DFMA and Lean: Partnership in Competitiveness*

A Working Paper

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By Richard J. Schonberger, Ph.D.

177 107th Ave. NE, #2101
Bellevue, WA 98004
+425-467-1143

sainc17@centurylink.net
www.wcm-wcp.com

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Abstract

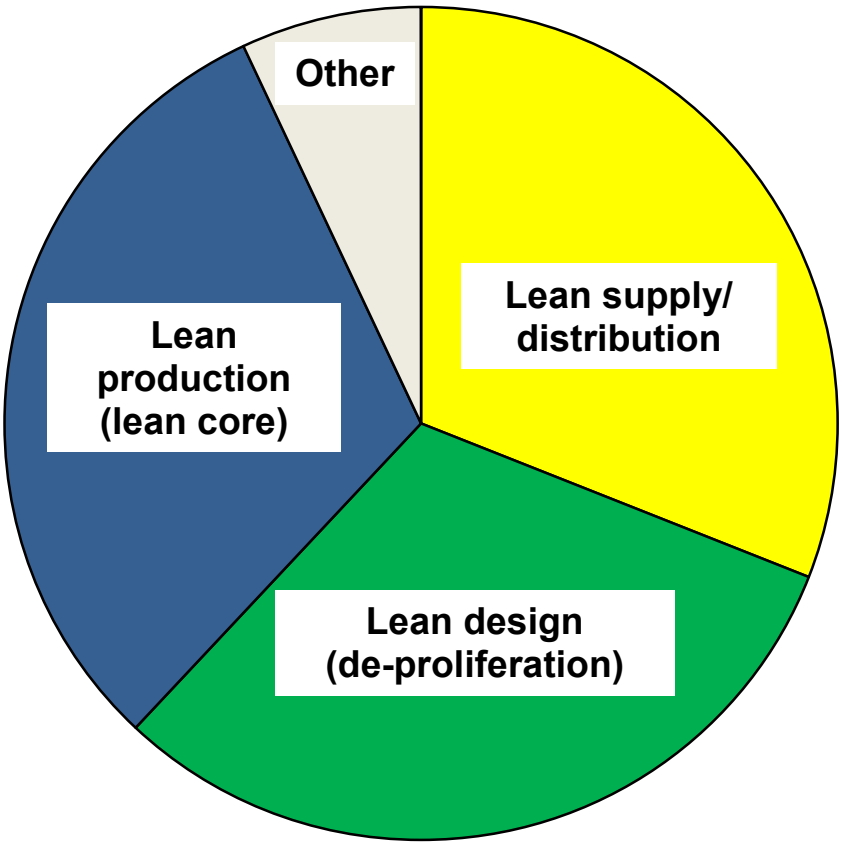
The effective implementation of lean progresses along three major pathways. One, the *lean core*, is widely recognized and employed. The second, lean in supply and distribution (*supply chain management,* or *SCM*), is treated separately and, in comparison, employed weakly. The third, *design for manufacture and assembly* (*DFMA*), has scarcely been recognized at all as a route to lean. Yet DFMA can achieve much of the lean agenda all by itself though large-scale reduction of what the lean core and SCM must deal with: too many parts, and by extension, too many finished products or stockkeeping units (SKUs). Separately, the three lean pathways typically receive only flurries of executive-level interest, with the result that lean lacks impetus and staying power. Corrective action calls for treating DFMA as a key route to lean, and promoting the three pathways jointly as a potent competitive—and therefore strategic—force centering on lean's primary mission: quicker, more flexible, higher quality response along downstream value chains to final customers.

Lean's primary purpose is customer-centered. That is, it aims at delivering to the customer—next process, and each step along the value chain to the final user—dependably quick response with high quality, and flexibility in synch with changing demand patterns. Lean does its work by reducing lead times and throughput times, while exposing quality issues for timely correction. Lean attempts to harness the pull of demand from the final user such that it ripples back along the chain. That backward ripple embraces three major contributory stages: product design, production, and supply and distribution.

Trouble is, lean *production* gets far more attention than lean *product design* and lean *supply/distribution*. Many-year hard-data "leanness" research shows that, globally, supply is loaded with inventory, and distribution loaded even more, indicating that logistics channels are fat, not lean.[1] And product design, though blessed with a powerful lean methodology known as design for manufacture and assembly (DFMA), is scarcely recognized as a lean fundamental. Correctively, this paper calls for treating all three lean components as primary lean pathways. Otherwise, lean will continue as a popular initiative but whose methods and competitive importance are seen by executives as worthy of only sporadic attention and involvement. Exhibit 1 portrays the three lean components, plus a small "other" category, in pie-chart format.

[1] Richard J. Schonberger, "Coping with Takt-time Tyranny and Capacity Confusion—Part 1," *Target*, Fall 2013, pp. 46-50

Exhibit 1. The Lean Value Chain



The exhibit shows, as dominant elements of the lean value chain (the large wedges of the pie), lean production (the "lean core"); lean supply and distribution, and lean design featuring DFMA-driven "de-proliferation" of part numbers and SKUs. Each is discussed next, with explanations as to why all three must be considered, treated, and promoted as relatively equal and mutually beneficial lean pathways.

Three Dominant Lean Pathways

Lean Core. The lean core consists of physical and human methodologies. To name a few, on the physical side are cells, kanban, quick setup, small lots and containers, dock-to-line delivery, and point-of-use tools and materials. Lean in human resources includes cross-training/job rotation, few job classifications, and operator-centered quality and maintenance.

Lean Supply and Distribution. Lean in the external logistics channels features supplier reduction and certification, milk runs, and small lots. In addition, advanced practices in supply chain management (SCM) have emerged largely in the retail sector or collaboratively with manufacturers. Included are supplier-managed inventory, cross-docking, quick response (QR), fast fashion, and intensive collaboration a la Wal-Mart.

DFMA/De-proliferation. Reduction of part numbers and SKUs, a matter of de-proliferation, is based primarily on design for manufacture and assembly. Following discussion focuses on the role of DFMA/de-proliferation as a critical lean methodology, and key to unlocking the potential of lean-driven competitive strategy.

DFMA/De-Proliferation Doing Lean's Work

Presume for a moment that what we usually consider as basic lean methodologies (quick setup, kanban, cells, etc.) are unknown. Lean, however, may still function well, because DFMA could, by itself, do much of lean's work—through large-scale simplification and reduction of what quick setup, kanban, and so on are obliged to deal with: an outsized variety of component parts. Moreover, DFMA also can do a good deal of SCM's work: Via modularization and related means, DFMA helps disentangle large, complex order books of SKUs, thereby getting product to customers more simply and quickly.

In general, the failure to see DFMA in these ways stems from limited vision, both from the lean community and from the stalwarts of DFMA. To explain, let's consider lean manufacturing's and DFMA's common challenge and pursuit.

Perhaps it should be obvious why large reductions in part counts, with resulting quicker, simpler manufacture and assembly, should be seen as lean-elemental. A Google search of the words DFMA and lean, however, brings up only a few linkages, none convincingly stated. One, from *Wikipedia* says, ". . . applying DFMA is to identify, quantify and eliminate waste or inefficiency in a product design. DFMA is therefore a component of Lean Manufacturing."

The logic is weak. In centering on wastes and inefficiencies, that kind of statement would apply to practically any management initiative, dating back to the works of Frederick W. Taylor a century ago. For example—to name just three—suggestion systems, training, and cost-variance systems have, as aims, elimination of wastes and inefficiencies. To clarify why DFMA deserves a central place in the lean agenda, we need to probe some of lean's primary methodologies.

De-proliferation/DFMA and the "Lean Core"

We begin with a lean-core methodology, quick setup and changeover, and its relationship to DFMA. Lean adherents see quick setup/changeover as lean's primary method of delivering quick, *flexible* response. That is because the typically huge array of component parts resulting from conventional product design requires many time-consuming setup and changeover steps. Bruce Hamilton, former general manager, of United Electric Controls, one of the earliest and

more successful manufacturers adopting JIT/lean, explained why no amount of quick changeover was enough: "Through our use of SMED (single-minute exchange of dies) we reduced many lot sizes to one—but even for that one piece, we had to activate our entire production system."[2]

DFMA to the rescue: Design for manufacture (DFM), by standardizing parts, reduces setups and related system activities. Design for assembly (DFA), by reducing a multi-part design to a single part, eliminates all setup-related activities.

More specifically, DFM may result in libraries of standard features, readily usable in new applications. Such is the case at Renishaw Plc (Gloucestershire, UK): Formerly hundreds of different tool assemblies were required to set up and produce its commonly ordered components; today, working out of its parts library, it does so with only about 70 different tool sets. Renishaw says it employs DFM not for cost but for lead time reduction; in other words, for lean reasons.[3] In another example GE Fanuc (robots) in Charlottesville, VA, recipient in 1992 of *Industry Week*'s Best Plants honor, applied DFM to more than 300 variously sized circuit boards, such that 98 percent of them would fit into a standard length and width form. That and other DFM applications reduced setup times by more than 80 percent.[4]

At the ultimate, a multi-part design reduces to a single part, requiring no setup adjustments at all. In some cases a no-setup part may get its own production equipment—perhaps a fully-depreciated conventional machine that had been collecting rust or dust in off-site storage. Re-rigged to produce but one part—with zero setup and zero defects—no one cares if it operates but two hours a week.

Design for assembly takes a further step: changing the product's design so it altogether eliminates certain parts. A famous example is the IBM Proprinter. "Designed for [assembly] . . . there are no screws, springs, belts—the parts are designed to snap together as they move down the robot-controlled line"[5]. Assembly became so easy that IBM pick-and-place robots, which were to be the means of assembly, went unused. As sales soared for this product, rather than setting up robotic lines in plants around the world, small crews of assemblers did the job manually.

In cases where lean-though-DFMA eliminates the part, it far outperforms lean's quick-changeover mode. Aside from that, DFA yields components common to multiple models, such that the need for changeovers in assembly is reduced to products requiring special components.

[2] Bruce Hamilton, foreword to book by G. D. Galsworth, *Smart, Simple Design: Using Variety Effectiveness to Reduce Total Cost and Maximize Customer Selection* (Essex Junction, VT: Oliver Wight Publications, 1994), p. xvi.

[3] "Maximum Efficiency," *Manufacturing Engineering*, May 2005.

[4] John Teresco, "America's Best Plants: IW's Third Annual Salute: GE Fanuc," *Industry Week*, Oct. 19, 1992, pp. 50-52

[5] "Unbelievable Levels of Quality," *Industry Week*, June 6, 1988, pp.56, 58.

Quick setup/changeover, however, is but one element of the lean core to which DFMA/de-proliferation does journeyman's service. Others include cells and one-piece flow, kanban, and space reduction.

Cellular manufacturing—the factory-layout component of lean—takes a long step toward lean's ideal of one-piece-flow. DFMA, in shrinking part counts, simplifies cell formation. At the same time it shrinks space to store, hold, handle, and transport parts, and does away with space-consuming storage and handling gear. Moreover, the low part counts favor kanban as an efficient way to deliver parts to the cells—from stores or directly from outside suppliers. In effect, kanban acts as a *queue limiter* in which queues may sometimes go as low as one piece, that piece residing on single "kanban squares" within compact cells. In the ideal, enabled through DFMA, there is room for multiple cells, each devoted to its own one-piece-flow part number, which does the work of multiple part numbers prior to DFMA.

In addition, DFMA/de-proliferation even has facilitating effects on an important aspect of lean accounting: reliably determining product costs. The explanation: It becomes simple to allocate costs to products when made from small numbers of component parts; difficult and dubious when many are involved.

DFMA/De-proliferation and the External Value Chain

DFMA with de-proliferation of SKUs contributes as well to the following SCM-related aims of lean: supplier reduction, local sourcing, and frequent, small-lot deliveries. DFMA attacks large varieties of purchased direct materials, and, often, even larger arrays of service parts, which tend to proliferate as product portfolios evolve. Both require sourcing from numerous suppliers, whereas small arrays, achieved through DFMA's commonizing, permit reduction of the supplier base. As the number of suppliers shrinks to "a few good ones," order volumes from each increase, sometimes to the point that some key suppliers elect to relocate "next door." With shortened transport distances, suppliers may no longer have reason to ship infrequently in full truckloads. That mode gives way to small-lot material-handling, and perhaps delivery daily or more often, just in time.

Lean/DFMA/SCM → Competitive Strategy → Executive Attention

Lean's overriding problem is that executives tend to view its elements divisively, that is, as three separate initiatives, with responsibilities residing at lower levels of three different functions. Compounding the problem, lean has long been burdened by being promoted, even defined, in terms of eliminating the "seven deadly wastes"—which has a decidedly low-level ring to it. Waste elimination has a worthy role in lean, and is easily taught and applied at low levels. However, it surely is not lean's essence.

Senior executives' busy lives revolve around what they see as large-sized strategic issues. So it is natural for them to devote themselves more to those and to delegate other matters down the hierarchy: DFMA to design engineering, lean to operations, and so on. This state of affairs is not

the fault of the executives. Rather, it stems from narrow thinking in the greater lean/DFMA/SCM community itself—such misunderstanding conveyed upward to senior levels of management.

Corrective action centers on repositioning lean and its three major pathways to where they are, rightfully, seen as basics of competitive strategy; competitive because their primary purpose and impact flows to customers; strategic because that impact is wide (three pathways leading in the same direction), and, if high-level support is there, deep and enduring. We are persistently told that initiatives such as lean, DFMA, and SCM must be consistent with company strategy. Sometimes, however, strategic wisdom needs to swim in the other direction—from the improvement initiatives up to the executive suite. Getting that wisdom moving upward requires all of us to modify our educational, training, presentation, publication, and publicity, materials accordingly.

Richard Schonberger, Ph.D., is an independent researcher, author, and frequent presenter at public and private-company events. He is author of 15 trade and text books, including *Japanese Manufacturing Techniques* (Free Press, 1982)—the first book in English extensively detailing lean management concepts and methodologies; and *World Class Manufacturing* (Free Press, 1986). His latest is *Best Practices in Lean Six Sigma Process Improvement: A Deeper Look* (Wiley, 2008). Richard's 170-plus articles have appeared in a wide range of academic and practitioner periodicals (e.g., *Harvard Business Review, Wall Street Journal, Lean Management Journal, Quality Progress, Cost Management, and Sales and Marketing Management*).

Following early years as a practicing industrial engineer, Richard joined the faculty of the University of Nebraska, becoming George Cook (chaired) Professor; and later affiliate professor in management science, University of Washington.

Richard's honors include:
1998 Shingo Prize for manufacturing research (for the 1996 book, *World Class Manufacturing—The Next Decade*)
1998 Puget Sound (greater Seattle) Engineer of the Year Award
1995 Academy of the Shingo Prize for Excellence in Manufacturing
1990 British Institution of Production Engineers' International Award in Manufacturing Management
1988 IIE Production and Inventory Control Award.

Schonberger is on the editorial boards of several business/academic journals. Currently, he is director of the "Global Leanness Studies" and the "World Class *by* Principles" international benchmarking project.