Sustainable Design Practices Help Manufacturing Companies Increase Profits and Growth

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ABSTRACT

This paper discusses Autodesk's role in helping a number of companies balance cost considerations and implement sustainable design methodologies to improve business operations, new product design, and the entire product development process. In executing this mandate, design professionals confront the challenge of developing innovative products while balancing environmental concerns. They are seeking design tools that enable them to make choices that reinforce sustainability at key points in the design, engineering, and manufacturing process, while reducing the number of physical prototypes and decreasing overall costs.

Keywords: digital prototyping, sustainable design, new product design, clean technology, design tools

INTRODUCTION

Our world is amidst a sea of change--especially in the manufacturing industry. Once plentiful materials like wood, copper, and steel grow ever more expensive and harder to find; energy prices continue to escalate regardless of type and source; and the global problem of waste is staggering.

Today manufacturers face mounting pressures to not only drive efficiency in the manufacturing process, but to ensure more sustainable manufacturing outcomes as well.

Sustainability in the Manufacturing Context: What It Is and Why It Matters

Sustainability is sometimes defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."[1] The sustainability of a manufacturer is measured by the impacts of its operations and products throughout their lifecycle.

The manufacturing process is resource-intensive by nature. Common sense dictates that using less energy and water during production and reducing materials waste will help a business lower its costs and operational footprint. In reality, however, some producers may be reluctant to modify familiar processes based on the chance that they can create the same quality product with fewer resources. The costs of downtime, retooling, worker retraining, safety, new capital investments and performance testing are well known to manufacturers; the benefits of a more sustainable operation are theoretical until proven.

Two factors reduce the risk of updating a production process to improve its sustainability – one is using a proven methodology and the other, a proven technology.

Lean Manufacturing and SixSigma are well-known process improvement methodologies that target and eliminate waste to drive profitability while improving the environmental performance of a process at the same time. Using a sustainable design methodology that borrows key elements from Lean and SixSigma can help a producer target areas for improvement efficiently and effectively, with minimal risk.

The other way to reduce risk is to take advantage of the latest software technology to design and engineer products. Businesses that use a design platform with digital prototyping capabilities, such as Autodesk Inventor software, can develop a single 3D model that evolves from concept through manufacturing. The model allows the designer to evaluate opportunities to reduce environmental impact throughout the design process—for example, by optimizing the amount of raw materials needed through finite element analysis.

Making the Product Design Process Greener

It is worth noting that the greatest environmental impact of some products comes not during their manufacture, but during their useful life. Industrial equipment, consumer electronics, cell phones—anything with an on/off switch—may consume many times more energy in a year than was consumed during its production or embedded in its raw materials. In other cases, the choice of materials may be the most critical environmental factor associated with a product. Both issues are of growing importance to customers, supply chain partners and regulators. Products with low eco-footprints offer a lower total cost of ownership, less chance of liability and fewer regulatory hurdles for producers and buyers alike. In short, such

products are more competitive than their traditional counterparts are and may fuel a manufacturer's growth.

To minimize the lifecycle impact of a product, producers can use a sustainable design methodology modeled on proven improvement methodologies. Like Lean and SixSigma, sustainable design "starts with the end in mind," a clearly defined desired outcome or end state. Because the interplay of inputs and process steps dictates the outcome of a process—or in this case, a product—sustainable design practitioners work backward and analyze the impact of materials choices and production processes on the product's overall sustainability and the desired outcome. Understanding the interplay allows a designer to modify elements of the process as needed to achieve the desired result. In SixSigma terms, the process output is a function of process inputs (Y= f(X)), so achieving a specific outcome involves manipulating the input variables until the desired result is achieved.

Manufacturers should choose sustainable outcomes that advance their top business priorities, such as lowering operating expenses or taking market share from a competitor. Business conditions such as cash flow, market trends, materials availability, and regulatory constraints may influence the selection. The chosen outcome will guide the product strategy and determine trade-offs, so the entire team must have a shared vision of the outcome throughout development and production. The more specific the desired sustainable outcome—such as an air conditioner that uses environmentally benign refrigerant or a zero-emission motorcycle—the easier it will be for the team to focus on the inputs and process variables that might achieve the intended result.

Optimizing for Outcomes with Digital Prototyping

Once the desired outcome is selected (such as lowering energy use during production by 20%), the design team can pick a strategy (reduce the number of heat-treating operations) and analyze the inputs and process steps to understand the impact of each on the outcome. The team can then build a 3D virtual model to facilitate its analysis and decision-making. As the model develops it becomes a more accurate digital prototype of the product, reflecting the material attributes such as weight, strength and recycled content, and process attributes such as energy intensity and water consumption.

The team can experiment with alternatives that might achieve the desired goal. In this example, the team might consider using designs that can take advantage of selective induction hardening processes rather than bulk heat-treating. Experimenting with different scenarios will reveal the feasible and cost-effective options.

As the product design evolves from concept through engineering and on to production, it can be tested, modified and optimized to achieve the desired outcome. Sharing a digital model among multiple team members throughout the process helps keep them aligned and focused on achieving the intended result.

Product outcomes and strategies will vary widely according to the type of business, constraints and market opportunities. Examples might include:

- Facilitating quick disassembly and recycling by using a single bolt to assemble the back to an office chair frame;
- Substituting recycled plastic for virgin lumber in playground equipment;
- Lowering energy use by 50% and eliminating the need for oil and lubricants by creating a gearless elevator hoist, and
- Enabling fast, cost-effective remanufacturing by using only standard, interchangeable parts.

Regardless of the specific sustainable outcome and strategy selected, a digital prototype will save the design team time and money as it analyzes and tests alternative options. In many cases, the digital prototype will be able to predict the impact of the proposed change on the product's characteristics and the energy consumed during its manufacture. Armed with such data, the design team can quickly and cost-effectively experiment with different material and process variables until it discovers the optimal combination. Multiple options for the same product can be saved at any stage, from concept through manufacturing, allowing the team to pursue multiple strategies in parallel. If the market or regulatory environment changes, the product can quickly be optimized to meet the latest conditions. The digital prototype reduces risk by keeping options open as long as needed.

The digital model can also be used to simulate stress and performance tests to facilitate compliance with safety standards. Rather than building physical prototypes, the optimized design can be tested and broken virtually before spending a dollar on materials or labor.

If a manufacturer chooses to optimize its product for disassembly, the digital prototype simplifies the analysis. By using the assembly design features in Inventor software, the design team can examine the parts and the process needed to dismantle a product and repurpose its materials. Quick disassembly is a critical product feature for companies interested in establishing an ongoing relationship with customers via a service and subscription model. It also simplifies recycling and resource recovery and lowers labor costs.

After the product is in production, the digital prototype assists with regulatory compliance and certification requirements. Data management of bills of material

simplifies compliance with either mandatory or voluntary frameworks.

Digital prototyping offers even greater promise for the future, and design software will become an increasingly important tool in efforts to improve the sustainability of manufacturers. By allowing designers to make better decisions in the early stages of product development, when they are most effective, future product capabilities may make it even easier and faster for manufacturers to design products that are resource-efficient, carbon neutral, healthy and safe.

Case History – Utility Scale Solar

Shakespeare put it nicely when he described the sky as a "majestical roof fretted with golden fire." Utility Scale Solar, Inc. (USS), may not be quite so poetic, but the Palo Alto, California–based company is poised to put that golden fire to the best possible use. The company's Megahelion™ MH144 product is a heliostat, a device that precisely follows the sun as it moves across the sky while pointing a photovoltaic (PV) array, concentrating solar power mirror, or other solar-reflecting, electricity-generating surface at the sun.

"Simply put, the Megahelion drive accurately positions any type of solar application, whether PV, thin film, or mirror reflectors, for optimal solar power harvesting at lower cost and with better performance," says Jonathan Blitz, chief technical officer at USS, who also co-founded the company with CEO Peter Childers in 2008. "USS technology represents a revolutionary method for smoothly and accurately moving these large, heavy objects to track the sun, even in extreme conditions. We're making something radically different from what is currently out there, and it's all about lowering the cost of these plants."

While tracking the earth's original energy source may seem as easy as slowly moving your head from east to west, reliable and accurate solar collection actually requires the precision of a fine watch. The best locations to collect solar energy, such as deserts, tend to be subject to all manner of weather extremes. High winds and superfine sand are just two elements likely to disrupt traditional solar tracking machinery. USS heliostats and drives, however, are designed to be virtually invulnerable to such obstacles. While conventional drives rely on complex and often fragile components, the Megahelion uses far fewer moving parts, distributing forces over a much larger surface area inside the drive, resulting in the same fluid motion with fewer breakdowns and at much lower cost to own and operate.

"We've been using Autodesk Inventor to great effect," says Blitz. "The software has significantly streamlined what we are doing and made it much easier to visualize and better communicate our designs. The ability to then subject these designs to realistic forces and loads has given us the confidence to remove mass and streamline the components without sacrificing structural integrity. Because stress analysis is integrated into the software, there has been much more rapid evolution of our designs since we moved them all to Inventor."

USS also uses Autodesk® Showcase® software for product and marketing images. Says Blitz, "Explaining solar energy collection can be a complex process, but it is much easier with detailed, realistic digital images."

CONCLUSION

Sustainability is still a differentiator, but not for long–it is quickly becoming an expected part of doing business in the global economy.

A sustainable approach reduces risks at every stage of business, leaving manufacturers and businesses less exposed to the possibility of materials shortages, energy price increases, higher fees for waste disposal and pollution abatement, liability and unwelcome shareholder actions. A sustainable design methodology and digital prototyping software are both essential tools to help designers develop products meet one or more business-oriented, environmental outcomes.

Smart business leaders will build sustainability into their business model, and choose to improve the sustainability of their business operations, production processes and product designs to drive profitability, competitiveness in a global design market and growth.

Sustainability is here to stay. The time to act is now.

ABOUT AUTODESK

Autodesk, a leading provider of 2D and 3D design, engineering, and entertainment software, understands the important role that design can play in creating a sustainable future. The company is committed to helping leading clean tech companies bring their ideas to market faster and more profitably.

The Autodesk Clean Tech Software Grant is a collection of industry-leading software applications and includes up to five licenses each of products including Autodesk Inventor Professional. These powerful tools enable designers to develop digital prototypes of ideas, for quicker innovation and more predictability in product development. For more information, visit www.autodesk.com.

[1] World Commission on Environment and Development (the Brundtland Commission), 1987.