SOLVING PROBLEMS THROUGH TECHNOLOGY FEBRUARY 22, 1988

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AMERICAN MANUFACTURING FIGHTS BACK!

Round 2 to U.S. Design. Round 3?

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BY L.W. HENCHEY

Ford Motor Company wants to be a champion again. The Dearborn, Mich.-based pioneer, like other American manufacturers, has been taking a bruising from imports, especially Japanese imports. American companies find they cannot go toe-to-toe with their Asian and European competitors, losing round after round—first TV and audio equipment and now computer chips and autos. But all of that is beginning to change, thanks to new technology that could make American companies contenders once more.

When Ford invested in design-for-assembly (DFA) software three years ago, it was aiming for a little increased automation on the production line. Today the company finds itself at the forefront of a select group of producers championing a second revolution—or, more accurately, a long overdue revival—in American industrial thinking.

One thing is certain: This software-inspired back to basics approach undeniably produces results. Ford has not only shaved labor and inventory costs, it's also improved product quality and serviceability and, in many instances, actually reduced the need for more automated assembly. In a typical case, Ford personnel using DFA's nuts-and-bolts approach to design succeeded in eliminating 35 percent of the parts cost and 65 percent of the assembly cost of a new windshield wiper. The benefits of such guerrilla tactics on the small scale are crystal clear, and the big picture is even brighter. When the redesigned wiper assembly becomes standard equipment on all Ford cars, savings on that assembly alone could reach $2 to $3 million.

In the two years since DFA came on-line at Ford, the firm has retrained 2,000 design engineers to use it, and has exported it to overseas operations in Europe, South America, Australia, and Mexico. Ford credits the software with overall savings approaching $1 billion.

But Ford is far from alone in singing the praises of DFA, or in backing its development. Giants such as IBM and General Electric (GE) are investing in DFA research, while other household names like Whirlpool, Black & Decker, and Xerox—which has trained

U.S. firms are slugging it out in the world heavyweight manufacturing ring. Design for assembly is winning rounds, but can it score a TKO?

800 designers in its use—also rely on the software.

Rebuilding American industry from the bottom up by simplifying design sounds to most producers like an idea that's too good—or too simple—to be true. In their search for what Ford DFA coordinator Sandy Munro likes to call the "computer panacea," the vast majority of American companies may have ignored the most basic tenet of manufacturing: "Getting it right the first time is the key to making products better and cheaper." But no one is blaming them for hearing the clarion call of DFA as little more than an echo of the high-tech battle cry of the '60s and '70s. That adventure led American industry slogging through a computerization campaign that didn't always deliver the decisive victories it promised.

Progress has been made, to be sure, but while today's finite element systems may represent an advance in technology equivalent to the leap from a slide rule to a desk calculator, at Litton Aero Products in Moorpark, Calif., technical staff member Don Leonhardt still longs for a more substantial interplay between design and production.

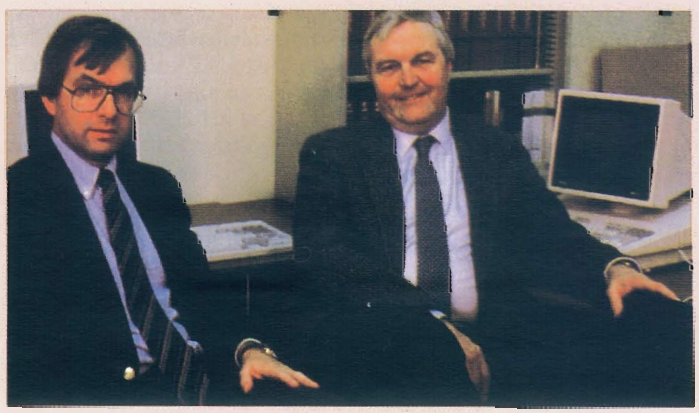
Likewise, Hriday Prasad, manager of Ford technology, development and support, still believes in the potential of robots. But he's realistic enough to characterize America's early forays into the area as "good examples of adding high-tech to existing business practices, with the result that all the robots had to be sent to psychiatrists."

WANTED: 100,000 LEONARDO DA VINCIS

The most important element in America's move toward a philosophy of designing for manufacturing is the recognition of the human factor: we need a new breed. Says Ford design-for-assembly (DFA) coordinator Sandy Munro, "The upshot of all the computer tactics we're using in our drive toward simultaneous engineering will hopefully be the creation of a renaissance engineer."

A prototype for the renaissance engineer is perhaps Leonardo da Vinci, the remarkable Italian artist who could not be pigeon-holed. He designed helicopters, tanks, bridges and towns as well as being a pioneering naturalist who was one of the first to perform scientific autopsies on human cadavers. What da Vinci learned in one discipline helped him in another. For example, da Vinci's observations of flying doves contributed to his helicopter design. Performing autopsies helped him sculpt accurately.

But when Munro uses the term, "renaissance engineer" he doesn't envision polymaths like da Vinci. Rather, he is calling for a reversal of the over-specialization that infects today's engineering.



Design for assembly experts Dewhurst and Boothroyd.

DFA co-designer Peter Dewhurst says, "Quantifying problems in design and producing efficiency ratings is really only the first step in establishing the atmosphere of collaboration between design engineers and manufacturing engineers that has been the keystone of the Japanese success story."

Ironically, the "renaissance engineer" may have been left behind when the split between blue and white collar jobs in America became an irreparable one—a schism many execs today trace back to the years following World War II.

"Design for manufacture can be achieved, but it will have as much to do with re-establishing the sort of cross-training of engineers that was discontinued in the U.S. 25 years ago as it will with expert systems," says Richard Bradyhouse, technical manager of producability for Towson, Md.-based Black & Decker. "Cross-training is the most significant thing the Japanese have over American industry at this point. Though DFA software can have a big impact, we can't ignore the importance of turning out engineers who have a strong background in both the design and manufacturing ends of a business, as well as a real single 'can do' attitude toward improving products at the design stage."

Happily, the recognition that—as Dewhurst puts it—"reuniting people from both ends is more important to our rebuilding of the manufacturing process than are vision-based robotics" does seem to be taking place, albeit in some unexpected ways. While Ford and Black & Decker use DFA to achieve impressive cost savings, the two firms have also found an unexpected benefit: the software can also capture the expertise of older manufacturing engineers, a process that proves to be essential in many cases.

"We didn't think of it as that sort of tool to begin with," says Munro, "but, frankly, a lot of the information we need to make design for assembly work is available only from old-timers, and the increased communication between design and manufacturing engineers that information-gathering process entails is all to the good."

—L. W. Henchey

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While DFA and its logical successor, DFM, may sound like the latest short-term computer salve for our country's wounded productivity, there is a critical difference. America's newest weapon in its assault on foreign competition does come from the computer arsenal, but this time around, the software is loaded.

EXPERT SYSTEMS TO THE RESCUE

In essense, what DFA offers over other do-it-yourself expert shells is an actual database that hits the screen in the form of easily read charts and tables. Powered by an algorithm distilled from 15 years of empirical studies, the software doesn't wait for something to happen, but prompts engineers question-and-answer style. It forces them to assess designs piece by piece, part by part, and to rate redesigns in real world terms that reflect dollars, cents, and seconds saved in assembly time.

Ford is using DFA on everything from windshield wipers to door panels. IBM is employing it to design the ProPrinter that takes three, rather than 30 minutes to assemble. The theory behind DFA is clear: "Every computer has a dollar key," says co-designer Peter Dewhurst, "and designers should be able to do something with it."

And DFA hits that money key."Debugging on the assembly line is hideously expensive. In fact, 25 percent of American manufacturing costs are typically wasted on scrapping and re-working due to problems that could have been addressed at the design end," says Singer-Kearfott quality assurance engineer Paul Wojnizz. "But that's the price we're paying for trying to rush new products out the door.

"It's only recently that we've begun to wake up to the fact that the Japanese and other foreign manufacturers aren't beating us with technology per se," adds Little Falls, N.J.-based Wojnizz, "but by their willingness to make drastic changes in design to ensure success in the long run."

Making the transition from post-mortem quality control to front-end problem solving won't be easy. Dewhurst cites aeronautics and industries using printed circuit boards as problematic special cases for the new application. Munro stresses that widening the market for the software will force the broadening of the database to account for a greater number of industry-specific issues.

However, DFA does represent a positive step in America's march "stretching beyond a mere desire to reduce costs and into the need to survive," according to Jim Kaspar, mechanical CAD/CAM development manager for Seattle-based Boeing.

Dewhurst claims that DFA today can aid in batch-manufacturing where "80 percent of production costs are being committed at the design end in terribly inefficient ways." He sees an even greater potential for reversing America's manufacturing woes in the development of design-for-manufacture programs that go beyond design critique and into the areas of material and manufacturing-process selection as well as cost analysis at the conceptual stage.

FROM DFA TO DFM

DFM is an extension of Geoffrey Boothroyd and Peter Dewhurst's work with DFA. Its development consists of transposing existing tables into databases addressing any one of the dozen or more main shape-processing techniques and manipulating the information with inference engines. Each given program establishes a standard quantitative analysis. In the case of machining, for example, everything is analyzed in terms of horsepower required, and for injection molding, the key is tonnage and ram force.

While Ford already has a design-for-machining program on hand and expects an injection-molding program soon, DFM won't go on-line until further refinements are made, according to Munro. "DFM is still a CAD tool that can't really be isolated from all the other tools we're working with," he says. Munro hopes that DFM's cost cutting potential may be expanded to include process planning.

Dewhurst aims a bit higher. He gives a window of at least two years before DFM programs currently in development will be ready for use in a majority of high-volume manufacturing situations. He expects that improvements in CAD will parallel the progress in DFM, resulting in DFM routines built into quick-sketch solid-modeling systems accessing both materials and process databases.

"As things stand today," says Dewhurst, "it takes as long to get a sketch on a computer screen as it does on a mechanical drafting board, and as a result, there is still a great reluctance on the part of designers to change their designs. But with the advances in quick-sketch capability, we'll be able to make giant strides not only toward more effortless design but toward really significant cost reduction."

That accomplishment could take Boothroyd, Dewhurst and other designers well into the 1990s. While it may sound like cost-control utopia, it will represent only a small victory in the bout against foreign competitors.

Still unclear is how fast and how far U.S. industry can go in approaching truly simultaneous engineering, and how big a role DFM programs can play in the campaign. Despite the progress at IBM's Lexington, Ky. installation in "getting rid of the paper and moving design into digital," development processes manager Reg Morris argues that DFM programs capable of geometry-driven rather than equation-powered parts analyses are essential for enlarging his firm's commitment to production via computerized numerical control (CNC) machines. "We've come a long way," says Morris, "but everything is definitely not in place." And while Munro sees DFM as a major factor in bridging the gap between CAD and CNC in producing simple parts, he questions whether producing more complicated parts will ever be achieved using DFM.

ROUND 3: SLUGGING IT OUT

Still, the mere existence of DFA is a sure signal that American industry is willing to take a new strategic tack in its battle against foreign manufacturers and—with the backing of U.S. businesses that are now targeting two and three, rather than five year, new-product-development schedules—it seems clear that the country will come back slugging in Round 3. □

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