AUTOMATING THE PRODUCT DEVELOPMENT PROCESS

HOW FOUR COMPANIES USE TECHNOLOGY TO AUTOMATE DESIGN

LIFECYCLE INSIGHTS

EXECUTIVE OVERVIEW

Today's manufacturers are under mounting pressure to improve traditional product development processes. They are increasingly expected to deliver more complex solutions under ever-tightening schedules, regardless of expertise or business model.

The Lifecycle Insights 2020 Engineering Executive's Strategic Agenda Study examined the most pressing challenges driving manufacturers to improve their product development processes. Some 53% of respondents identified challenges in satisfying target requirements as one of the top two drivers. Keeping up with development schedules was another oft-repeated issue—45% consider it a top-two driver. The need to better balance time and complexity may be an even heavier burden for those organizations that provide engineer-to-order products.

To understand how companies manage such pressures, Lifecycle Insights interviewed manufacturers who have successfully harnessed design automation to address the competing forces of time and complexity. This report highlights the commonalities across these case studies, identifies the factors that supported their success, and offers actionable insights to help other companies seeking to balance today's challenges.

The following pages include:

- discussion of the advantages and disadvantages of technology enablers that assist in such initiatives, including: programming spreadsheets, CAD applications with rules-based configuration, cloud-based solutions that support both CAD and product lifecycle management (PLM), and cloud-based development platform solutions; and
- case studies on a variety of manufacturers, including FS-Elliott, GEA, Viewrail, and Technica International, that outline how each is working to enhance its design process.

To gain—and keep—competitive advantage, manufacturers need to find meaningful ways to automate core product development processes. There is no one-size-fits-all approach, but companies can gain valuable guidance by looking at the different strategies available.

TABLE OF CONTENTS

COMPARING DESIGN AUTOMATION APPROACHES

Many organizations traditionally rely on spreadsheets and documents, or even homegrown software applications, to support design configuration and engineer-to-order needs. A more productive and efficient approach, however, is to use a progressive set of design automation solutions that can support the product development process from in-CAD tools to higher-level development platforms.

PROGRAMMING SPREADSHEETS FOR AUTOMATION

One traditional approach to capturing the configuration logic of a product involves spreadsheets. Engineers can document a specific product's requisite if-then statements, calculations, and interaction interfaces in this format and then export it to a document that can guide the rest of the development process. The results can also be used to develop the specifications to configure a 3D model in a CAD application.

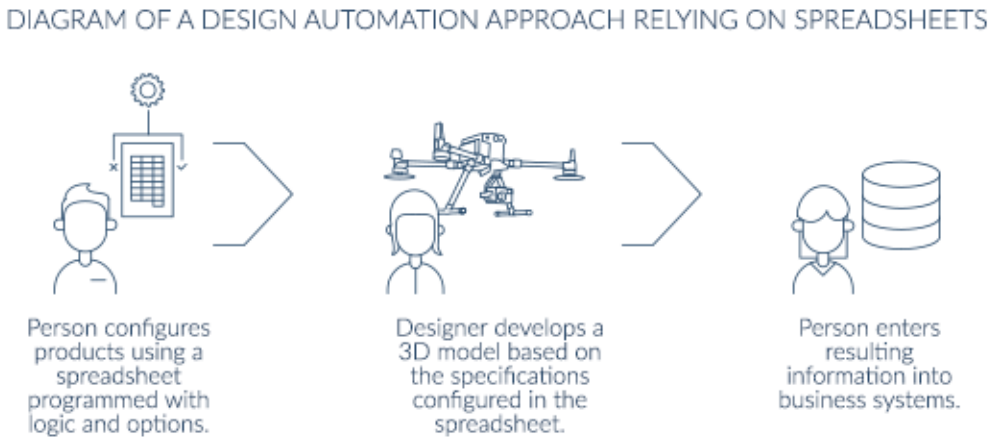

Figure 1: The Spreadsheet Automation Approach

While this may be a method to which engineers have grown quite accustomed, there are drawbacks. To start, when using a spreadsheet to configure the 3D model, there is no feedback regarding the form, fit, and function feasibility of the design. Engineers are flying blind as they attempt to document complex specifications regarding 3D geometry, fit between various components, and other physical checks that involve center gravity, weight, surface area, and more. As a result, they are not likely to discover design feasibility issues until someone starts to build out the 3D model of the product, or worse, in the prototype and test stages of the design process.

A second issue is that a spreadsheet cannot automate the process of modeling the configured product. Engineers must interpret and translate the spreadsheet's data and specifications into a 3D model manually. This can lead to inadvertent human errors. The spreadsheet will also have to guide the creation of design documentation for any new components. Without the ability to automate these essential steps, this part of the process becomes painstakingly slow—as if engineers were designing a new product from scratch every time.

Many of the companies highlighted in the following case studies used this spreadsheet approach to configure their products before switching to a more progressive approach.

- Centrifugal air compressor manufacturer FS-Elliott manually configured a 3D model for each impeller application, usually taking a full day in each case. This slowed the development process significantly.
- GEA used a standard starting equipment model that was then customized to meet new requirements. The work was time-intensive,

taking up to a week to perform. Manually synchronizing configuration spreadsheets and 3D models opened the process to human error.

- At Viewrail, it usually took several days to document specifications for custom stair components and create custom 2D drawings. This approach often resulted in design errors.
- Technica International utilized a sequential, spreadsheet-based process to develop designs for its automation equipment. This approach increased costs and delays as it proceeded from one department to another.

CAD APPLICATIONS WITH RULES-BASED CONFIGURATION

Advances in CAD application capabilities allow engineers to capture configuration logic directly within the 3D model as they are building it. And, importantly, the engineering team can easily and interactively enter essential inputs and requirements for the design as they go. As such parameters are specified, the 3D model can then automatically update itself based on the documented information about relationships between components, calculated values, logic, and other vital design data. That is a boon for time-strapped engineering teams, saving precious work hours for other vital design tasks.

In addition, this approach enables the automated creation of design documentation, and not just for the product's usual and standard parts. CAD applications with rules-based configuration can now take the appropriate design information directly from the model to create these essential reference documents, even when the product design includes brand-new components or assemblies. Again, this saves design engineers significant time.

When engineers can automate the configuration process and the development of the 3D model and associated design documentation, they save time and resources and avoid costly scrap and rework. The benefit here is obvious: It accelerates the engineering design portion of any product development process. This approach also provides manufacturers a significant advantage by allowing the engineering team to verify key characteristics of the design long before prototype and test. This is especially true of elements driven by the 3D model, like center gravity, weight, and surface area.

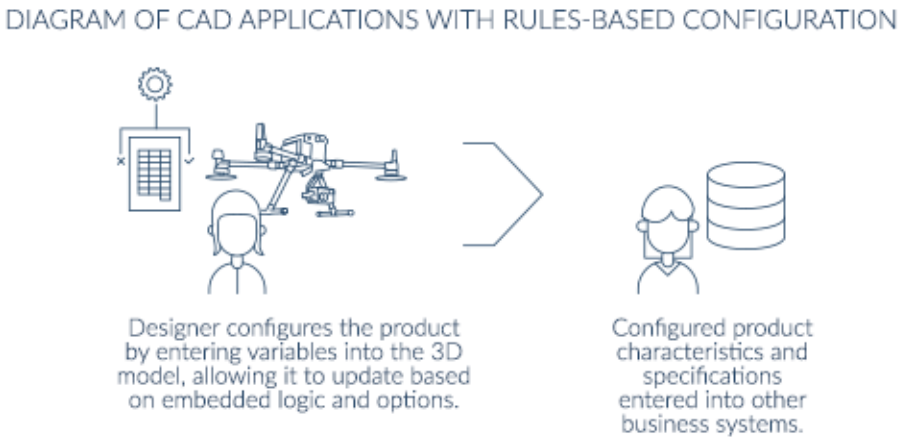

Figure 2: CAD Applications with Rules-Based Configuration

FS-Elliott and GEA both use rule-based logic capabilities of CAD applications to configure their products.

- FS-Elliott harnessed CAD-embedded rules-based design functionality to create a script that fully models an impeller and multiple variations using point data from spreadsheet templates. Engineers can now model the design to the desired level of complexity quickly and easily. As a result, the department saves time and gains consistency and flexibility.
- Rules-based configuration capabilities are among the various CAD software functionality GEA is now using to automatically update drawings to new specifications, calculations, and geometry. The result is the elimination of repetitive work and a reduction in errors.

INTEGRATED CAD-PLM SOLUTIONS WITH RULES-BASED AUTOMATION

Taking design configuration one step further, today's engineers can also use integrated CAD-PLM solutions with rules-based automation. These combined solutions offer the same design benefits of regular CAD applications, but further allow groups of engineers to easily collaborate on the configuration of a particular product. Furthermore, the integration of both CAD and PLM capabilities provides the opportunity for even more automation. Among other things, manufacturers can automate:

- workflows for business processes such as authorizations,

- requests for special documentation, and
- integration with other key enterprise applications like enterprise resource planning (ERP), various procurement platforms, and more.

Integrated CAD-PLM solutions with rules-based automation help ensure that the engineering and business sides of the house can work in lockstep.

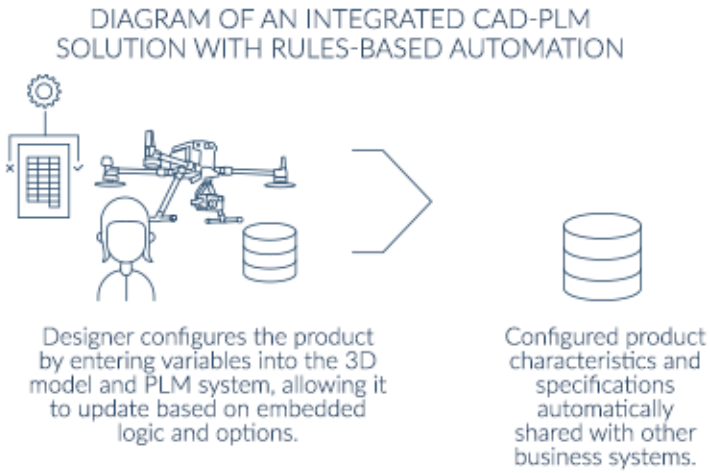

Figure 3: Integrated CAD-PLM Solution with Rules-Based Automation

Using these solutions spreads the time and cost savings to the entire enterprise. Not only can the engineering organization better manage design configuration tasks, but other functional departments also benefit from the automation of combined design and business processes. Key stakeholders can follow and integrate the necessary development processes that tend to begin or end in the engineering department. And manufacturers can coordinate activities between engineering and other areas of the company. The end result? Companies are in a better position to deliver configured products more quickly and standardize automated processes more broadly across the organization.

Technica International centralized its product development processes and linked them to core business applications using a CAD-PLM solution. The end result? Reduced costs, increased productivity, and faster product development.

CLOUD-BASED ENGINEERING APP DEVELOPMENT PLATFORMS

More advanced manufacturers are now extending their automation even further by leveraging web services from the cloud platforms upon which today's CAD and PLM solutions are built. These customized, and often configurable, solutions support various scenarios across the entire product development process.

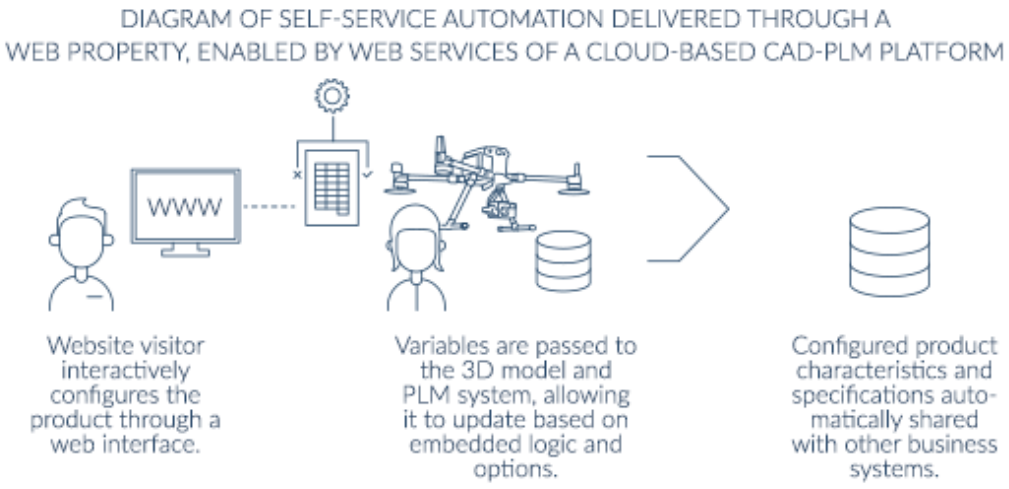

Figure 4: Cloud-Based Engineering App Development Platforms

For example, a manufacturer may be able to embed the configurator on its own web property, allowing customers to tailor a product or component to their own needs without interacting with an engineer. Such enhanced self-service options are likely to give companies a distinct competitive advantage. They also help the design team, as team members can automatically integrate customer designs into the development process without a lot of onerous back-and-forth.

Clearly, such an approach to design configuration supports business needs well beyond the scenarios associated with a traditional development process. Cloud-based development platforms are well known for their reliability, scalability, and cost savings. But the flexibility of these cloud-based development platforms also allows manufacturing organizations to extend configurations more broadly, as in the above example where an organization can offer its customers direct configuration capabilities through a web property. This approach also enables more of the overall design process to be automated from day one. Advantages include greater product differentiation and improved customer experience.

Viewrail's integration of Autodesk Inventor's iLogic capabilities into its web site is a prime example. Clients can configure 3D models of stair products to their own specifications using the new interactive interface.

TAKEAWAYS

Today's manufacturers use a range of enabling technologies for design automation. The most traditional approach relies on spreadsheets and documents, which give little visibility into form, fit, and function and are subject to human error. CAD applications with integrated rules-based design functionality represent a step up, in which configuration logic and calculations can be embedded in a 3D model to allow interactive configuration. Another step up relies on employing CAD-PLM platforms that integrate automated workflows and share data with other enterprise systems like ERP. In the most advanced step up, manufacturers use cloud-based development platforms to develop their own design automation applications for use on web properties.

CASE STUDIES ON DESIGN AUTOMATION

Organizations, particularly engineer-to-order shops, are looking at a variety of ways to resolve challenges regarding time and complexity. This section shares four companies' efforts to reduce time and errors in the design development process.

- FS-Elliott, a leading manufacturer of centrifugal air compressors, uses CAD-based design configuration tools to automate specifications from spreadsheet templates to customize impeller models.
- GEA uses CAD-based automated design configuration tools to automatically update design documentation based on customized specifications, calculations, and features, saving the engineering team significant time and resources in the process.
- Viewrail is making it easier for customers to directly input specifications into its website to create customized yet easy to assemble staircases and stair supplies.
- Technica International has undergone a widespread digital transformation to better meet complexity and time demands from its customers—and Industry 4.0 demands. It has invested in various applications to automate both product design and core business processes.

FS-ELLIOTT: AIR COMPRESSOR MANUFACTURER

FS-Elliott has been a leading global manufacturer of oil-free centrifugal air compressors for decades. The company, located in Export, Pennsylvania, with a sister facility in Shanghai, China, employs approximately 350 people and serves general plant air needs for industries ranging from auto manufacturing to power generation.

Creating massive industrial air compressors for such a wide range of customers requires expertise in nearly all engineering disciplines, from aerodynamics to electrical instrumentation. And the products created for gas and petrochemical customers are even more sophisticated. As more customers are now looking at remote monitoring and control of such products, FS-Elliott's design team is seeing increased complexity in all of its products, including internet-of-things (IoT) connectivity and big data.

To better manage that complexity, FS-Elliott invested in a new process to model impellers, which the company refers to as the "heart" of a centrifugal air compressor. The design of the impeller varies from compressor to compressor, depending on its specific application.

In the past, the engineering team created the 3D model for this key component using arduous manual processes. These processes required quite complex 3D geometry and could take a single engineer days to complete. To improve the process, the team harnessed Autodesk Inventor's iLogic functionality. Using the function, they created a script that automatically reads point data from spreadsheet templates to fully model the required impeller with multiple design variations. With the click of a button, the team can now model the design to any level of complexity in a fraction of the time it would take to create such documentation manually. It not only saves the engineering department precious hours, but also gives the team greater consistency across designs and the additional flexibility to iterate more quickly.

With the success of this process improvement, the FS-Elliott engineering team is considering further process improvements, looking for steps within the product development workflow where automation could save additional time and money.

GEA: FOOD AND BEVERAGE EQUIPMENT

One of the largest suppliers for food processing machinery and plants as well as process technology and components, GEA manufactures products

for the food and beverage industry and pharmaceutical, chemical, utilities, and marine companies. With more than 18,000 employees working across facilities in North America, South America, Europe, Africa, Asia, and Australia, GEA takes its mission of "engineering for a better world" seriously.

As a manufacturer of a wide range of different products, GEA's customers can order standardized equipment from its catalog or work directly with the manufacturer to create a customized machine. Given the breadth and complexity of its work and the fact that the company relies on mechanical, electrical, and other engineering disciplines to create its products, GEA has long looked to find ways to refine its product development processes. Recently, the company undertook new initiatives to enhance the way it creates its machine models.

Previously, engineers would work from a standardized model for a particular piece of equipment and then make changes to the configuration to meet customized requirements. The work was time-intensive, often taking up to a week to perform, and the use of manual processes to update particular specifications opened up the possibility for inadvertent errors. Today, GEA uses various CAD software functionality, including Autodesk Inventor's iLogic and PTC's Creo to automatically update drawings based on new specifications, calculations, and geometry. These applications save the engineering team significant time by eliminating repetitive work and reducing the potential for errors.

GEA has seen such success with this automation that it is currently looking at new ways to leverage iLogic to further enhance the product development process. The manufacturer is also looking to identify other areas where automation might assist the engineering team as it creates designs for customized projects.

VIEWRAIL: STAIRS AND RAILINGS

Viewrail is a leading manufacturer of high-quality stair parts based in Goshen, Indiana. The company employs approximately 250 employees and serves the residential construction market across the United States. While Viewrail is well known for its traditional wooden products, today it is seeing significant growth in more modern aluminum, glass, and steel stair components. Customers find the company via its website, where they can directly order engineer-to-order treads, railings, newels, and other stair supplies.

While Viewrail does provide prefabricated options, consumers and builders are becoming much more creative about how to utilize staircases in different work and living spaces. Requirements and specifications, based on both spaces and materials, change what kinds of products customers may

need to build out a staircase. Every unique part needs to be fleshed out in a model before it is manufactured.

Creating such a detailed model, historically, could take an engineer several days to complete. To account for increasing complexity and consumer demands, Viewrail was looking for ways to more efficiently manufacture products that builders can assemble quickly and easily. So the engineering team sought to automate its process, starting from customer inputs on their website to CAD applications.

In the past, engineers relied on paper forms to document specifications and then manually added them to a 2D AutoCAD model. It was incredibly time consuming and increased the likelihood of errors in the design. To make the process more accurate and efficient, the engineering team used Autodesk Inventor's iLogic functionality to create a new generative interface where customers can enter their specifications. Those specifications can be automatically configured within a 3D model. The new system reduces engineering hours as well as scrap and rework for the company.

The improvements were impressive enough that Viewrail is working to get its current stock of generators onto the Autodesk Forge development platform. And while the company has not, as yet, been able to automate railing production, it is looking to simplify the engineering process for that aspect of design work in the future, too.

TECHNICA INTERNATIONAL: AUTOMATION AND ROBOTIC SOLUTIONS

For nearly 40 years, Technica International has provided customized and cutting-edge automation equipment around the globe. Today, the Lebanon-headquartered company employs 180 industry professionals, nearly 70% of whom are engineers and technicians. Together, they serve industries ranging from food and dairy manufacturing to personal care and paint manufacturers.

Technica International's products include turnkey plants as well as packers, palletizers, conveyance systems, and inspection systems. As more industry players have adopted "smart" manufacturing—and desire machines that can work in the IoT—Technica has seen the complexity of its products grow exponentially. And like many other manufacturers, its customer base expects it to develop more sophisticated products in less time. Today, Technica's customized end-to-end manufacturing solutions require mechanical, electrical, and controls engineering expertise, as well as IoT and software engineering.

Like many of its competitors, Technica International historically customized products using various manual processes across the product development process. Yet, to evolve and create the complex, customizable systems currently in demand, the organization invested heavily in new software applications to support product design. It also pushed for cultural change to shore up the use of these new technologies.

Instead of the traditional process where one department completes a step in the development process and then hands the design off to the next, those software investments allow the organization to centralize all product development processes from procurement through design and link them to core business applications. Doing so has allowed them to "go lean" on their modeling processes, automating as much as possible. This, in turn, has reduced costs, increased productivity, and decreased the amount of time it takes for the engineering team to develop the product the customer has specified.

While any change as significant as this one doesn't occur without some growing pains, Technica International sees this digital transformation as a stepping stone to expanding its Industry 4.0 capabilities and global customer base. Its technology investments have enhanced product design, offering more flexibility, collaboration, and productivity to the engineering team and other functional departments. Given its current successes, Technica International plans to continue centralizing and automating as much of the business as possible in the future.

TAKEAWAYS

Each of these manufacturers faced the challenge uncovered by the 2020 Engineering Executive's Strategic Agenda Study: the difficulty in balancing increasingly complex requirements and shortening schedules. Each company initially used slow, manual, painstaking processes prone to human error, but transitioned to more automated design processes that relied on design configuration capabilities. And all have succeeded, improving business performance.

SUMMARY AND RECOMMENDATIONS

Engineering organizations increasingly must do more in less time. The rising complexity of today's products and growing customer demands for tightened development schedules have manufacturers looking to automate the design process, particularly the development of 3D models for engineer-to-order products. Engineers have typically relied on time-consuming, error-prone manual processes to create these products. Even with expanded CAD use, trying to detail the requirements and geometry of complex products by hand was often time-intensive, with the risk of scrap and rework.

Today, organizations are mitigating the challenges of complexity and short schedules by automating different aspects of the product development process from the very beginning. They are relying on advances in different CAD programs to support such initiatives.

- FS-Elliott relies on Autodesk Inventor's iLogic functionality to improve the way it customizes a key centrifugal air compressor component.
- GEA can now automatically update design documentation with customized specifications using a variety of CAD applications.
- Customers interested in one-of-a-kind staircases and stair components can now directly input requirements into a website.

Viewrail's CAD software can use that information to automatically update the associated customized product specifications in the design model.

- To keep up with the complexities involved with Industry 4.0, Technica International has undergone a complete digital transformation, enhancing both engineering and business processes along the way.
- Traditionally, manufacturers have relied on spreadsheets and documents, which can't predict product feasibility and are vulnerable to human error.
- A step up from that approach enables interactive configuration via CAD applications with rules-based configuration that embed configuration logic and calculations into a 3D model.
- Manufacturers wishing to take yet another step up can employ CAD-PLM platforms. Such platforms can integrate automated workflows and share data with other enterprise systems like ERP.
- In the most advanced scenario, manufacturers harness cloud-based development platforms to develop their own design automation applications that customers can access on the web.

RECOMMENDATIONS

Based on the case studies documented in this report, Lifecycle Insights recommends that companies assess their needs for design automation and identify the biggest problems in their processes. This self-assessment should guide companies in choosing an improvement approach.

- Manufacturers that experience issues with the form, fit, and function of designs will find transitioning to CAD-based design automation a logical next step.
- Manufacturers that value the acceleration of formalized business processes, especially in other functional departments, will likely find a CAD-PLM solution to be the best fit.
- For manufacturers seeking to expand beyond the traditional design configuration process (for example, looking to allow clients to configure products on a web property), a cloud-based engineering app development platform is the best solution.

There is no universal solution to reduce engineering hours and manage increased product complexity. But examining how other manufacturers successfully address these pressures can help companies stay lean and competitive in an evolving industry.

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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