How Design Teams Use DFM/A to Lower Costs and Speed Products to Market

Doing two things at once — product and process design — really does make sense.

John Ingalls

Imagine spending 40 percent less time and 25 percent less labor to develop a new product. And that new product not only reaches your customers sooner, but it costs less money to develop and produce. Speed, quality, and efficiency all in one. That's what some companies are accomplishing with a common-sense manufacturing technique called Design For Manufacturing/Assembly (DFM/A). To top it all off, DFM/A actually costs little in time or effort to implement.

Sound too good to be true? Honestly, it works. DFM/A's premise in a nutshell: Have designers develop a product at the same time that manufacturing engineers figure out how to manufacture it, while keeping a watchful eye on product cost and applying some principles.

DFM/A is neither new nor trendy. Leading product development organizations have been quietly applying this secret weapon to their operations for 15 years.

Let me acquaint you with little discussed, often misunderstood DFM/A, so you can see how its methodology can help your organization. In addition, I'll present you with examples of how companies are using DFM/A to their advantage and how your company can emulate them.

In a survey of top executives of 250 manufacturing companies with annual sales of $10 to $500 million, we discovered that 64 percent of mid-size companies are currently *designing the product and manufacturing process at the same time.*

More than a third of mid-size manufacturers have yet to unearth the time and cost benefits of DFM/A.

DFM/A Defined

DFM/A is a methodology for product development or product improvement projects in which designers and manufacturing engineers work together instead of separately. The two groups design a product's manufacturing and assembly process at the same time they design the product itself. As a result of their teamwork and focus on DFM/A axioms, they create a product that is well-designed, cost-efficient, and easy to produce and maintain.

The DFM/A philosophy contrasts with how product design engineering and the process design engineering department usually work. Traditionally, manufacturing is a sequential process. First, the design staff designs a

Halmar Robicon and Datcon Instrument used DFM/A to streamline production and save money.

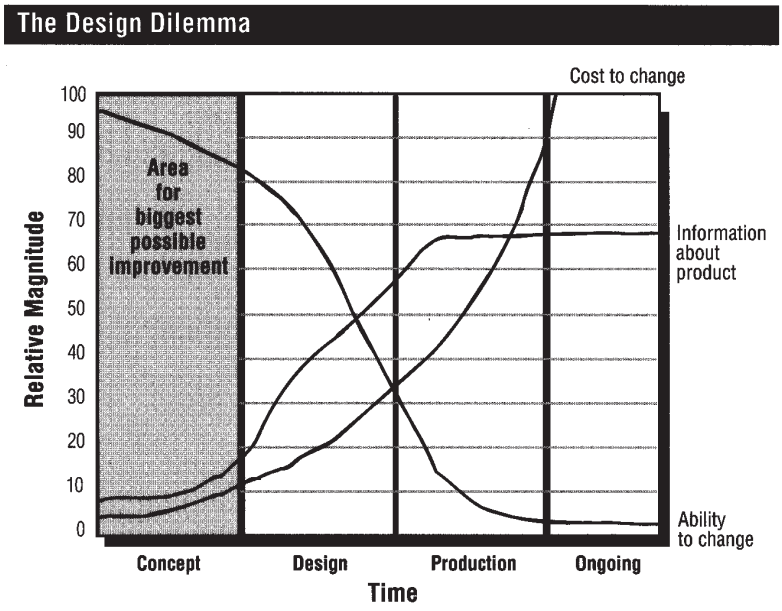

Figure 1. *As time passes during the design cycle more information becomes available about the product; the dilemma facing every manufacturer is that the cost to change a design spirals after a period of time, thereby limiting the ability to change.*

More than 75 percent of a product's manufacturing costs are built into it when it is designed.

product, then the design is passed on to the engineers who, in turn, develop the manufacturing process. The problem with this strategy is that the two departments' goals don't necessarily intersect. The designers pay little attention to either the cost or difficulty of producing the product. After all, that's engineering's headache. And the manufacturing engineers must work within the constraints of the product's design since it's already been conceived. If the design dictates that the product consists of 15 parts, the engineers must work out a system for assembling those parts into a whole.

With DFM/A, however, designers consider costs as well as form, fit, and function. They address manufacturing, assembly, and sourcing issues in the initial stages of design, including supplier capability. DFM/A improves what could be called a product's "ilities," namely producibility, inspectability, testability, designability, recyclability, and serviceability.

It is also cost-effective. More than 75 percent of a product's manufacturing costs are built into it when it is designed. Manufacturing costs can be cut dramatically since a product's design doesn't need to be tweaked to facilitate mass production. The cost to change a design is almost inversely proportional to one's ability to change over time. This is sometimes referred to as the "Design Dilemma" (See Figure 1).

The Design Dilemma

As the design cycle progresses, more information becomes available about the product. But while more is known, it also becomes more costly to change the design. The manufacturer faces the dilemma of what should be changed versus what he can afford to change and still make a profit. DFM/A addresses product costs early on in the design, thus mitigating expensive revisions in the later stages of production.

In addition to reducing development costs, DFM/A also speeds time to market. That's crucial for many manufacturers, most of whom work in industries where "quality" products are taken for granted and a company's real advantage comes in being first to market.

Take personal computers, which are now commodities. The PC manufacturer who wins is the one that can come out first with a model sporting the newest, leading-edge processor chip.

Time-to-market is also a big factor in determining whether a product makes or loses money. It is far more important than overall production cost, although it's often overlooked as a cost factor. It has been shown that with a 50 percent cost overrun on your production budget, product profit may fall ten percent. But a six-month delay in the introduction of a product has the potential to slash profits in half.

Any company that manufactures a product made of components and requiring assembly can usually take advantage of DFM/A. The manufacturing technique can be applied to everything from footwear to aerospace components. It isn't restricted to new products. This approach can overhaul existing ones. Below are the stories of two companies that have gained competitive advantage by exploiting DFM/A.

Halmar Robicon Saves Money and Streamlines

Six years ago, Halmar Robicon Group, a Pittsburgh-based subsidiary of High Voltage Engineering Corporation, Wakefield, MA, needed to reduce manufacturing costs by three percent annually in order to remain competitive. The manufacturer of solid-state power equipment for industrial, commercial, municipal, and scientific markets turned to DFM/A in 1989 to streamline production and save money.

The company began at the top with its premier line of variable frequency (AC) motor drives. Since printed circuit boards (PCBs) can constitute up to 60 percent of the cost of these small motor drives, that's what Halmar Robicon's manufacturing engineer, Ken Foltz, tackled first.

He and his staff produced standardized design guidelines for the PCBs. In their guidelines, they took advantage of the strengths of Halmar Robicon's manufacturing machinery, in particular, its automatic and semi-automatic PCB assembly equipment. The specifications covered every aspect of the manufacturing and design process: from component selection, to component layout and orientation, hole size, hole spacing, and hole clearances. The guideline writers also addressed issues such as board solderability, cleaning, and testing.

Once the PCB design was revisited it was time to move on to redesigning the 15-to-30-horsepower range AC motor drives themselves.

Under the leadership of Richard Osman, vice president of integrated product development, parts were either combined, eliminated, or made multi-functional. In general, the drives' design became simpler, employing fewer parts, and made more modular.

For instance, Halmar Robicon's engineers reduced the number of sheet metal parts used in the drives by about 50 percent. "Use of elaborate sheet metal was eliminated," notes Osman. Each drive's power bridge was designed as a separate complete module. Such modularity — as well as fewer parts — reduced final assembly time and labor. (Later in this strategy we will show the outstanding results of this effort.)

While these changes were not difficult to implement, the resulting cost savings were impressive. "DFM/A definitely produces results and pays for itself," says Foltz. "You can measure where you start and where you finish. The results will almost always be dramatic."

The group design effort was remarkable because of the way in which it boosted productivity and lowered costs. But it also encouraged Halmar Robicon to consult with its assembly-line staff and get input from workers on how products should be designed and manufactured. Says Osman, "Their feedback helped a great deal." The assemblers commented on a variety of fronts, from what components and materials to use, to the actual assembly process.

With such success under its belt, Halmar Robicon decided to expand its use of DFM/A. It provided extensive training on DFM/A and its methodology to its entire development staff.

Halmar Robicon's positive experiences with assemblers, in turn, inspired the manufacturer to involve suppliers and vendors. Why not work more closely with suppliers by tapping their expertise and then applying it to Halmar Robicon's manufacturing operations?

Teaming Up With Suppliers

Foltz, the engineer, briefed the company's strategic suppliers on DFM/A during one of Halmar Robicon's "Vendors' Days." His presentation explained DFM/A in great detail, including its practical methodology and key terminology. It also highlighted the potential benefits for the company and its manufacturing partners. To further drive those points home, Foltz also relayed Halmar Robicon's success to date with DFM/A. At the end of the presentation, he asked vendors to help Halmar Robicon with its development process and cost reduction program by incorporating DFM/A.

"Hardware and component manufacturers, semiconductor manufacturers — we asked them all to help," Foltz recalls. "They're the experts at what they do and they're always willing to share their expertise."

The manufacturer's suppliers now routinely preview designs concepts, critique them, and help "solve" any engineering dilemmas as they may crop up much earlier in the product development process. For example, one of Halmar Robicon's PCB suppliers has helped overhaul the design of the boards it manufactures for the company. The supplier helped Halmar Robicon devise an innovative board design that eliminates the need for most of the motor drives' wiring.

As a result of this joint effort, Halmar Robicon's new line of motor drives will be strikingly simple, inexpensive, and a snap to manufacture. Total parts for the motor drives will drop 64 percent, from 137 parts to 50. Screw connections are reduced by 43 percent, from 168 to 95. Control wires were decreased by 74 percent from 54 to 14, while power wires will be totally eliminated.

In turn, final assembly labor has fallen from 13.4 hours to 3.5 hours, a drop of 74 percent. Final test time has also dropped from 3.9 hours to 2.0 hours, a 49 percent reduction.

"Because of these improvements to material and processes, we were able to reduce the cost of production from $2500 a unit to $1500 a unit," Foltz says. "The cost to actually produce this motor drive will drop 41 percent, generating savings that will considerably improve the companies profit margin and value to the customer," adds Osman.

Foltz believes that companies should feel free to ask for help from its suppliers and vendors since they also have a vested stake in your success. "One of your biggest

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untapped resources is suppliers," says Foltz. "Most vendors are very willing to work with you on DFM/A."

It is possible to apply DFM/A to the sales and marketing cycle to speed it up just as it reduces the time it takes to develop and manufacture a product.

Datcon Embraces DFM/A

Datcon Instrument Company of Lancaster, PA, another subsidiary of High Voltage Engineering Corporation, designs and manufactures engine monitoring instrumentation. The instrumentation subsidiary has deftly deployed DFM/A by making it the centerpiece of its new integrated product development (IPD) process.

"Datcon has significantly changed the way in which it defines, approaches, and executes product development and DFM/A is at the core of this philosophy," says Hank Grilk, vice president of engineering.

Historically, reduction of design cycle time has focused on how the engineer can minimize the design, testing, and documentation processes. However, with increasing use of computer aided engineering, design and manufacturing, design cycle time has been slimmed down to the point where it no longer represents a significant factor in the total time-to-market.

"Recent trends toward the application of concurrent development, where the manufacturing process for producing a product is developed by the IPD team at the same time as, and in close cooperation with, the development of the product itself, have resulted in minimizing the always lengthy hard tooling and materials procurement critical paths," explains Grilk.

Sales and marketing plans should be conceived concurrently with the design and manufacture of the product.

However there is a third and potentially even bigger source of delay in transforming a project that's received a "green light," to a finished product that's in the hands of the customer. That lag comes from the sales and marketing process, and the time it takes to educate the customer on the product, its features, and benefits. The marketing and sales functions include such time spenders as drawing up a proposal, the customer's review of that proposal, the give and take of negotiating between seller and customer, and so forth.

At Datcon, DFM/A is being applied not only to traditional manufacturing functions such as product design and production, but also to such disciplines as sales and marketing.

In early 1994 Datcon adopted DFM/A product development. One product that has already benefited is a two-inch tachometer for heavy duty industrial and commercial applications. Pre-DFM/A, it cost Datcon in excess of $10 (typically $11 to $13) to manufacture the tachometer. Using DFM/A's principles to minimize parts, capitalize on multifunctional parts, and employ a modular design, the company has substantially lowered the tachometer's production cost. It's also made the tachometer more "flexible," making it easier to customize the product.

"The base product has a manufacturing cost of under $7 and the product has provisions to be upgraded to be applicable to virtually any input voltage, input signal wave form and amplitude, and technical specification required in this industry as a result of the DFM/A conducted" says Grilk.

The redesign took no time at all, less than a month, and Datcon is currently switching over to the new design.

Another example of Datcon's innovative approach to DMF/A is its Smart Instruments™ product, which sports electronic circuitry that works side by side with standard analog instrumentation. The electronic circuitry monitors critical engine operating parameters and activates a visual alarm if they fall outside of safe operating limits.

Grilk notes that Datcon achieved this improved monitoring function by using DFM/A. The designers did so without having to resort to adding separate senders to the engine. The senders would have added to the product's wiring. The Smart Instruments™ design is also more eloquent and lower in price. The Datcon executive estimates the cost savings at between $10 to $15 per instrument compared to predecessors.

Like the DFM/A-design of the tachometer, developing the Smart Instruments™ didn't take long. It took less than seven months for Datcon to develop, produce, and deliver the new product to customers.

DFM/A provides a great focal point for the development process. At the same time it promotes teamwork among members of the design group, it encourages teamwork for the company at large. "It gets all functional groups working with each other in an effort to design the optimum product and process," Grilk says. As a result Datcon has become better at mass customization of its products, which in turn has increased customer satisfaction.

The Methodology Behind the Success Stories

The basis of DFM/A is reducing the number of parts and their assembly time. Complicated designs with many parts are abandoned for simpler designs with modular construction and fewer parts. Design focuses on quality and reliability as well as adding functions to the product

An Example of a DFM/A Evolution

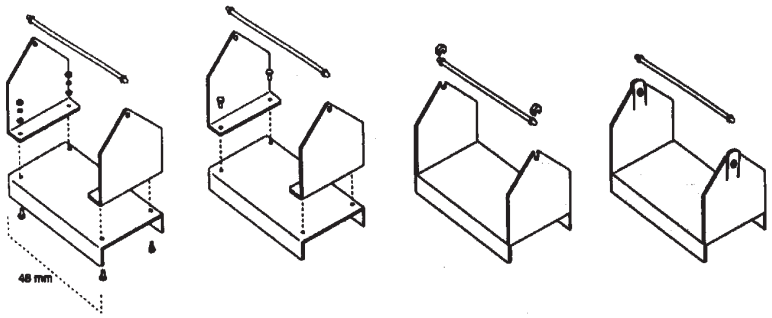

Figure 2. *This example illustrates the progression of a tool box insert from design inception through the evolution of a DFM/A study that resulted in reducing the design part count from 20 to two parts, improving reliability, and lowering product cost.*

that the customer will value but will add little to the cost (see Figure 2).

Other Benefits

DFM/A yields many benefits for manufacturers and their customers. Products are made at lower cost with higher quality and improved performance. They are more easily produced, tested, inspected, and arrive in the market much faster.

Because they have fewer parts, they are more reliable and easier to service and maintain. Often, the product can be recycled.

Companies using DFM/A typically have lower capital equipment costs because they are using their machinery more efficiently. They are more automated, have significantly shorter ramp-up times to production, and find that later-stage engineering changes are reduced along with the need for drawings and blueprints.

For example, General Motors used DFM/A when redesigning its Grand AM in 1993. As a result, the car's steering column worked better than its predecessor and consisted of 30 percent fewer parts. In real terms, this part reduction translated in to a three-fold increase in assembly worker productivity and a seven-fold increase in steering column quality. Another example from the automotive arena: Ford Motor used it on its Taurus model in 1986 and reduced its assembly costs by 30 percent — saving more than $1 billion.

There are other benefits: The need for "redesign during manufacturing" is eliminated; fewer parts are needed from suppliers, and manufacturers keep lower inventories since they're dealing with fewer parts.

Eliminating parts reduces costs throughout the company, not just directly in manufacturing. It can positively affect the bottom line of such departments as materials, purchasing, expediting, and receiving. For example, there are fewer parts to inspect; inspection costs fall, as do the costs of material handling and inventory. Engineering changes are easier to make; documentation costs fall.

Because production problems are now far fewer, the company itself enjoys an overall increase in efficiency.

Typically, with DFM/A and integrated product development, a company can see 40 percent reduction in parts. Total labor to make the product is reduced by more than 25 percent in many cases. And, of course, time-to-market typically falls by a significant percentage.

The Art of Implementation

The first step toward DFM/A is establishing a multifunctional design team and structure. Unless engineering and manufacturing work together, the process simply won't work. DFM/A is a very powerful concept, but it's not a tool that a person can wield in isolation.

One approach is to establish a core team for each project. Its members consist of the project engineer and designer, representatives from marketing, technical support, and purchasing, as well as factory line assemblers and foremen. The entire team meets regularly and works together on the project. DFM/A training and facilitation are musts to maximize results.

Of course, some manufacturers complain that they don't have enough people to staff these teams. These teams should be working on several projects at once, so staffing should not be a problem. Ideally, the team meets, its members are assigned tasks, and then they regroup only when the work is done. However, this approach takes discipline. That said, the benefits easily outweigh the effort.

Effective teams will continually surprise you with innovations. For example, design teams that are empowered to use DFM/A can produce impressive results as evidenced by a manufacturer of tourist-class aircraft seats. His DFM/A team uncovered millions of dollars of potential savings during their development efforts. The team, not withstanding demanding performance requirements of the Federal Aviation Administration (FAA), conducted a DFM/A analysis and reduced by 27 percent the number of steps needed to assemble a seat. Assembly time declined by more than 80 minutes and a minor modification to the product suggested by the team will allow the manufacturer to meet future, more stringent FAA requirements.

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