Tech-Clarity

Issue in Focus:

The Evolution of Digital Prototyping

*Extending
"Right First Time"
Value Beyond Design*
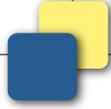
Table of Contents

Introducing the Issue

Digital prototyping helps manufacturers get products right the first time by letting them define, design, develop, and validate products in a virtual environment before committing to time-consuming and expensive physical prototyping. The technique enables them to efficiently develop high performance, high quality products and optimize them for form, fit, and function. Formerly accessible only by those with deep pockets and highly trained simulation specialists, digital prototyping has become much more accessible in the last decade due to reduced solution cost and complexity. This ease of access has allowed many manufacturers to take advantage of the significant business value and competitive advantage available from leveraging digital prototyping.

> *The best product is no longer enough to differentiate and compete*
> *in today's crowded, competitive, global markets.*

The best product, however, is no longer enough to differentiate and compete in today's crowded, competitive, global markets. Manufacturers have to be agile to adapt to threats and take advantage of opportunities on a global scale. They must be able to shift production as business strategies dictate, for example moving manufacturing closer to consumers or raw materials or shifting production from developing countries as advantages fade due to changing economic and business conditions. They must be ready to take on new competitors as formerly "low cost" countries take a more direct role in innovating and bringing their own products to market. They must be able to respond to new competitors as they arise, potentially competing with new business models like 3D product models sold to be printed at home via 3D printing. In addition, they must find innovative ways to engage with customers to rise above the noise.

> *Manufacturers must holistically improve the way they design, develop,*
> *produce, and sell products. Status quo is a failing strategy.*

To compete in this environment manufacturers must holistically improve the way they design, develop, produce, and sell products. Status quo is a failing strategy. They have to enhance their ability to innovate and deliver products from concept to customers rapidly, efficiently, and with confidence. Digital prototyping has evolved to meet these needs and now offers manufacturers a significant opportunity to achieve benefits beyond getting product design right up front.

> *Today, digital prototyping is more accessible, supports more functions,*
> *and can be deployed to a broader community*

Extended Digital Prototyping

In response to competitive pressures, manufacturers are leveraging broader, more integrated digital prototyping solutions to improve the business of product innovation, product development, and manufacturing all the way through marketing, sales, and service. Today, digital prototyping is more accessible, supports more functions, and can be deployed to a broader community (Figure 1). Digital prototyping has expanded in four key areas:

- Product (a richer view of the product or asset, beyond technical specification)
- Lifecycle (integrating further up and down the lifecycle)
- People (more collaboration across departments and the supply chain)
- Processes (supporting more processes outside of design and engineering)

Figure 1: Four Dimensions of Digital Prototyping Expansion

Extended digital prototyping capabilities now allow significant, strategic business improvements beyond "getting products right the first time."

The expanded digital prototyping solution set goes beyond enabling individual engineers. It allows manufacturers to work in much more collaborative ways, integrating information in real-time and connecting teams beyond engineering and outside of the enterprise. It has also extended to new platforms such as the cloud and mobile devices, reaching new people and enabling a range of new device capabilities and form factors. Extended digital prototyping capabilities now allow significant, strategic business improvements beyond "getting products right the first time." The bar is raised in manufacturing and those that take advantage of these broader capabilities will have a leg up on their competition.

© Tech-Clarity, Inc. 2013

The Business Value of Digital Prototyping

Before discussing the extended value of digital prototyping, it's important to recognize that getting products right may not be enough, but it's still critically important. As the Principal Tech Specialist from auto manufacturer Jaguar says in the report, "*When we use simulation simultaneously with the design, we can get it right the first time and eliminate very costly issues later on*." Optimizing products in the virtual world before committing to physical production helps manufacturers get products to market faster, reduce rework, improve quality, enhance productivity, and reduce cost. As Tech-Clarity's The Business Value of Simulation explains "*Simulation allows companies to meet the demands for reduced cost and faster time to market, but without compromising product quality*."

It's important to recognize that getting products right may not be enough, but it's still critically important.

3D modeling and simulation capabilities such as kinematics, FEA, CFD, and others allow companies to hit targets, make design tradeoffs, and find errors early in design where the windows of opportunity are still open and changes are relatively easy (Figure 2). As the Director of Engineering from agricultural equipment manufacturer Unverferth states in Engineering's Role in Surviving a Down Economy, "*A digital prototype is much easier to manipulate than the actual iron. The big advantage is seeing your 3D, and the movement you can create helps you do a much better job of interference checking. Things like that make a big difference, we can evaluate options more quickly, build fewer prototypes, and make a lot fewer mistakes so we have fewer reworks*."
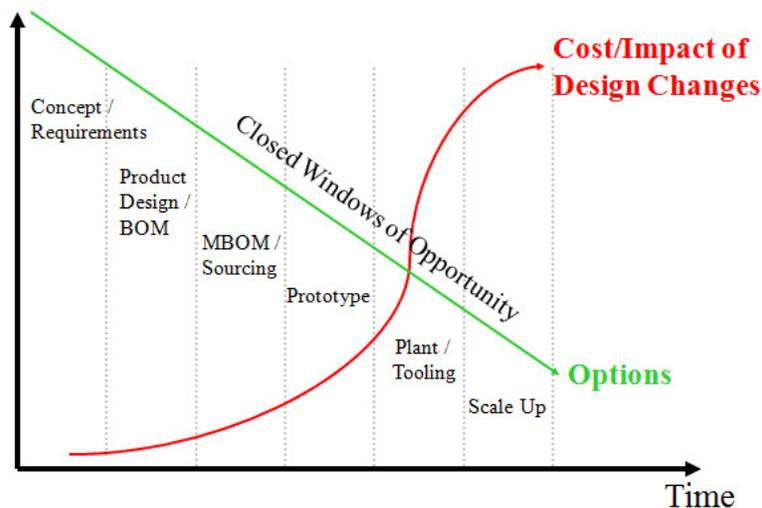

Figure 2: Windows of Opportunity for Change

> *"When we use simulation simultaneously with the design, we can get it right the first time and eliminate very costly issues later on."*
> *Principal Tech Specialist, Jaguar*

Digital prototyping also enhances innovation by allowing engineers to innovate with more confidence because they can validate how products will behave based on a digital model. As the Jaguar technical specialist explains, "*With simulation you get fast evaluation of design alternatives and you can do a lot of iterations quickly. It helps you really explore more of the design space.*" New cloud capabilities can help by providing nearly limitless computing power so engineers can send multiple design iterations to the cloud to test more ideas concurrently. Digital prototyping gives product developers more time to innovate and try out new ideas so they can explore more options, collaborate more, and bring more differentiated, compelling products to market to raise top line revenue, market share, and margins.

> *The basic value of digital prototyping is getting more innovative products to market, faster, without compromising quality.*

The basic value of digital prototyping is getting more innovative products to market, faster, without compromising quality and it is more important than ever. Many manufacturers have adopted digital prototyping in recent years because it's now a much more realistic option for smaller companies and those without simulation experts. Adoption has also increased because the luxury of time for physical prototypes and slow introduction to manufacturing are gone. For many, increased product complexity demands digital prototyping just to maintain quality and ensure they don't encounter costly and embarrassing quality issues. As The Business Value of Simulation shares, "*Complexity is leading more companies to utilize simulation to predict how products will behave in the real world*."

Move Beyond Form, Fit, and Function

Getting the product right is no longer enough to maintain profitability. For example, many manufacturers face rapidly expanding environmental compliance demands from regulations such as RoHS, REACH, and the Dodd-Frank restrictions on conflict minerals. Digital prototyping has grown to assist product developers by offering real-time alerts that provides instant feedback if they include environmentally unfriendly materials. This is critical to profitability because noncompliance can restrict available markets and prohibit sales. Some manufacturers use digital prototyping to go beyond compliance to differentiate themselves as "green" to gain market advantage by reducing the materials and energy required to produce and run the product.

© Tech-Clarity, Inc. 2013
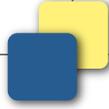
> *Getting the product right is no longer enough to maintain profitability.*

Engineers and product developers now have to address a variety of requirements early in the product lifecycle, including:

- Compliance
- Weight
- Sustainability
- Supply (shortages, obsolescence)
- Manufacturability
- Serviceability
- Cost

> *Innovative companies are taking advantage of more accessible and integrated digital prototyping capabilities to evaluate different design options so engineers can make proactive tradeoffs between competing needs.*

Digital prototyping helps designers understand the impacts of their decisions on these factors. Innovative companies are taking advantage of more accessible and integrated digital prototyping capabilities to evaluate different design options so engineers can make proactive tradeoffs between competing needs. This is important for initial designs but also for implementing design changes. Digital prototyping allows manufacturers to confidently implement change requests originating from customers, Manufacturing, or Service to improve products. As <u>Best Practices for Factory Adaptability</u> states, "*Simulation technologies help manufacturers predict and optimize the impact and scope of proposed changes during the planning stage to avoid late surprises and optimize designs while options are still flexible.*"

Pursue Right to Market

It takes a lot of work to make sure products hit their specs, requiring knowledge-driven tradeoffs between conflicting needs like cost and quality. But determining what the specs *should* be in the first place is another issue entirely. Forward-thinking manufacturers are including their customers early in the product lifecycle to help shape and validate products ideas. Digital prototyping can help designers demonstrate and iterate product ideas visually with customers to kill or correct ideas sooner if they don't resonate with buyer needs. It can also help them demonstrate how they can be agile in responding to customer needs to develop lasting relationships.

> *Digital prototyping can also be leveraged later in the product lifecycle to help market and sell product.*

Digital prototyping can also be leveraged later in the product lifecycle to help market and sell products. 3D models and simulations can be used to create high quality visual representations that include realistic reflections, shading, and motion to generate customer enthusiasm. As the Managing Director of aerospace manufacturer Adept Airmotive shares in Engineering's Role in Surviving a Down Economy, "*We like digital prototyping because it looks so darn good. Generating interest in our products is a less recognized advantage of 3D design*." Smaller companies are now able to use digital prototyping to develop lifelike renderings and animations that were previously only available to a select few. Now, companies can go further than just the product and simulate the experience the customer will have with the product, for example seeing the product in context such as in the customer's factory or driveway.

> ***Smaller companies are now able to use digital prototyping to develop lifelike renderings and animations that were previously only available to a select few.***

Tech-Clarity's Best Practices for Developing Industrial Equipment reports that innovation and customization are top priorities for manufacturers differentiate (Figure 3). In addition to supporting innovation, digital prototyping can help companies differentiate and ensure they win profitable orders in "make to order" and "engineer to order" business. Digital prototyping provides significant improvements in this area by allowing designers to rapidly model and validate products to determine their cost. This is critical to win business and ensure profitability to maintain margins. In fact, Best Practices for Developing Industrial Equipment determined that higher performing companies have better quoting capabilities, concluding that "*Companies without the capability to create accurate quotes are at a competitive disadvantage, having to choose between losing business by pricing too conservatively or losing money by selling bad business with aggressive pricing that turns out to deliver low (or negative) profit margins*."
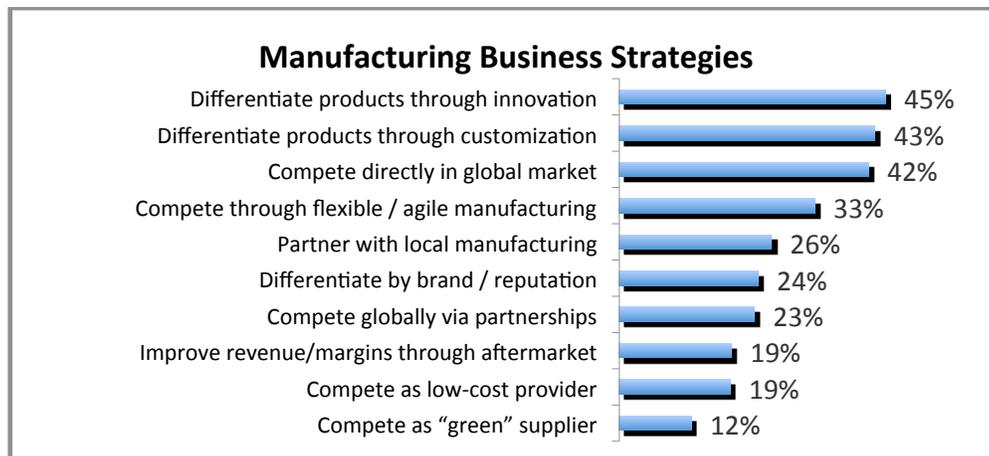

Manufacturing Business Strategies

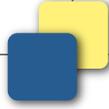| Strategy	%
Differentiate products through innovation	45%
Differentiate products through customization	43%
Compete directly in global market	42%
Compete through flexible / agile manufacturing	33%
Partner with local manufacturing	26%
Differentiate by brand / reputation	24%
Compete globally via partnerships	23%
Improve revenue/margins through aftermarket	19%
Compete as low-cost provider	19%
Compete as "green" supplier	12%

Figure 3: Business Strategies in Manufacturing

Another valuable capability of digital prototyping is allowing customers to directly explore design options by designing the product they imagine on the web. Including customers in the configuration and design process based on predefined engineering rules and constraints provides a highly compelling customer buying experience that used to take millions of dollars and years to build as custom websites. Digital prototyping puts this in the reach of much smaller, nimble companies to help them compete with much larger companies while remaining agile and responsive. Integrated suites not only help win the order and get the product right up front, they create a digital model that can be passed on for final engineering and automatic creation of drawings.

> *Including customers in the configuration and design process … provides a highly compelling customer buying experience that used to take millions of dollars and years to build as custom websites.*

Go Beyond Design for Manufacturability

Digital prototyping offers numerous advantages to improve production. The first and most obvious is enabling Design for Manufacturability (DFM) to ensure that products can be readily produced. This is a proven discipline and digital prototyping plays a valuable role by allowing manufacturing experts to collaborate and provide early input on designs. Sharing digital prototypes provide a more realistic understanding of products because people can view them, measure them, rotate them, and interact with them. Digital prototyping also enhances communication between Engineering and Manufacturing by easily providing up-to-date, accurate drawings or through a "model-based enterprise" approach where the factory personnel view 3D directly.

> *Digital prototyping not only ensures products can be produced it also compresses the time it takes to ramp up production.*

Digital prototyping not only ensures products can be produced it also compresses the time it takes to ramp up production. Manufacturing engineers can practice concurrent engineering to develop and optimize manufacturing facilities, equipment, procedures, and tooling in a virtual setting in parallel with product development. This allows manufacturers to rapidly commission new products or quickly shift production to new plants without costly and time-consuming errors. With the confidence of digital validation, manufacturers can order equipment and tooling earlier and begin pre-programming automated equipment.

In addition to speeding up product design, digital prototyping can be used to speed up and reduce errors in infrastructure and physical asset changes. Manufacturers can model their

factories in 3D or use reality capture technology like laser scanners to create models of their existing plants. Infrastructure changes can then be digitally prototyped and validated, including the "fourth dimension" of time to validate the project plan so demolition and construction can start sooner without fear of rework. As Digital Prototyping in the Plant reports, top performing manufacturers use simulation and "*are much better at understanding the full scope and impact of changes during the planning phase*" through simulation and "*visualizing changes in the context of the existing factory*." Lower barriers to entry for digital prototyping allow more companies to improve factory modifications to get to market faster without having to make compromises that impact cost, quality, or productivity.

> ***In addition to speeding up product design, digital prototyping can be used to speed up and reduce errors in infrastructure and physical asset changes.***

Conclusion

The basics of digital prototyping already add significant value by allowing manufactures to get products right the first time. This improves time to market, reduces cost, and improves quality. An increasing number of manufacturers have adopted digital prototyping due to easier access and lower cost of entry. Manufacturers can now implement these technologies and get up to speed quickly. The benefits are compelling. As the Jaguar technical specialist states in The Business Value of Simulation, "*Simulation is the one tool that keeps us competitive and in the market. Simulation is an engineering tool that should be part of the design process and part of the business strategy*."

> ***Beyond getting the product right, digital prototyping helps manufacturers innovate to differentiate themselves in crowded, global markets.***

Beyond getting the product right, digital prototyping helps manufacturers innovate to differentiate themselves in crowded, global markets. It allows them to confidently analyze and explore more design options. It facilitates greater collaboration across departments, with customers, and with design partners. It can even help them demonstrate and promote products virtually to get customers excited, or allow customers to configure products online. These formerly "high end" marketing capabilities are now in reach for most manufacturers, allowing them to compete with even the largest competitors. Digital prototyping can help manufacturers plan and validate product processes and factory changes to increase speed and reduce errors.

> ***Expanded digital prototyping suites are poised to allow manufacturers big and small, across the globe, to expand their top lines and improve profitability.***

Expanded digital prototyping suites are poised to allow manufacturers big and small, across the globe, to expand their top lines and improve profitability. Digital prototyping has evolved to improve a broader scope of the business of innovation, designing, developing, and producing products. The examples above are just some of the benefits available, manufacturers are also using digital prototyping to create world-class service documentation, improve their ability to manage projects, collaborate more effectively across teams, and more.

> *Digital prototyping capabilities are more available, integrated, and accessible than ever and those that fail to adopt them will be at a competitive disadvantage as the manufacturing market evolves.*

The bottom line is that digital prototyping provides real business value. For example, top performers in <u>Best Practices for Developing Industrial Equipment</u> grew revenue 2.2 times more than average performers and increased profit margins 2.4 times more than average. How did they do that? "*Although the top performing companies have differences in strategy compared to average performers, what really sets them apart is the way they go about achieving it – their processes and their enabling technology*" which include simulation, configurators, design automation, PLM, and factory layout/simulation tools among others. These digital prototyping capabilities are more available, integrated, and accessible than ever and those that fail to adopt them will be at a competitive disadvantage as the manufacturing market evolves.

Recommendations

Based on industry experience and research for this report, Tech-Clarity offers the following recommendations:

- If your company has not invested in digital prototyping, it is time to start
- If you have started, continue to expand capabilities to stay ahead and go beyond the basics as the competitive bar raises
- If you haven't explored digital prototyping tools recently, reevaluate feasibility based on reduced cost and complexity, greater computing power via the cloud, and the availability of more integrated suites
- Extend digital prototyping to more people, including those that traditionally don't have access to 3D and design data because they don't use CAD
- Use digital prototyping sooner in the product lifecycle at conceptual design and ideation
- Go beyond DFM to simulate factory changes to quickly commission products, shift production, and quickly ramp to full production at high quality

- Allow customers to validate product offerings in context, to bring the right product to market and enhance the customer experience
- Leverage digital prototyping to create compelling sales and marketing experiences for customers
- Look for integrated toolsets for efficiency, reuse, and speed
- Recognize that while achieving a broad use of digital prototyping is valuable, it should be achieved in an incremental, step-wise fashion. Choose small projects with short timeframes and real returns. Start small, pilot, and implement what works. Consider subscription models to minimize cost and risk.

About the Author

Jim Brown is the President of Tech-Clarity, an independent research and consulting firm that specializes in analyzing the business value of software technology and services. Jim has over 20 years of experience in software for the manufacturing industries. He has a broad background including roles in industry, management consulting, the software industry, and research. His experience spans enterprise applications including PLM, ERP, quality management, service lifecycle management, manufacturing, supply chain management, and more. Jim is passionate about improving product innovation, product development, and engineering performance through the use of software technology.

Jim is an experienced researcher, author, and public speaker and enjoys the opportunity to speak at conferences or anywhere he can engage with people with a passion to improve business performance through software technology.

Jim can be reached at jim.brown@tech-clarity.com. You can read additional research, watch Tech-Clarity TV, or join Jim's *Clarity on PLM* blog at www.tech-clarity.com. You can also follow Jim on Twitter at @jim_techclarity, watch him as a "dueling analyst" in the Tech4PD web show, or find Tech-Clarity on Facebook as TechClarity.inc.