Erdman Center for Manufacturing and Technology Management

Manufacturing and Technology Matters

University of Wisconsin-Madison School of Business

Spring 2001

Getting Lean

Nearly fifty years ago, Toyota Motor Company began codifying its production processes into what became generically called "lean manufacturing." The Toyota Production System, Toyota's version of lean manufacturing, is seen by many as the source of the company's outstanding success as an automobile manufacturer. Lean manufacturing, consequently, has been adopted by many firms, including American car and truck manufacturers.

Consultant Mark Avakian of St. Orge Company, as stated in the article, "How Lean Manufacturing Matches Today's Business" in the October 1, 1999 issue of *Materials Handling Engineering*, believes that lean manufacturing incorporates five key concepts: supplier development programs, continuous improvement, flexibility, elimination of waste, and zero defects. Suppliers of products and services are recognized as a key to building a lean organization. Companies embracing the lean manufacturing concept insist that suppliers maintain the quality of their products as well as manage the inventories of materials to be delivered. Often the relationship between the manufacturer and its suppliers involves the manufacturer helping the suppliers become "lean." Ford Motor Company, through its Lean Resource Center, helps its first tier – and sometimes second and third tier – suppliers to implement their own lean manufacturing systems.

The second concept, continuous improvement, is perhaps the most basic concept of lean manufacturing. Kaizen, as continuous improvement is known in Japan, begins with an understanding of the organization's processes. Employees directly involved in the processes are trained to generate and are empowered to implement ideas for the improvement of their processes. Continuous improvement results in "lean" processes in which all activities become value adding.

Flexibility in the manufacturing system is important to ensure that the company makes the products customers want. Lean manufacturing relies on customers to "pull" products they want to purchase from the system rather than the manufacturing company "pushing" products that it hopes to sell. While the concept seems simple, the process requires a great deal of coordination and control in order to minimize manufacturing times and to keep inventories low. "Mass customization," where the customer is able to select from a number of options and configurations, requires careful scheduling and sequencing of material

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University of Wisconsin-Madison
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One Hundred Years ◆ 1900-2000

deliveries and manufacturing. For example, sophisticated management systems are required to ensure that the blue Chrysler Sebring the customer ordered has the right sound system, seat options, engine, wheels, tires, etc., and is still delivered in the shortest possible time.

Eliminating waste in any business would seem to be fundamental. However, many processes produce and even hide waste. Lean manufacturing focuses on the elimination of waste in a number of ways. The fact is, some processes produce waste in the form of products that must be scrapped or reworked. The "pull" system of manufacturing helps reduce the inventories that often obscure this fact. If you can't tell when and where the defects were produced, you probably cannot correct the underlying problem. Lean manufacturing also relies on workers to help eliminate the waste of non-value added activities in the process and the waste associated with poor "housekeeping" at workstations.

"Zero defects" in a product is, in reality, un-attainable. However, in lean manufacturing systems zero defects is the goal to be strived for. The concept includes everything from engineers designing a product that can be simply manufactured to production workers using statistical process control to detect and correct problems in the manufacturing process.

The principles of lean manufacturing seem simple enough. Like many concepts, however, lean manufacturing is a simple idea that is very difficult to effectively implement. As the title of Steven Spear and Kent Bowen's September/October 1999 *Harvard Business Review* article "Decoding the DNA of the Toyota Production System" implies, there is much more to the success of lean manufacturing than the "adoption" of manufacturing principles. The success of the manufacturing system depends on the consistent use of the scientific method – the Plan-Do-Check-Act (PDCA) cycle articulated by Walter Shewart and advocated by Edwards Deming.

According to Spear and Bowen, several rules govern the implementation of the lean manufacturing system. First, employees are disciplined enough to perform their work in a consistent prescribed manner so methods can be scientifically evaluated. Second, communication systems between workers are standardized and direct with no ambiguities. Finally, production lines are simple and clearly specified with no alterations allowed except in an "authorized" redesign.

(Right) MTM students and staff visit the Ford Mustang Plant in Dearborn, MI.

(Bottom right) DaimlerChrysler staff gave a great overview of their e-business strategies.

(Bottom left) MTM students and Lean Manufacturing Center staff presentations.

Road Trip to Motor City

Hadrian D'Souza and Leonel Preza Bonilla

We had our bags packed and we were filled with excitement as the 1st MTM Best Practices Road Trip kicked off from Grainger Hall January 24, 2001. The charter bus took our group of 22 students and faculty from Madison to Chicago's O'Hare airport. Upon arrival in Detroit, after checking into the hotel, everyone headed to bed for an early start on Thursday.

After a quick breakfast, we headed for the Ford Mustang Assembly Plant in Dearborn. Following an initial video about the facility and its history we took a detailed tour through the assembly line. Our next stop was Ford's first tier seat supplier, Johnson Controls Inc., in Plymouth, Michigan. After touring the plant, we were given a presentation of the relationship and interaction between JCI and Ford, illustrating the workings of their supply chain.

The next day started at 5:30 a.m. We began with breakfast, then went to the DaimlerChrysler Sterling Heights Assembly Plant. After several brief presentations of their various information systems we were given a tour of the facility. Our hosts then spoke to us about their current e-business initiatives and supplier relationships.

Our next stop was to the Ford Lean Resource Center to have lunch and learn about their focus on quality and lean manufacturing. Later that afternoon we visited Ford's Benchmarking Center, giving us the opportunity to see how they study and learn from their competitors.

Our trip concluded with a delayed flight back to Chicago and this group of weary travelers arrived in Madison after 1 a.m. We were tired but happy to have increased our knowledge of the automotive industry. We also had a new-found appreciation for the manufacturing process and a different perspective on the intricacies of supplier relationships and lean manufacturing principles.

"It was awesome to see the largest industrial complex in the world — the complexity of it!"

—MTM student

"Ford and DaimlerChrysler are more similar than different. How they adapt to supply chain systems will determine the winner."

— MTM student

Focus on a Board Member

Jerry Oleston
Manufacturing Engineering Manager
General Motors Truck Assembly Plant
Janesville, WI

Jerry Oleston is the Manufacturing Engineering Manager at the General Motors Truck Assembly Plant in Janesville, WI. He has overall responsibility for planning, engineering, and maintenance of all manufacturing equipment and facilities at Janesville. The Janesville Assembly Plant, one of the largest in North America, assembles Tahoe, Yukon, Suburban, Yukon XL, and Medium Duty GM/IZUZU trucks.

Has General Motors adopted lean manufacturing principles into its operations?
We have not only adopted lean manufacturing principles, but have incorporated them into a very comprehensive GM-Global Manufacturing System (GMS). With an organization that spans several continents, numerous countries, and many diverse cultures, it was imperative that we have a common language and approach to lean manufacturing. The priority is to be as common as possible with lean, flexible operations. A great deal of the knowledge and procedures in the policy came from our joint venture with Toyota at NUMMI in California. We have had many years of experience working with Toyota at NUMMI, but it wasn't until last year that GM's GMS was established. It incorporates all the critical concepts, such as: Standardized work, fixed position stop, team concept, material flow systems, TPM, standardized inspection process, Total Lead Time, and through put analysis. Each assembly plant is at various stages of its implementation of GMS, yet each has a plan and schedule for full implementation.

To the casual observer, it fundamentally is the same assembly-line approach that Henry Ford used to revolutionize mass production. Car and truck bodies are welded together, painted, and trimmed out on a moving conveyor. However, today's processes are much more sophisticated and are driven by electronic information that is carried by things such as wireless transponders attached to the carriers. Data fed to various assembly stations determine the parts needed for each vehicle. Bar code readers identify whether they are the right parts and in what order they must be assembled. The company with the most flexibility wins in the long term. When it comes to changing model lines, we now can do in days what it used to take months.

How does lean manufacturing principles fit in with GM's business objectives?
Our business priorities at GM can be summed up simply into four items: 1) Produce innovative products and services. 2) Become a leader in E-business. 3) Grow our market share. 4) Achieve excellent business results.

There is no doubt that lean manufacturing can greatly assist in achieving all those goals. In fact, lean manufacturing is a requirement to General Motors achieving its business goals. What lean manufacturing primarily does is eliminate "waste." Eliminating waste means our products can be produced less expensively and provide more of a value to our customers. We always must remember that we need to have great business processes, but our customers don't buy "lean manufacturing" or "fast vehicle development." They buy quality cars and trucks that are a good value and that they are enthused about. They also buy products and services that meet their needs like GMAC, ONSTAR, and Direct TV. At the end of the day in the auto business, it all comes down to product. You have to earn your customers one sale at a time.

Has the proliferation of models and options available to the consumer affected the ability of the process to be effective in the manufacturing of automobiles?
Yes, it certainly is a factor in how effective you can be in applying all the principles of lean manufacturing. The amount of proliferation is a matter of balance between what is truly an important prefer-

ence to the customer versus what is the most efficient and economical design. This is an area where we have made some improvements but still need to get better. We presently have 115 different models of vehicles in General Motors, and our business plan reduces that number to 70 in three years. The goal is to eliminate the overlap between our product lines and to provide much more differentiation among brands. However, we are still designing specialty vehicles aimed to capture niche markets. Coming out this year will be the Chevrolet Avalanche which combines the best attributes of a sport utility with a pickup truck. Also, the Buick Rendezvous, and OPEL speedster will be out this year and fit that scenario.

Probably the best example that I have seen recently in the vehicles that we build at Janesville was in our new redesigned "2000 Model" Tahoes and Suburbans. The new models were more appealing, more functional, and had a great deal more differentiation between Chevrolet and GMC brands. Yet, we had approximately 20 percent fewer parts than the previous year. Now that is a success story!

Another challenge that comes along with numerous models and options is the increased possibility of wrong part selection during assembly. We have implemented about 70 error proofing part pick stations here at Janesville on some of our critical operations. They amount to a signal device which indicates which is the proper part to install and a light fence which must be broken in order to assure that part has been installed. If it is not broken within the proper cycle, the conveyor line stops until the problem is corrected.

Any other thoughts about lean manufacturing?
One of the most important principles of lean manufacturing is continuous improvement. This is not a "Program of the Month" that you implement, and then all of your problems are gone. It's all about, "How can I be better tomorrow than I am today?"

When Albert Einstein was teaching at Princeton, he gave a final exam to a class of grad students. After reading over the exam, one of the students raised his hand and looking rather confused said, "Professor Einstein, these are the same questions you gave us last year." Einstein smiled and said, "Yes, but the answers are different." What I assume he meant, was that intellectual discovery is not a static exercise. It requires a constant infusion of imagination to recognize that different answers sometimes provide better solutions to the same old questions.

Some of our answers go beyond our cars and trucks. Today we are also driving innovation into our automotive products and services like e-GM, Covisint, and ONSTAR. In fact, ONSTAR is a great example. It does all of the services that we are familiar with today like; satellite communications, auto call for help when the air bag is deployed, GPS technology, and remote unlocking of the doors if the keys are locked inside. But the really great things are the new ideas that keep popping up. Things like voice controlled-no handset cellular phone service and satellite digital radio tailored to your individual desires. Three years ago, ONSTAR was first installed in a vehicle and this year it will reach the million subscriber mark. I can tell you when we started ONSTAR, we weren't thinking much about personal calling or satellite digital radio. "The questions are the same, but the answers are different."

Focus on a Faculty Member

Tim McClurg
Assistant Professor
Operations & Information Management
University of Wisconsin-Madison
School of Business

In 1983 I received a B.S. in Accounting from Penn State. After graduation I worked for several years in managerial accounting, first with a small private electrical contractor and then with a tool-and-die shop, which was a small part of a huge corporation. My experience in the tool-and-die shop, where I worked closely with the industrial engineers and the production workers and supervisors, really heightened my interest in the manufacturing side of the business. When I returned to school at the University of Pittsburgh to work toward an MBA degree, I decided from the start that I would focus my studies around learning more about manufacturing and operations. After receiving my MBA, I went directly into the PhD program in operations management in the Krannert Graduate School of Management at Purdue University. I taught from 1993-1998 at Georgia Southern University, and joined the School of Business here at UW for fall semester 1998.

Courses taught

For most of my time here at UW, I have been teaching the undergraduate core course in operations management. It is a special challenge to teach this course well, for a couple of reasons. First, it is taught in a large lecture format. This makes it difficult to achieve a reasonable level of student participation, and it takes some real effort to make the course interactive. I have tried to do this through the use of outside readings for in-class discussion and by doing some different non-lecture activities in the weekly discussion sessions, which are smaller group sessions that are run by teaching assistants. Second, because few of the students are operations majors, many of them do not have a natural interest in the course material up front, so it's my job to get them interested. I have really enjoyed the challenge of making this a better course and, while I feel like I have made some progress, there is still a lot of room for improvement.

This semester, I have had the opportunity to teach the MBA core course in operations management. This has been a nice change of pace from the large lecture format, as there are only about 35 students per class. The class size, along with the extensive work experience and the varied backgrounds of the MBA students, allows the course to take on much more of a discussion, rather than a lecture, orientation. This has allowed me to make much greater use of readings, homework problems, and cases. It has been a lot of fun teaching the students in this course.

Research Interests

One stream of research in which I have been involved has focused on the area of equipment replacement and capacity expansion decisions in a manufacturing environment. This work has mostly been geared toward looking at the replacement of aging production equipment under a variety of circumstances. We have looked at issues such as learning effects and the timing of capacity expansion decisions under conditions of increasing demand.

I have also done some work on the issue of coordinated decision-making in a supply chain setting. For example, we look at the benefits of a manufacturer and a retailer sharing cost and demand information in order to jointly arrive at better order/production quantity decisions. It is clear that joint decision-making, if it can be accomplished, will lead to better system-wide performance and increased system-wide profits. Of course, this raises a number of other questions, such as: How is the information-sharing accomplished in a fair manner? What are the additional costs associated with achieving a joint decision? How will the increased system-wide profits be shared between the two parties?

Finally, there are a couple of other areas that I am greatly interested in, but for which I have not yet

done any research beyond some background reading. First, I am very curious about the accounting/manufacturing interface. In particular, how are capital investment decisions made, and how are product costs tracked? These are both critical areas of decision-making in the operations area, and a lot of work has been done, but there are still many questions unanswered. Second, I am interested in multi-party decision-making and modeling techniques based on game theory and principal-agent theory. I believe that there are a lot of decision problems in operations that take on an entirely new dimension when viewed as multi-party decisions, and that multi-party models are much more realistic for many decisions.

What skills do you see as most needed by college graduates in order to be successful in business?

I feel like the most basic requirement for real success in the business world is to have good people skills. I am a firm believer that good managers should be good people first. We have all run into managers or colleagues over the years who lacked basic skills for dealing with the people around them in an acceptable manner and, although some of them may have been successful in a narrow sense (e.g., increasing profits or reducing costs), in the broader sense I do not really see them as successful managers. Successful managers create an environment in which those around them can be happy and successful.

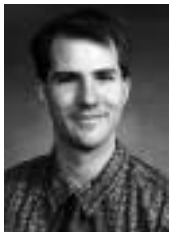
One other area that I feel pretty strongly about is analytical skills. I have seen too many students and managers over the years who, because they are uncertain about their analytical abilities or because they just do not like number-crunching, refuse to commit to developing this area of their skills set and are willing to rely on others to do the analysis for them. It seems to me that everyone needs at least a minimal level of skill and confidence in this area, and managers who rely too heavily on others to provide the numbers for decision-making are taking a real risk.

Board Member Update

We would like to take this time to thank two members of the Board who concluded their terms last fall. First, we extend our thanks to Jeff DeMonaco of Motorola as his job responsibilities take him out of the field of manufacturing and technology management. Jeff had served on the Board from 1998. Also, we say good-by and thank you to Bill Sterman of Eaton Corp. and Newton Technologies, who had served on the Board since 1996. We wish both of them well in their new endeavors.

We would also like to welcome two new members, Jay Peterson and Joe Bulat. Jay Peterson is Senior Manager from Deloitte & Touche of Minneapolis. On board from Arbor Hills, MI, is Joe Bulat, Manager – Material Control Systems at DaimlerChrysler. We know their experience and expertise will be of great benefit to the students and to the MTM program.

Internship Summaries



Brian Larson: RAYOVAC

Last summer I worked as a project manager for Rayovac Corporation, at their manufacturing plant in Fennimore, Wisconsin. Rayovac produces batteries and flashlights, and utilizes the low price strategy in the marketplace. The Fennimore plant manufactures all of Rayovac's alkaline batteries, and operates 24 hours per day, seven days per week.

My project entailed the implementation of new battery testing equipment, including a microscope with imaging equipment and software, a saw and two grinders for cutting and polishing, and a real-time X-ray machine. A former MTM student, Vikram Gore, started the project last summer, ordering the equipment to aid in improving quality control at the plant.

I arrived at Rayovac to find all of the equipment still packaged, and the two rooms that had been set aside for the new laboratory were unfurnished. My job was to unpack, layout and install all of the equipment in consultation with engineering. Once installation was completed, I had to learn how to use each piece of equipment, set up standard operating procedures, and train the engineers and quality employees. I automated the process, wrote instructions on using each new apparatus, and provided training for the employees, including extensive training for two individuals in the engineering and quality departments, whom I taught to write programs and train others.

I enjoyed working at Rayovac and the experience taught me about project management, an important role in a manufacturing facility. I learned about coordinating efforts not within my direct control, and dealing with unanticipated problems (also beyond my realm of control). This project incorporated layout planning, equipment installation and implementation, and training, which compromised a good, well-rounded experience for me

Jingfang Guan:

AUTOMOTIVE DIRECTIONS

During this past summer, I was given a unique opportunity to work in Automotive Directions, a business consulting and marketing research firm in Madison specializing in customer relationship management (CRM) for automotive retailers. The company provides CRM software, primary and secondary market studies, statistical sales reports, and targeted consumer mailing lists to dealerships located throughout the United States.

I started my internship by first working in the Customer Support Team. My primary responsibilities included contacting clients to acquire necessary business and software information, customizing software for new clients, and doing maintenance and troubleshooting for existing clients on a daily basis. With the help of other software engineers, I quickly grasped technical skills and enhanced my communication skills. By analyzing software customization procedures and customer feedback, I found out that efficiently managing product customization guided by project management methodologies could help reduce operation costs and customization period, and it would help alleviate cash flow problem at the end. This suggestion later became a deliberate project plan after further discussion in management team. By the end of August, average customization time for a client with two or three stores has reduced from six months to two. One thing I am always fond of about small business is that you can get problems solved very quickly. Creative idea and suggestions can be passed around in a day and will be implemented if management sees feasibility there.

I was given the opportunity to get involved in the analysis, design and development of web based E-commerce applications, which are considered to be the future business direction of the company. The E-commerce project is designed to help our clients share real time information with their customers. Vehicle customers can shop online, view special service information, and check the status of their car service in the body shop or service center. As a part of the team, I help establish methodologies, design application structure, and develop application module.

This internship brought great experience, joy and memories to my life. Not only did I learn a lot of inside information and gained deep knowledge about business and car retailer industry, I also learned how to efficiently solve conflicts and create new idea in a diversified working environment. By working with such a small company, I learned how to carefully examine all aspects of a business, evaluate them, and then improve them. By far, the most satisfying and awesome experience was seeing such clear positive results from incorporating my own ideas into the business.

Nathan Blair:
SANDIA NATIONAL LABORATORY

I worked as a summer intern at Sandia National Laboratory in Albuquerque New Mexico. Sandia National Laboratory employs roughly 6000 people and there are roughly 24 researchers in our division with many more support staff. This internship built on the work I had done before returning for a business degree last semester. I was working in the Concentrating Solar Power division primarily with Scott Jones

This internship developed due to a need at Sandia for engineering system simulation expertise. In particular, they were interested in conducting research with a computer program entitled TRNSYS (TraNsient SYstem Simulation) that was developed at the University of Wisconsin-Madison Solar Energy Lab. I was the coordinator for the TRNSYS project for three years and have extensive experience with many aspects of the use of this tool. However, I had little or no experience with large-scale power systems, which were the focus of this project.

The tasks conducted during this internship (and several which were begun during a program assistanceship in the UW Solar Lab last semester) primarily involved adding and improving features in the TRNSYS package so that concentrating solar power projects could be accurately simulated by the software. Extensive previous research was done to generate a library of "components" related to concentrating solar power systems. I updated and improved the models to be used with the latest version of TRNSYS (version 15) and the front-end to TRNSYS, IISiBat. Due to the fact that the latest version has only been available for three months, this updating task involved many communications with the IISIBat and TRNSYS developers with whom I have a good working relationship. Additional tasks included adding additional complexity to existing models so that the simulation results more accurately matched the measured data taken at existing solar power plants in the Mohave Desert in California. Finally, we began work on a modeling project to determine the effects of adding energy storage to the existing and planned power plants.

New MTM Students - Fall 2000

Ernest Nicolas
Ernest has his BS degree in Manufacturing Systems Engineering from Kettering University in Flint, Michigan. Prior to joining the MTM program, Ernest worked in manufacturing systems with General Motors. He is also completing an additional degree in Manufacturing Systems Engineering at UW-Madison, College of Engineering.

Marni Sauer
Marni is currently working at Promega in Madison and has been a special student at the UW-Madison prior to enrolling in the MTM program. Her undergraduate degree is from Purdue University where she majored in Neurobiology and Physiology.

MTM Alumni - Where Are They Now?

Michael Johnstone, 1999

Program Manager
Office of Project Management
Rayovac Corporation
Madison, Wisconsin

I work for Rayovac Corporation, the fastest growing battery manufacturer in the United States. I work in the Office of Project Management, a unit responsible for helping to develop, and subsequently lead the implementation of, the company's key strategic initiatives. These initiatives include product development, manufacturing innovation, cost reduction, quality improvement, and technological excellence, among others. The Office of Project Management is a new and expanding unit within Rayovac Corporation created to improve the results of the organization through the application of a systematic, disciplined project management methodology directly linked to the strategic planning process. It was born of the realization that a disciplined, systematic approach to project management is a key source of competitive advantage.

My activities involve strategic initiatives related to alkaline battery production and sales. One of my current responsibilities includes oversight of the implementation of a new alkaline battery production line. This task requires coordination of the manufacture, installation, quality control testing, and production "ramp-up" of the new production line. One of my other responsibilities is to conduct strategic analyses on potential product improvements to existing battery designs and product lines. For example, I recently conducted an analysis on a performance improvement for one of the company's existing products, including technological, cost, and market implications of the improvement. In executing these responsibilities I lead project teams made up of individuals from all disciplines of the organization to ensure that the proper resources are available at the right time to deliver the intended results efficiently. Finally, I am involved in further expanding the Office of Project Management, including developing appropriate methodologies, expanding those methodologies throughout the company, and project manager recruitment.

The University of Wisconsin-Madison Manufacturing and Technology Management (MTM) Program contributed significantly to my ability to add value to Rayovac Corporation in my role as Program Manager. Most importantly, the MTM Program enabled me to leverage my technical undergraduate degree in Physics and my practical management experience in the United States Navy by studying state-of-the-art engineering and management theories/practice. In addition, the MTM Program encouraged networking between students and key business leaders. My current role with Rayovac Corporation grew out of an after-graduation consulting opportunity that was the result of MTM Program networking that sought to capitalize on areas of student/business-leader mutual interest and expertise. I am confident that the skills that I learned during my tenure in the MTM Program will continue to provide value to Rayovac Corporation as my responsibilities grow within the company, and will serve me well into the future as I strive to advance my career.

MTM Graduates December 2000

Brook Nienhaus joined TRW in Detroit, Michigan in its Management Associate Program and will be moving into a Materials Scheduler/Planner position.

Wenhui Du joined Philips Broadcast in Syracuse, NY in the position of Supply Chain Management Development Trainee.

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The Newsletter is produced by the graduate students in the Manufacturing and Technology Management Program. The objective is to inform professionals, faculty, and students of Erdman Center activities and events in the field of manufacturing and technology management.

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