The Pros and Cons of Lean Manufacturing for the Small to Medium Size Fabrication Shop

The annual (year 2001) survey of manufacturers conducted by IndustryWeek magazine, and reviewed by a national engineering society, indicates that the average manufacturing company is "just beginning its journey to adopt lean strategies". The review confirms there is a small but definite increasing trend in the movement towards the adoption of lean manufacturing techniques within U.S. plants. However, the survey also confirms that many companies are "struggling to adapt their manufacturing processes to lean principles".

The employment of a cellular production approach in manufacturing is widely recognized as a key component of lean manufacturing. The implementation of manufacturing cells is slowly becoming popular in the U.S. - some would say very slowly. IndustryWeek's year 2000 survey indicated that 17% of all manufacturers surveyed had adopted cellular manufacturing. The latest 2001 survey indicated this proportion had increased to 19%. Therefore, the good news is that more companies are indeed attempting to implement manufacturing cells. However, the bad news is that only 1 in 5 companies has reported doing so.

Of all the lean tools used by U.S. manufacturers today, cellular manufacturing techniques have clearly been the most widely employed, and reportedly, the most successful. This is bolstered by the fact that 50% of the plant managers surveyed by IndustryWeek singled out cellular manufacturing to be "extremely effective". However, it is somewhat surprising that, even though 50% of the survey respondents are positive with regard to cells, only 20% have widely adopted the technique.

For most of us, cellular manufacturing is not new. This is particularly true for those of us who produce and assemble small to medium size electromechanical products on a repetitive basis. Cross training of assemblers and cellular assembly of relatively small products has been employed for many years in traditional manufacturing plants. Industrial engineering books published in the 1950s also cite machine shop examples of cellular manufacturing approaches being used just after the close of World War II (the term cellular was not used at the time). What is relatively new is the coupling of this technique to lean manufacturing concepts such as lead time reduction, batch size reduction, and the fine tuning of inventories, in a traditional, process/equipment centralized, fabrication environment.

Most of these newer cellular implementation efforts have been focused principally on reducing inventories and customer order lead times. But there are several other benefits to be gained by implementing lean techniques which will be discussed shortly. Most of us will tend to place these benefits on the positive side of the ledger. However, we need to keep in mind that there are always 2 sides to a ledger - one side for positives and one side for negatives.

Most of the reports of lean manufacturing and cell implementation results have been focused purely on the benefits achieved - the positives. There has been very little written about the pitfalls or negatives. We should all realize that the achievement of good results (as well as negative results) has a cost. The implementation of cellular manufacturing is no

exception. There are both pros and cons for any company and its employees when implementing lean manufacturing methods. This is even more so in a traditional process centralized operation, such as a fabrication shop or job shop, when it attempts to convert to a cellular approach.

Let me first try and list the major positive and negative effects achieved from converting to cellular production. These were originally published in the August/September 1995 issue of Forming & Fabricating magazine in an article titled "Cells Spell Success". I will attempt to update and expand upon the pros and cons in this article based on industry research and my own personal experience.

Cellular Manufacturing Pros and Cons for Forming and Fabricating Plants

Pros	Cons
1. Shorter lead time (for low to medium lot quantities) from order taking to shipping.	1. Lower equipment utilization for “non-bottleneck” cell operations, unless multi-functional equipment is employed.
2. Much reduced (and preferably eliminated) work-in-process (WIP) inventories outside the cell.	2. If there is no equipment redundancy within the cell, the whole cell may shut down when one piece of equipment goes down.
3. Potential large space savings as a result of reduced WIP.	3. Loss of dedicated or centralized expertise for cells where one operator must operate several different pieces of equipment.
4. Tendency to have higher quality output (out-of-spec problems are discovered much sooner, before the “pipeline” is full).	4. If demand falls and production output is below the planned cell capacity, per unit manufacturing costs tend to be higher with some cells. This occurs when a good labor balance cannot be achieved at the lower output level.
5. Better cell “team” communications.	5. Any small subsequent changes in the production process or sequence can have major changes on the cell layout and cell efficiency. There sometimes is more flexibility when using traditional departmentalized layouts.
6. Fosters a beneficial employee “ownership” and “we can do” attitude.	6. Some multi-product cells are not suitable for higher volume orders where they may become a bottleneck to scheduling other parts.
7. Supports a demand “pull” operation. Yields much better material control and schedule control compared to traditional MRP-based “push” scheduling systems.	
8. Much reduced risk of scrap generation caused by engineering changes or obsolescence.	

FIGURE 1 - Pros and Cons

THE POSITIVES - REPORTED BENEFITS

One of the best summaries of the benefits attained from cellular manufacturing is given in Kinni's 1996 book "America's Best". This guide to world-class manufacturing looks at 62 of America's best plants. The data given in the book is based principally on research conducted by IndustryWeek over a 5 year period. The statistics shown in Figure 2 are adapted from the study. Most of the companies profiled are well known larger companies, however, many of the companies cited in that study tend to be smaller plants or divisions of larger companies. The study cites several plants with fewer than 200 employees. These include small to medium sized plants or divisional plants of Advanced Filtration, Mettler-Toledo, Lord Corp., Coherent, and one of Allen Bradley's facilities. Most of the successful plants have implemented cellular manufacturing. It should be emphasized that the improvement statistics are based on individual plant performance and not necessarily total corporate performance.

In my own experience, I have found that most plants have only partially converted to lean manufacturing via a cellular approach. Most cell implementations appear to have achieved outstanding results, but only in limited areas of the plant. That is to say, most companies have chosen only selected areas of their plants to implement cells. This is particularly true with small to medium sized plants. The cells tend to be the more obvious and easiest to implement. Many processes remain centralized with all of the typical associated problems such as high work-in-process inventories, bottlenecks, and long lead times through the shop.

The cell positives still hold. I have personally witnessed productivity increases of greater than 40%, more than a tripling of inventory turns, and customer order lead times/shop floor times reduced by more than 70%. Does this happen in all cases? Obviously not. But there is no question that cellular manufacturing is a great improvement over traditional manufacturing schemes in plants which are laid out with departments and/or centralized processes.

Is the conversion to cellular manufacturing easy for small plants? Is the conversion generally inexpensive? Usually the answer to both questions is no. Some companies can successfully implement cellular manufacturing in localized areas with simple Kaizen blitz events. And I would highly recommend that procedure to prove out and test the cellular concept. However, in most cases, a well thought out phased plan, including value stream mapping and value network mapping for the entire plant and all of the company's product lines is required to really make a difference on the company's bottom line. Even if a company believes itself to be a pure job shop, with no repetitive manufacturing or standard products per se, a production flow analysis (PFA) will usually show that a general purpose, mixed model cell will be more efficient than the typical plant layout found in most small to medium sized job shops. There is even custom software available today to help small job shops perform a PFA and arrange its equipment accordingly.

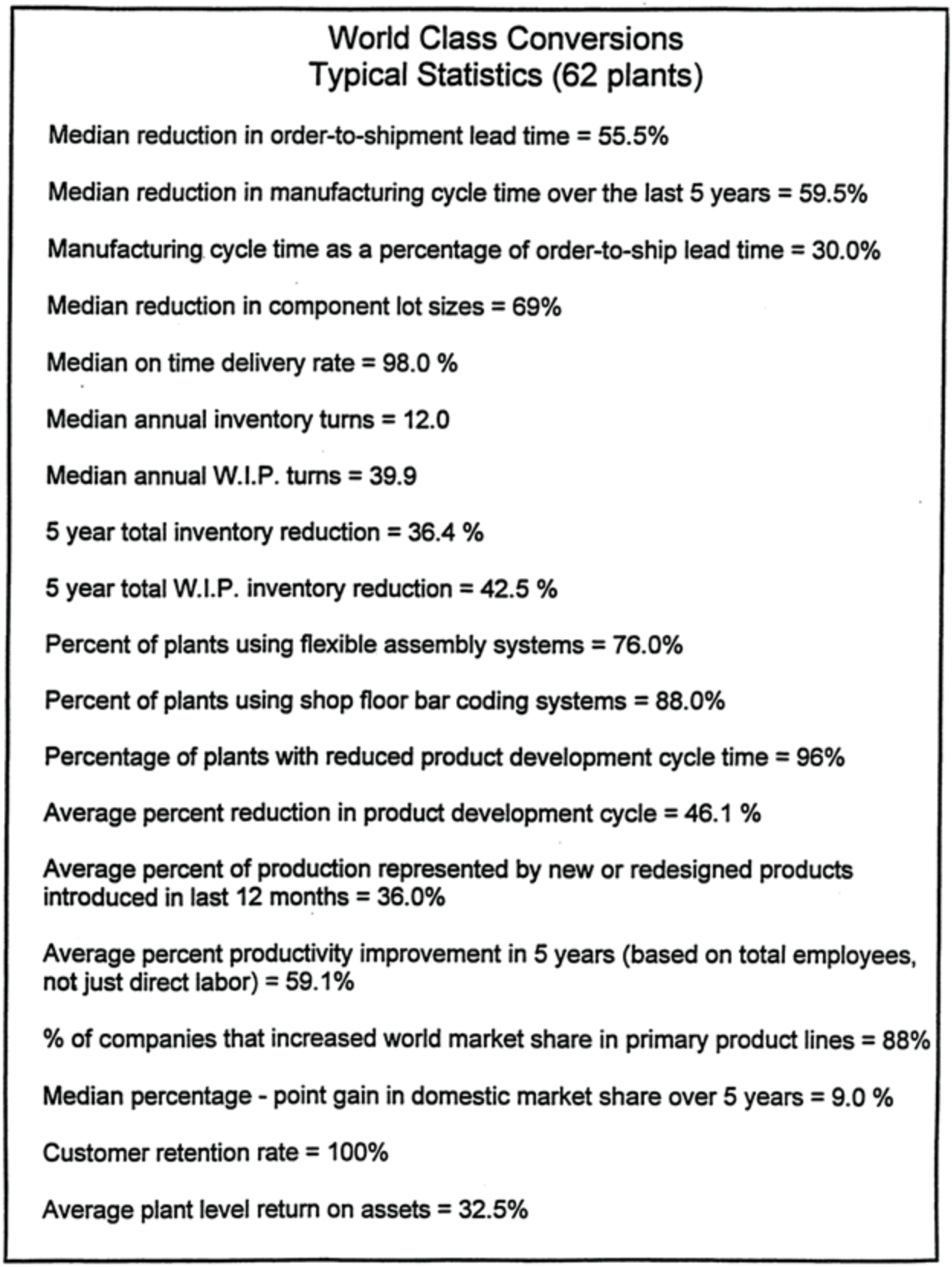

FIGURE 2 - World Class Conversions - Typical Statistics

THE NEGATIVES - LESSONS LEARNED

The writer has visited more than a few plants where the transition to lean manufacturing and cross trained cell teams has been curtailed or stopped altogether. Likewise, the original gung ho attitudes of the 1990s towards employee empowerment and security have faded with the layoffs, plant consolidations, reduced 401K values, and reduced trust in company management experienced in recent times. In recessionary periods that many companies have recently experienced, the implied lean/cellular benefit of lifetime employment has faded, both in the U.S. and Japan. In slow business periods, as many companies have experienced in the Fall of 2000, companies have been forced to consolidate operations and to move cells to other plants or divisions. Cells were originally implemented successfully by promising the operators that their jobs would be secure with this new manufacturing partnership and the new employee empowerment within cell teams. Job losses have led to diminished employee support of team based work cells where, theoretically, everyone is supposed to be cross trained and equal.

The biggest and perhaps the cruelest lesson learned is that zero advancement can be made without the true support of the shop floor operators involved. The word operators include those individuals directly tasked with producing the parts and products within a cell. No matter how good your labor balance may look on paper, it will absolutely fail if the workers themselves are not involved in helping to establish the balance. Even when a theoretical balance is achieved, without mutual operator assistance and the support of the workers involved, you will have a hopeless task in convincing people to change the way they are doing things.

In many older plants, people have been trained for years to run large batch sizes so as to amortize set-up costs over the largest number of parts and products. It is extremely difficult to convince people of all the latent problems associated with running large batches. Some people may never be convinced. This is a major "culture" change problem that adversely affects many companies.

Also, some larger companies who are running repetitive production are literally "stuck with" the latest whiz-bang ERP, CRM, or other material control/product costing system that higher-ups have purchased for millions of dollars. Oftentimes these systems are purchased without even talking to the people on the shop floor. Most of the newer systems claim to support flow, cells, and/or lean operations but many in fact do not. Certainly few, if any, support a mixed traditional and cellular environment very well. I have seen several instances in repetitive production environments where a simple Kanban materials control system would suffice, while reducing inventories and improving operations dramatically.

Shop floor operations in general and cellular production in particular have to continually try to work around these newer material control and product costing systems. Many of the newer systems simply will not work on the shop floor as anticipated and will tend to force either a large batch manufacturing approach, or an approach that forces the wrong subcontracting decisions to be made. Implementing cells in these types of system controlled environments can be an exercise in frustration and futility. Allocation of indirect overhead and factory burden in a plant with both traditional process centralized activities, cells (where processes are mixed within the cell), and outsourced operations is a continuing problem. The cost accounting systems in use today are a major negative or impediment

when trying to determine the affect of outsourcing on product cost in a mixed traditional and cellular manufacturing environment.

One of the other major pitfalls of cellular manufacturing is the subject of equipment utilization in a mixed model or job shop environment. I worked with several large companies, with dozens of plants, that "talked the lean talk" with middle management and their employees. They offered extensive training and employee team empowerment to convince the employees of the benefits of converting to lean manufacturing. However, the corporate executives themselves felt they were at too high a level to sit in on the actual lean training and instead opted for a broad brush overview instead, which apparently broad brushed the equipment utilization issue. When it came to appropriating the capital investment required for the cell equipment, the corporate executives shied away from the cellular approach, since some redundancy in equipment would be required. In other words, they wanted the benefits of cellular production, without paying the price. To put it bluntly, they "talked the talk" but would not "walk the walk" when it came to footing the bill for the redundant equipment. One company had a long standing policy that if a piece of equipment could not be utilized 36% of the time, the factory did not deserve to have that piece of equipment and the operation should be outsourced to others. This myopic return on investment (ROI) policy placed them at a severe strategic disadvantage to their competitors whose investments were more attuned to reducing lead times and inventories and gaining market share.

Many companies are still driven by archaic business models based purely on cost savings. These models will only allow equipment investments if an extremely high ROI is achieved. Ironically, if most of these companies added up all of their theoretical ROI savings, based on capital appropriation requests submitted and approved over the last 10 or 20 years, they would conclude that production costs should now be zero! In a competitive lean manufacturing world, companies need to focus more strategically on achieving growth and increases in profits rather than just pure cost savings. There is no way a company can grow on cost savings alone. I am not advocating that we totally ignore ROI, as that would be foolhardy in the long run. However, I am saying that we need to take into account other factors that may be just as important or even more important than achieving a high ROI based on cost savings alone.

That is a key benefit that smaller companies, with adequate financial resources, have over larger companies. Smaller companies can make quicker investment decisions and will invest in new equipment when they believe in their hearts that they can capture more market share and increase profitability. Larger companies oftentimes take months or even more than a year to go through a capital appropriations process, with multiple potential stopping points along the way, before they can approve capital investments.

Lastly, one of the major reasons many lean programs fail is due to a loss of interest by top management, and eventually the workers themselves. This typically occurs after the first one or two cell implementations, when management notices there was no beneficial improvement on the plant's bottom line performance. These types of failures can typically be traced to a poor selection of products or parts for cell implementation. Usually, when analyzing these failures, one finds that no value stream or network mapping was performed, there was no analysis of the "real" factory constraints or bottlenecks affecting output, and there was no overall long term plan developed for a coherent, phased

implementation. In other words, the company jumped on the bandwagon of lean without first analyzing what the real problems and constraints were in the factory. Simply put, they selected the wrong products at the wrong time.

The above are only a few of the negatives or issues residing on the "iceberg" tip of problems companies face when converting to cellular operations. Cultural change, establishing an environment for true teamwork, the building (or rebuilding) of trust between employees and management, and ongoing training will be the key factors in lean manufacturing success. Of all the issues involved, the people and cultural change issues are, and will continue to be, the major negatives involved with implementing a lean, cellular, manufacturing approach. The older the company and the more senior the employees, the more difficult the challenge is. However, that does not mean we should not accept the challenge.

SUMMARY

Cells continue to be a major part of lean manufacturing and the adaptation of cellular techniques continues to grow in the U.S. A similar approach is sometimes referred to as the "quick response" or "demand flow" method of manufacturing. A side-by-side comparison of the manufacturing emphasis and culture comparisons of these techniques compared to traditional manufacturing methods is shown in Figure 3.

When balancing the positives against the negatives, I believe the lean/cell approach benefits far outweigh the negatives for most companies. Just because there are negatives and costs associated with converting to cells is no reason or excuse not to make the conversion. The waste associated with older, traditional manufacturing methods, clearly is far higher than the waste associated with a properly planned and executed lean manufacturing system. The comparison shown in Figure 3 should help highlight the key benefits and opportunities of implementing lean manufacturing in general and cellular manufacturing in particular.

MANUFACTURING EMPHASIS & CULTURE COMPARISONS

TRADITIONAL MFG.

- STRUCTURED, MULTI-LEVEL (INDENTED) BILLS OF MATERIAL WITH SUB-ASSEMBLIES
- DEPARTMENTALIZED, PROCESS FOCUSED DEPARTMENTS
- HIGHLY SPECIALIZED INDIVIDUAL SKILLS FOCUSED ON INDIVIDUAL PROCESSES
- WORK PERFORMED IN LARGE BATCHES BY SOLO INDIVIDUALS WORKING IN PROCESS CENTRALIZED DEPARTMENTS
- REWARD/REPRIMAND INDIVIDUALS
- WORK ORDER SYSTEM WITH EXTENSIVE PAPERWORK/DATA ENTRY REPORTING
- INVENTORY REPORTING AT MANY POINTS
- BUILD TO STOCK PHILOSOPHY
- STANDARD COST SYSTEM (ABSORPTION)
- MAINTAIN HIGH EQUIPMENT UTILIZATION (KEEP HIGH COST EQUIPMENT RUNNING)
- FOCUS ON REDUCING LABOR COST
- OVER PRODUCTION A MANUFACTURING PROBLEM (INVENTORY THE EXCESS LABOR AND MATERIALS)
- FUNCTIONAL, SEQUENTIAL PRODUCT AND PROCESS DESIGN WITH LONG LEAD TIMES
- RELATIVELY HIGH INVENTORIES
- BASE LINE LEVEL RETURN ON INVENTORY ASSETS EMPLOYED
- RELATIVELY LONG LEAD TIMES TO PROCESS A CUSTOMER'S ORDER
- FOCUS ON OPTIMIZING STAND-ALONE PROCESSES AND MAXIMIZING PIECES PER HOUR PRODUCED

LEAN OR DEMAND FLOW MFG.

- SINGLE LEVEL "PILE OF PARTS" PHILOSOPHY FOR EACH SELLABLE FINISHED PRODUCT
- PRODUCT FOCUSED CELLS CONTAINING MIXED PROCESSES WITHIN THE CELLS
- MULTI-SKILLED, CROSS TRAINED, EMPLOYEES CAPABLE OF RUNNING SEVERAL PROCESSES
- WORK PERFORMED BY TEAMS WORKING ON SINGLE PIECE FLOW OR WITH SMALL BATCHES IN A CELLULAR WORKSTATION ARRANGEMENT
- REWARD/REPRIMAND MULTI-FUNCTIONAL TEAMS
- KANBAN WITH INVENTORY BACK FLUSHING AND VERY LITTLE PAPERWORK/DATA ENTRY
- INVENTORY REPORTING AT FEW POINTS
- BUILD TO ORDER PHILOSOPHY
- FLOW BASED (REAL THROUGHPUT) COSTING
- SHUT DOWN EQUIPMENT IF PARTS ARE NOT NEEDED TO MEET CURRENT DEMAND
- FOCUS ON REDUCING MATERIAL AND OVERHEAD COSTS
- OVER PRODUCTION A MARKETING PROBLEM (MARKETING ASSUMES OWNERSHIP OF OVERAGE)
- SIMULTANEOUS ENGINEERING WITH RESULTING SHORT LEAD TIMES
- VERY LOW INVENTORIES
- MUCH HIGHER RETURN ON INVENTORY ASSETS EMPLOYED COMPARED TO TRADITIONAL BASE LINE LEVELS
- RELATIVELY SHORT LEAD TIMES TO PROCESS A CUSTOMER'S ORDER
- FOCUS ON FULFILLING EXACT CUSTOMER REQUIREMENTS QUICKLY, WITH THE HIGHEST QUALITY LEVEL ACHIEVABLE

FIGURE 3

by
Edward J. Phillips
The Sims Consulting Group, Inc.
Telephone: 614-571-4252
E-mail: phillips@simsconsult.com

References:

"America's Best - IndustryWeek's Guide to World-Class Manufacturing Plants" by Theodore B. Kinni, 1996, John Wiley & Sons, Inc., New York, NY

"Manufacturing Plant Layout" by Edward J. Phillips, 1997, Society of Manufacturing Engineers, Dearborn, MI

"Cells Change Everything" by Richard P. Koons, Viewpoint article in the September, 1999, issue of Manufacturing Engineering Magazine, Society of Manufacturing Engineers, Dearborn, MI

"Cells Spell Success" by Raymond E. Chalmers, article in the August/September, 1995 issue of Forming and Fabricating Magazine, Society of Manufacturing Engineers, Dearborn, MI

"Going Lean Gains Slow Foothold" article in the February 2002 issue of Engineering Times, National Society of Professional Engineers, Alexandria, VA