# THE MODERNIZATION OF PRODUCT DEVELOPMENT

*HOW PROGRESSIVE TOOLS PROMISE TO SAVE THE MULTI-TASKING ENGINEER*

LIFECYCLE INSIGHTS

# THE MEANS OF *MAKING THINGS* IS CHANGING

Remember when the concept of *making things* first emerged? It was an impressive movement of professional grade artists, hobbyists, tinkerers and more. It was inspiring. It was innovative. It broke many rules that needed to be broken. But as remarkable as it was, it didn't stay the same. It morphed. Its methods, practices and processes actually started to influence startup product companies, who could easily adopt maker approaches to their benefit. More recently, larger organizations are scrutinizing the maker movement, trying to figure out how they can leverage these impactful ideas.

Of course, the maker movement hasn't just spread into manufacturing startups and larger companies. It has also transformed in terms of the types of things that are made. No longer is it just about designing and manufacturing mechanical stuff anymore. You now see electronics integrated into such things in the form of embedded software and control systems. And you especially see such things being hooked into the Internet of Things. Today, objects that haven't become connected and smart are often seen as outdated antiques, waiting to be obsoleted by a new crowd funded thing and its backers.

With a broadening scope in terms of the stuff that goes into these things, there has been a need to take the professional tools often seen in large manufacturers and make them more broadly accessible to makers and startups. Traditional Computer Aided Design (CAD), machining methods, Integrated Development Environments (IDE) and coding for Internet connectivity can be complex and, frankly, out of the reach of many. That, in turn, has led to a quiet revolution in the tools that are used to make these things.

The transformation of those tools into a new version of themselves is the exact focus of this eBook. It starts by sharing some research findings on how the work of today's engineers differs from those of the past. Next, it looks at the advantages and disadvantages of both traditional and progressive toolsets, comparing and contrasting them against one another. Finally, it provides a recap and a few conclusions, offering guidance for those looking at how to adopt more maker methods, practices and processes.

The way that things are made has changed, and will continue to change. New tools should be considered for those looking to change along with it.

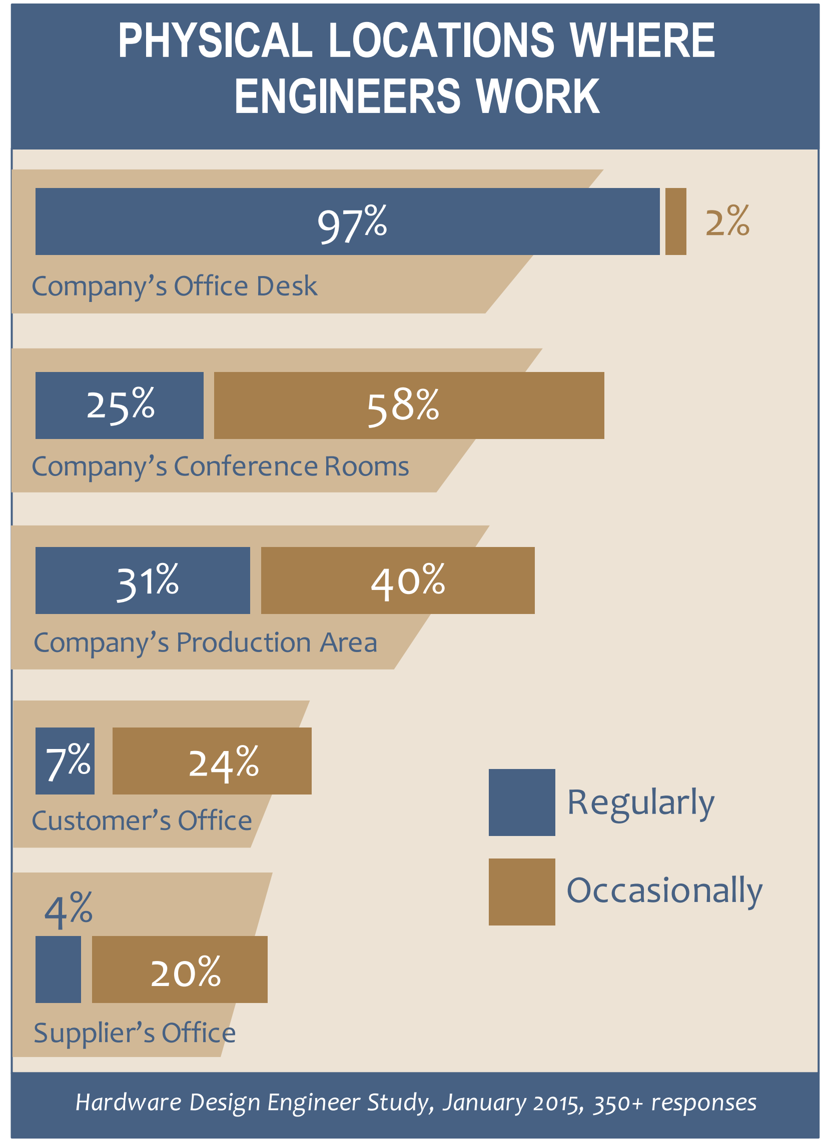
# THE NEW CHALLENGES OF PRODUCT DEVELOPMENT

Engineering has never been an *easy* job. Schedules are always tight. Budgets are shrinking. Products are getting more complex. Today, though, engineers are facing new demands that make product development harder than ever. Findings from Lifecycle Insights' Hardware Design Engineering Study shed some details on those challenges.

It is a fact: today's engineers regularly spend a good amount of time at their desk. Yet, that is rarely the *only* place they spend their time. Findings from our study, shown in the figure on the right, show that engineers also spend a significant amount of time in conference rooms, manufacturing environments, supplier's campuses and customer's offices. They are frequently on the go.

With today's compressed schedules, this becomes a major challenge to staying on track with projects. Engineers often can't afford to wait until they get to their desk to resolve issues. They need to resolve them on the go in order to keep the development cycle from stalling. Organizations must find ways to eliminate availability at a desk as a bottleneck for product development.

In addition to *availability*, though, *efficiency* is also critical. One must be wary of how much time engineers spend on non-value-added tasks at any point in product development, as it will directly detract from the value-added tasks engineers could be fulfilling.



## BALANCING MANY RESPONSIBILITIES

Another challenge that engineers face today is that they are stretched incredibly thin. From a field of thirteen core and extended design responsibilities, the same study asked respondents to select which ones they fulfilled. On average, engineers tallied a total of 4.4 core design responsibilities, which included managing requirements, predicting product performance and more. Furthermore, on average, engineers tallied 2.9 extended design responsibilities, which includes things like project management, collaborating with suppliers and more. In all, that totals 7.3 responsibilities for the average engineer. Note that making design decisions is *only one* of those responsibilities.

This finding confirms that today's engineers have a lot on their plate and need assistance. Furthermore, it means they don't have the bandwidth to explore their design options to any reasonable measure. They are too often forced to accept the very first feasible design they encounter. For the company, that means many opportunities in the design cycle are left on the table. That includes the potential to reduce product costs, thereby increasing profitability, incorporating innovative product features to out-differentiate competitors and drive revenue growth and much more.

## IMPLICATIONS FOR THE PRODUCT DEVELOPMENT

Today, many things about the engineering environment are faster paced than in years past, including the product development cycle and engineers' responsibilities. Engineers are called upon to spend time on the manufacturing floor, in conferences, visiting suppliers and on other tasks that take them out of their offices. Furthermore, the Hardware Design Engineering Study found that engineers have 7.3 responsibilities on average, only one of which is making design decisions.

Because today's engineers wear many hats and have limited time, they may accept the first design they create that meets all design requirements. They don't have time to iterate to find the best design possible, and this can affect product innovation and organizational profitability. In light of the study's findings, organizations that wish to see maximum innovation and revenue:

- Must find ways to ensure engineers can actively participate while they are away from their desks so product development doesn't grind to a halt.
- Must also eliminate non-value added tasks from engineers' routines, so they can contribute more to product development.
- Must find ways to automate and empower engineers to explore and assess more design options.

# TRADITIONAL DESIGN AND SIMULATION SOLUTIONS

A well-functioning, innovative product has its root in great design. Product design is all about exploration and evaluation, iterating again and again as the design is refined and honed. It is a cycle that is repeated again and again, project after project. Of course, engineers have been using advanced technology and software for these tasks for decades. But do the traditional solutions address these latest issues? This section answers that question.

## TRADITIONAL MCAD, MCAE AND PDM SOFTWARE

Engineers use two tools to iterate on and evaluate designs: Mechanical Computer Aided Design (MCAD) software and Mechanical Computer Aided Engineering (MCAE) software. MCAD software allows them to create and refine the 2D or 3D geometry of designs. MCAE software enables engineers to simulate design performance. These two tools enable engineers to develop designs, iterate on them as well as check their physical performance. Product data management (PDM) software is also part of the design and simulation cycle. It acts as the central, secure repository for design data, which must be checked in and out of the system. As a whole, these three sets of software are critical tools for any modern engineer.

## THE DRAWBACKS OF TRADITIONAL SOLUTIONS

These traditional tools have significantly improved the way that engineers design products. However, there are some drawbacks to them, especially in the context of the new challenges in product development.

One such flaw is that the traditional versions of these tools live on desktop computers. This restriction translates into big problems in today's product development environment. As we've seen, engineers spend a good amount of time away from their desks. When engineers are at meetings or performing other responsibilities, they can't access their desktop design tools and so product development grinds to a halt.

A different fault of these traditional tools, especially MCAD, is that they require engineers to explicitly drive the exploration and iteration design effort. Engineers must manually change the thickness of a rib or choose material, for example. Yet findings shared earlier in this eBook show that engineers have a multitude of jobs to perform. Requiring them to manually explore design alternatives drives them to accept the first-feasible choice simply to save time.

Another failing of this set of tools lies in the effort required to manage design and simulation data. Checking data in and out of a PDM system is yet another manual task that the engineers need to initiate. While preserving and securing design data is vitally important, overseeing design data stored within the PDM system takes away from the time engineers could be spending exploring and assessing design alternatives or carrying out other tasks. In short, it is a non-value added task in design.

Traditional design and simulation desktop tools have provided tremendous value for engineers over the past few decades. But times have changed. New alternatives are available.

# TRADITIONAL SOFTWARE DEVELOPMENT TOOLS

While mechanical hardware is still an important part of many of today's products, many engineering organizations now collect and put to use data returned by sensors placed on their products. That information can be used to deliver new product capabilities or enhance service and maintenance offerings.

## TRADITIONAL APPLICATION DEVELOPMENT TOOLS

Leveraging data from sensors promises great value to an engineering organization's products. However, technically figuring out how to collect and aggregate that information in a meaningful way is a job for software engineers. That's where Rapid Application Development (RAD) comes into play. These tools are desktop-based applications that offer access to a library of functions. The tools help to automate coding by checking software semantics and promoting the reuse of software snippets.

## THE DRAWBACKS OF TRADITIONAL SOLUTIONS

While engineers can reuse software snippets and build libraries of reusable functions, developing software code requires significant manual effort. This can be a challenge when it comes to writing codes to connect to sensors that stream readings back to the product manufacturer. Standards and protocols can change quickly, making it difficult for engineers to keep pace as technology advances. Ultimately, this translates into repetitive efforts to code and recode software to connect to critical sensors and other electronic hardware.

Another critical issue exists when it comes to building the data model that aggregates data from the sensors. The data model is important because two or more sensor readings may need to be combined and compared to provide the insight needed or value-added services. With RAD tools, engineers must cobble together their data models with unified modeling language.

Finally, when product manufacturers first decide to instrument their products with sensors, they often add as many as possible, measuring practically everything conceivable about the product. Yet, when they start streaming readings from all those sensors, they can easily be overwhelmed with data. So manufacturers face some difficult questions. How many sensors are enough? Which sensors are the right ones to include? RAD applications offer no capabilities to mock up or prototype the streams of data that they will receive from product sensors. As a result, too many manufacturers only realize any mistakes they've made with sensors and sensor placement when they are physically prototyping their products.

In the past, RAD tools helped coders by promoting reuse and catching software errors. But in today's quickly evolving world of hardware standards and protocols, software engineers need even greater assistance.

# TRADITIONAL PROTOTYPING AND MANUFACTURING

While developing and testing a product's design in the virtual world is critical, engineers ultimately must construct and test products in the physical world. Today, there are a number of tools and methods that have been traditionally called upon for that purpose.

## TRADITIONAL CAM TOOLS AND MACHINING

Traditional manufacturing methods used to prototype and produce parts and products are based on removing material. These are subtractive manufacturing approaches. Such machining operations, including milling, turning and electrical discharge machining (EDM), have been used for more than one hundred years to make products from metal and other hard materials.

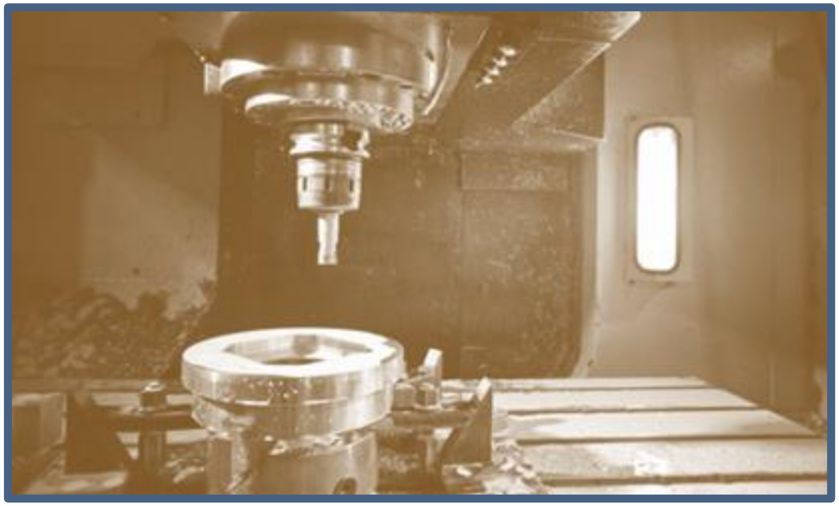
Computer aided manufacturing (CAM) software can be directly integrated with CAD and CAE as part of a suite to create products from metal and other hard materials. These tools use the geometry created in CAD applications to produce Numerically Controlled (NC) toolpaths, which instruct machining equipment on how to machine material. CAM applications, then, create and assess tool paths that drive milling, turning and wire electrical discharge machining operations on NC manufacturing machinery.

## THE DRAWBACKS OF TRADITIONAL SOLUTIONS

While subtractive manufacturing has been in practice for decades, it acts as a heavy constraint on design. The method requires a tool to access the material and cut it away to shape a part. By its very nature, subtractive manufacturing renders some designs impossible to manufacture. For example, a hollow design cannot be made with subtractive manufacturing methods because tools cannot reach the inside of the component.

In another drawback to the subtractive manufacturing method, traditional CAM software applications suffer from many of the same issues as their traditional CAD and simulation counterparts. Sharing geometry can be difficult, especially with machine shops. Engineers must email designs to machine shops and to other types of suppliers, which is a security concern. Furthermore, when an engineer makes changes to a design, those changes often invalidate design toolpaths already created in a standalone CAM application and requires toolpath work to be recreated.

Subtractive manufacturing and CAM software have worked hand-in-hand over the past few decades, enabling engineers and machinists to prototype and manufacture components for testing and production. However, new approaches offer significant advantages and should be explored.



# PROGRESSIVE DESIGN SOLUTIONS

As the needs of product development stakeholders evolved, software providers have listened. In the past few years, new sets of tools and entirely new platforms have emerged to change how product development is executed.

## PROGRESSIVE DESIGN AND SIMULATION TOOLS

Traditional CAD and CAE tools are morphing into a new generation of cloud-based tools that perform as part of an online platform. These tools aren't the traditional desktop-based tools made virtual. These tools have been entirely remade and optimized to run in the cloud.

Cloud-based CAD and CAE systems run directly in a browser or a lightweight client connected to remote servers (i.e., the cloud). While an engineer interacts with the tool, the actual activities are executed in the cloud where expandable compute resources are readily available. Furthermore, the data management capabilities of PDM systems have been directly integrated into such tools, automatically saving every change made to designs.

The cloud software owner is responsible for updating and enhancing the applications, and makes updates usually every six to eight weeks, a much shorter time than desktop software sees updates. Designs, simulations, and design iterations created with these cloud offerings are saved on remote servers and are always available. PDM services allow designs to be managed, tracked, checked in and out, and accessed by collaborators.

Cloud software is subscription, rather than license based. That means engineering organizations can buy access on a monthly or other type of ongoing basis, and can ramp up or down the number of software seats it requires based on its ongoing needs.

## THE ADVANTAGES OF PROGRESSIVE SOLUTIONS

CAD and CAE software that exist on remote servers, rather than on an organization's servers, offer many advantages to that organization, not the least of which is accessibility. The lightweight clients used to access the cloud software can run on practically any device, including PCs, Macs or mobile devices. Designs created with and stored on cloud software can be accessed from practically anywhere: desktops, conference rooms or customer or supplier campuses. And that means engineers can stay productive and engaged with product development even when they are away from their desks, thereby ensuring that product development does not grind to a halt.

Accessibility to these solutions in the cloud also carries important implications for simulation. Usually the domain of simulation experts, analysis tools can be more readily accessed by common engineers to conduct simulations during the design process, allowing for more informed decisions early and often in the development cycle.

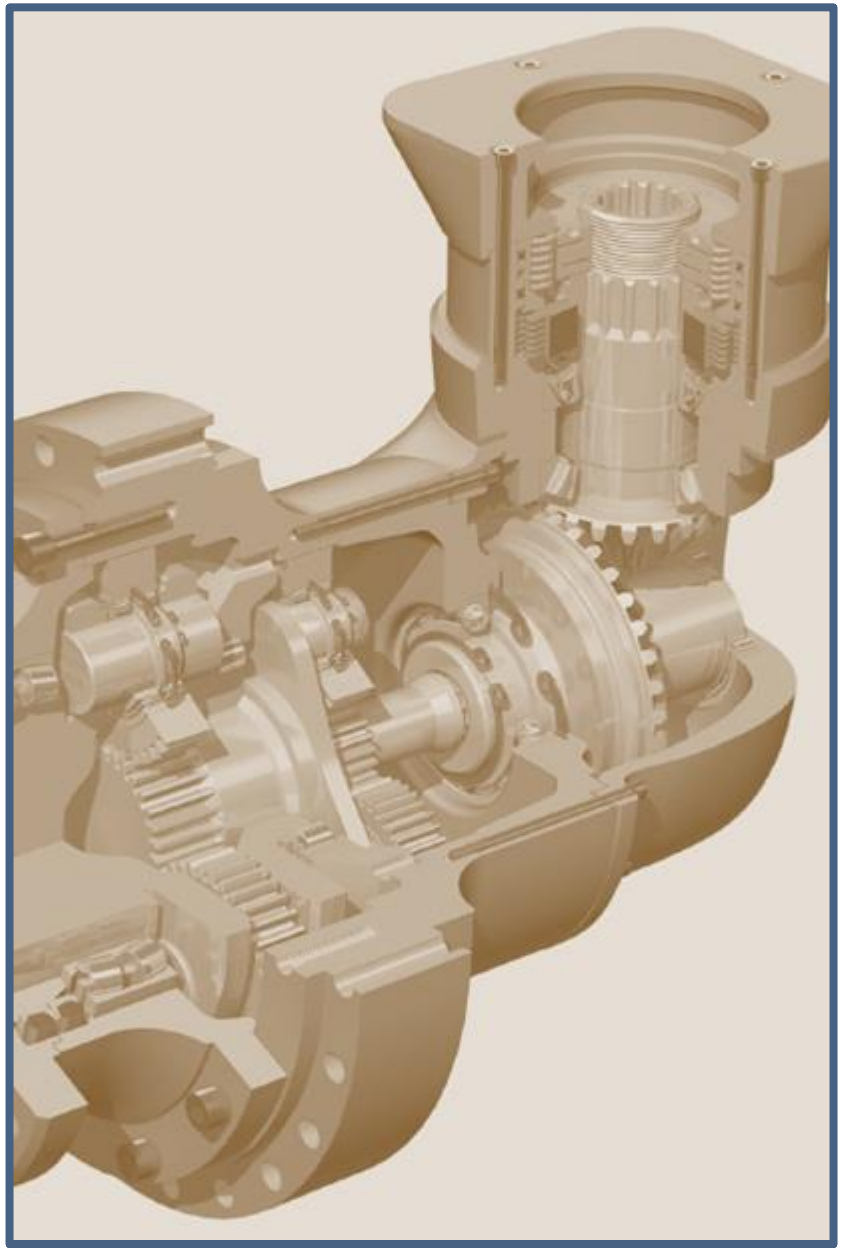
Design software that exists in the cloud provides integrated functions. A single tool can often be used to create 2D and 3D sketches and surface models and also provides parametric modeling, and direct modeling capabilities. Because a single tool is used, these models don't need to be translated from one form to another, which means engineers need not spend time fixing or recreating design geometry after translation.

Some suppliers of cloud-based CAD and CAE tools offer capabilities that suggest design alternatives for engineers. Once geometric, functional, aesthetic and other constraints are defined, the tool automatically generates and assesses many designs against those requirements. When engineers are away from their desks, these tools are busy working. After returning to their desks, engineers can assess and choose between those options. They no longer need to choose the first design that meets requirements. They can select the best design.

With the cloud tools, design data exists on remote servers, making data management automatic. The software automatically tracks design changes and stores all design iterations. These can be called up in an instant should the need arise. In this way, the CAD and CAE cloud tools eliminate the non-value added activity of manually checking data in and out. Engineers can instead apply their time to other design tasks.

From an IT and cost perspective, there are significant advantages as well. Cloud-based tools are accessed for a monthly subscription instead of a large upfront license purchase that often qualifies as a capital expenditure. Furthermore, such cloud-based tools do not require any installation as they run in browsers, eliminating many IT maintenance issues.

The design information permanently exists in a secure location: the remote servers that act as the cloud. Collaborators from around the world can securely access that design data. The data is provided to collaborators in accordance with the capabilities needed, often only view and markup, for example. Cloud software also allows all users, including suppliers and manufacturers, to be updated on and have current design changes, which are shared via an intelligent link to a part or product. Also, such participants do not need to purchase a CAD or CAE license, as they simply need a subscription as well.



# PROGRESSIVE SOFTWARE DEVELOPMENT SOLUTIONS

As mechanical hardware design tools have changed, so too have tools for developing products linked to the Internet of Things via sensors and software. These tools have also moved to the cloud, and have also developed an array of capabilities to specifically address the challenges of developing IoT-enabled products.

## PROGRESSIVE SOFTWARE DEVELOPMENT TOOLS

Progressive software development tools are really a platform of applications that run in the cloud. They include a constantly evolving set of communication and connectivity protocols to keep pace with always-changing standards and emerging sensor technologies. Software engineers can use the tools to develop data models that accept data streams from sensors. Also, the tools can contain emulation capabilities for virtually prototyping incoming data streams from sensors.

## THE ADVANTAGES OF PROGRESSIVE SOLUTIONS

The tools accelerate product development because they include all the lower-level standards, protocols and software snippets needed to create IoT-enabled products. Engineers don't need to spend their time developing these lower level functions, yet the functions are constantly being updated as these standards and protocols are updated.

After engineers build the data model, the platforms allow sensors to be connected quickly and easily. When the product goes to prototyping or even out into the field, the data streams from the sensors can be fed directly into the data model used to plan the product. Furthermore, as sensors are replaced and upgraded in the product line, the platform allows the data model to be updated easily.

Before a product is prototyped or delivered into the field, the platform allows engineers to emulate data streams coming from sensors into the data model. This capability offers engineering organizations significant advantage because engineers can validate their approach long before hard dollars are spent on prototyping and testing.

The tools used to develop IoT-enabled products have also moved to the cloud. Those tools are comprised of always evolving communication and connectivity protocols, to the benefit of software developers.

# PROGRESSIVE PROTOTYPING AND MANUFACTURING

Along with evolving design tools, manufacturing software as well as manufacturing methods have seen significant advancements in the past few years. The impact has greatly improved the process by which products are prototyped and manufactured.

## PROGRESSIVE CAM AND 3D PRINTING

In a logical move, CAM has moved to the cloud along with CAD and CAE and the tool can be used as part of an overall design and manufacturing platform that exists exclusively on remote servers. Just like those counterparts, progressive versions of CAM software have been transformed and optimized to run in the cloud. It runs directly in a browser or a lightweight client connected to remote servers (i.e., the cloud). Each step or modification made by a user is executed in the cloud.

Significantly, subtractive manufacturing has been joined by additive manufacturing, which is the creation of parts and products by building up a material layer upon layer, rather than taking away material. While additive manufacturing has been available for the past two decades, it has only recently advanced in terms of accessibility, material and production quality. As a result, the components being produced can be used as final components in some applications. Furthermore, some equipment now offers combined capabilities of both additive and subtractive manufacturing approaches.

## ADVANTAGES OF PROGRESSIVE SOLUTIONS

The changes to both CAM software as well as 3D printing approaches offer a number of advantages over the traditional peer approaches.

Additive manufacturing methods are not constrained in the same way as subtractive manufacturing approaches. Engineers can design hollow components or unusual shapes without worrying about how a cutting tool will get to the negative space of the design. They have more freedom to design against functional requirements with fewer manufacturing constraints.

Another advantage of additive manufacturing is that it gives engineers an accelerated way to develop prototypes. Whether they are prototyping individual components or an entire product, time to completion is far shorter when prototypes are made through additive rather than subtractive manufacturing.

But updated subtractive methods, particularly through the use of cloud-based CAM tools, offer advantages as well. CAM-in-the-Cloud software calculates and generates toolpaths much faster than traditional, desktop-based CAM tools. Furthermore, numerically controlled toolpaths can also be updated and verified more quickly with cloud-based tools, compressing the time from receiving to manufacturing part design.

Working with CAM-in-the-Cloud offers advantages in the supply chain as well. Because engineers can share their designs with their machine shop suppliers via a cloud-based CAD-CAM solution, they need not exchange digital files. The machine shop simply gains access to that geometry in the cloud. As toolpaths are built from the design, changes propagate intelligently. This saves engineers' time spent answering questions about design and design geometry and further speeds manufacturing.

Modern CAM tools often sit alongside CAD tools in the cloud. That means more seamless changes back and forth, allowing for iterations on design for better manufacturability.

# SUMMARY AND CONCLUSION

Engineers no longer spend eight hours a day at their desk. They need design tools that can follow them. They also need tools that allow them to develop IoT-enabled products. At the same time, manufacturing methods are also changing. Progressive design and manufacturing tools are emerging to help engineers and manufacturers reach their goals in these changing times.

## THE NEW CHALLENGES OF PRODUCT DEVELOPMENT

The Lifecycle Insights' Hardware Design Engineering Study found that, on average, engineers held 7.3 responsibilities, which includes things like predicting product performance, making design decisions, project management and collaborating with suppliers. Furthermore, the same study found that engineers are spending time away from their desk at the shop floor, at the customer's office and in conference rooms. Today's engineers are on the go. Yet, organizations can't let product development come to a halt because engineers aren't at their desks.

## TRADITIONAL SOLUTIONS

Traditional design, simulation, software development and manufacturing tools often restrict an engineer's work because they are constrained to desktop computers. Furthermore, these tools often require manual effort and non-value added tasks, which translates to spending time on activities that is better spent on design. These tools have provided great value in the past, but new options are needed for the modern engineer.

## PROGRESSIVE SOLUTIONS

A new class of tools is emerging, however, that exists on remote servers or "in the cloud." They offer engineers a number of advantages. Some applications, for example, assess a number of design variations. They can also be integrated with CAM in the cloud for quick toolpath generation and faster virtual prototypes. A cloud-based platform aids software engineers as they create the software for sensors that tie products to the IoT. Additive manufacturing methods have also been updated in the recent past and offer a number of advantages, including the capability to be tied to subtractive manufacturing methods.

## FINAL TAKEAWAYS

Organizations that move CAD, CAE and CAM tools to the cloud have a number of competitive advantages. Product development cycles are sped. Products are more innovative. IoT-enabled products can be readily developed. Manufacturing is more cost effective and timely. Times have changed. It is time to consider a new set of tools to enable the modern engineer.



**Chad Jackson** is an analyst, researcher and blogger with Lifecycle Insights, providing insights on technologies that enable engineering, including CAD, CAE, PDM & PLM.
chad.jackson@lifecycleinsights.com