



# OVERCOMING GROWING E/E SYSTEMS COMPLEXITY IN SMALL COMPANIES

Today, engineering and manufacturing companies are entering a new era of complexity. Many are transitioning from traditional, mechanical products to smart, connected ones. In the process, they have to manage the growing sophistication of electrical/electronic (E/E) systems and architecture.

This phenomenon is not limited to large, multinational corporations. Even smaller manufacturers now must consider how to design products with additional sensors, antennas, microprocessors, and controls. As more electronics and software make their way into specialty vehicles such as forklifts and small tractors, engineers have to proactively develop architectures to fulfill a variety of competing and conflicting requirements. The need to manage increasing product complexity is a challenge that is only expected to grow with advances in technology and continued demands for smart products.

This brief guides smaller engineering and manufacturing companies in addressing this product development challenge. It looks closely at the issues driving rising E/E complexity, assesses the need for more collaboration and coordination across suppliers and engineering teams, and analyzes the impact of cloud-based software-as-a-service (SaaS) solutions.

## RISING E/E COMPLEXITY AND SMALL MANUFACTURERS

Manufacturers are taking note of growing E/E system complexity and its accompanying design challenges. In fact, respondents in the 2020 Lifecycle Insights Engineering Executive’s Strategic Agenda study stated that the complexity of the design domains in E/E systems are increasing or increasing greatly.

PRODUCT COMPLEXITY IS RISING ACROSS MANY DESIGN DOMAINS FOR E/E SYSTEMS

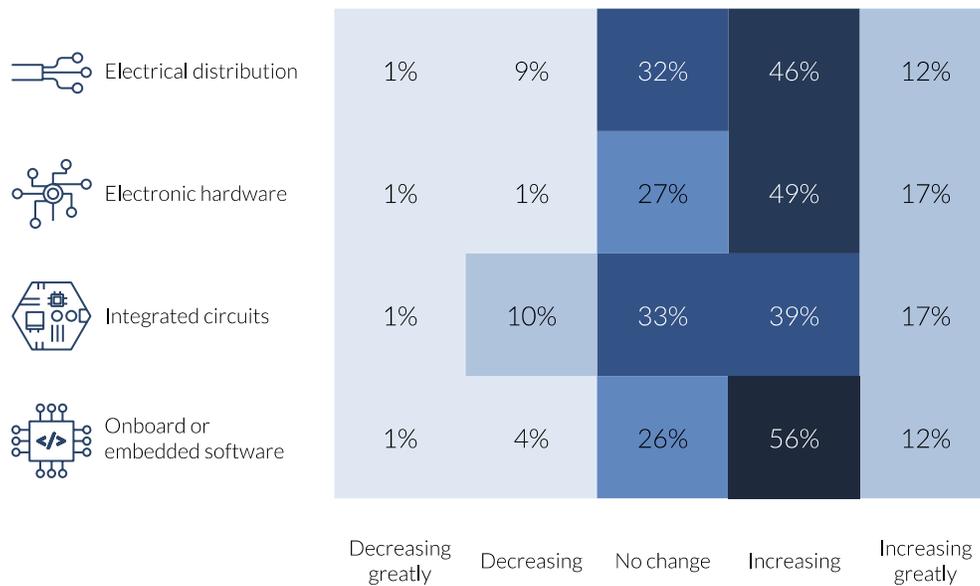


Figure 1: Findings from Lifecycle Insights’ Engineering Executive’s Strategic Agenda study show that the majority of engineering respondents are seeing complexity growing across electrical distribution systems, electronic hardware, integrated circuits, and onboard software.

Larger manufacturers are not the only ones grappling with rising complexity. Midsize to smaller engineering and manufacturing companies are in the same boat, but their burden is heavier.

First, smaller companies have fewer resources to manage and mitigate such complexity. They work with very tight budgets and have little room to tolerate unnecessary costs or time delays. But designing more complex products without the right support very often results in errors and delays that cost time and money.

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Second, engineers who work for smaller manufacturers are usually less specialized than those who work in larger ones. To support the company's overall goals, engineers are generalists that wear many hats and take on different responsibilities. In start-ups or newer companies, some engineers also double in an executive role. This means they do not have the time or the specialized skills and knowledge to make a deep dive into any one design domain to address rising complexity.

By their very nature, smaller companies cannot approach the growing need for complex E/E systems in the same manner that their larger peers do. They will benefit from guidance on best industry practices. Technology-led initiatives that augment and empower generalist engineers are very valuable here.

Unfortunately, rising E/E complexity is far from the only challenge that smaller companies face in today's climate. Findings from the 2020 Lifecycle Insights Engineering Executive's Strategic Agenda study demonstrated that organizational complexity is also shifting in this category.

### ORGANIZATIONAL COMPLEXITY FOR DEVELOPMENT IS RISING

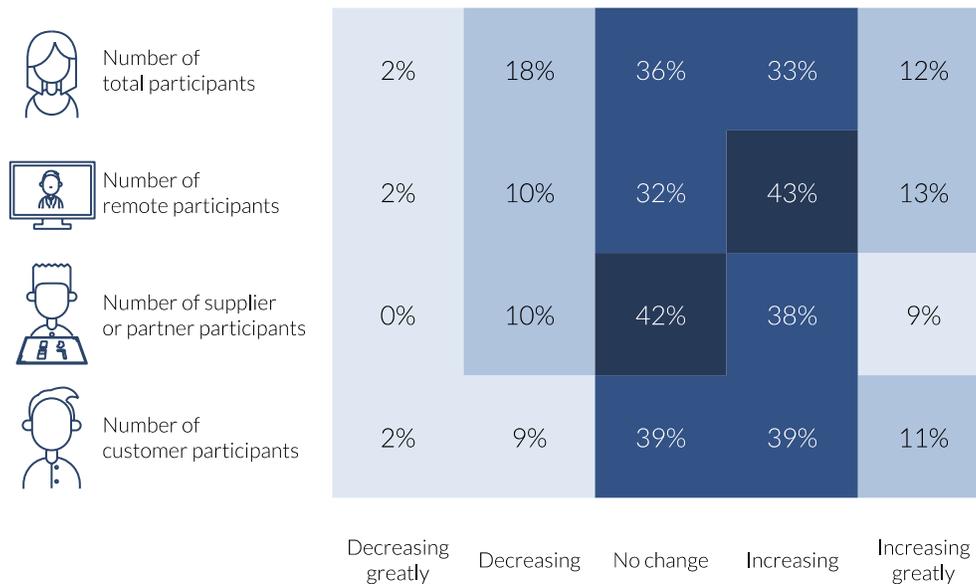


Figure 2: Findings from Lifecycle Insights' Engineering Executive's Strategic Agenda study show that organizational complexity in development is growing fast. Manufacturers struggle with more participants, including those that are remote and those that are external to the company.

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The industry has been shifting toward remote collaboration for some time. While those efforts often came in fits and starts, the COVID-19 pandemic dramatically accelerated the shift. With social distancing mandates in place, employees were forced to work from home. This only added to the challenges engineering teams face in developing more complex E/E systems.

While some larger companies were able to quickly pivot to remote collaboration, it was a bigger change for smaller ones. This does not come as a surprise, given that smaller manufacturers rely on more face-to-face interactions to support design and development. Larger companies, on the other hand, have branched out into separate, functional departments responsible for different aspects of the product development process as they've grown. They have needed reliable remote collaboration tools for some time.

It is clear that collaboration is essential to success, especially when it comes to identifying, managing, and resolving issues related to the development of E/E systems. Growing complexity brings new challenges to the design table. Many engineers lack the knowledge or skills to confidently resolve the many competing requirements in a timely manner. The combination of new complexity challenges with organizational issues is an even more dangerous mix. SaaS solutions, however, offer unique and powerful capabilities to help engineers face such challenges head on and better address evolving product requirements.

## CROSS-DOMAIN COLLABORATION TO RESOLVE REQUIREMENTS

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At the end of product development, any E/E system must work as a cohesive whole across mechanical, electrical, electronic, and software design domains. Issues are sure to arise as engineers work to make that happen, especially when engineering is dealing with complex and sometimes competing requirements. When such issues do come to light, engineers adjust their designs in response. Yet, some of those changes will impact the product outside that single domain. A change to the mechanical enclosure may cause a circuit board short. Software updates may lead to glitches in electronic performance. The old adage “the whole is greater than the sum of its parts” is never truer than while developing a complex E/E system. As such, it is essential that engineers across different design domains work closely with one another so that everyone can keep track of any adjustments and their potential impact—and, more importantly, collaborate as a team to resolve any problems that may come up during design and development.

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Traditionally, engineers in different domains use different software applications and systems to do their design work. Most of the time, such systems are completely siloed: They can't talk to one another or share essential data without transfers and translations. As participants break down the concept of a single, comprehensive digital representation of the E/E system on their disparate tools, it is all too easy for engineers in one domain to overlook important changes that were made in the systems of another. The end result is that everyone is looking at different designs and models in their own applications. When it comes time to put the whole design together, the pieces may not work together as expected, if, even, at all.

When the engineering team leverages a SaaS solution, however, it can continue to use separate software applications and systems, but also seamlessly connect and collaborate through the SaaS environment. This environment can effectively communicate changes to the design across all the different domain-specific software systems, closing the loop by providing notifications to other members of the engineering team. The SaaS environment provides a single, cohesive definition of the E/E system across a variety of tools. This unambiguous definition also allows the engineering team to weigh in on any changes to the design that will impact their domain and the overall performance of the product.

## COLLABORATING WITH EXTERNAL EXPERTS AND SUPPLIERS

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Small engineering and manufacturing companies also need to collaborate with external stakeholders to address complex requirements, whether they are product- or manufacturing-related. In many cases, smaller organizations work with many contractors, rolling them on and off different projects as needed, to provide specialized engineering expertise or other product development or manufacturing support.

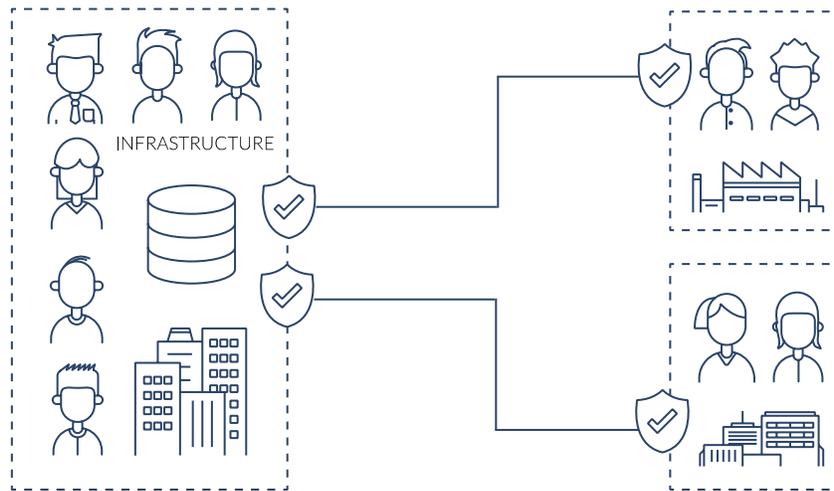
To effectively enable this kind of collaboration, it is important to have a clear and unambiguous definition of any E/E system so that everyone is on the same page. Having a comprehensive digital twin of the E/E system that is configuration managed is one key component of this process. Even small companies need a holistic representation of the architecture and the design to guide product development. The digital twin provides just that.

Yet, too often, companies overlook a vital factor in the success of this particular enabler. Everyone must be able to gain access to that clear, comprehensive digital twin of the E/E system. But this can be especially difficult when external collaborators are involved. To share the digital twin, companies must set up a virtual private network (VPN) and give outside

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collaborators explicit access to internal, on-premise systems. This is a time-consuming process, made even more painful when there is a revolving door of contractors for different projects. If this process is not diligently managed, companies may find that outside collaborators are working with incomplete or outdated models, or that they have access to aspects of the design they should not.

### METHODS TO PROVIDE EXTERNAL ACCESS TO INTERNAL, ON-PREMISE SYSTEMS



*Figure 3: Traditionally, providing access to external participants requires setting up a VPN and creating credentials to on-premise systems. This requires significant time and effort for engineers in smaller companies.*

This is another place where SaaS solutions can help smaller companies effectively collaborate with contractors or other design or manufacturing collaborators. Companies can purchase access to cloud solutions online, providing access in minutes. Stakeholders merely need to invite external collaborators to work on specific projects—something that can be done via email. Furthermore, they can tightly control access to specific projects, specific architectures, and specific models in these SaaS platforms. Finally, they can give external participants access and control to design documentation dramatically faster than alternative systems. This is important especially considering the condensed timelines many companies need to work with to stay competitive. SaaS solutions support the speed at which product development actually occurs.

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## METHODS TO PROVIDE ACCESS TO CLOUD-BASED, SAAS SYSTEMS

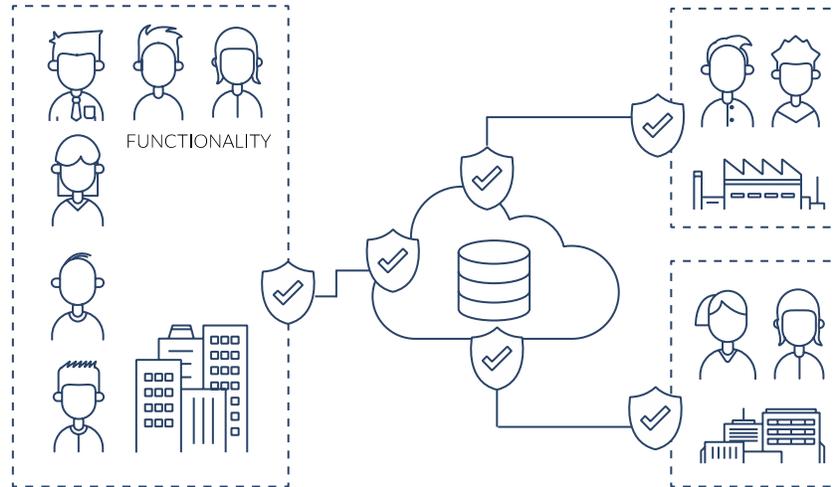


Figure 4: Providing access to cloud-based SaaS systems is simple for engineers in smaller companies. They simply invite external participants via email.

## FAST ACCESS TO BEST PRACTICES AND ADVANCED CAPABILITIES

Traditionally, engineers tried to satisfy increasingly competing and conflicting requirements using manual techniques. Engineers would explore a variety of different architectures and designs to try to identify a viable solution. This approach is time-consuming, but that is not the only drawback. These manual approaches often lead to poor trade-offs, unnecessary compromises, or a failure to fulfill requirements altogether. As complexity grows, so does the probability that engineers will overlook an important aspect of the system during the early design phase. The more complex the product, the less ideal a manual approach becomes. Finding a suitable design solution is much easier with more automation and design support.

Some of today's engineering tools have advanced capabilities that adeptly support the development of complex E/E systems. These platforms provide varying levels of design automation, so engineers can use the system tools to interactively or automatically explore different design alternatives while

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assessing requirements satisfaction in a short amount of time. Then the engineering team can explore, design, and iterate as needed to satisfy an E/E system's requirements, without risking too large a chunk of the product development timeline.

Furthermore, these tools often provide built-in best practices representing tried and true industry-standard approaches to solving common design issues and embedding regulatory compliance within the design. These practices enable more generalist engineers to explore different design alternatives and troubleshoot any issues that may arise from design decisions past the exploration stage. And small companies trying to do more on limited timelines and budgets can access these tools when they are needed most.

Here, again, SaaS solutions offer strong value to smaller engineering and manufacturing companies that can benefit from those design tools and their built-in best practices. A subscription to a SaaS platform will include those base design capabilities to fulfill an organization's year-round needs. Smaller companies can also access more advanced capabilities through short-term subscriptions. This allows them to address more complex requirements on a budget they can afford.

## REDUCING THE LOAD ON IT RESOURCES

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As noted earlier, the different employees at small companies are likely to wear a lot of different hats. An engineer may not only act as a technical lead but also play a liaison role with outside contractors and collaborators. This same engineer may also be responsible for managing the team's hardware and software, too. This means that engineer isn't only responsible for designing creative new solutions to address complex requirements, which is challenging enough in and of itself. He or she is also tasked with resolving issues within the supply chain, addressing problems on the shop floor, managing all of the software applications and systems, collaborating with outside contractors, and communicating progress to executives. The end result is that engineers are spread thin. The less time they have to focus on satisfying requirements in new and innovative ways, the less likely it is that they will be able to come up with a suitable and competitive design. This puts the entire operation at a disadvantage.

SaaS solutions can help engineers who play a variety of different roles within their company. The software applications and systems in these SaaS platforms are already running on optimized hardware in the cloud. That means that engineers won't have to worry about taking on extra IT duties within the company. Instead, they can rest assured it's taken care of with their subscription. Furthermore, the solution provider is continually

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assessing and upgrading the software to ensure it is running the latest version, so those applications are always sound and stable for production work. That multi-tasking engineer won't have to worry about spending the weekend updating various software platforms.

Relying on a SaaS solution has the power to take several time-consuming tasks off engineers' plates, dramatically reducing the workload for those juggling so many jobs. As a result, engineers in smaller companies can spend more time where they are most needed: addressing increasingly complex requirements and participating in vital design and troubleshooting activities.

## RECOMMENDATIONS

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Smaller companies are not immune to the design challenges inherent to the increasing complexity of E/E systems. In fact, due to their very natures, they may be even more affected by these changes than their larger counterparts. For this reason, Lifecycle Insights recommends that these smaller engineering and manufacturing companies:

- Assess the complexity of the E/E systems they are responsible for developing. Simultaneously, they should evaluate the level of collaboration needed in the supply chain to successfully develop such systems.
- Investigate SaaS solutions as a means to:
  - Access advanced design automation functionality that dramatically improves engineering's ability to satisfy competing or conflicting requirements for E/E systems.
  - Coordinate across domains to allow a range of engineering and other technical specialists to successfully develop E/E systems. It is important to leverage capabilities that enable faster, quicker, and easier collaboration.
  - Collaborate with external participants up and down the supply chain, leveraging cloud-based tools that allow granular control over access and communicate discrete changes to designs. This is especially important for the interplay between design and manufacturing teams that are often in separate companies.
  - Reduce the IT administrative load for engineers on the team, allowing them to spend more time on design.

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Chad Jackson leads Lifecycle Insights' research and thought leadership programs, attends and speaks at industry events, and reviews emerging technology solutions.

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