CLOSING THE R&D COST ANALYSIS GAP
PLUS CRYOGENICS, FLOW BEHAVIOR, PARTICLE MEASUREMENT, AND CAVITATION EROSION

August 2012 Vol. 54, No. 4

Advantage Business Media

R&D™

Better Parts Build a Better Product

Suppliers for original equipment manufacturers rely on a variety of innovative strategies to keep pace with a demanding, shifting marketplace.

EDITORIAL

Rita C. Peters
Editorial Director
rita.peters@advantagemedia.com

Action Speaks Louder Than Words

The two opposing presidential campaigns recently engaged in a war of words about the amount of assistance small business owners need to be successful. The "he said-he said" duel may be directed to capture votes, but in my opinion, only demonstrates how little regard the candidates have for voters.

Instead of describing and debating a plan for economic recovery, the nation's declining technology competitiveness, energy development, terrorism, banking reform—to name a few pressing issues—the candidates instead are using business owners as pawns in political sparring. Innovators have a tough task, take risks, and should be commended for their contributions. And most need technical assistance along the way.

Products have become more complex, requiring sophisticated materials, power sources, software, and designs, often beyond the capabilities of a single company. The challenge is finding the most appropriate partners and suppliers. In this issue, we examine product development from three angles.

The cover story, "Better Parts Build a Better Product" (page 6) describes how suppliers for original equipment manufacturers are employing a variety of innovative strategies to keep pace with demands for new power sources, vacuum pumps, optics, machined parts, and even screws and nuts. Off-the-shelf components may not always meet the required specifications. Sophisticated R&D practices are needed throughout the product supply chain to meet technology demands.

Better parts do make better products, but sometimes, less is more. The more parts a product has, the more costly it is to manufacture and maintain. In addition, more parts mean more opportunities for failure. The article, "Closing the R&D Cost Analysis Gap" (page 10) describes design for manufacture (DFM) and design for assembly (DFA) techniques and software that can exploring design tradeoffs and alternatives, with an eye toward trouble-free manufacturing and on-time delivery.

Another way to drive product development is through partnerships or acquisition. In "License to Innovate" (page 20) the editors offer a quick view of three technologies developed in government research laboratories that are available for licensing.

The bottom line is that developers are highly dependent on other organizations to bring innovative products to market, and this trend is increasing. In the last decade, the number of organizations receiving R&D 100 Awards in the decade jumped 18%, an indication of an increase in collaboration and joint efforts needed to develop technologies that are ever more complex. Almost half of the 100 technologies selected as winners in 2012 were developed by teams from multiple organizations.

The candidates can argue about words taken out of context. Innovators know the real story: The R&D innovation chain is interconnected, evolving, and more substantive than any political campaign.

Closing the R&D Cost Analysis Gap

DFM and DFA costing and redesign methods can prevent product development problems and preserve financial resources.

By its very nature, research is an upfront effort. Those who practice it best understand how critical it is to quantify new advances early on before applying them in full product development.

In the field of manufacturing, the research role is changing. It is increasingly spread out among designers, analysts, and managers once exclusively responsible for development. Credit some of this change to how closely—and early—computer-aided design (CAD), finite-element analysis (FEA) multiphysics, and product life management (PLM) tools converge to capture geometry and simulate the performance of designs and materials. The trend away from dedicated, separate research also is occurring because of perceived budget and time-to-market pressures.

Is the current approach of compressing research into development working? The short answer is yes; products are improving and goods are getting to market more quickly. But how can companies continue to build better products and make even stronger use of integrated digital systems? What's still largely missing from the R&D equation is quantitative costing and the remarkable collaboration that can result from it.

Many people view costing as a 19th century practice. It's mostly done through late-stage supplier bidding or by price-referencing past designs. When numerical models are used, they're generally rudimentary material weight- and volume-based estimations. This all comes near the end of the development process, a step before launch, and rarely influences decisions about redesigning features or substituting different materials and processes. However, costing ideally should be started before designs are locked down into details and simulations that teams may not question or repeat because of perceived time constraints.

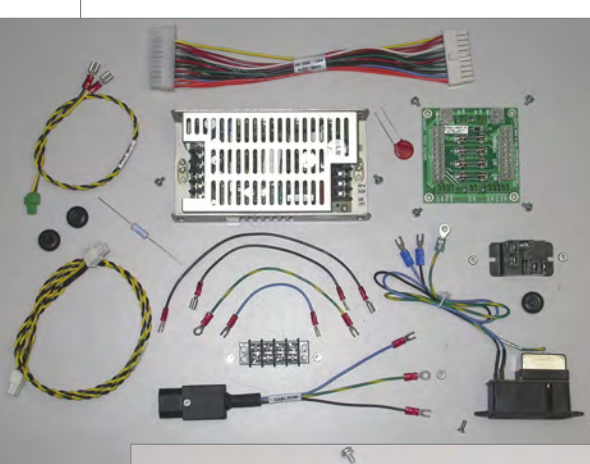
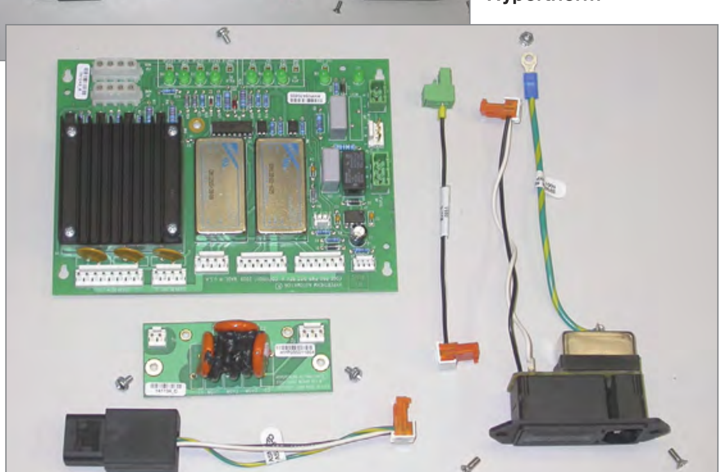


Figure 1. The 31 wiring components in the Hypertherm EDGE II CNC controller (left) were reduced to 11 in the EDGE Pro (below) following a Boothroyd Dewhurst DFMA-guided redesign. This parts consolidation improved assembly and reliability of the unit. In addition, the power sub-assembly requires less overall space in the unit. Images: Mike Shipulski, Hypertherm



Why upfront costing matters

Engineering teams today concentrate on functionality and time-to-market. Of course, products must work fully, meet high customer expectations, and be introduced when demand is highest. Paradoxically, though, in not deploying early, science-based costing during concept phases, teams further lengthen the detailed design and supplier negotiation stages. This wastes time that could otherwise be devoted to exploring design alternatives and improving functionality. It also delays launches.

The solution to easing this cycle is use of design for manufacture (DFM) and design for assembly (DFA) techniques and software. DFM today is an umbrella term for all DFM/DFA programs related to ease of manufacture and assembly. These range from CAD-based producibility software for sheet metal and molding, to rules-based handbooks, and in-house cost/time studies captured in spreadsheets.

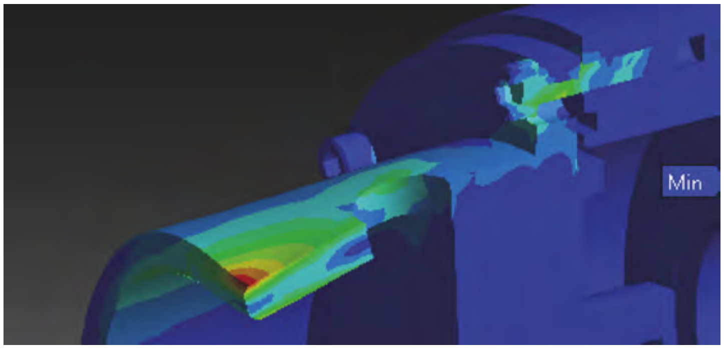
Whatever mix is used, it is important to apply DFM methods and software early, and in conjunction with quantitative cost analysis. This allows more resources to be focused on product performance and profitability and drives resources back into the true R&D function: exploring design tradeoffs and alternatives, with an eye toward trouble-free manufacturing and on-time delivery.

What the hard numbers can provide

Quantitative DFA is a set of questions—attached to assembly time and labor tables—that when answered serve to guide engineers to reduce product complexity by consolidating parts into unified, multifunctional designs. Product simplification is key to eliminating unnecessary parts and processes that devour organizational resources. Each part removed from a product configuration saves in CAD and product data management (PDM) documentation, inspection, inventory, part tracking, enterprise resource planning/bill of materials/material requirements planning (ERP/BOM/MRP), supplier management, and general overhead.

Efficient assemblies improve factory floor utilization, production throughput, quality, and landed costs, such as shipping, warranty, and service. Survey results spanning more than 20 years also reveal a 42% average reduction in labor costs for DFA analyzed products. Such savings could have significant impact on manufacturers seeking to produce within their primary domestic markets and avoid offshoring.

DFM analysis, often known as "should costing," is a companion



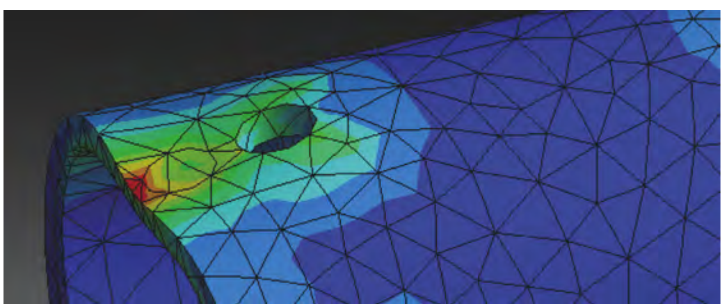


Figure 2. Part interfaces are a traditional source of quality failure. Elimination of separate parts into single, unified assemblies helps reduce stress points and improve performance and durability. Using Boothroyd Dewhurst DFMA on a prototype transducer housing for the energy industry, Dynisco eliminated 18 parts and fasteners. FEA test results (above) reveal a corresponding improvement in quality throughout the cast housing. Images: Dynisco Instruments

approach to DFA and allows the design engineer—often the central person between requirements creation and procurement—to quickly judge the cost of producing a new design against the original model.

Working alone, or in a cross-disciplinary team, comparative trade-off studies can be done in DFM that select among the most feasible shape-forming processes and then determine the ideal material, process, and manufacturing sequence for the given geometry. DFM isolates overly expensive features (bosses, bevels, radii, etc.) for redesign consideration, and accounts for secondary operations (deburring, polishing, etc.), cost by volume, set-up times, and waste. This information allows teams to avoid subjective opinions and do authentic "what if" exercises. Outside quotes and expert input are quickly reviewed with transparent DFM databases, bringing in suppliers as well for an early, faster, and more dynamic design-review system.

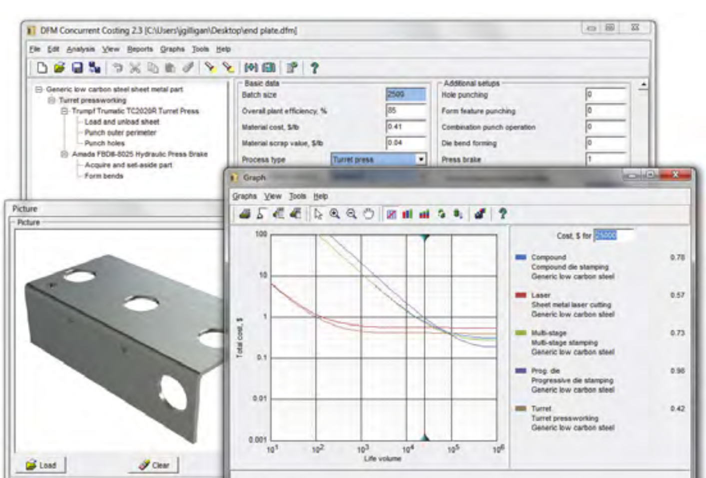


Figure 3. A series of cost curves for making the sheet metal end plate pictured at left. The Boothroyd Dewhurst DFM analysis compares five different sheet metal tooling options and shows how costs vary depending on the life volume planned for the part. At a life volume of 25,000, the least expensive manufacturing strategy utilizes a turret press. As volume increases, however, the analysis shows that other processes become more economical. Image: Boothroyd Dewhurst

Making the business case for using DFM

Improving functionality, shortening time-to-market, and reducing costs go hand in hand. **Hypertherm Inc.**, a leader in plasma metal cutting technology, undertook a DFM/DFA program with a five-year plan to transform both product performance and cost. Research, development, and manufacturing are all grouped together in their Hanover, N.H. headquarters. In terms of R&D, Hypertherm product development teams interact closely and, like most others in U.S. manufacturing, share a research function.

With the goal of continuous improvement, the company undertook the redesign of its leading plasma cutter as the first project. The director of engineering, Mike Shipulski, PhD, an expert in Lean and Six Sigma, sought clear engineering and business progress. A multidisciplinary team was gathered—because what would take place would affect everyone—and designers were asked to visit the factory and disassemble the previous system. Together they set an aggressive benchmark. With a DFA analysis of structural efficiency as a guide for brainstorming and measuring, they reduced half of the 1,000 parts in the system.

In the new plasma cutter, named the HPR130, system subassemblies took 45 to 89% less time to put together. Assembly floor space availability increased by 40% and warranty cost decreased 83%. Cost savings accrued to $5 million over 24 months, helping the company achieve record earnings that year. A new modular design approach derived from the project enabled standardization across the entire product family.

Most remarkable were the results as measured by the initial five-year redesign plan. Across several product lines, Hypertherm achieved a 600% increase in profit per square foot of factory floor space; warranty cost per unit declined more than 75% in that period; and unit labor expenses fell by 50%. The company is seeing success in both up- and down-markets, and enjoys strong cost-to-performance ratios in its products.

As Hypertherm and many other companies know, DFM/DFA tools and techniques complement emerging PLM technologies in advancing product excellence and breaking down walls.

Continued success for R&D departments involves understanding and exploiting the dynamic relationship between product design, production efficiency, and profits. The role of R&D in product development is to not only advance functionality, but to fully comprehend the impact that design decisions have on the extended organization and its customers. Structurally efficient, simplified designs, achieved through DFM/DFA costing and redesign methods, ensure that problems downstream are prevented and that financial resources are preserved and repurposed for further product improvement.

— John Gilligan, President
Nick Dewhurst, Executive Vice President
Boothroyd Dewhurst Inc.
Wakefield, R.I.