Retool Semiconductor Innovation for Profit

A Lifecycle Approach for Smart Products and Devices

Julie Fraser, Vice President, Tech-Clarity

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Executive Overview

Our current way of working and living has been upgraded and retooled due to the innovation of semiconductor, electronics, and high-tech companies. Technology breakthroughs have enabled Moore's Law for decades, resulting in improved products at a lower cost.

Yet, in today's market, technical prowess is insufficient to ensure profitability. Even top technological innovators continue to feel pressure mounting not only on products but also on their entire portfolio and business.

Semiconductor Top Performers think and act holistically to achieve their higher levels of financial success.

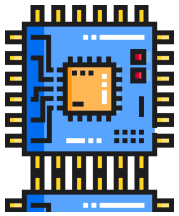
Tech-Clarity conducted a survey of 277 semiconductor and high-tech professionals to find out how semiconductor companies manage product development and product lifecycles. This industry-specific survey indicates that success requires some retooling. Semiconductors and high-tech products must not only be innovative but also high-quality, reliable, high performing, and cost-effective (Figure 1). Plus, each company must quickly navigate change and complexity on many fronts and keep costs low at the same time.

How to gain design ins and get each product into the market to be profitable and successful is a puzzle. Solving that puzzle repeatedly and reliably is an enterprise- and ecosystem-wide endeavor that requires retooling to support that scope.

Some appear to have done that. These are companies we identified as Top Performers, the companies with the best revenue, profit margin growth, and revenue from products less than two years old. They think and act more holistically. Top Performers have better capabilities for ecosystem collaboration and IP protection, they waste less time in product development processes, and have faster time to market.

These leaders accomplish their higher performance through better use of commercial technology. Top Performers are more likely to use Product Lifecycle Management (PLM) technology and to have better access to have data and digital continuity. Hence, data flows to support the many design and development processes. Top Performers also exhibit higher digital maturity, managing and sharing data across partners and disciplines.

The Top Performers show a way forward for semiconductor, electronics, and high-tech companies. It is a path of thinking body and broadly and of acting not in silos by discipline or even company but across the lifecycle and the ecosystem. Winners are emerging by rethinking how to improve, then retooling by leveraging their own products to being modernizing innovation processes and product data flows.



Surveyed 277 semiconductor and high-tech professionals

Products Drive Success and Profit

Innovative and high-performance products have always driven the semiconductor and electronics industries; today, the stakes are higher. Our smart, connected world rests on these products. In applications such as smart cars and cities, medical devices, factories, avionics, and emergency communication, product quality and reliability are life-or-death matters.

Perfect Products for Profit

Customers expect products to be perfect. More than half of respondents report that product quality, reliability, and performance are among the most important factors to their company's success and profits. Over 40% see product innovation and cost as essential to profits as well. (Figure 1)

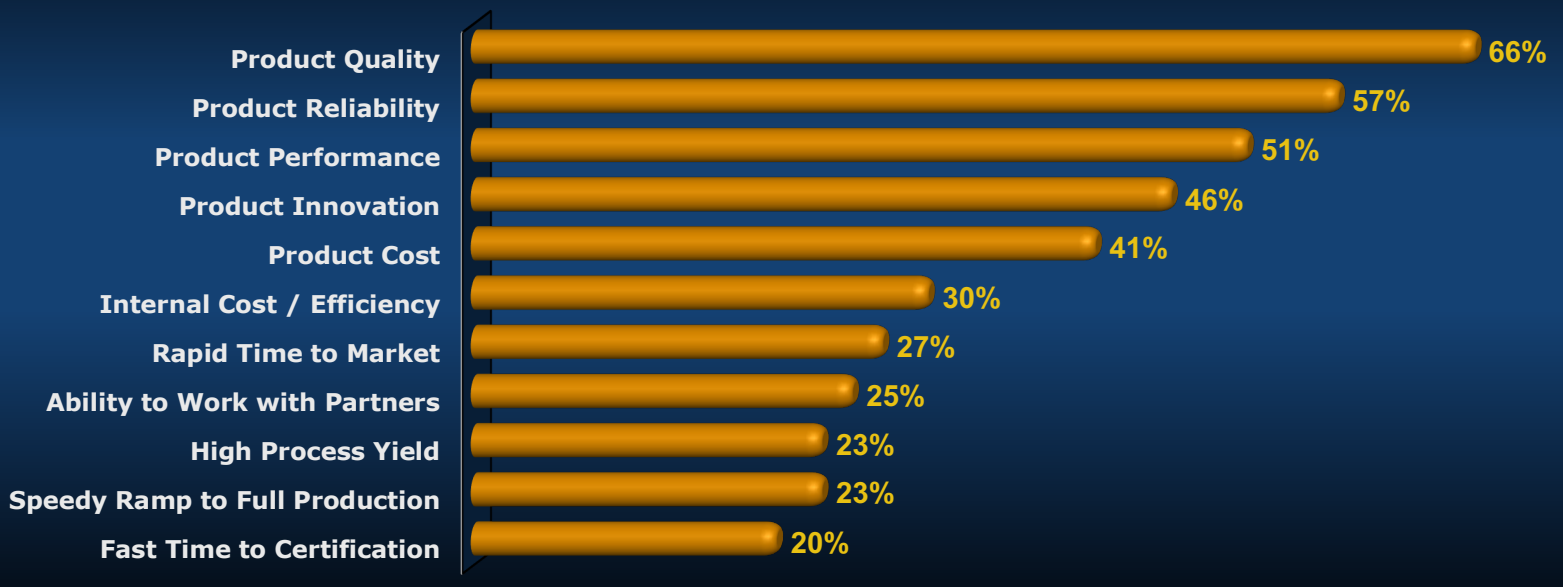
Customer Pressure is Up

Automotive and consumer electronics applications have been pushing the industry for better quality and more rapid innovation cycles for years. Over 60% of respondents report that over the past two years, customer expectations are higher for product quality and new product introduction (NPI) time.

Technical innovations in materials, line widths, stacking, and processing do not necessarily deliver those benefits. Some applications are not pushing the technology at all, keeping 200mm fabs busy. Whether technology innovation is pressing or not, manufacturers must retool to focus more broadly. It is product and business innovation that helps foresee and meet new applications, get design wins, and stay on approved and preferred vendor lists.

> "Our biggest KPIs are go-to-market time and product quality. If bad product escapes, we have fundamental problems in our process."
>
> **Parveen Satyavolu**
> Senior Manager, Applications Engineering
> **LUMILEDS**

FIGURE 1: IMPORTANT FACTORS TO COMPANY PROFITABILITY AND SUCCESS



Opportunity Brings Challenges

Semiconductor and electronics are among the fastest-moving manufacturing sectors. Product lifecycles are short, prices drop rapidly, and constant innovation is table stakes.

What's New? Scope of Change

The digital transformation movement is an accelerator with many implications for these companies that power everything digital. It accelerates opportunities and also imposes many new requirements. Companies must be ready to meet ever-changing market demands to maximize their profit.

Today, the structures of products, markets, and companies are all prone to change. That reality is accelerating. All these changes lead to challenges both for the business overall and at the operational level.

Business Challenges

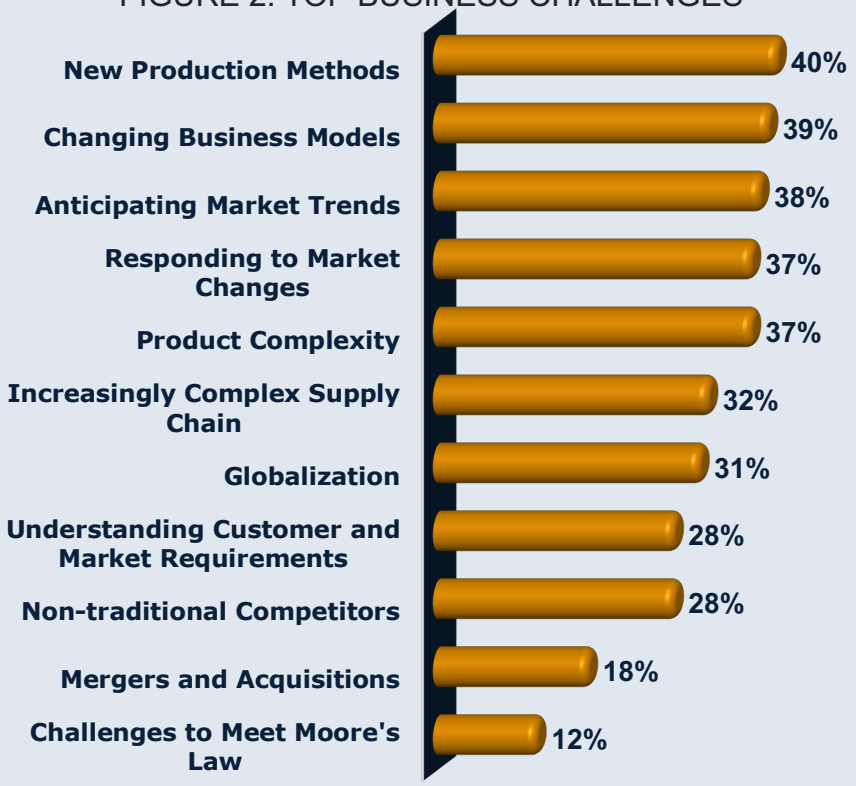
This research confirms that change and complexity are the dominant challenges for this industry in creating profitable products. (See Figure 2) New production methods and changing business models are replacing high tech companies' current ways of working. Anticipating market trends and responding to market shifts show the external pressures. And, of course, the products themselves can be extremely complex.

Challenges Vary

Notice that these business challenges are not universal. Respondents selected as many as they feel are important. Yet, no more than 40% of respondents chose any of these. The variety in responses indicates that technology is no longer the only critical dimension of innovation to win in the semiconductor market.

Some companies are growing by providing relatively simple, older technology chips, low-cost sensor-based IoT, or consumer electronics. These companies may not need new product methods. But many others are pushing Moore's law with new materials like Germanium, making systems-on-a-chip (SOC), stacked semiconductors, multi-layer printed circuit boards, and groundbreaking products that do require new production methods and business models.

FIGURE 2: TOP BUSINESS CHALLENGES



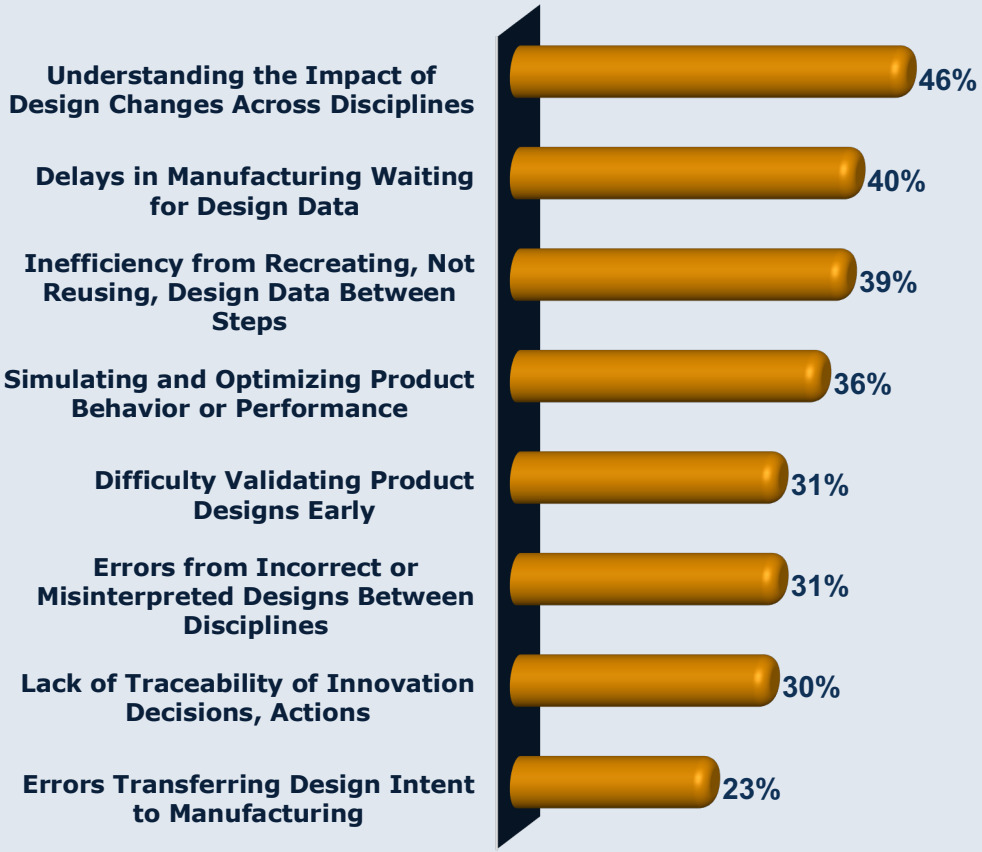
Operational Challenges

Business challenges and changes invariably lead to operational difficulties. We asked respondents about their challenges related to product innovation, design, development, and production.

The most frequently cited operational challenge is understanding the impact of design changes across disciplines (Figure 3). As products, companies, and ecosystems become ever more complex, it is increasingly difficult to anticipate each design or business decision's ripple effects.

Another major issue is wasted time. When manufacturing waits for design data or when design groups recreate data, they are inefficient. It also happens when errors occur due to misinterpretation or incorrect handoff of validating product designs matter as well; these support the product quality, reliability, and performance that drive business success.

FIGURE 3: TOP OPERATIONAL CHALLENGES



> "M&A is one of the challenges we've had. Everybody has their own working practices and tools. Managing the technology is not as challenging as trying to get everyone to agree on a process that will work globally."
>
> **Manjit Salh**
> Senior IT Manager, Engineering Applications
> **COHERENT**

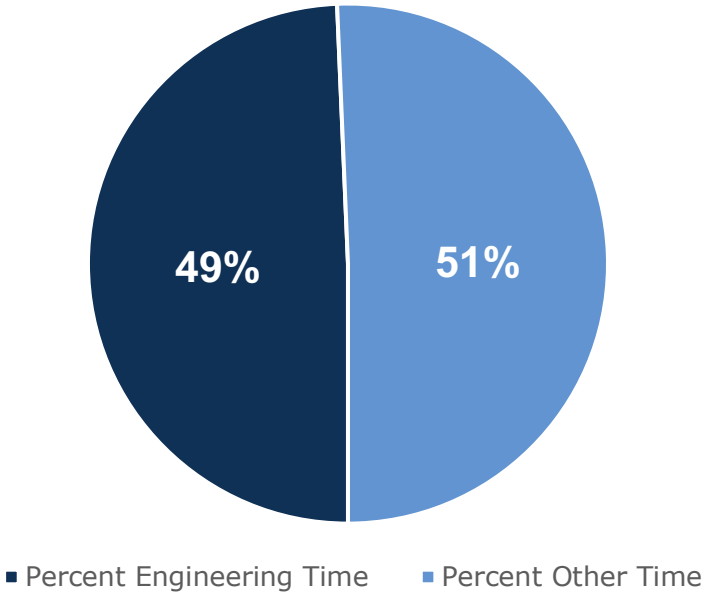
Technical Team Efficiency

Another significant challenge is that designers and engineers cannot focus fully on their role. Respondents estimate that only about half of their company's technical resources' time is spent directly on product innovation, development, and engineering (Figure 4).

Tech-Clarity does quite a bit of research on engineering processes and PLM, and the team spending half of their time on non-innovation tasks such as finding or re-creating data is not unusual. However, it is a challenge for companies to overcome, with design engineering talent in short supply, particularly for semiconductor companies.

As products, companies and ecosystems become ever more complex, it is increasingly difficult to anticipate each design or business decision's ripple effects.

FIGURE 4: PORTION OF ENGINEERS' AND DESIGNERS' TIME SPENT DIRECTLY ON PRODUCT INNOVATION



Retooling to Lifecycle Management Strategies

At both the business and operational levels, accelerated change is a pressing challenge. So, how can semiconductor and electronics companies manage change better? One option is to adopt a product lifecycle management (PLM) strategy for digital innovation across the enterprise and ecosystem.

Tech-Clarity defines PLM: PLM is a software-enabled strategy to improve processes to conceptualize, design, develop, and manage products - to drive higher levels of product profitability.

Lifecycle Management for Digital Thread

The concept of lifecycle management for products has been around for many years. Automotive and aerospace companies adopted PLM strategies early, and for these companies, it is a foundational enterprise system. Over that time, the strategies and the supporting software platforms have evolved and expanded. Today, PLM supports an encompassing innovation, design, and product development process; this is more than managing lifecycles.

It is sometimes called digital product innovation or digital thread. At Tech-Clarity, "Our view is that the digital thread ties product information, decisions, and history together in a structured, integrated way that captures product innovation and knowledge throughout the product lifecycle."[1]

Data in Context, Available, and Ready for Collaboration

One aspect of product lifecycle management is ensuring data from different design, engineering, test, simulation, and validation platforms comes together to create a complete picture of a product. This comprehensive, easy-to-find product data enables new streamlined processes.

Product lifecycle management focuses on ensuring accurate, up-to-date data is readily available across disciplines, partners, and phases of a product's lifecycle. PLM also focuses on collaborating based on all needed information about engineering intent, decision criteria and rationale, and relevant events throughout the entire lifecycle.

"Lifecycle management is a mature ideology which has been around for more than three decades. Yet, it is surrounded by cultural and accountability issues. Many industry leaders and engineers understand it up to a certain degree but don't want to fully embrace it in practice. The common misconception is 'it is slow and cumbersome.' But stakeholders need to understand that quality, collaboration, velocity and innovation all need to be in tandem to result in successful product management."

Parveen Satyavolu
LUMILEDS

Driving Success

In our previous research across manufacturing industries, we found, "In addition to financial performance, Top Performers have higher capabilities compared to competitors in their ability to:

- Get new / changed products to market quickly
- Design innovative products
- Meet market cost requirements
- Develop high-performance products
- Deliver high quality / reliable products

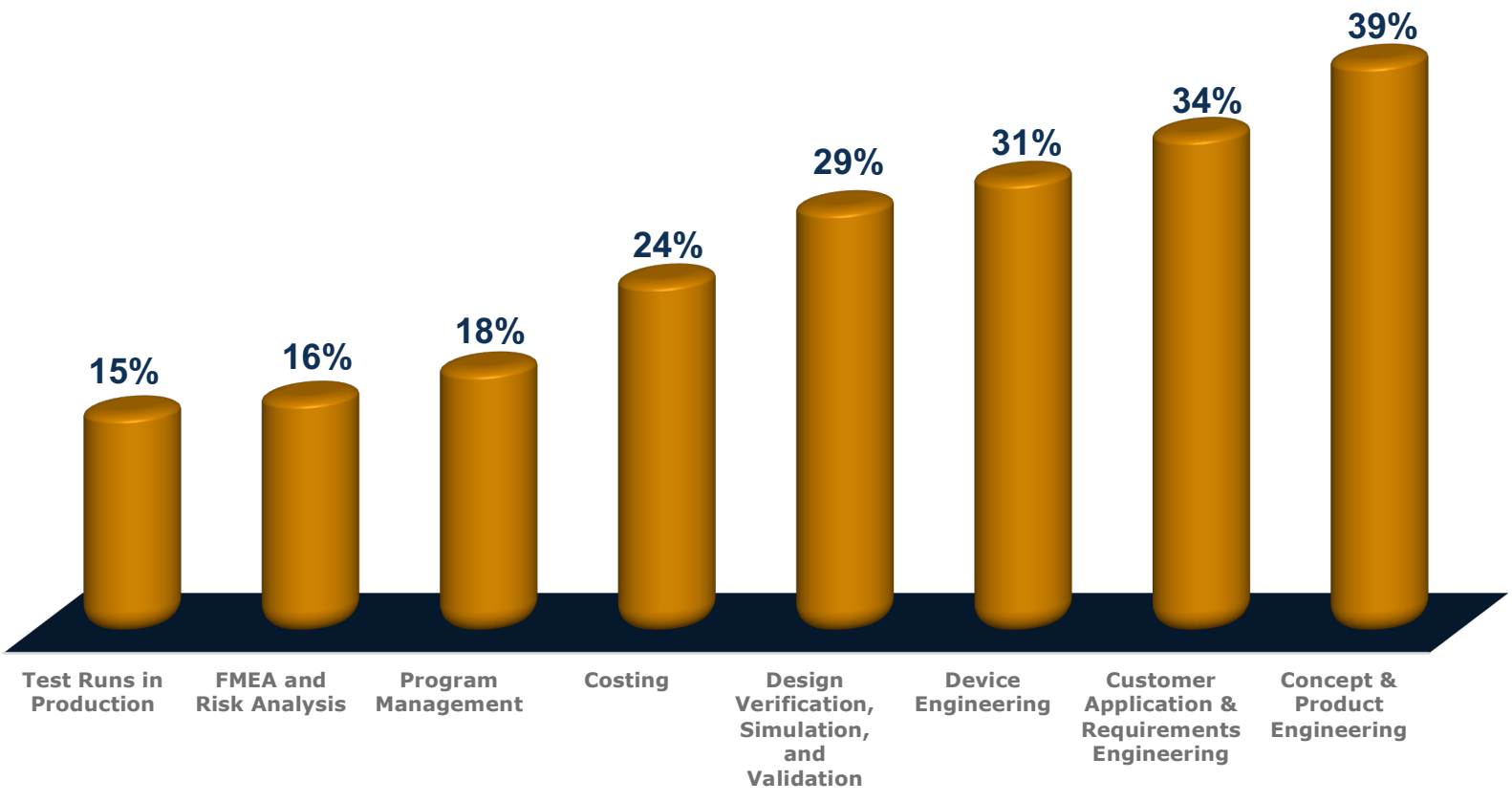
These companies also have higher digital product innovation maturity, having retooled with digital technologies and approaches.

New Product Introduction Time Rests on Holistic Engineering Processes

Some of the most difficult issues are those broad ones that cross disciplines. The top opportunities to improve new product introduction time reflect that (Figure 5). Concept and product engineering, Customer applications and requirements engineering, and device engineering are all holistic.

> "The intent in our overall vision is for a consistent, unified product lifecycle management process. That will allow us to drive innovation and bring different functional groups closer together. It will help us align many of the working practices as well."
>
> **Manjit Salh**
> **COHERENT**

FIGURE 5: TOP OPPORTUNITIES TO IMPROVE NEW PRODUCT INTRODUCTION CYCLE TIME



Identifying the Top Performers

What do the best do differently than others? To help understand what processes and technology correlate with higher performance, we use a "Performance Banding" process.

We identified the top 27% performing respondents as "Top Performers."

We evaluated three criteria that reflect semiconductor company success and profitability:

- Revenue growth (over the last 2 years)
- Profit margin expansion (over the last 2 years)
- Percent of sales from products < 2 years old (to measure innovation)

We created an aggregate metric across these and identified 27% of respondents as "Top Performers." The rest with lower performance in these metrics, we designated as "Others." Then, we analyzed what the Top Performers do differently. We make recommendations based on which processes those with higher performance levels have mastered and which technologies they use to support them.

Through the rest of this report, charts comparing these groups will use blue to show Top Performers and gold to show Others.

Business Capabilities Matter

What capabilities do semiconductor and electronics companies need to drive profitability and succeed? There are many, and they revolve around speed, innovation, efficiency, and product results.

Top Performers' Excellent Capabilities

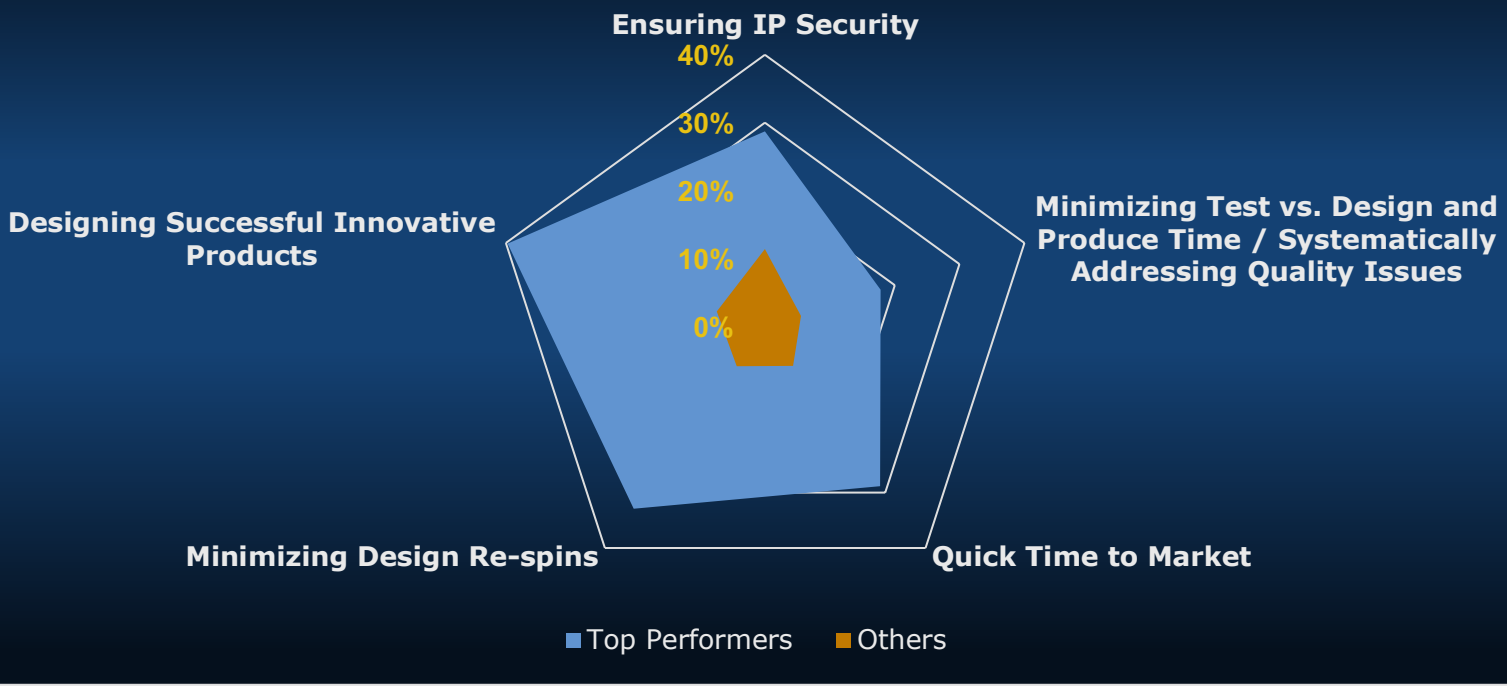
Top Performers are several times as likely to say they perform significantly above average on business innovation capabilities (Figure 6). These are very significant differences.

- 5.3 times as many outperform on designing successful innovative products
- 4.7 times the percentage excel at minimizing design re-spins
- 4.1 times the portion reliably achieve quick time to market
- 3.2 times as many are so efficient their ratio of value-added engineering production vs. testing and validation is significantly above average
- 2.5 times the percentage are excellent at ensuring IP security

Capabilities for Success

Those capabilities feed Top Performers' strong growth in revenue, profit margin, and new product-based income. Each one requires enterprise and ecosystem coordination.

FIGURE 6: PERFORMANCE SIGNIFICANTLY ABOVE AVERAGE



Top Performers Manage Product Data Better

The business capabilities listed above depend on product data. With such rapid change plus complex products and ecosystems, semiconductor and electronics companies need many product data management processes to survive. Could companies retool to do better?

Managing Data Across Partners, Lifecycle

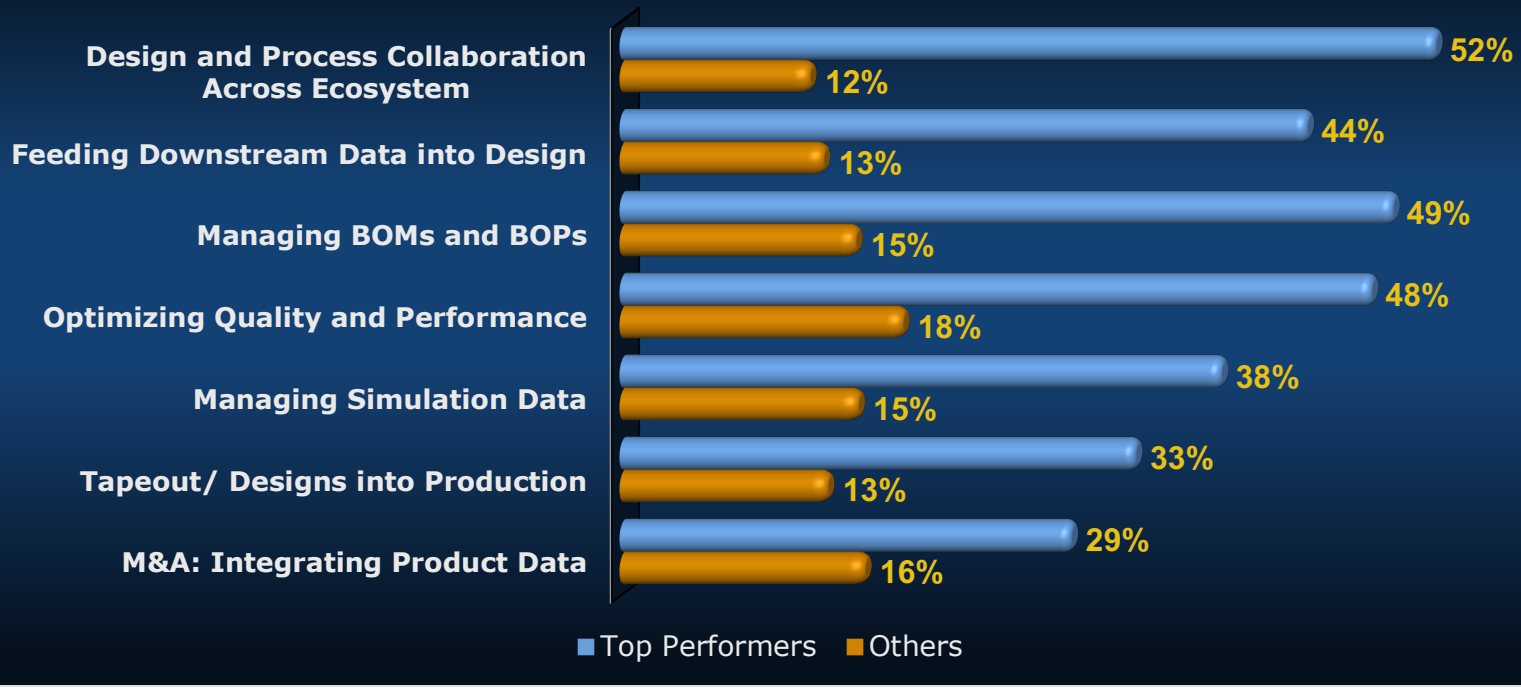
It appears that the Top Performers answer that question with yes. They are much more likely to have excellent product data capabilities across the lifecycle (Figure 7). Top Performers manage product data well. They also control it, harmonize it, share it, collaborate with it, and streamline processes with it.

Excellence for Top Performers

Top Performers are far more likely to have "Excellent" product data capabilities (rather than good, fair, or poor). Some examples of the considerable differences:

- 4.3 times more excel at collaboration across their ecosystem of partners for design and development, at over half
- 3.4 times more at providing data from later in the lifecycle to designers
- 3.3 times more at handling the unified product and process bills of materials and process
- 2.7 times more can use product data to optimize quality and performance, two top issues for company profitability

FIGURE 7: EXCELLENT CAPABILITIES BY PERFORMANCE BAND



Top Performers' product data capabilities enable a more coherent lifecycle management approach. Equipped with effective business processes that leverage data, these companies can execute high-level strategies with greater confidence and success. These might include changing suppliers or contract partners, producing in many sites, mergers and acquisitions (M&A), and entering new markets and application areas.

With effective business processes that leverage data, Top Performers can execute high-level strategies with greater confidence and success.

Organizing and Supporting People for Success

Effective processes for products and product data rests on people. So how do organizational and human resource issues play into this lifecycle success?

Organization for Collaboration

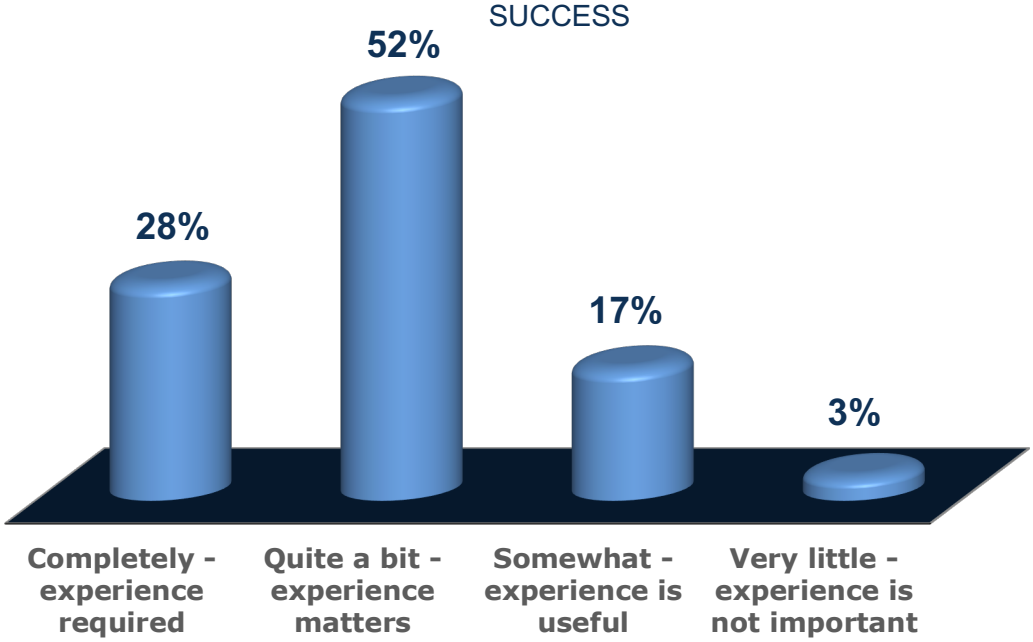
Some companies, particularly in the semiconductor industry, have top executives for each technical discipline. In some cases, this means they little incentive or means to collaborate in cross-disciplinary ways.

The good news is that nearly all of the respondents report having an enterprise-wide continuous improvement (CI) function. In other words, the company has a person or team tasked with finding and fixing the places where processes are inefficient, including gaps and disconnects between disciplines, steps, teams, or partners. This role is present in 95% of Top Performers, compared to 74% of others.

Measuring Designers

Developing successful semiconductor and electronics products is a team sport. Thus, it's good that most companies measure designers and design teams on the success of the product in the market (60%). However, no designer can ensure that alone, so it might not change behavior. Companies also use metrics designers can directly impact, including timely delivery of their aspect of the design (49%), communication to the next steps of the lifecycle (46%), and completeness of information they deliver to the following steps (51%).

FIGURE 8: IMPORTANCE OF TEAM EXPERIENCE TO PRODUCT SUCCESS



Reliance on Experience

Designers and engineers are highly educated and trained. And four of five respondents in this industry believe that their products' success relies heavily on having an experienced team (Figure 8).

In fact, over a quarter think product success is completely dependent on having a very experienced team. Given that many semiconductor engineers are nearing retirement age, this is a challenge.

PLM for Knowledge Sharing

The innovation team must share information and knowledge to achieve the product quality, reliability, performance, and cost companies need to succeed. Fortunately, that is precisely what a PLM strategy tackles.

To move toward the vision, many companies use PLM software to retool and support sharing, collaboration, understanding, and trust among experts. It can also enable those with less experience to make sound decisions because they have easy access to information that reflects the team's knowledge.

"My team is responsible for driving harmony and consensus between all enterprise product master data stakeholders. The goal is to balance time to market without sacrificing quality and make sure right set of information is available to right stakeholders at right lifecycle of the product"

Parveen Satyavolu
LUMILEDS

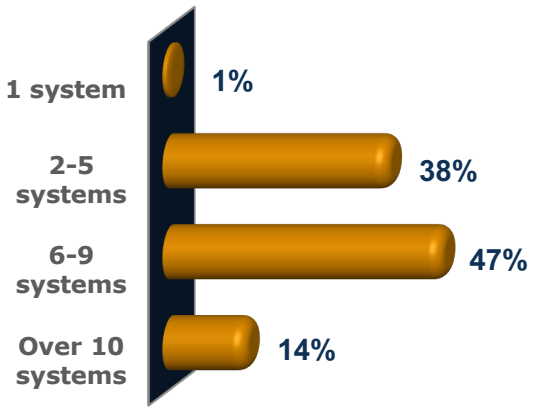
Semiconductor's Complex Technology Landscape

Just as the products and ecosystems are complicated in these industries, so is the constellation of systems used to manage product data. Because product lifecycles are so short in these industries, some companies invested early.

Many Systems

With so many engineering and design disciplines involved in semiconductors and electronics, companies have many systems to manage data also. Over 60% of the respondents use six or more systems to store, access, and put in context the following data: requirements, concept, design, development, simulation, detailed engineering, production process design and simulation, test and verification, in-use (Figure 9). Top Performers are a bit more likely than others to use ten systems or more (21%).

FIGURE 9: NUMBER OF SYSTEMS USED FOR PRODUCT DATA STORAGE, ACCESS, CONTEXT



Technology in Use Varies

With so many systems per company, there is a surprising lack of consistency in which systems semiconductor and electronics companies use as the primary ones to store, share, and control product design and definition data. None of the system types we included are considered primary by even 40% of respondents (Figure 10).

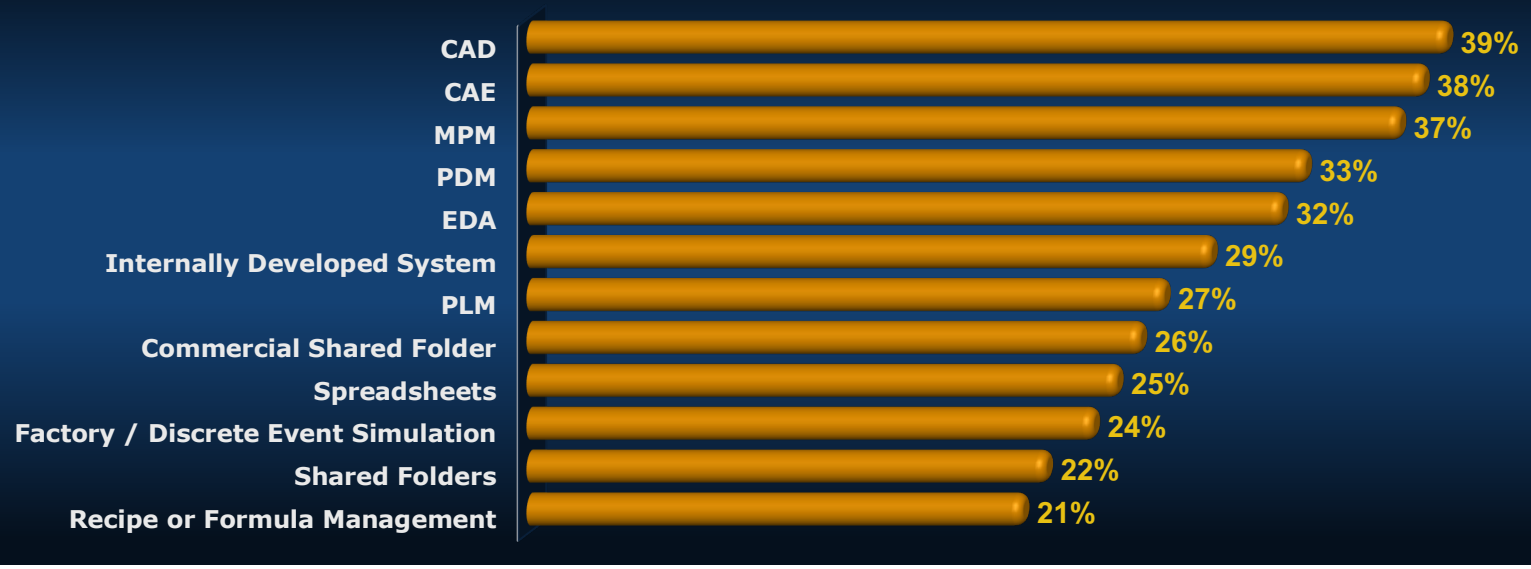
PLM Use is Relatively Low

Today, PLM is a "product innovation platform" for managing design, development, NPI, and improvements based on use and feedback. It also provides effective tools for knowledge sharing and collaboration and supports rapid yet effective processes to speed successful products to market.

Previous research shows that the electronics and high-tech sector is 18% less likely (30%) than other industries (36%) to use PLM as the foundation for a digital thread. That is true even though 62% of high-tech respondents in the same study said PLM is crucial or important to the digital thread.[2]

> "PLM supports gains on turnaround time. We had so many heterogenous systems across the company the innovation cycle time was long. We had data degradation and aging issues."
>
> **Parveen Satyavolu**
> **LUMILEDS**

FIGURE 10: PRIMARY TECHNOLOGY SYSTEMS FOR PRODUCT DATA



Top Performers are significantly more likely to use PLM as a primary system for managing product data than others (36% vs. 23%). This type of end-to-end enterprise platform aims to deliver robust data management, data sharing, and collaboration to support business processes and capabilities.

Tech-Clarity Defines PDM: A structured, collaborative solution that helps manufacturers control, access, and share crucial product data. Examples of capabilities include version control, release status, file ownership, IP protection, and BOM (Bill of Materials) Management.

Early Adopter Challenge

So why are semiconductor and high-tech companies not using PLM? Some high-tech companies may have adopted an earlier and more limited concept, such as product data management (PDM). Top Performers are about 30% more likely to use PDM than Others. PDM does provide structured data management for the diverse product information companies have. If they also built or bought a PDM technology platform, they may have decided against further investment.

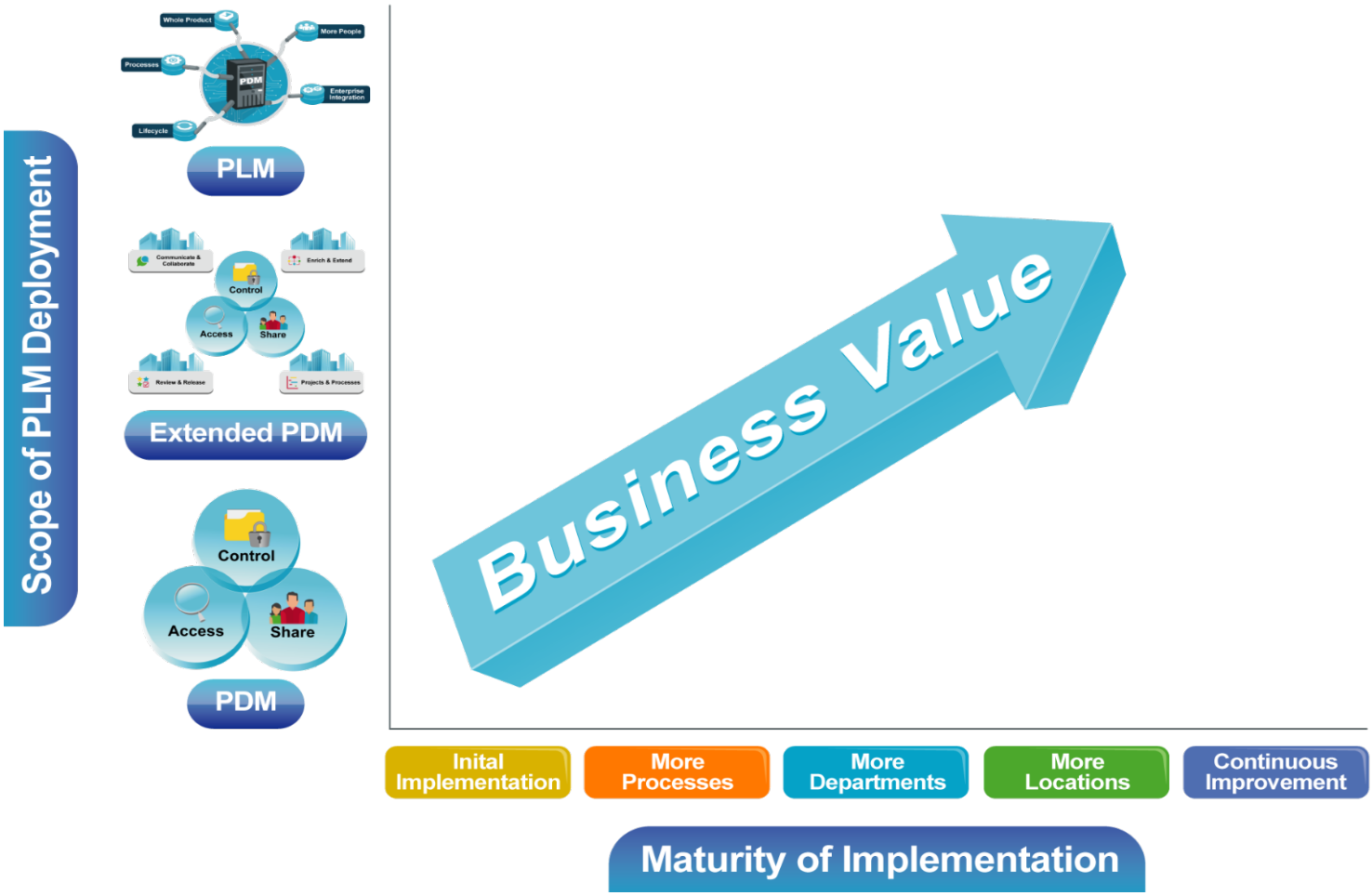
Yet, it may be time to reconsider that decision and invest further to gain additional value. PLM typically includes PDM but extends that to enable processes that use and support the product data across the lifecycle, enterprise, and ecosystem. It moves beyond managing the data to provide complete support to many more processes beyond the technology innovation and engineering/design areas.

> “Engineering tools are mature now; the technology is proven. The question is how to leverage the functions and features and put them together for a competitive advantage.”
>
> **Manjit Salh**
> **COHERENT**

Tech-Clarity PLM Value Maturity Model

We mentioned that digitalization is a journey – and so is gaining value from PLM. Two dimensions enable added value: maturity of implementation and scope of deployment (Figure 11). The Tech-Clarity PLM Value Maturity Model shows these two aspects.[3]

FIGURE 11: THE TECH-CLARITY PLM VALUE MATURITY MODEL



The value an organization can achieve with PLM relies on a combination of:

- Maturity of Implementation: how broadly the business uses PLM – how many people and business processes it supports – shown on the horizontal axis.
- Scope of Deployment: what capabilities are in play, ranging from basic product data management to PDM extensions for revisions and releases, managing projects and processes, enriching and extending the data and communication. To gain the most value, companies move beyond

PDM to full PLM for collaboration - shown on the vertical axis.

Today's PLM is an enterprise and ecosystem enabling platform for product innovation processes. As the name suggests, it spans processes across the lifecycle from concept through manufacturing. PLM also supports processes for more people and the entire product, not just one aspect. It integrates into other applications to pull data about suppliers, plus production operations at your sites and partners. In these ways, PLM supports more profitable innovation in many dimensions.

Digital Continuity from PLM

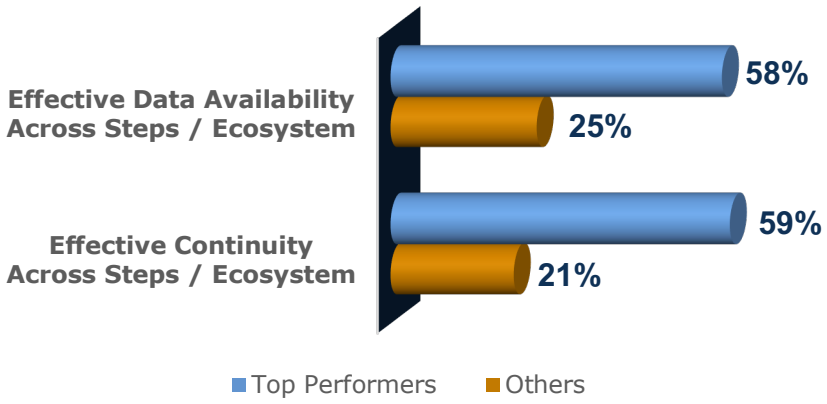
With many applications, it can be challenging to achieve digital continuity. Digital continuity is the concept of information flowing smoothly, with integration and coherence. It also typically provides good, secure data availability to all who need it. So, it means retooling to leverage the data from all those systems effectively.

Tech-Clarity defines: "Digital design continuity leverages data from prior design steps as the basis on which to add new design information. This approach streamlines design and reduces the need for design translation and remodeling between design functions. It also helps coordinate design data and processes across the product lifecycle to improve efficiency and decision-making, such as understanding the cascading impact of design changes."[4]

Most Top Performers Have Digital Continuity

Top Performers are dramatically more likely to enjoy digital continuity. Most of them are excellent at integration, coherence, and continuity of their product data across steps, phases, facilities, and partners. All but 3% of Top Performers feel they are at least good at this compared to 22% of others who are "Fair" or "Poor."

FIGURE 12: TOP PERFORMERS VS. OTHERS RATED EXCELLENT AT DIGITAL CONTINUITY



Top Performers are also twice as likely to have excellent ease of data access and availability across innovation steps / phases / facilities / partners, at 58% vs. 25% of others (Figure 12). In this case, no Top Performers rated themselves lower than good. They have addressed digital continuity in their retooling.

Keeping Technical Team Focused with Digital Continuity

Digital Continuity from a PLM strategy can help keep engineers more focused and efficient. With easy access to product data, technical resources no longer need to spend half their time (Figure 4) searching for, providing access to, massaging, or re-creating essential product data. They also do not risk introducing errors and wasting more time on entering data that may exist elsewhere. The continuity of data flow and its easy availability helps to improve this situation where designers and engineers only have half of their time available for their core tasks.

> "The intent in our overall vision is to go for a consistent, unified product lifecycle management process. That will allow us to drive innovation and bring different functional groups closer together. It will help us align many of the working practices as well."
>
> **Manjit Salh**
> **COHERENT**

How Semiconductor Companies Differ from Their Customers

Anyone who has worked in or near semiconductor companies knows that it's very different from other segments. By including both semiconductor companies and their high-tech customers in this research, we can compare semiconductor respondents to others. For the most part, the differences are small. However, differences are statistically significant in a few areas.

Success in Innovation and Certification

Semiconductor companies are much more likely to see that success and profit rest on product innovation (58%) and time to certification (28%) than others. As the component suppliers to the entire world of smart products and systems, this is no surprise.

Business Model and Optimization Challenges

Changing business models is a top business challenge for nearly half of semiconductor companies (47%). On the operational side, 45% see simulating and optimizing product performance as a top challenge. Semiconductors are more complex to design and make than nearly any other product, with exacting specifications, iterative processes, and interdependencies in both product and process design.

Good at Some Data Management

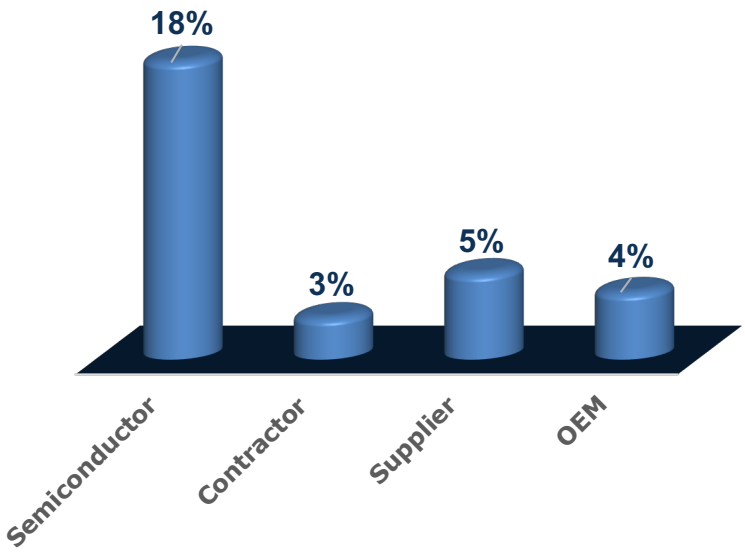
In their challenging situation, semiconductor companies are more likely to be excellent or above average at some key capabilities than others. Some of these are managing bills of materials (BOMs) and bills of process (BOPs) and simulation data, plus digital continuity across steps. They are more likely to have a lifecycle-wide continuous improvement role than others, at 88%.

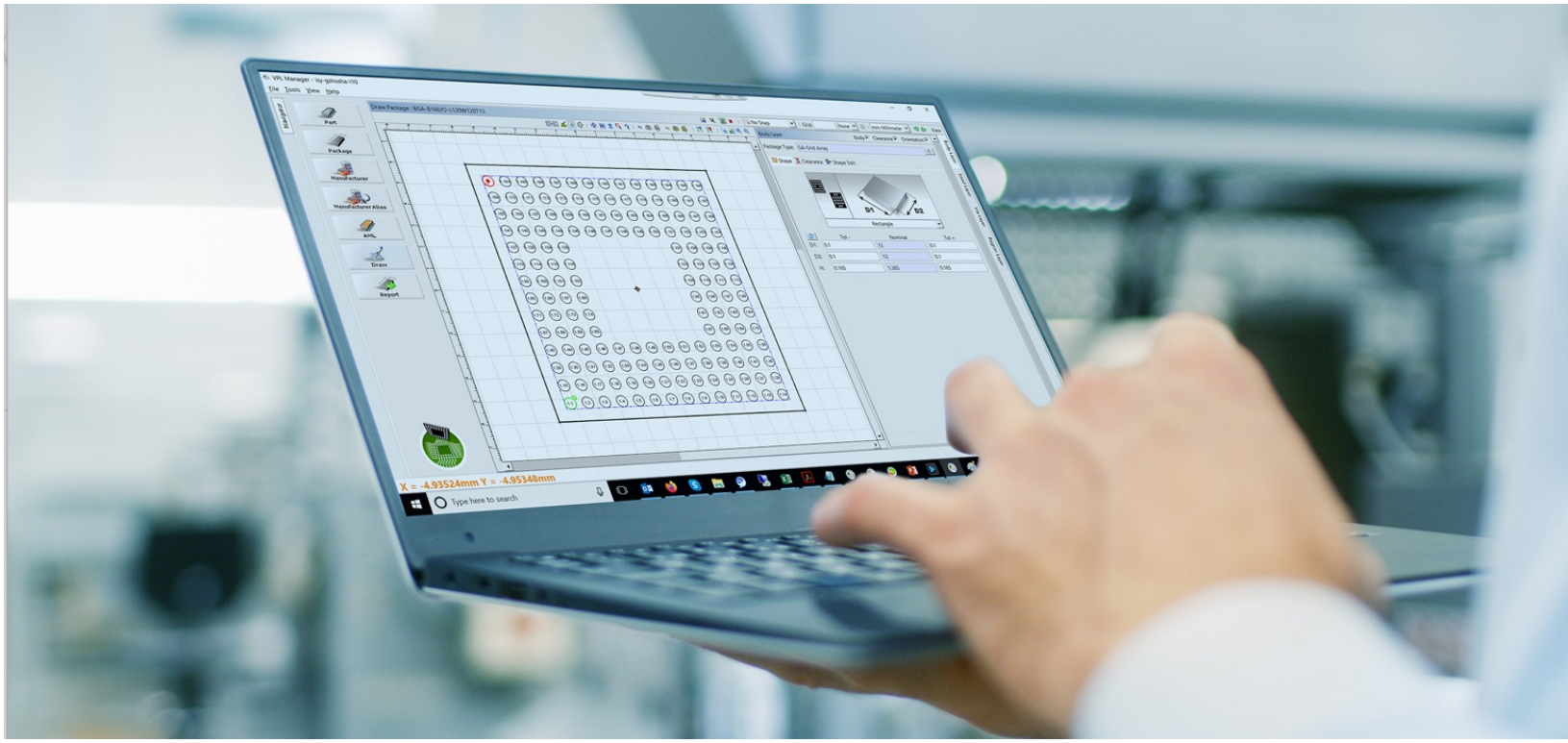
Poor at Collaboration and Knowledge Sharing

At the same time, semiconductor companies struggle in some aspects of collaboration and coordination. They are more likely to have little or no ability to coordinate across external partners (Figure 13). Given how many companies are not vertically integrated, but rather fabless, foundries, or OSATs, this can be particularly problematic.

Semiconductor companies are more likely to be below-average at systematically addressing quality issues and also at ensuring IP security. Another weakness of semiconductor companies is that they believe their product success relies completely on having an experienced team (36%). These areas of knowledge sharing are where semiconductor companies will most benefit from retooling and broadening their vision of innovation.

FIGURE 13: LITTLE OR NO COORDINATION ACROSS EXTERNAL PARTNERS





Conclusions

Every aspect of life increasingly depends on semiconductors and electronics to become smarter. Opportunity is growing. Yet to seize it, companies must improve not only the technology inside the product but also the enterprise and ecosystem processes. Remember, success rests on achieving product quality, reliability, performance, innovativeness, and cost all at once. Beating the competition in all those ways is no small feat.

To improve product success and shorten NPI cycle time, retooling for more efficient and effective engineering is urgent.

Meeting the Pressures

Companies must enhance products not just technically but in ways that address the many business challenges and issues. The complexity and rapid change of semiconductor products, ecosystems, customer needs, and business models are only growing. To improve product success and shorten NPI cycle time, retooling for more efficient and effective engineering is urgent. Ways of working must be multi-disciplinary, collaborative, and secure. Other methods are no longer sufficient, no matter how innovative they once were.

Top Performers' Holistic View

What differentiates Top Performers from Others is how much they have done to ensure their business and product innovation work effectively. They are better at cross-functional and multi-partner processes than others. Rather than settling for trade-offs, they have developed capabilities to balance all the objectives. They can design successful innovative products while at the same time being efficient and protecting their IP. This balanced view and set of capabilities enable them to get to market faster and more confidently with lower operating costs.

Digital Support

It's not realistic to expect to simplify the multi-application technology environment. That's not what differentiates Top Performers. How they achieve superior performance is by being better at

- managing their product data, whether BOMs, BOPs, simulation data, or IP
- digital continuity
- data access through the lifecycle
- using PDM or PLM technologies
- collaboration across their enterprise, ecosystem, and product lifecycle.

> "Product lifecycle management will eliminate a lot of rework, streamline processes resulting in operational efficiencies, and improve communication and collaboration between functional teams. It will also have a cultural impact as everybody feels they are doing something that is actually making a difference to the organization."
>
> **Manjit Salh**
> **COHERENT**

Recommendations

Based on research for this report and years of experience in the semiconductor, electronics, and high-tech industries, Tech-Clarity offers the following recommendations. To capture the immense opportunities available and stay profitable, companies in these industries should follow the lead of Top Performers.

1. **Innovate as a Business:** Move beyond technical innovation to address the many issues of product innovation that, together, spell company success. Work toward excellent product and business capabilities to get out ahead of customer demands.
2. **Retool for a Lifecycle Approach:** Develop an enterprise PLM strategy. Ensure it not only manages data but also shares it securely across the enterprise and ecosystem. Leverage the lifecycle-wide continuous improvement team your company may already have.
3. **Assess Capabilities:** Examine where your business processes and abilities are lagging and evaluate which will matter most to your market success. Prioritize those to improve, but keep all of them in mind as a roadmap.
4. **Shift the Mindset:** Without complete product data, semiconductor innovation has often been more art than science. However, the lifecycle approach and supporting technologies change that. Generating concepts may be an art, but profits flow to those who master the science of best using product data for continuous improvement.
5. **Explore Digitalization:** Examine where you can create the digital continuity and data access you need to make those key improvements. PLM software platforms are designed for digital product innovation and are proven in the market. Focus your PLM implementation on areas that will generate improvements that are visible and important to the business' success.
6. **Invest for the Future:** When crafting IT projects, consider how easily systems can expand into more of the ecosystem and lifecycle over time. Digital continuity will be the hallmark of profitable semiconductor and high-tech companies.

Companies in these industries should follow the lead of Top Performers and move beyond technical innovation to address the many issues of product innovation that, together, spell company success.

About the Author

Julie Fraser is the Vice President of Research for Operations and Manufacturing for research firm Tech-Clarity. She covers Industry 4.0, Smart Manufacturing, Smart Connected Supply Chain, MES/MOM, QMS, APS, APM/CMS, IIoT, AR/VR, and other technologies, approaches, and solutions for manufacturing.

Julie has over 25 years as an industry analyst in addition to experience in marketing and strategy (Berclain/Baan, now Infor) and editorial roles for computer and technology publications. She worked as an assembler over college summers and that got her hooked on manufacturing. She has a BA in German and French, Magna cum laude, Phi Beta Kappa, from Lawrence University in Wisconsin. She is also a certified business change agent, yoga and meditation teacher, and conscious business ambassador.

Julie's current areas of research include the realities of moving Industry 4.0 from vision to reality; the role of MES/MOM in the new landscape; incremental vs. transformational change in manufacturing; approaches to empower plant workers and their leaders; IT/OT convergence; personalized and local manufacturing; and more. She is fascinated by the organizational, cultural and personal transformations required to drive success with new technology and approaches to manufacturing.

Julie can be reached at julie.fraser@tech-clarity.com.
You can read additional research, watch Tech-Clarity TV, or join the Clarity on PLM blog at www.tech-clarity.com.
You can also follow Julie on Twitter at @juliefraser, LinkedIn /JulieFraser/20982 or find Tech-Clarity on Facebook as TechClarity.inc

About the Research

Tech-Clarity gathered and analyzed 277 responses to a web-based survey on lifecycle management practices and challenges in the semiconductor industry and companies who design products using semiconductors. Survey responses were gathered by direct e-mail, social media, and online postings by Tech-Clarity, Siemens Digital Industries Software, and a third-party data collection partner.

Role in the Ecosystem

The responding companies are a good representation of the high-tech ecosystem:

- over a third in semiconductor with IDM (32%) and fabless (5%)
- contract manufacturers / designers / foundries and OSATs at 14%
- suppliers at 21% including raw materials, components, leadframes, substrates, and subassemblies
- OEMs at 27%.

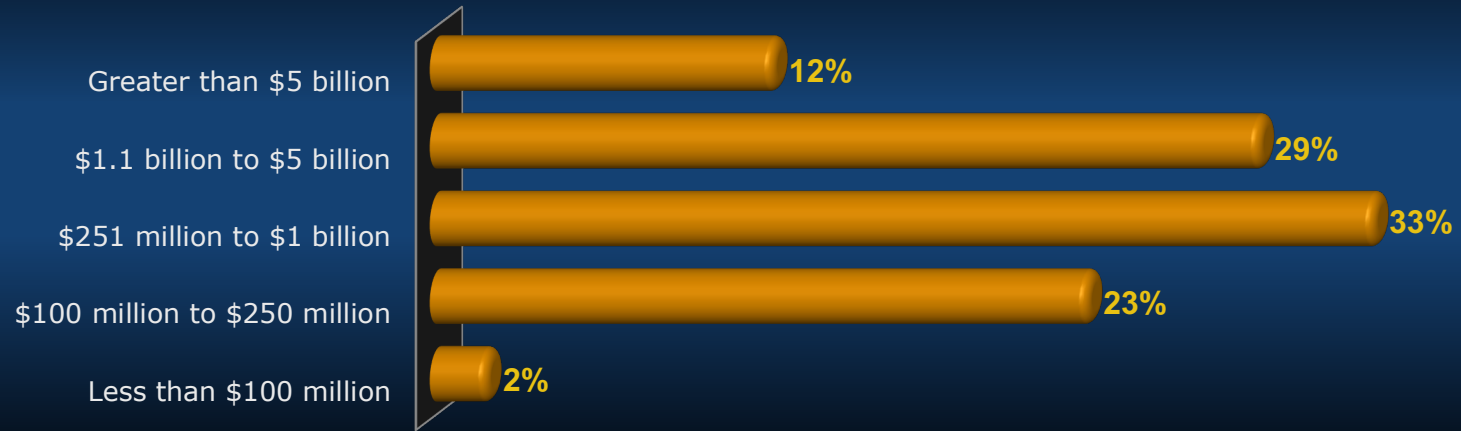
Industries Served

More than half of these respondents report that semiconductor (57%) or semiconductor equipment (52%) provides over a quarter of their revenue. Other industries served, in the order cited, are industrial electronics (31%); automotive and transportation (25%); industrial equipment and machinery (20%); consumer electronics (20%). Other industries that make up a quarter of revenue are telecommunications and mobile; consumer durables; aerospace and defense; photonics and optoelectronics; networking; medical devices; energy and utilities; and solar. Less than 10% of respondents get significant revenue from these.

Headquarters Location

The responding companies are headquartered from around the world. A third have US headquarters, followed by Western Europe, Japan, China, Southeast Asia, Taiwan, Korea, and Eastern Europe.

FIGURE 14: RESPONDENTS BY REVENUE BAND



Companies by Revenue

The respondents represented a mix of company sizes, including 25% from smaller companies (less than $250 million), 33% between $250 million and $1 billion, 29% between $1 billion and $5 billion, and 12% greater than $5 billion. All company sizes were reported in US dollar equivalent (Figure 14).

Individuals by Level

The respondents create a nice bell curve through the roles of an organization. 18% are Executive or C-level, 19% Vice Presidents, 27% Directors, 23% Managers, and 13% who are individual contributor level.

Individuals by Discipline

Respondents come from a wide range of disciplines, topped by Electronics Engineering (14%), Manufacturing (13%), and IC design and engineering (11%). Disciplines at 8% each: Supply Chain and Logistics; Quality and Reliability; Simulation Engineering; IC Packaging Design and Engineering. An additional group each comprises 7% of respondents: IT; Procurement; and Product Management. Fewer than that but still represented are corporate management; Project, Program, or NPI Management; Marketing; Mask Designer; and Product Architect.

The responding companies are a good representation of the high-tech ecosystem

Acknowledgments

Tech-Clarity is an independent research firm focused on how manufacturers use digitalization, software technology, best practices, and IT services to drive operational improvement and business value. Tech-Clarity shares this knowledge with companies through publications, speaking, and strategic workshops to help company leaders understand and achieve the business value of product innovation, product development, engineering, manufacturing, service, Internet of Things (IoT), and other related software. The firm is dedicated to educating companies on making strategic improvements through the intelligent use of enterprise and digital software.

Endnotes

1. Jim Brown, "Choosing the Right Enterprise PLM to Support the Digital Thread," © Tech-Clarity, Inc. 2020
2. Jim Brown, "Innovation and Profitability Based on Increased Digital Maturity," © Tech-Clarity, Inc. 2019
3. ibid., Jim Brown, "Innovation and Profitability Based on Increased Digital Maturity," © Tech-Clarity, Inc. 2019
4. ibid., Jim Brown, "Innovation and Profitability Based on Increased Digital Maturity," © Tech-Clarity, Inc. 2019

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