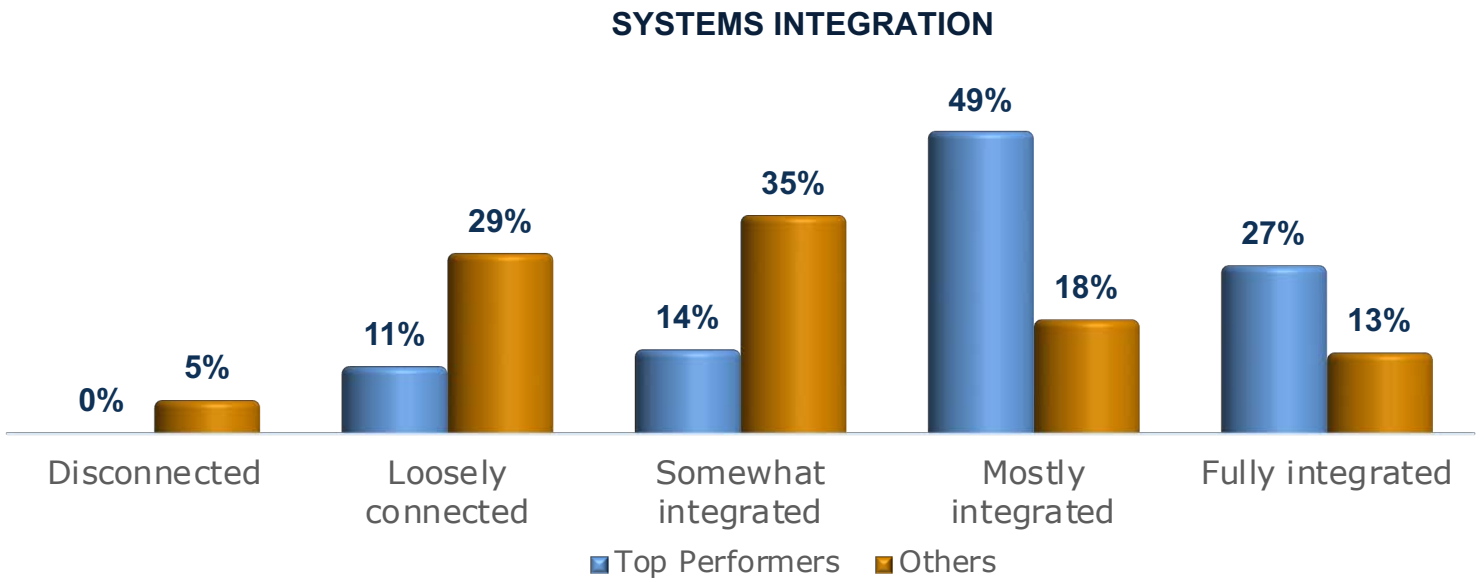
Integrate Manufacturing Planning Tools

Top Performers are More Integrated

Top Performers start with a more integrated planning process and support factory design and process planning with more integrated technologies. In addition to being more likely to use individual digital tools, Top Performers are much more likely to have fully or mostly integrated applications supporting factory design and manufacturing planning.

Integrate Digital Systems

Three-quarters of Top Performers are mostly or fully integrated, while only about one-third of others are integrated at that level. This integration helps with collaboration and communication, but also helps alleviate data sharing issues and streamlines the overall factory design and manufacturing planning process. Others are more likely to have somewhat integrated or loosely connected applications which make collaboration and communication more challenging.



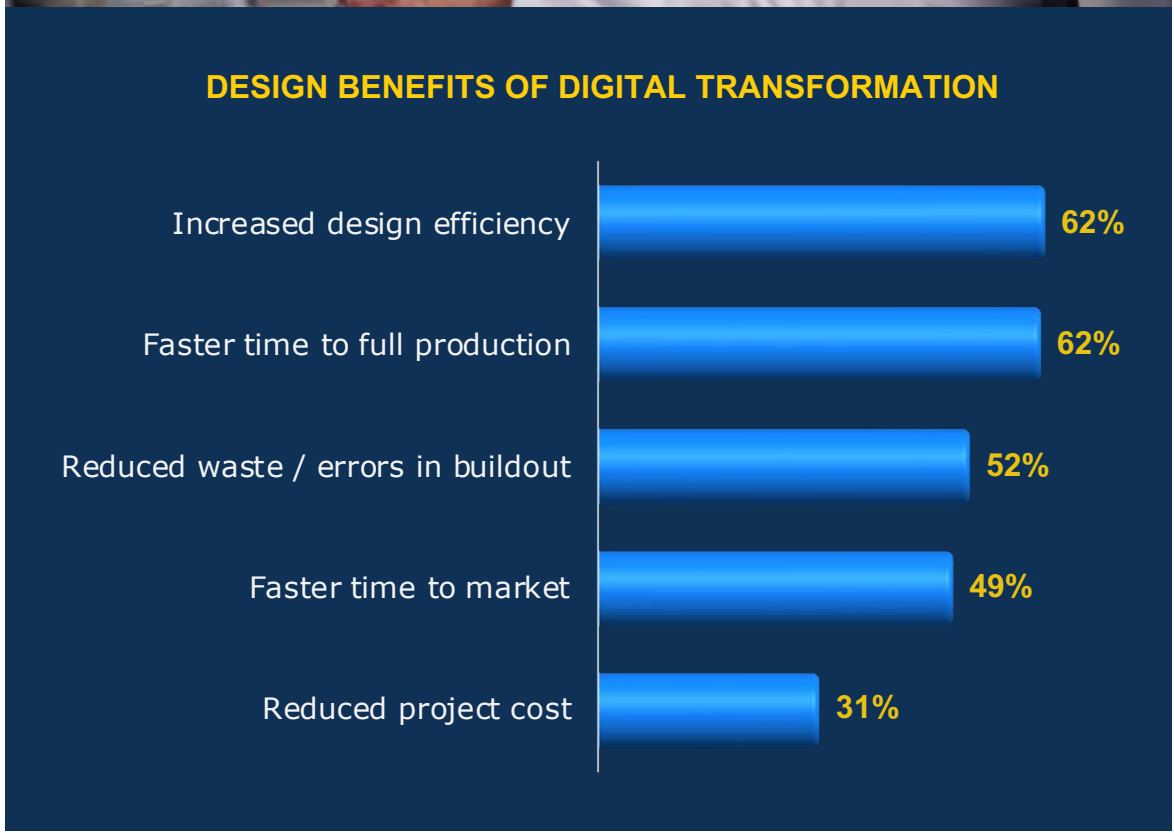
Understand the Advantages of Digital Transformation

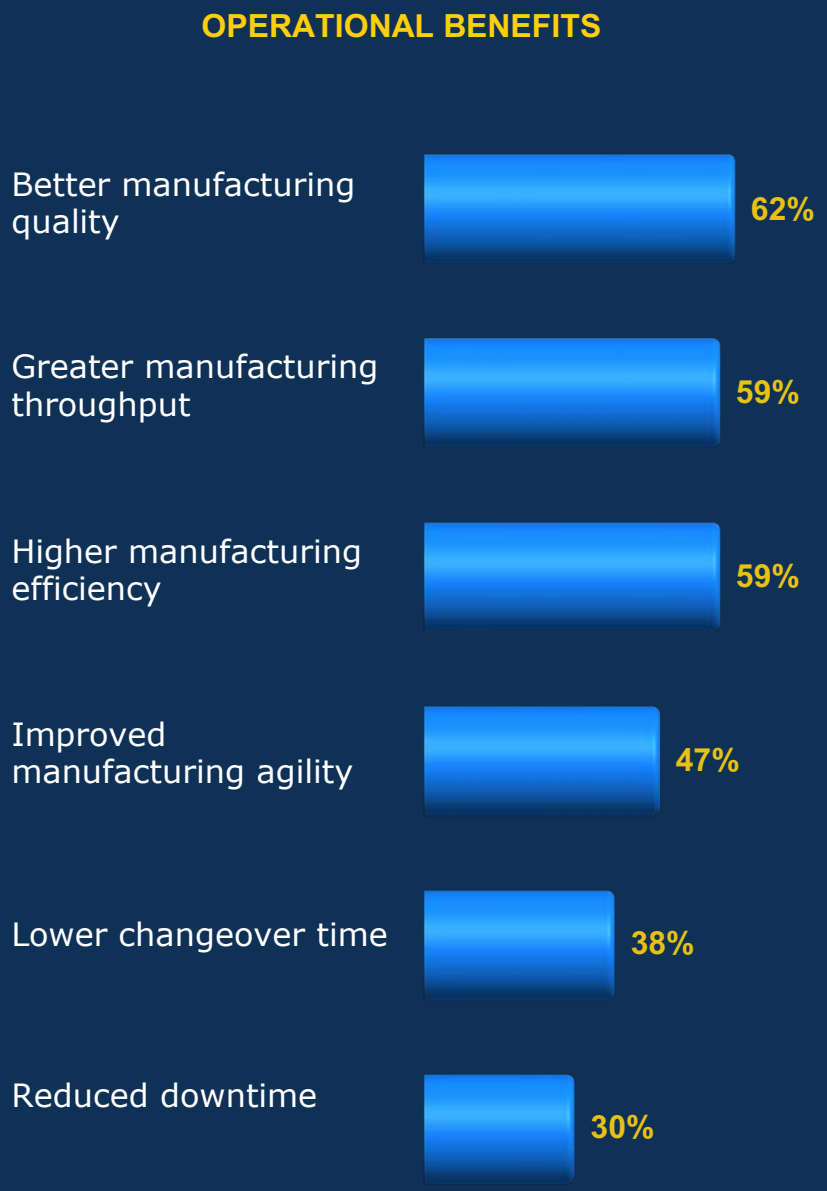
Follow the Lead of the Top Performers

The survey results show that Top Performers are more digital, supporting our experience that digital transformation drives benefits across the factory lifecycle. But that doesn't mean that companies have to be in the top 25% to improve factory design and manufacturing planning performance. In fact, all companies can benefit from digitally transforming the way they plan, design, build, and operate their factories. Digital transformation can help everyone overcome the data and process challenges identified earlier.

Improve Design Performance

Digital transformation impacts performance in a number of ways. Let's start with the design perspective, the manufacturing planning process itself. Survey respondents say that digitally transforming helps them move faster, reporting increased design efficiency and faster time to full production. About one-half report the outcome of efficiency, saying they have achieved faster time to market. In addition to speed, survey respondents report project cost reductions and reduced waste/errors in buildout. Reducing errors, of course, also contributes to faster time to market and lower cost due to less rework.





Gain the Business Value of Digital Transformation

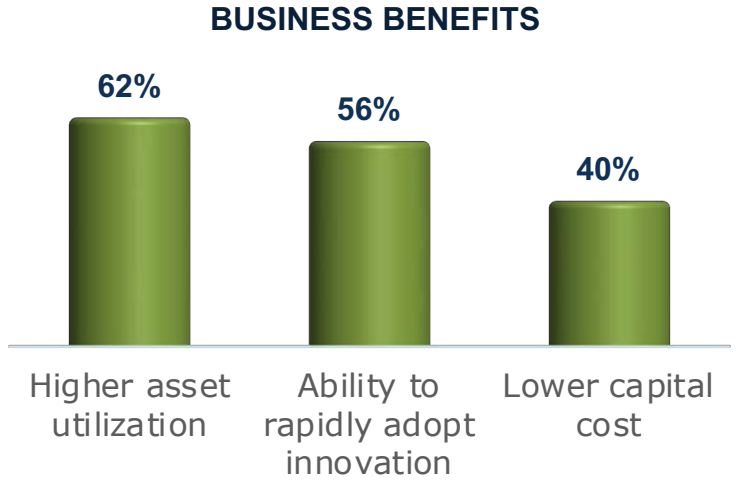
Improve Manufacturing Operations Performance

Digital transformation benefits aren't limited to the planning and design phases, they can drive improvements to overall equipment effectiveness (OEE). Survey participants also share that digital transformation helps from an operational perspective. Respondents report higher manufacturing quality, greater throughput, and higher efficiency. These valuable benefits are each reported by about three out of five manufacturers. In addition, almost one-half report improved manufacturing agility. They also report contributing factors in operations such as faster changeovers and reduced downtime, which likely contribute to the higher efficiency and throughput.

Reap the Business Benefits

Digital transformation also helps drive better business results, helping to counteract the challenges and business impacts reported earlier. About two-thirds report that digital transformation results in higher asset utilization.

Higher asset utilization allows manufacturers to drive more value from the existing infrastructure. In addition, over one-half report that they can more rapidly adopt innovation, which can allow them to be more agile, adopt new manufacturing technologies, and capitalize on new market opportunities. Ultimately, 40% of responding companies report that digital transformation reduces capital cost, which is a significant business advantage to drive ROI from the factory lifecycle.



Conclusions and Next Steps

Operational Factory Lifecycle Challenges

The survey uncovers challenges and business impacts but also ways to overcome them. Manufacturers face business, data, and process challenges in factory design and manufacturing planning. These challenges result in project delays, budget overruns, higher product cost, and reduced manufacturing flexibility - all of which damage asset utilization, innovation, return on capital, and profitability.

Today's manufacturing business environment is too competitive and dynamic for companies to ignore these challenges. They have to pursue innovation, flexibility, and agility through digital transformation. The Top Performers have taken this to heart. They are more able to hit their critical targets including program timelines, project spend, manufacturing quality, and agility. To do this, they start with more integrated planning and higher-level leadership.

Embrace Digitalization and Collaboration

In addition to organizing for success, Top Performers are more digital. They have:

- Implemented more effective collaboration capabilities
- Leveraged digital twins more broadly from planning through operations
- Adopted digital tools across factory design and manufacturing planning
- More fully integrated their systems supporting the factory lifecycle

Enjoy the Benefits of Digital Transformation

Digital transformation offers benefits to all, not just the Top Performers. These benefits include efficiency, speed, quality, productivity, time to market, cost, and agility. These are critical capabilities given the challenges and rapid pace of change that manufacturers face. More importantly, the survey shows that digital transformation drives business benefits including higher asset utilization, ability to rapidly adopt innovation, and lower capital costs.

Based on the survey results, we conclude that manufacturers that don't digitally transform their factory lifecycles will be at a disadvantage to those that do. It's time for manufacturers to review their current capabilities and put a plan in place to improve factory design and manufacturing planning performance.

Digital transformation offers **value to all parties in the factory lifecycle**. Manufacturers don't have to be a Top Performer to improve factory design and manufacturing planning performance through digitalization.

About the Research

Data Gathering
Tech-Clarity gathered and analyzed responses to a web-based survey from 180 companies involved in the factory lifecycle. Survey responses were collected by direct e-mail, social media, and online postings by Tech-Clarity and Autodesk.

Industries
The respondents represent a broad cross-section of industries. 22% were from Industrial Equipment / Machinery, 22% Automotive / Transportation, 20% Electronics / High Tech, 13% Aerospace / Defense, 12% Consumer Products (Retail and Hard Goods), 11% Life Sciences / Medical Devices, 10% Architecture / Engineering / Construction, and others including Energy / Utilities and Building Products / Fabrication.*

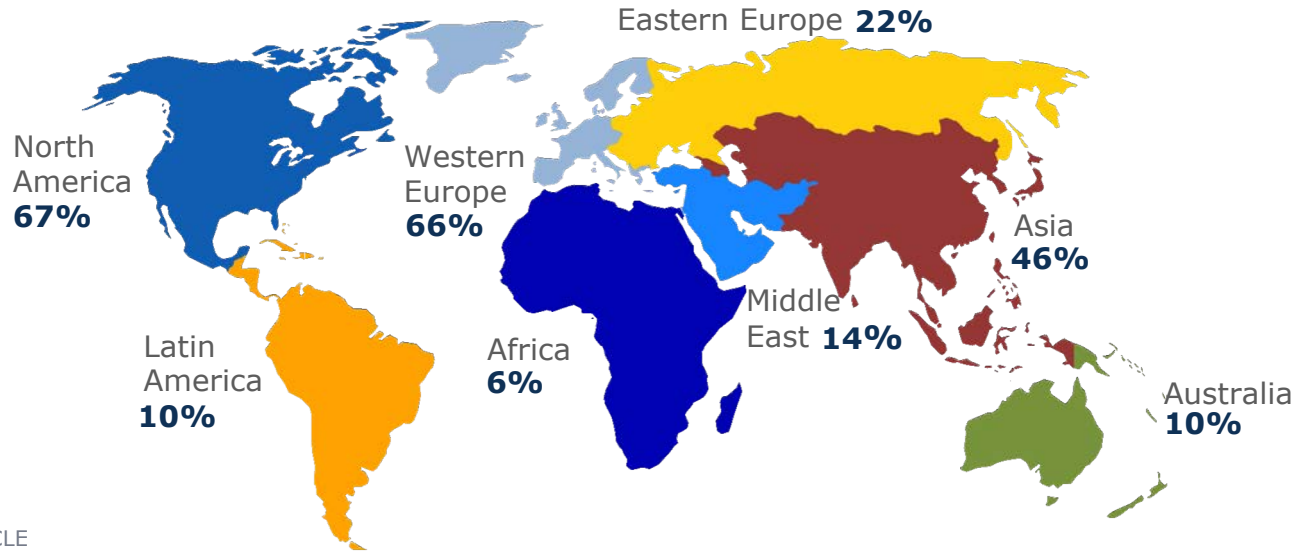
Company Size
The respondents represent a mix of company sizes, including 19% greater than $5 billion, 16% between $1.1 billion to $5 billion, 26% between $251 million and $1 billion, 21% between $101 million and $250 million, and 18% from less than $100 million. Sizes were reported in US dollar equivalent.

Geographies
Responding companies report doing business in North America (67%), Western Europe (66%), Asia (46%), Eastern Europe (22%), Middle East (14%), Latin America (13%), Australia (10%) and Africa (6%).*

Title
The respondents comprised of 11% Executives, 21% VP Level, 31% Directors, 23% Managers, 7% Supervisor / Team Lead, and 7% individual contributors.

Organizational Function
Of the respondents, 47% were in Industrial / Manufacturing / Process Engineering, 15% Product Design / Engineering, 11% Industrial Design, 11% Manufacturing, 6% Plant / Facilities Engineering and the remainder were from a variety of other roles including Information Technology (IT) and Architect.

* Note that the values may total greater than 100% because companies reported doing business in multiple industries and geographies.



Acknowledgements

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About the Author

Jim Brown founded Tech-Clarity in 2002 and has over 30 years of experience in the manufacturing and software industries. Jim is an experienced researcher, author, and speaker and enjoys engaging with people with a passion to improve business performance through digital enterprise strategies and supporting software technology.

Jim is actively researching the impact of digital transformation and technology convergence in the manufacturing industries.

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