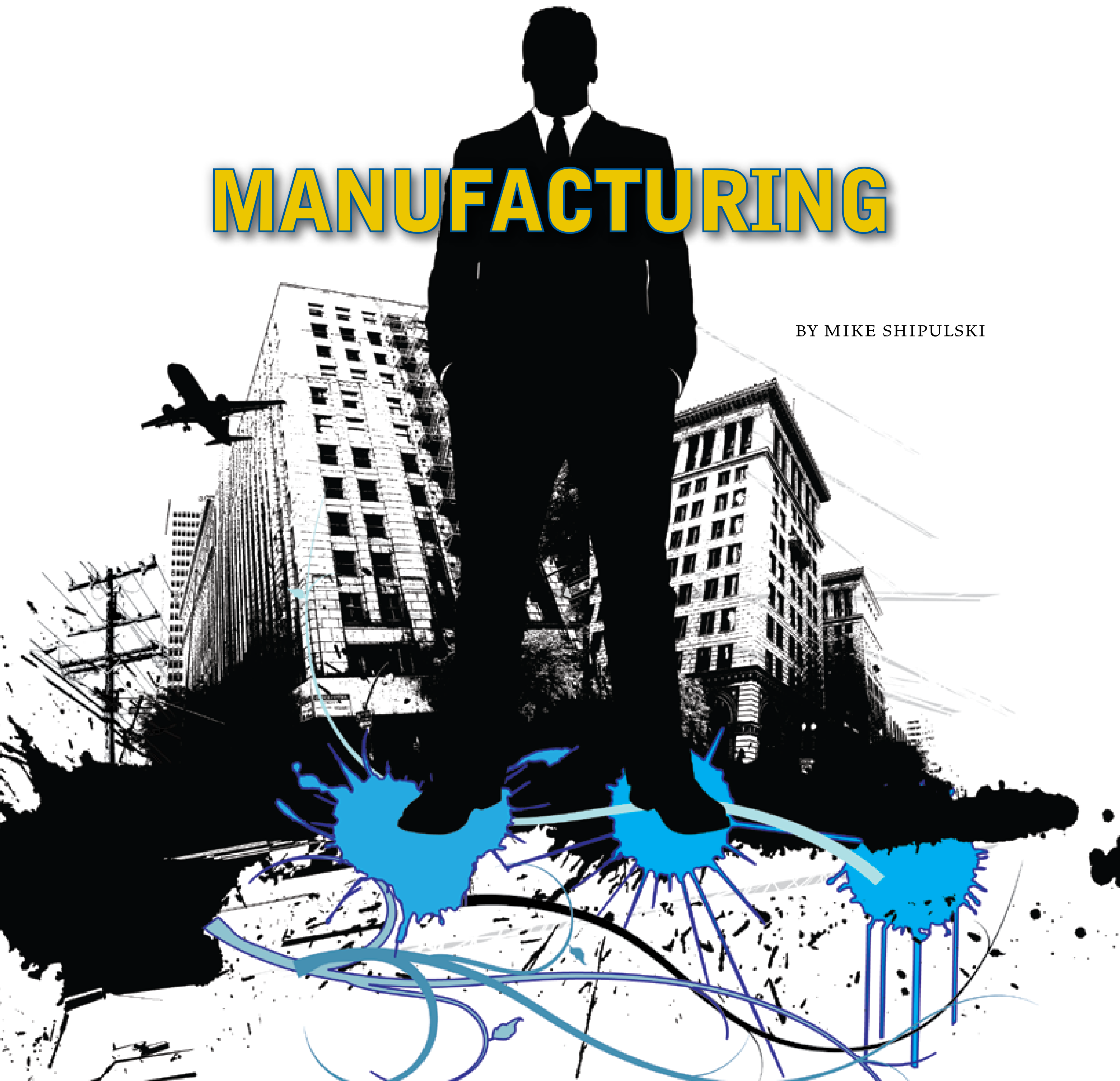
RESURRECTING MANUFACTURING



BY MIKE SHIPULSKI

How DFMA can save money, industry and possibly the economy

For too long we have praised financial enterprises for driving economic growth knowing full well that moving and repackaging financial vehicles does not create value and cannot provide sustainable growth. All the while, manufacturing has taken it on the chin with astronomical job losses, the thinnest capital investments and, most troubling, a general denigration of manufacturing as an institution and profession. However, we can get back to basics where sustainable economic growth is founded on the bedrock of value creation through manufacturing.

Continuing with the back-to-basics theme, manufacturing creates value when it combines raw materials and labor with thinking, which we call design, to create a product that sells for more than the cost to make it. The difference between cost (raw materials, labor) and price is profit. The market sets price and volume so manufacturing is left only with materials and labor to influence profit. At the most basic level, manufacturing must reduce materials and labor to increase profit. We can get no more basic than that.

How do we use the simple fundamentals of reducing labor and material costs to resurrect U.S. manufacturing? We must change our designs to reduce costs using Design for Manufacturing and Assembly (DFMA). The program is typically thought of as a well-defined toolbox used to design out product cost. However, this definition is too narrow. More broadly, DFMA is a methodology to change a design to reduce the cost of making parts while retaining product function.

Systematic DFMA deployment is even broader; it is a business method that puts the business systems and infrastructures to deploy DFMA methods in place systematically across a company. In that way, it is similar to the better known business methodologies lean, Six Sigma and design for Six Sigma. Lean is a systematic methodology that focuses primarily on the cost of manufacturing processes; Six Sigma focuses on the quality of manufacturing processes; design for Six Sigma focuses on the quality (functionality) of the product design; and DFMA deployment fills the gap at the intersection of product design and product cost.

Like the big three methodologies, DFMA deployment is more than a toolbox in the way that Six Sigma is not Minitab, lean is not value stream mapping, and DFMA deployment is not the DMFA toolbox. To be successful, a complete business methodology requires all quadrants – tools, business processes, organization and infrastructure – to realize benefits sustainably. Business processes and tools must be considered together. The questions to be answered include how to start, how to select projects, how to plan projects and how to staff and manage projects. All must be answered with a business process and a set of tools.

Infrastructure needs are relatively light but important. Computer resources are needed to store the analyses and some thought must be given to how to share and reuse DFMA analysis. However, the most important infrastructure component is file security. DFMA analyses should be treated as proprietary information as they are recipes to lower cost products. It is important to share the analyses across your company and the supply base, but it is critical to keep them out of the hands of your competitors.

Two organization components are vital. First, design engineering must lead the work. The "D" in DFMA stands for design, not purchasing, so a project run out of purchasing will fail. Second, the supply chain must see the work as a way to make more profit not less profit. This is challenging since the supply chain's willingness to participate is shaped by past interactions. If the company has taken margin from its supply chain in the past, it will be reluctant to participate. However, this must be overcome since radical savings are achieved when the supply chain embraces the work. We must reconcile our past sins if we are to realize future savings.

Savings from systematic DFMA deployment

Many studies have presented radical savings from DFMA work, and material and labor reductions of 20 percent to 50 percent are commonplace. Yet, companies don't use the methods.

Figure 1 is a graph of data from a DFMA deployment effort showing profit per square foot and warranty costs data over the five years between 2003 and 2008. The data have been normalized to show trends and allow comparisons to other companies. In blue is profit per square foot, which is price minus cost, or profit, divided by the square footage of the factory floor space used to produce the product. In orange is warranty cost per unit, defined as warranty expense per month divided by number of units in the warranty period.

Normalized profit per square foot increased from $1 per square feet in 2003 to $7 per square feet in 2008, a 600 percent increase. The increase came about by designing new products with reduced material cost, which increased profit per unit and reduced labor time (50 percent reduction), which, in turn, reduced the floor space needed to assemble the units. And because the new units functioned better and the price was less than the old products, more products were sold. The jaggedness is month-to-month variation due to the make-to-order production system.

Normalized warranty cost per unit decreased from $4 in 2003 to $1 in 2008, a 75 percent decrease. Reduction in warranty cost is the best surrogate for improved product quality and robustness. Customers recognized the improved robustness and the company's brand was positively impacted. The jaggedness is month-to-month variation due to batching of warranty claims.

It is clear that the DFMA methods resulted in lower cost products, a reduction in required floor space, and an improvement in product robustness (as indicated by reduced warranty cost per unit). Needless to say, your management team would like these types of improvements.

Reinventing the supply chain

The direct savings of labor and materials are staggering, but the downstream savings in the supply chain are more significant. The downstream savings result from eliminating non-value-added (NVA) activities – activities that the customer will not pay for – or waste. Lean thinkers who lead the daily crusade against NVA activities understand this concept and have the mindset and the toolbox to eliminate NVA activities throughout the supply chain. The lean thinkers have largely been relegated to NVA reduction on the manufacturing floor where value stream mapping (VSM) is the tool of choice to define the activities, resources and information flow required to deliver value to the customer. What's different about the value stream map is that a time is put to every activity in the value stream and each time is defined as value-added or NVA. It's common for NVA time to be far more than 95 percent of the time in the value stream. Since NVA time makes up most of the time in the value stream, there is a huge time savings even with modest percentage reductions in NVA time. Now, replace "value stream" with "supply chain," and the picture is clear.

The lean toolbox cannot simply erase NVA time from the supply chain; reduction in NVA time is the result of something – a reduction in the NVA activities themselves. So the open question is how to design out the NVA activities. That's where DFMA deployment comes into the picture, specifically, reducing part count through design for assembly (DFA). NVA activities are strongly linked to part count; reduce part count and NVA activities are reduced.

The link between part count and NVA activities is clearest when thinking in the context of the seven wastes, the grouping of NVA activities first made by Taiichi Ohno:

DEPLOYMENT DATA

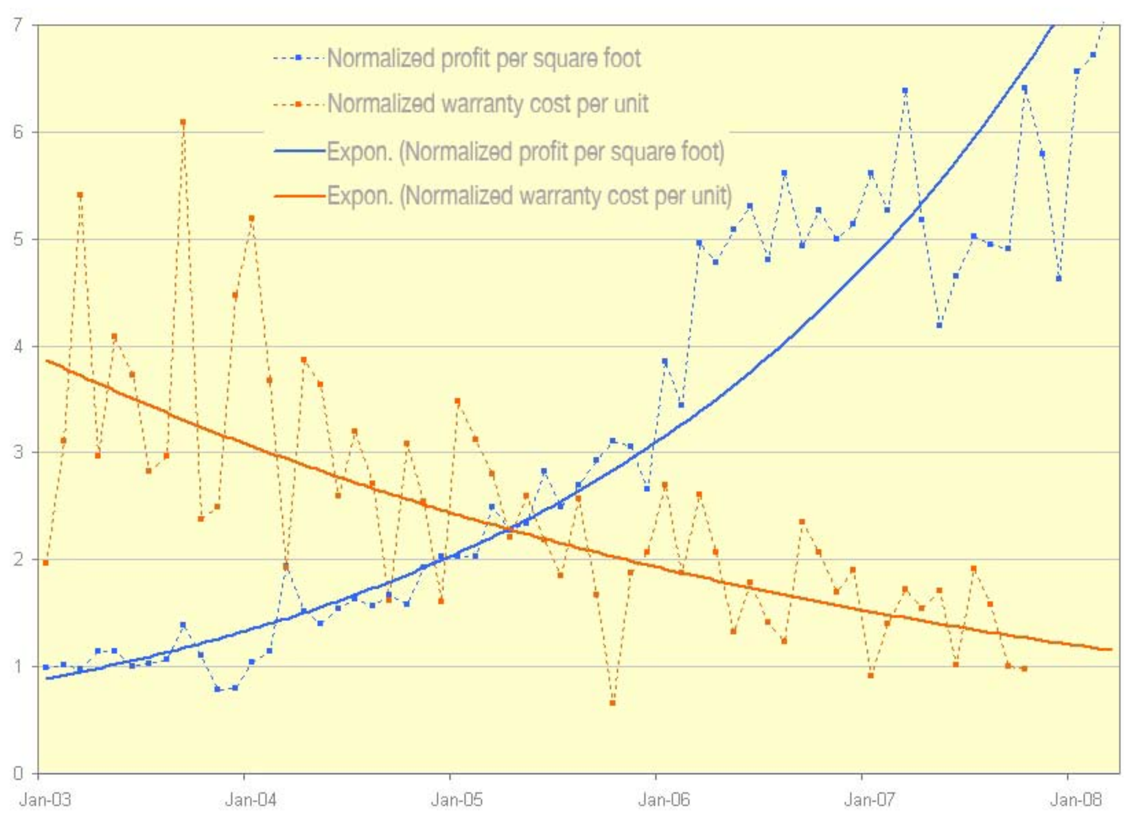


Figure 1. Monthly data of profit per square foot and warranty cost per system between 2003 and 2008

Changing roles of process optimization

BY ROB HOCKLEY AND RON BECK

Engineering know-how and experience has always been central to the safe operation, debottlenecking, yields and optimization of a process manufacturing plant. Employing engineering models in operations provides a partial substitute for that experience. Software modularization, user interface innovation and computing power have increasingly made these models available for plant optimization and operations.

Once a model has been engineered and calibrated to predict a particular application and instance reliably, it becomes more valuable to an organization if that work can be re-used in all tasks that require that unit or process to be modeled, which is becoming a growing trend.

The role of process modeling has evolved in two distinct ways. First, from being focused on individual calculations, process modeling has evolved to address integrated conceptual and front-end engineering design problems such as process economic analysis, safety and operability analysis and equipment design. This integrated approach yields time, cost and quality benefits for engineering and operating companies.

Second, process models developed originally for front-end engineering are now being used in plant operations. Owner-operators are increasingly using models to support operating decisions, to optimize processes in real time and to improve the accuracy of planning systems. In recent years, significant global economic growth has driven demand for new process plants. This had led to a major increase in engineering activity in the process industries – particularly refining, petrochemicals and polymers. Projects need to be executed efficiently with fewer engineers and engineering work flow has to be streamlined.

The integration of economic analysis with the basic process development activity yields sizeable benefits. Process engineers do not need to wait until a formal package is handed over to the estimating department before gaining accurate understanding of the economic trade-offs between alternate designs. Process costs are calculated and optimized concurrently with the conceptual process development to understand the economic impact of their design decisions.

The use of dynamic models for safety and operability analysis is another advance. This clarifies whether a design simulation solution is stable under real-world dynamic conditions. The goal is to use the same unit operations models for both steady-state and dynamic analysis, avoiding the redundant work of redeveloping the models.

Integrated basic engineering represents another area where work flows have advanced. The heat and material balance and flow sheets from simulation studies is directly put into the basic engineering process, where multiple disciplines define the front-end engineering design and then pass that information to detailed design.

Process models developed during process development and design phases of a plant represent significant engineering effort and knowledge. The design benefits include engineering productivity and reduced capital expenditure and plant life cycle costs. Application of process models to plant operations spans a spectrum from offline steady-state simulation to debottlenecking analysis through to closed-loop, real-time optimization for optimum process performance.

Process modeling systems can be redesigned for re-use in a modular fashion throughout an asset's life cycle. One example is the physical properties database, a re-usable information bank that is available as a standardized component to a number of different model-based applications. This ensures maximum flexibility and consistency regardless of choice of modeling tools.

Future innovations will lead to the modularization of unit operation models, increased ease of use and integration of work processes so that rigorous models will become even more widely used.

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- Waste of overproduction
- Waste of time on hand (waiting)
- Waste of transportation
- Waste of processing itself
- Waste of stock on hand – inventory
- Waste of movement
- Waste of making defective products

Adding "parts" to the traditional seven wastes drives the point home. All the wastes are related to parts. But we are stuck since only the design engineering community can design out parts. The design engineering community has been isolated (some say, *protected*) from the lean initiatives, and therefore, part count reduction efforts have not been part of the lean equation. It is amazing, however, to imagine the savings in the supply chain if the design engineering community gets involved. Their involvement would result in fewer parts to overproduce, fewer opportunities to wait for late parts, fewer parts to ship, fewer to receive, fewer to move, fewer to store, fewer to handle and fewer opportunities for incorrect assembly. If you open up your mind, the list broadens: fewer suppliers, fewer qualifications, late payments, supplier quality issues and expensive black belt projects. Most important, however, may be the reduction in transactions associated with reduced part count; for example, work in process tracking, labor reporting, material cost tracking, inventory control and valuation, routings, work orders, and engineering changes. So we must engage the design engineering community to reduce part count with DFA.

What sectors can use DFMA? The answer is all sectors. In all sectors, labor cost is labor cost, material cost is material cost, part count is part count and waste is waste. Yet there is a tendency for all sectors to reject the applicability of DFMA deployment. High-tech sectors say their products are too high tech and complex. Isn't that more reason to simplify using DFMA? Commodity sectors say their products are too simple; yes, but a 50 percent part count reduction is still significant even when reducing from four parts to two. Manufacturing processes of commodities are not simple and design changes can radically reduce the complexity of the supply chain. The military sector says the government won't let them change their product. I disagree. When the savings are measured in billions and trillions, government will do what it takes to make the changes. The heavy industry sectors say their products are too big. Well, savings are bigger when big parts are designed out. What's your sector's excuse?

DFMA deployment is straightforward work, but it is hard work. It is a part-by-part, process-step-by-process-step approach to designing out cost. And for some, that is too much to take on. There must be a forcing function, or source of energy, to push a company or sector over the threshold of inactivity, and that forcing function must come from company leadership. The burning platform created by the 2008 economic downturn is making it easier for company leadership to push itself over the threshold and try DFMA deployment.

Would your company's leadership notice a 30 percent savings in total labor and material costs? Would that make a difference for your company? A crude analysis puts the magnitude of the savings in perspective:

Total revenue in 2008 for GM, GE and Ford was $531 billion. Assuming half of that revenue came from products, total revenue from products was $265 billion. And assuming cost savings from DFMA was 10 percent, total profits would have increased by $26 billion. That would have been meaningful to the U.S. economy.

In summary, systematic DFMA deployment is a rigorous process that can guide manufacturing companies toward increased profitability. The methods can resurrect U.S. manufacturing and re-elevate manufacturing as a profession. Once re-elevated, our children will be attracted to manufacturing and learn how to create a robust, sustainable economy for the next generation.

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