

Alumni Newsletter

Winter 1999

Department of Industrial and Operations Engineering

IOE Goes Lean

By Jeffrey Liker, Newsletter Editor and Associate Professor, IOE

In past issues of our Alumni Newsletter we discussed how IOE is “going lean.” We developed a complete course on lean manufacturing (IOE 425: Manufacturing Strategies) and a number of faculty and adjuncts associated with the Japan Technology Management Program were doing research on lean and running successful conferences. Over time the revolution in manufacturing embracing lean has grown exponentially, but the number of universities developing strong

programs has not kept pace. At U-M we have been continuing to build capability and interest in lean manufacturing. Our fourth annual lean manufacturing conference sponsored by the Japan Technology Management Program and organized by John Shook and Mike Rother drew about 400 registrants this past year. A number of faculty put on short courses in the annual Traverse City Management Briefings in August. Lean concepts are being introduced into other courses like Production and Inventory Control and Facilities Planning.

In this issue we hear from a number of faculty and adjuncts about what they are up to in lean manufacturing. John Shook, originally a Toyota manager, who taught TPS to many Americans while at Toyota, has taken a lead role as Director of Lean Manufacturing Programs working with Mike Rother through JTMP. Walt Hancock, Professor Emeritus, is now consulting on lean manufacturing to a number of different industries. Izak Duenyas is teaching short courses and a new academic course on “Factory Physics.” Factory Physics was created by

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an IOE alumni and an associate and provides a scientific framework that helps make decisions about implementing lean manufacturing. Yavuz Bozer has incorporated lean concepts into his facilities layout teaching and research and now offers short courses to industry on lean facility layout. Steve Rasch and John Birge have been teaching short courses on “financial engineering for lean manufacturing.” Steve is an adjunct and an alumnus whose dissertation empirically estimated the financial returns on lean manufacturing and Steve is one of our most popular instructors.



Philip T. Dentillo

Financial Engineering student Anchada Charoenrook studies to the tranquil sounds of the reflecting pool fountain. This addition to North Campus was a gift from the Engineering Class of 1947.

From The Chair



Philip T. Dattilo

From the Chair

By John R. Birge, Department Chair and Professor, IOE

How is higher education going to change in the next century? That is among the questions the IOE department is facing as we undergo our transition to the College of Engineering's Curriculum 2000 and our next accreditation visit in the Fall of 1999. In both efforts, we are focusing on measuring our outcomes, which include you (our alumni) and your accomplishments. You will soon receive a survey that asks about your education and career. Please help us in our continuous improvement process by completing and returning that form. Your feedback is a crucial part of this effort.

Our other outcome measures

include a course-by-course skill listing that we are mapping into our program objectives. With this list of abilities, IOE students can now describe their undergraduate experience explicitly for prospective employers and set their career objectives accordingly. We will then help improve their focus by using your survey replies to modify our skill list and enhance the overall experience for all undergraduates.

At the graduate level, we have been steadily increasing the number of classes offered via distance learning. In the Winter of 1999, we may have as many as a half-dozen courses offered via interactive and tape-delayed video. With interactive video available to unite students at remote locations, we can now offer off-campus students opportunities to share experiences and perspectives with on-campus students. If you would like to explore these possibilities, but your employer does not currently have access to the U-M educational network, you can contact the College of Engineering's Center for Professional Development at off-campus-ed@umich.edu.

Outcome-based curricula and distance learning are two of the trends overtaking higher education. Other waves include asynchronous learning that follows the just-in-time

philosophy that so many of us have preached for years. In this approach, students can learn at their own pace when the knowledge is critical for practical tasks that they must complete. The curriculum then becomes a set of these experience-based tasks and a collection of the skills mastered to complete those tasks. This system calls into question the fixed-credit, graded semester courses that have dominated this century's higher educational system and gives faculty a different role as mentors instead of lecturers. Many believe that productivity gains in higher education can only be possible if this change occurs.

I would appreciate hearing your views about the future of higher education or any other aspect of IOE teaching, practice, or research at jrbirge@umich.edu. I also encourage you to visit our web site often at <http://www.engin.umich.edu/dept/ioe>. We will soon have additional alumni-focused items on the page including employment listings and a forum to communicate with other IOE alumni. Please send me any comments you might have on the web page as well. I look forward to hearing from you.

Alumni Society Merit Award

The University of Michigan College of Engineering Alumni Society awarded Ralph E. Reins the Industrial and Operations Engineering Alumni Society Merit Award at the College's annual Alumni Society Awards Dinner held on October 23, 1998.

The Alumni Society Merit Awards were established to honor alumni who personify the College's tradition of excellence and who have achieved significant accomplishments in their professional life. The Award is given to one alumnus from each of the eleven academic departments within the College. Recipients are selected by the departmental committees whose members are chosen and headed by the department chair.



Ralph E. Reins is chairman and chief executive officer of Reins Enterprises, an Arizona-based consulting and investing firm.

After spending his youth in Detroit, Mr. Reins earned his bachelor's degree in industrial engineering at the University of Michigan in 1963. For the next 10 years, he took on various engineering management positions with General Motors Corporation.

Then, in 1972, he left GM for Rockwell International Corporation, where he was appointed engineering and reliability manager for the Truck Axle Division. He rose rapidly through the management ranks at Rockwell, eventually serving as president of three different divisions.

In 1985, he was offered and accepted the role of senior vice president of ITT Corporation and president and CEO of ITT Automotive. In this position, he had responsibility for a \$2.9-billion global automotive components business with 30,000 employees.

In the early 1990's, he held top management positions with Mack Truck, United Technologies Automotive, Allied Signal, and Envirotec Systems Corporation. In 1995, he settled in at AP Parts International, leading the company

from the dual positions of president and chief executive officer. Under his tutelage, the company restructured its OEM business, rebuilt its leadership team, instituted new business practices, encouraged team-focused manufacturing, and negotiated a strategic alliance with a French supplier. At the request of the company's owners, Mr. Reins negotiated the sale of AP Parts to an interested buyer.

Since retiring from AP Parts in January of this year, Mr. Reins has launched and fostered a family business enterprise. He also serves on the National Advisory Committee of the University of Michigan College of Engineering.



Ralph Reins received the 1998 IOE Alumni Society Merit Award from College of Engineering Dean, Stephen W. Director, along with Jody Hall and John Birge, IOE Department Chair.

Michael Schimpf Photography

IOE Goes Lean

IOE: A Leader in Lean Manufacturing

By Jeffrey Liker, Newsletter Editor, Associate Professor and Director, VCAP and Japan Technology Management Programs

In recent years, the momentum in industry embracing lean manufacturing as the new paradigm has grown. There seems to be general agreement on a number of principles:

1. Mass production thinking which encourages large batch processing and emphasizes the efficiency of individual machines and workers is outmoded as a paradigm.
2. Lean manufacturing, which views continuous flow as the ideal and emphasizes optimizing systems of people, machines, materials, and facilities, can lead to great gains in quality, cost, and delivery performance.
3. Lean manufacturing is a fundamental transformation of a business and needs to be approached as a total organizational transformation.

Lean manufacturing is a term coined by a group of researchers from MIT to describe what they saw at Toyota. The Toyota Production System (TPS) is the original lean manufacturing model. Over time Toyota has continued to excel as a company and a model, not only for automotive, but for industries throughout the world. The two key pillars of TPS are just-in-time manufacturing (JIT) and built-in quality. JIT is not just a matter of delivery, but a matter of building just what is needed when it is needed. There are many tools available to help support the ideal of continuous flow and building just what the customer wants when they want it, i.e., pull. These tools include quick changeover methods, error proofing, workplace organization, standardization, and total productive maintenance. But these are just tools. The overarching goal is to create a value-added flow in order to give customers what they want when they want it. The movement in industry to build-to order with short lead times is one of the drivers of a desire to adopt lean manufacturing practices.

My edited book, *Becoming Lean: Experiences of U.S. Manufacturers*, this year won a Shingo Prize for Excellence in Manufacturing Research. IOE faculty, students, and adjuncts wrote many of the individual chapters. A book by Mike Rother and John Shook (both instructors of IOE 425), *Learning to See*, is only being sold through James Womack's Lean Enterprise Institute and is selling like hot cakes. A new program within IOE, the Value Chain Analysis Program, looks at the supply chain from a lean manufacturing perspective. With all these activities IOE has emerged as one of the leaders in lean manufacturing – another accomplishment that can make you proud to be IOE alumni!

Financial Engineering and Lean Manufacturing

By Steven Rasch, Adjunct Assistant Professor, IOE

Frederick Taylor revolutionized the workplace during the early twentieth century with his ideas on work organization and task decomposition. Since then, many organizational theorists have redefined management and workforce relations to improve productivity and worker satisfaction. Today, “lean manufacturing” concepts are widely accepted as the most effective way to manage manufacturing processes and attain a high degree of worker competency and dedication.

Similarly, financial management and cost allocation methods were initiated at the beginning of the industrial revolution as manufacturing firms instituted mass production techniques and started tracking expenditures in an effort to understand the overall cost structure of the products they produced. Inventory valuation methods were established to account for production work-in-process. Conventional methods of standard costing were developed to estimate material, direct labor, and overhead costs. In turn, these standard costs formed the basis for establishing operational and maintenance budgets and, ultimately, financial performance measures used to measure managements performance. Finally, capital budgets and equipment acquisitions were justified using financial analysis techniques based on product cost information.

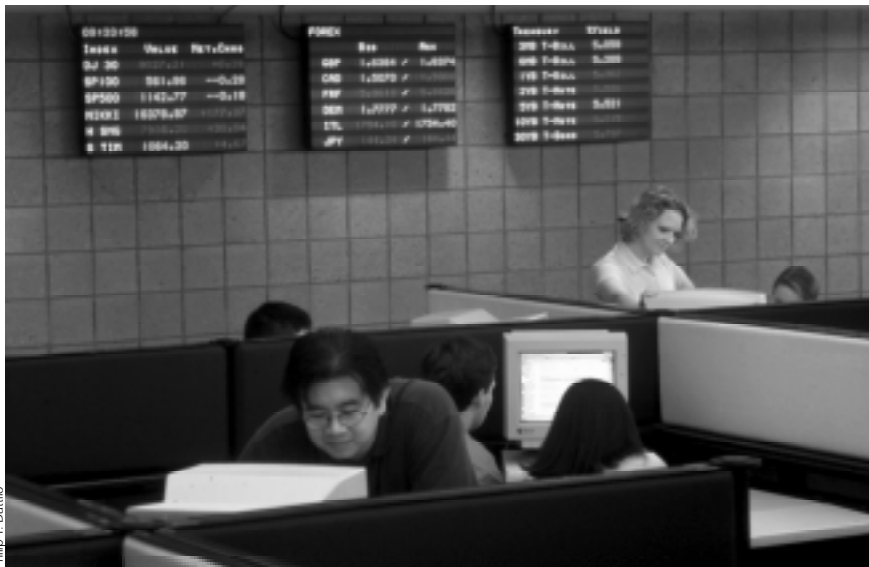
This process worked well for many firms until the mid

1980's when Japanese competition forced western companies to look at lean manufacturing techniques. The Japanese system of lean manufacturing eliminated many western business practices through team-based organizations which focused on quality and just-in-time production methods. The heart of lean manufacturing practices can be summarized as follows:

- Concurrent Engineering Teams
- Use of Sole Source Suppliers
- Formal Production Teams
- Pay Incentives
- Production Worker Cross-training
- Production Worker Involvement
- Business System Automation
- Just-In-Time Inventory Methods
- Preventative Maintenance
- Formalized Quality Programs

As lean manufacturing techniques became widely accepted in western companies, several problems associated with measuring financial performance through the use of standard cost accounting systems surfaced. These problems include:

- Batching of orders to create favorable variances by eliminating setups at the expense of higher priority orders
- Production overruns to create favorable variances at the expense of unneeded inventories
- Completing easy orders at the expense of tougher orders which have a higher priority
- Maintaining high inventory levels to prevent worker idle time
- Allowing marginally acceptable levels of quality to pass inspection
- Delaying scheduled preventative maintenance to attain higher productivity levels
- Delaying production training and cross-training to



Philip T. Dattilo

Students in the Financial Engineering Program are now able to perform real-time financial simulations via the Reuters, Intel, and Fame sponsored computer lab located in the Media Union. Ken Hung and Kristin Missil of the FE Program work with students Dmitry Davydov and Anchada Charoenrook to increase the value of their portfolios.

prevent under-utilization

- Accepting a buffer of backorders to insure an adequate level of work for production workers

Lean manufacturing practices are redefining the way organizations view their business. This repositioning necessitates a reassessment of overall goals, operational procedures, and financial justification practices. New and innovative financial metrics for accurately determining the financial performance of lean manufacturing practices is the next challenge for industrial engineers during the next decade.

Facility Layout and Lean Manufacturing

By Yavuz A. Bozer, Professor, IOE

In manufacturing facilities, facility layout is primarily concerned with the placement of production and service departments in the facility and the parts-flow patterns generated by alternative placements. Long before new paradigms such as “just-in-time” and “lean manufacturing” were introduced, facility layout was (and continues to be) a very active area of industrial engineering practice and research. As new products

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are introduced (and obsolete ones are removed), as product design or process changes occur in the spirit of continuous improvement, one is often forced to reevaluate the layout in order to maintain efficient flow paths in the facility. Quite frequently, however, the layout falls behind, and as a result of poor strategic planning, people “paint themselves into a corner.” Before long, new lines or new departments are placed in the facility on a where-there-is-room-available basis, which leads to poor space utilization, poor flow paths, and wasted material handling dollars in the long term.

The primary goal of lean manufacturing is to eliminate waste. A poor (or out-of-date) layout generates considerable waste due to longer travel distances and possible damage to the parts in the process of handling them. However, a more subtle yet more extensive “waste” generated by a poor layout has to do with “transfer batch sizes,” also known as the transfer lot size or handling batch size. In simple terms, the transfer batch size (TBS) is the number of parts moved together in one trip from one department to another in the factory. The ideal TBS under lean manufacturing would be a batch size of one (also referred to as “one-piece flow”). While one-piece flow can be achieved within a department (such as a U-shaped line that consists of several machines arranged in series), moving parts one at-a-time across the factory as a whole is not practical due to a finite-capacity material handling system.

Generally speaking, the longer the travel distance for a particular move, the larger we need to keep the corresponding batch size in order to stay within our material handling system’s throughput capacity. In other words, long travel distances imposed by a poor layout often forces one to use large TBSs throughout the factory. A large TBS, however, leads to a significant increase in work-in-process (WIP). A part that has been processed at a particular department has to wait for all the remaining parts in that batch before it can be moved to the next department. Likewise, the department receiving the parts experiences what is known as “bulk arrivals,” where there are no arrivals for a while and then suddenly a batch of parts arrive and they must now each wait for processing. Such increases in WIP lead to increases in the cycle time (i.e., the total time required in the factory to complete one end-product)

as well as delayed feedback concerning possible quality or scheduling problems between the departments.

The cycle time itself affects the lead-time; that is, the longer it takes to complete the product, the longer it will take for the product to reach the customer. The significance of maintaining short lead-times in a competitive market is well-known. Consequently, the wasted material handling dollars generated by a poor layout may actually be small compared to the cost of running a factory with long lead-times and excessive WIP. Next time you are faced with the question of what to do with the factory layout, ask yourself what it would mean to save material handling dollars and reduce the travel distances for the parts. But don’t forget to also ask yourself what it would mean to reduce your WIP and lead-times.

Factory Physics: The Science of Lean Manufacturing

By Izak Duenyas, Associate Professor, IOE

Just-In-Time and lean manufacturing are extremely popular buzzwords in industry today. Many companies hire Just-In-Time consultants who typically undertake a high-profile pilot project and educate employees on the basics of *takt* time, kanban, and setup reduction.

In a recent paper, Buzacott (1995) differentiates between naïve JIT and sophisticated JIT. He writes that naïve JIT assumes that “systems have no uncertainty and variability and that good managers can get rid of any process variability... Once this is done, we can then aim at the ideal lot size of one.” As Buzacott also points out, naïve JIT usually works well for large corporations for dealing with much smaller suppliers or as a pilot project in a small portion of the plant. However, when further areas within the plant or a whole division attempt to introduce JIT, progress is lacking. Much of this is due to the fact that JIT is easy to describe as an ideal; however, although most practical JIT manuals tell companies where they want to be, they do not necessarily do a very good job of describing how to get there. For example, the practical JIT literature emphasizes the importance of reducing setup times to ideally achieve setup times of zero. However, it does not give a way to prioritize setup reduction

projects to achieve the largest improvements first. Similarly, reduction of process variability to zero is emphasized but in the pragmatic JIT literature, there is no guidance on how to identify the areas where variability reduction would have the highest impact.

One of the central tenets of the JIT philosophy is that inventory is evil as it hides the problem areas. Just as when the level of water is decreased, rocks will become more visible; when inventory is decreased, the problem areas will become more visible. Therefore a lot of JIT consultants will prescribe cutting inventory levels to find out the problem areas in a plant. The assumption is that the only reason problems are not solved is because inventory is hiding them. However, it would clearly make more sense to first identify all the non-value added processes, all sources of variability, uncertainty and disturbance in a manufacturing system. One could then prioritize improvement alternatives based upon the effect that each alternative would have on basic performance measures such as Work-In-Process, cycle time, and throughput.

Factory Physics, a recent book by Hopp and Spearman (1996) which won the Institute of Industrial Engineers book of the year award, develops basic manufacturing laws and a systems approach that help managers identify the manufacturing strategies that will be most effective in their environment. The “laws” of Factory Physics describe the underlying logistical behavior of manufacturing systems, including the fundamental relationships between basic performance measures such as throughput, Work-In-Process, manufacturing cycle time, and process variability. By understanding these relationships, and using the powerful analytical tools described in the text, managers can diagnose their manufacturing systems and make major improvements in throughput, cycle time, customer service, and quality. In particular, the laws of “Factory Physics” give managers a way to identify the largest sources of waste and variability and to compute the effect of alternative improvements before implementing them. As Hopp and Spearman note, it makes much more sense to use sonar to identify the rocks and remove them before lowering the level of water. “JIT, as described in the American literature, offers neither sonar (i.e., models that predict the effects of system changes) nor a sense of the relative economics of level reduction versus rock

removal—that is, procedures for evaluating the trade-offs between the benefits of WIP reduction and the costs of eliminating problems.” *Factory Physics* offers both.

Hopp and Spearman have developed an innovative course based on their book. I had a chance to teach an offering of their course during my sabbatical at Northwestern and Wally Hopp and I also taught an executive short course last summer in Ann Arbor which was very well received. It seems that many companies are now realizing the dangers of management by buzzword and imitation and looking for tools that provide means of sound analysis.

I will offer a version of the factory physics course next term for students in the Tauber Manufacturing Institute at the University of Michigan and continue to offer short courses to industry. My graduate students and I are also continuing our research on development of tools to address different problems using the factory physics framework.

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What Led Me to Lean Manufacturing

By Walt Hancock, Professor Emeritus, IOE

In the early 80's, the American auto industry had a renewed interest in quality control of their manufacturing processes. This renewed interest led to a substantial increase in statistical process control, design of experiments, and process capabilities. This effort continued throughout the eighties. Many assumed that the quality methodologies were the primary reason why Japanese automobiles were of superior quality until we began to hear that the Japanese had stopped using control charts and were dissatisfied with design of experiments because it was too cumbersome. We began to hear about the Toyota

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Production System and how it differed from the traditional Mass Production System that dominated American manufacturing. In order to learn more, I became involved with the American Supplier Institute and through them went to Japan on study missions. This effort resulted in the establishment of IOE 425 “Manufacturing Strategies” in 1987. The teaching style was to lecture on various aspects of Lean and Mass manufacturing for about three weeks and then tour a local industrial plant. The students in groups of two were asked to compare what they saw with the Lean concepts and give an estimate of the potential savings. Two by-products of this approach were that the students gained confidence that they would be able to make major contributions after graduation and learned how to ask insightful questions to the plant management at the end of the tours.

With the exception of Just-in-Time Inventory, the concepts of Lean Manufacturing have as their roots classical industrial engineering. Standardized work, balanced flow processes, group teamwork, minimized setup times, methods analysis, maintenance systems, and root cause analysis were taught in Industrial Engineering Departments in the 1950’s. This made it easy for me to quickly assimilate the finer points and to teach them to the students. I have also been practicing lean manufacturing in my consulting work with great success.

Lean Manufacturing at the Japan Technology Management Program

By John Shook, Adjunct Lecturer, IOE and Director, Lean Manufacturing Systems, JTMP

The Japan Technology Management Program is a major IOE program that has sponsored numerous Lean Manufacturing projects and programs. JTMP was founded by Jeff Liker and John Campbell, Professor of Political Science, in 1992 with funding from the Air Force Office of Scientific Research. In 1994, the Program took a strong Lean Manufacturing focus as they brought in John Shook from Toyota and then Mike Rother from the Industrial Technology Institute to develop new Lean initiatives. The results have been outstanding. U-M has the reputation of being a

national leader in lean manufacturing. In this article we will describe what JTMP has contributed to lean manufacturing in IOE. But first it is worth taking a few paragraphs to define what we mean by lean manufacturing.

JTMP’s view of Lean Manufacturing :

Beginning in 1984, the International Motor Vehicle Program at MIT began its now-famous five-year, five-million dollar study of the world auto industry, the findings of which were summarized in the bestselling volume, *The Machine that Changed the World*. The researchers concluded that the system of manufacturing pioneered by Taiichi Ohno at Toyota differed so fundamentally from mass production as to warrant recognition as a new *kind* of manufacturing. As they put it: “(The system) required half of everything to produce twice as quickly so we decided to call it lean.”

Since the publication of that report, extraordinary attention from industry, academia, and government has focused on lean manufacturing with little furthering of the task to define “lean” but with much focus on the Toyota Production System. Considerable confusion has resulted regarding exactly what this “lean” is (what does it look like, how can we say that a given production system or site is “lean” or not?). Some assert that lean is simply another word for the Toyota Production System. Others have expended extraordinary amounts of time and effort developing related theories that essentially rehash the same or similar concepts (agile manufacturing, re-engineering, continuous improvement), adding little of substance to the issue but much to the confusion.

The concepts “mass production” and “lean production” do not refer to production systems so much as they reflect ways of thinking about production, the assumptions that underlie how people and institutions formulate solutions to the problems of organizing people, equipment, material, and capital to create and deliver products for customers. Mass and lean are paradigms that reflect and inform the thinking about production within particular cultures and eras. From these paradigms are developed production systems. The original Ford production system and all the systems subsequently developed by auto and auto

parts manufacturers, as well as virtually all manufacturing systems in most industries around the world have reflected the mass way of thinking for most of the 20th Century. The rise of the Japanese manufacturing industry after the second world war took place in a constrained, resource-poor environment where the mass paradigm would simply lead to failure. The struggles to adapt to these circumstances gave birth to a new approach to manufacturing, lean production, which is best exemplified by the Toyota Production System (TPS). TPS is nothing more or less than one set of solutions to achieve the “lean” ideal.

The term “Lean Manufacturing” is unfortunate in a couple of ways. First of all, “Lean” should not be confused with “mean” or with simple “downsizing” or “re-engineering.” Lean means fundamentally rethinking and changing the way we do business, with the aim of providing optimum value for the customer with a minimum of waste. Second, it is not just “manufacturing,” but demands the “rethinking of all business processes” product development, engineering, operations management, the customer interface, and all corporate governance functions. Thus, Lean refers to an underlying philosophy that supports a comprehensive system that consists of numerous specific tools and techniques.

Following are descriptions of a few of the Lean activities sponsored by JTMP.

The Annual U-M JTMP Lean Manufacturing Conference.

June 1999 will see the 5th Annual U-M JTMP Lean Manufacturing Conference. The conference attracts a crowd of over 400 attendees from various ranks, functions and industries, sharing a common interest in Lean Manufacturing. The conference has become recognized as one of the premier events in the “Lean world”.

Lean Manufacturing course in IOE.

JTMP has subsidized one section of IOE 425 since Winter semester of 1995.

IOE has offered the course, “Manufacturing Strategies”

(IOE 425), since the fall of 1990. Created by Professor Emeritus Walton Hancock as Special Topics 591 in the Winter of 1987, the course originally focused on providing students with more real-world manufacturing exposure than the students were getting through their ordinary course work.

The course quickly evolved along with the thinking of Professor Hancock. By the time of the publication of *The Machine That Changed the World* by Dan Roos, James Womack, and Dan Jones in 1990, Professor Hancock had already become one of the first engineering scholars to embrace lean manufacturing as the new manufacturing paradigm and to begin teaching about it to university students. As he became convinced of its power he made lean manufacturing the focus of the Manufacturing Strategies course. The course became one of the most popular courses of the department, with a perpetual waiting list of dozens of students.

Professor Hancock retired from the university in 1996. In the Fall of 1994, John Shook sat in and provided some lectures for Professor Hancock’s last semester of teaching Manufacturing Strategies. The following semester John began teaching the course, utilizing the basic structure established by Professor Hancock, and drawing upon his Toyota experience to make the content even more specifically focused on the Toyota Production System. New lecture material and exercises were added, so the course took on a look and feel not dissimilar to a Toyota internal training course for employees.

The following semester (Winter 1996), Mike Rother co-taught the course with John, and the two have alternated teaching one section of the course since that time, steadily revising and improving the course along the way. Over the following couple of years, Mike strove to improve the teaching materials, making them more professional and understandable and adding several new exercises. An improvement of particular note, beginning in the Fall of 1997, was the inclusion of Value Stream Mapping as a major focus of the course in general and specific focus of the plant visits and reports in particular.

Throughout this time, Don Jahncke, an ex-Ford Motor Corporation plant manager, has taught another section

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of the course, also using the structure established by Professor Hancock, and utilizing his extensive experience in manufacturing gained from many years working in manufacturing management at Ford. Don Jahncke worked closely with Mazda to launch Ford's Escort plants in Mexico and Dearborn and was exposed to the Mazda Production System, modeled after the Toyota Production System.

Jeff Liker began teaching the course in the Fall of 1998, with plans for Steve Rasch to teach a section in the Fall of 1999. Beginning with the Fall of 1999, IOE 425, like many other courses in the College of Engineering, will switch to a 2 credit hour structure, which will result in further evolution and no doubt improvement of the course. One thing is certain, the basic purpose of the course will remain the same, to provide a balanced look at Lean Manufacturing as a strategy to meet the manufacturing challenge: how to make what the customer wants – no more, no less – when he or she wants it, with a value stream that has the shortest possible lead time and a minimum of waste.

Objectives of the Manufacturing Strategies course:

1. Acquire understanding of lean manufacturing as a philosophy, as a system, and as a set of techniques.
2. Acquire an appreciation for manufacturing.
3. Learn about and practice Value Stream Mapping.
4. Acquire the ability to quickly and thoroughly assess a manufacturing facility.

The focus of the course is plant floor manufacturing and management. Other systems – supplier management, human resources, product development – are brought in as appropriate and as they relate to or support manufacturing.

Internships.

Internships for students in Japan and with companies in the U.S. attempting to implement Lean. JTMP has arranged internships for eight students at four American and three Japanese companies.

Lean Study Tours.

To Japan. JTMP has twice led study tours of leading

lean companies in Japan. The tours have been attended by a mix of industry executives and faculty. U-M faculty who have joined the tour include IOE faculty Jeff Liker, Walt Hancock, Izak Duenyas, Tava Olsen, as well as Business School faculty Bob Haessler, Roman Kapuzinski, Will Mitchell and Shannon Anderson. Many of these faculty members focused their research and teaching toward more lean topics following their experience on the tour.

To Toyota Kentucky. In the Spring of 1998, students and faculty joined a bus trip to visit Toyota's Georgetown, KY assembly plant and a leading JIT supplier, Summit Polymers, combined with a pre-visit seminar on "What is Lean Manufacturing?"

Lean implementation projects.

CIUG. Mike Rother is a co-creator, along with Kiyo Suzuki, of the Continuous Improvement Users Group method of learning about and implementing Lean. Mike led a JTMP sponsored project involving five area manufacturers in a one year lean joint Lean initiative.

Mechanical Products. JTMP is partnering with the Industrial Technology Institute to work with this Jackson, MI-based aerospace company in a hands-on implementation project that has already led to significant improvements in plant floor operations.

Short Courses, lectures.

Lean Executive Seminar. The first JTMP Lean Executive Seminar was held November 11-13 1998. A three-day curriculum took about thirty participants through a detailed overview of Lean, including a hands-on value-stream mapping exercise at a host company's plant floor.

Conclusion: Lean In the IOE Department.

Promoting Lean within IOE has been a central objective of JTMP for the past five years. The inclusion of more Lean content in various courses, the addition of new, specifically Lean-focused courses, the conduct of Lean-related research by faculty and students, and the creation of numerous Lean-oriented conferences and seminars are all evidence of significant progress in the development of a Lean curriculum within IOE.

Center For Ergonomics

By Thomas Armstrong, Professor, IOE and Director, Center for Ergonomics

The Center for Ergonomics continues to be a focal point for ergonomic related teaching and research within the Department. The NIOSH Occupational Health and Safety Engineering Center continues under the leadership of Professor Monroe Keyserling as one of the major sources of support for students wishing to pursue graduate education in occupational health and safety. Although there has been some tempering in the overall demand for safety and health professionals, the demand for graduates from our programs remains high. Professor Gary Herrin is completing a project on the quality, productivity and health/safety impact of ergonomics in manufacturing. Professor Yili Liu just returned from a sabbatical at the University of California at Irvine where he completed his contribution to Wickens, Gordon, and Liu: *Introduction to Human Factors Engineering*, a new text book on ergonomics which was introduced in IOE 333 this year. Professor Liu also continues his research in the cognitive area of human computer interaction and driving. Dr. Martin is involved in studies of virtual reality, keyboards, and vibration exposure. Dr. Martin has also joined Professor Chaffin as a co-author of the third edition of Chaffin, Andersson and Martin: *Occupational Biomechanics*, which is due out in time for the winter term. Dr. Sheryl Ulin directs a Safety

Education Training Grant from the State of Michigan. In addition to providing a service to small Michigan employers, this project has spawned many research opportunities. Randy Rabourn directs the NIOSH ERC Continuing Education program. The Center continues to offer a selection of state-of-the-art education health, safety, and ergonomics programs and symposia. Check out our web page for the latest offerings. James Foulke, Charles Woolley, and Eyvind Claxton continue to provide essential technical support for ergonomic research and teaching activities.

Professor Chaffin has relinquished the directorship of the Center for Ergonomics, to focus on a new initiative: Human Motion Simulation. This initiative is concerned with development of biokinematic models that simulate human movements with a high degree of fidelity. We are grateful for the direction and standard of excellence Professor Chaffin has given to Center and the faculty, staff, and students personally. Professor Tom Armstrong has moved to the department full time and is acting director of the Center for Ergonomics. He is both honored and humbled by the prospect of representing faculty and staff of the Center for Ergonomics. Professor Armstrong is also director of a newly funded Rehabilitation Engineering Research Center concerned with ergonomic barriers to employment. Co-investigators in this initiative include Professors Don Chaffin, Monroe Keyserling, and Bernard Martin and Dr. Sheryl Ulin from the department. It also includes Professors Andrew Haig,

Simon Levine, and Robert Werner from the Department of Physical Medicine and Professor Alfred Franzblau from the Department of Environmental and Industrial Health. Professors Werner and Franzblau also hold Research Scientist positions in the Center and provide important clinical links for health related projects.

Dr. Jerry Duncan (*middle*) is shown presenting a \$17,000 thesis support grant and scholarship from the John Deere Foundation to IOE PhD candidate, George Page (*left*) at the annual Human Factors and Ergonomics Conference this past October. Don Chaffin (*right*), George's thesis co-chair, looks on during the presentation.

