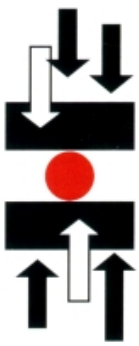
Jobshop Lean Workshop

Lean Manufacturing in Custom Forge Shops

Sheraton Gateway Suites
Chicago, IL
August 3, 2004

Sponsored by The Defense Logistics Agency, FDMC, FIA Plant Engineering Committee and The Ohio State University



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THE OHIO STATE UNIVERSITY

DLA

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Sponsors:

Defense Logistics Agency
Forging Defense Manufacturing Consortium
FIA Plant Engineering Committee
Ohio State University

*Jobshop*Lean: Lean Manufacturing in Custom Forge Shops

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August 3, 2004 (Chicago, IL)
August 5, 2004 (Long Beach, CA)

5300 International Blvd.
North Charleston SC 29418
(843) 760-4346

August 3, 2004

Memo

Subject: Welcome and Challenge!

To: Attendees of the Job Shop Lean Workshop

Welcome to your Job Shop Lean Workshop! We are glad that you could participate in today's event to invest in your organization. Over the past three years the Defense Logistics Agency (DLA) and the Forging Industry Association - Department of Defense Manufacturing Consortium (FDMC) have invested in Professor Irani's Job Shop Lean Project at the Ohio State University. Slowly but surely we have seen this project unfold and yield results for the project's partners such as Ulven Forging, TECT, Anchor Harvey, Aluminum Precision Products, Scot Forge, Consolidated Industries and others. Today you will see Professor Irani's results, and tomorrow, as you return to your own shop, you can harness these concepts on your shop floor to improve lead time, reduce waste and improve profitability which brings us to my next point.

For each of you attending this event I personally challenge you to invoke the lessons learned today on your shop floor. Some of these concepts you can apply quickly without any support; however, concepts that exceed your reach might be applied through a partnership with the FDMC and the Job Shop Lean Project. If you wish to take the next step, please contact Professor Irani or me. Together we can formulate and implement a plan of action to maintain your competitiveness in supplying short run forged components, not only for your commercial customers but also for the Department of Defense. In addition, the FDMC PRO-FAST Program provides other opportunities for your forge to improve its performance through projects such as our National Tooling Forging Database, or Rapid Tooling and Simulation Projects not to mention our award winning FORGE-IT Team. Here again you are challenged to review these projects and ascertain whether there is an untapped opportunity for your company in the PRO-FAST Program.

Once again, welcome to your Job Shop Lean Workshop, and remember the challenge – it's up to you to implement these concepts in your organization!

Jon D. Tirpak, PE, FASM
Executive Director

*Jobshop*Lean: Lean Manufacturing in Custom Forge Shops

Featured Speakers

Douglas Brown

Doug Brown is the Director of Forging for the Inductoheat/Inductotherm Group and is the President of the Alpha 1 Induction Service Center. Doug received his BSEE degree from Penn State University and an MBA from Kent State University. He has his Professional Engineering (PE) license from the State of Ohio and received international patents in the field of induction heating for forging. He is a board member and on the Technical Roadmap subcommittee of FIERF. As a member of the Plant Engineering Committee of the Forging Industry Association (FIA), he helped develop the Induction Heating for Forging FIA Web training program and was the founding chairman of the FIA Induction Heating School. Mr. Brown has taught for the FIA Press Fundamentals and Die Design School and was the Chair for the Utilities Deregulation seminar presented by the Plant Engineering Committee. Mr. Brown was part of a team that worked on a DOD-sponsored project through NCMS to show the feasibility of using Autonomous Agent technology to control a complex system – induction heating for forging. Doug is a world traveler, and has visited most of the forging companies in the USA, as well as forging companies in the UK, France, Italy, Brazil, Taiwan, China, and Japan (where he and his wife lived for 4 years in the early 90's).

Sharon Hale

Sharon Hale is the Lean Manufacturing Manager for Jorgensen Forge in Seattle, Washington. Jorgensen melts, forges, heat treats and machines large metal products like ship shafts, periscope tubes, and drill collars for oil fields. Sharon reports to the Chief Executive Officer and is responsible for all continuous improvement activities for the company.

Born in Priest River, Idaho and raised in Kent, Washington, Sharon obtained her Bachelor in Science in Psychology from the University of Washington in 1985 and is enrolled in the Masters in Adult Education program at Western Washington University. Sharon has completed over 220 hours of Lean training and she has obtained a Lean Tool Awareness Certificate from Productivity, Inc and the Fisher School of Business at Ohio State.

Ms. Hale has owned a precision aerospace machining company, taught in a trade association apprenticeship program and also taught CNC machining at a community college. Prior to coming to Jorgensen Forge in January of 2004, she was the Lean/Training Coordinator at Neuvant Aerospace, a Boeing supplier. She has served twice as Chapter President for the Puget Sound Chapter of the National Tooling and

Machining Association and also as a board member. She is a current member of the American Society for Training and Development, the Society of Manufacturing Engineers and the International Lean Association.

Shahrukh A. Irani

Dr. Shahrukh A. Irani is currently an Associate Professor in the Department of Industrial, Welding and Systems Engineering in the College of Engineering at Ohio State University. He is the Director of the Advanced Manufacturing Interest Group (AMIG), a consortium that seeks to incorporate industry experience across the Industrial Engineering curriculum through a variety of engagements with Ohio manufacturers. In 1995-96, he worked in industry on a Faculty Internship that was partially supported by the Grant Opportunities for Academic Liaison (GOALI) program of the National Science Foundation. Dr. Irani is the Editor of the Handbook of Cellular Manufacturing Systems published in 1999 by John Wiley. In 1996, Dr. Irani was voted Young Engineer of the Year by the Minnesota Federation of Engineering Societies and the Minneapolis Chapter of the Institute of Industrial Engineers. He served as the Director of the Facilities Planning and Design (FAPAD) division of the Institute of Industrial Engineers for 1999-2001 and 2001-2003.

Bill Kirchmier

Bill Kirchmier is the president and founder of Data Based Systems (1996 to present) and founder of IPPSA. He has more than 40 years' experience in application and system integration of manufacturing and production improvement technologies. Thirty years of this experience has been in computer-related applications. His industrial experience in manufacturing applications is extensive while working for the following companies: Fairbanks Morse & Co. in the Pacific Northwest (8 years); designing and implementing fluid power hydraulic and servo systems at Rucker Control Systems, Emeryville Ca. (5 years); applications using remote computing at Optimum Systems Inc. San Francisco Ca. (10 years); President of MKT in San Francisco, CA (9 years). He is a pioneer in the domain of Finite Capacity Scheduling (FCS). For twelve years, as a partner at Jobtime Systems from 1984 until 1996, he was on the systems development and implementation team and installed in excess of 200 Finite FCS systems in a broad range of manufacturing industries worldwide. The FCS applications implemented varied from the production of nuclear fuel to fiber optics and from book publishing to offshore oil well drilling rigs. In 1996 he created Data Based Systems to educate and consult on FCS. He has introduced thousands of people throughout the world to the principles and practicalities of Finite Capacity Scheduling through seminars, workshops and consulting. Bill recently co-authored a book with Gerhard Plenert, Ph.D. titled "*FINITE CAPACITY SCHEDULING*" published by John Wiley and Sons.

Shardul Phadnis

Shardul Phadnis received his MS in Industrial Engineering from the Ohio State University. Since graduation, he has been working as the Supervisor of the Lean Promotion Office (LPO) at Russell-William Ltd. RWL is a custom store-fixture

manufacturing company. In his current position, he has been involved in educating RWL employees in Lean Thinking, conducted several kaizen events, and implemented the DBR (Drum-Buffer-Rope) scheduling methodology in RWL's high-variety low-volume Make-To-Order (MTO) manufacturing environment. Before joining RWL, Shardul worked as a graduate intern at Fisher Controls where he developed and implemented IT solutions to support Lean Thinking on the shopfloor, such as an Electronic Kanban Management System and a program for Load Leveling and Scheduling of an assembly cell.

Richard Rooker

Richard Rooker is currently the Operations Process Manager at Green Bay Drop Forge, Green Bay, WI. He has a Bachelor's Degree in Mechanical Engineering and a Master's Degree in Architectural Engineering. Richard is an active member of the Forging Industry Association (FIA) Plant Engineering Committee. With 30 years experience in plant design and manufacturing management in the plastics, woodworking, steel and fabrication industries, Richard has now brought his change management and implementation expertise to the steel forging industry.

George Schriver

George Schriver has over thirty years experience in manufacturing. He has fifteen years experience as Plant Manager, another five years as Engineering Manager and, for the last seven years, he has been Quality Director for three divisions at Pratt & Whitney AutoAir, Inc in Lansing, Michigan. George's experience in Lean includes five years engineering and implementing process flow improvements for client companies in office operations, electronics, metal stamping, wire forming, printing, wood milling, and assembly line operations. He has implemented Dynamic Flow Control, Total Quality Management (TQM) Systems, and the Pratt & Whitney "ACE" Lean initiatives. In addition, he is an instructor for Material Requirements Planning (MRP), Statistical Process Control (SPC), Lean Manufacturing and Value Stream Mapping. He has participated in numerous kaizens conducted by Shingijutsu sensei; and, in the past two years, he has himself been conducting kaizens. He has also participated as a Lead Team member in the implementation of an MRP system and an Enterprise Resource Planning (ERP) system. George holds both a Bachelor of Science and a Master of Science degree from the University of Wisconsin – Milwaukee, and he will complete his Master's degree in E-Business in Fall 2004.

Mark Symonds

Mark Symonds is Executive Vice President of Plexus Systems, LLC, a leading supplier of Manufacturing Information Systems (MIS). Mark is APICS certified and has spent the last twenty years helping manufacturers and other organizations define and implement efficient and effective Information Technology (IT) solutions. After earning a Bachelors degree in Economics from the University or Rochester and an MBA from Cornell, Mark began his career with Arthur

Andersen (the part that is now Accenture). He then helped start and grow three IT consulting companies specializing in ERP/MRP/Scheduling solutions. He joined Plexus in 2001 and helped with the rollout of Plexus Online, the first comprehensive, integrated enterprise business solution for manufacturers.

Overview of this Workshop

"Toyota Lean" vs. "Jobshop Lean (JSLEAN)"

The Toyota Production System (TPS) was designed for design and operation of assembly line-type facilities. However, this type of low-variety high-volume (LVHV) manufacturing system differs significantly from the typical high-variety low-volume (HVLV) manufacturing system. Here are some specific differences between the two systems:

Product Variety: The TPS is based on a single product family with minor variations whereas the HVLV system must be designed for a complicated material flow network resulting from the large number of dissimilar (100 to 5,000+) manufacturing routings.

Layout: The TPS is based on the common manufacturing routing for a product family whereas the HVLV system must have a layout based on multiple dissimilar manufacturing routings.

Demand Volumes: The TPS relies on a high and *relatively* stable market demand whereas the HVLV system, being dependent on a broad customer base for business, may not have the luxury of stable demand volumes.

Product Design and Process Engineering: The TPS can enjoy the benefits of "variant design" because a car is a car is a car whereas the HVLV system often needs to design and manufacture parts and products that have little to no similarity with past orders.

Availability of Internal Resources: The TPS is utilized by companies that often have the resources to hire full-time engineers or high-profile consulting companies to implement Lean Manufacturing. Whereas, the typical HVLV system may not have the engineering talent, technical resources and finances to finance extensive training and kaizen activities.

Flowline vs. Jobshop Scheduling: The TPS can utilize "Takt Time" to schedule a single U-shaped cell based on a Single (or Mixed) Model Assembly Line Balancing problem. Whereas, the HVLV system, unless fully decomposed into independent manufacturing cells, yields a Jobshop Scheduling (JSS) problem.

Pull vs. Push of Orders: The TPS can rely on market "pull" to control inventory buffers using kanban signals. Whereas, the HVLV system, since it lacks the repetitive and stable demand, must use priority-based scheduling of orders based on their due dates and $ value.

The actual list of differences between the two manufacturing systems – Assembly Line and Jobshop – is actually much longer! It is not our intention to take anything away from what the architects of the TPS have achieved. However, it must be recognized that custom forge shops operate in a Make-To-Order business environment. Hence, unlike the OEMs and their top-tier suppliers, these jobshop-type manufacturers do not have an extensive suite of *correct*, well-documented, *easy-to-implement* and well-tested methods and tools to implement Lean Thinking in their manufacturing facilities.

Deployment of Lean Thinking in Jobshops

The how-to books and tools for design and operation of profitable jobshops are significantly fewer in number than those written for Lean Manufacturing for assembly line-type facilities. Here is a sample of challenging implementation roadblocks that, if workable solutions were to exist for them, could serve as the foundations for a guidebook on "Jobshop Lean":

- How does a jobshop segment its product mix into categories such as "Runners", "Repeaters" and "Strangers"? Do viable computer-oriented methods exist, such as Product-Quantity-Routing Analysis, Group Technology and Product-Process Matrix Clustering, capable of analyzing a large database of anywhere between 500 to 5000+ routings?

- How does a jobshop identify and implement, *not just a single "pilot cell"*, but *all* potential cells for different families of parts that may exist in its large product mix? What does it do about the "cats and dogs" in its product portfolio? There is a significant body of literature on hybrid cellular layouts, reconfigurable cells, virtual cells, etc. that may of interest to their facilities planners.

- How does a jobshop develop a self-motivated workforce knowledgeable in Industrial Engineering and Manufacturing Engineering skills to seek out and eliminate *muda* in administrative and production processes?

- How does a jobshop adopt, or adapt, the essentials of Lean Thinking, Theory Of Constraints, Quick Response Manufacturing, Demand Flow Technology, etc. when
    - demand forecasts are unreliable or non-existent?
    - suppliers may not be prepared to deliver JIT?
    - equipment must be multi-function, *and not right-sized*, to compensate for a small multi-skilled workforce?
    - customers could be here today but gone tomorrow?
    - drawings, route sheets, inspection plans, gauges, tools, etc. for past (or new) orders need to be retrieved (or made from scratch) on a routine basis?
    - …… there are **many** such differences between the low-variety high-volume Toyota Production System (TPS) and the high-variety low-volume jobshop and custom manufacturer.

- How does a jobshop define and distill its "core manufacturing competencies" into a guidebook that its sales staff could use to accept, evaluate or reject new orders based on past cost/benefit performance measures?

- How does a jobshop implement Finite Capacity Scheduling without purchasing expensive software, since Theory Of Constraints and Drum-Buffer-Rope scheduling have been known to succeed in such facilities?

- How does a jobshop layout its facility to achieve flow and be flexible to changes in product mix, demand and manufacturing technology?

- How does a jobshop train its material handlers to perform shopfloor scheduling and order progressing functions, similar to the "whirligig beetle" ("mizusumashi") who is employed in the Toyota Production System?

- How does a jobshop adopt real-time inventory tracking technology utilized in warehouses and distribution centers to achieve pseudo-JIT operations?

The above sampling of questions pertaining to jobshops and custom manufacturers will surely grow tenfold in the future as we gain further insights by working with more industry partners. It is our hope that this FDMC workshop will bring together academics, consultants and professional engineers at companies that have either solved or are currently studying problems specific to any and all jobshop-type facilities, including custom forge shops.

Philosophy of this Workshop

The essence of Lean Thinking is the identification and elimination of waste in any and all administrative and manufacturing processes in any production system. Waste is defined as those elements of the system (including design features and components of the final product) which do not provide value to the customer. Value is defined as anything that the customer is willing to pay for. The customer is defined as the entity that monetarily pays for the final product (which would include those that wholesale and distribute your products, but does not include internal customers, management, or other stakeholders in the production system).

A custom forge shop, like any other manufacturing facility, contains waste in its administrative and manufacturing processes, and therefore provides numerous opportunities to eliminate those wastes. Waste elimination is an immediate, often simple, strategy for any business organization to cut operating costs and improve profit margins. However, a custom forge shop, like any other machining, fabrication or assembly jobshop, is unlike the assembly facility of any OEM like Toyota, Ford, Maytag, Alcoa, Boeing (or their top-tier suppliers). Hence, a custom forge shop requires a distinct order and application of the *appropriate* Lean Tools in order to address specific opportunities

which exist with respect to the forging industry, and the specific internal culture of that organization.

Jobshop Lean (JSLEAN) provides concepts, tools and implementation strategies to map, reduce and manage the deployment of Lean Thinking in jobshops, specifically custom forge shops where monuments, batch-manufacturing processes, variable demand, and small lot sizes nullify many of the standard best practices of “Toyota Lean”.

Deliverables from this Workshop

- Understand the important differences between “Toyota Lean” and “Jobshop Lean”
- Learn the integrated use of Spaghetti Diagrams, Flow Process Analysis and Value Stream Mapping
- Learn the new computer-aided method – Value Network Mapping – to map and visualize a complex network of interacting Value Streams that share capacity-constrained resources in a typical jobshop
- Case study on how the PFAST software was utilized for material flow mapping and part family formation to understand the complex product mix of a custom forge shop
- Case study on how the PFAST software was utilized to design a flexible forge shop layout to produce different families of forgings without relocating the “monuments” in the facility
- Case study on the integration of Lean Thinking and Theory Of Constraints to design a flexible and demand-driven custom forge shop
- Understand how an ERP (Enterprise Resource Planning) system and FCS (Finite Capacity Scheduling) software can support timely flows of information in a custom forge shop
- Understand the challenges of leadership buy-in and culture change to transform from a batch-oriented to a waste-free and flexible “Lean” manufacturing system
- Discuss with peers the numerous opportunities, constraints and strategies for successful deployment of Lean Thinking in custom forge shops

*Jobshop*Lean: Lean Manufacturing in Custom Forge Shops

Agenda

August 3, 2004 (Chicago, IL)
August 5, 2004 (Los Angeles, CA)

TIME	TOPIC
7:00 – 8:00 a.m.	▪ Registration ▪ Breakfast
8:00 – 8:45 a.m.	(Shahrukh Irani, Ohio State University) Overview of Lean Manufacturing: ▪ What is Lean Manufacturing? ▪ What are the Seven Types of Waste in any Manufacturing System? ▪ What is the 5-step Process for Implementation of Lean Manufacturing? ▪ Enabler Strategies for Implementation of Lean Manufacturing ▪ Differences between "Toyota LEAN" and "Jobshop LEAN"
8:45 – 9:15 a.m.	(Richard Rooker, Green Bay Drop Forge) LEAN: Up Close and Personal
9:15 – 10:00 a.m.	• (Shahrukh Irani, Ohio State University) **PFAST:** Software for Group Technology (GT) and Production Flow Analysis (PFA) for JSLEAN Implementation[1] • (Shahrukh Irani, Ohio State University) Design of a "Lean Flow" Layout for a Custom Forge Shop using PFAST
10:00 – 10:15 a.m.	BREAK
10:15 – 10:45 a.m.	(Shahrukh Irani, Ohio State University) Value Network Mapping: Visualization and Analysis of Multiple Interacting Value Streams in a Jobshop
10:45 – 11:15 a.m.	(Shahrukh Irani, Ohio State University and Shardul Phadnis, Russell William Ltd.) Application of TOC and Drum-Buffer-Rope Scheduling to a High-Mix Low-Volume Manufacturing Environment
11:15 – 12:00 noon	(Shahrukh Irani, Ohio State University) Integration of Theory Of Constraints (TOC) and Lean Thinking in a Custom Forge Shop
12:00 – 1:00 p.m.	LUNCH
1:00 – 1:45 p.m.	(Sharon Hale, Jorgensen Forge) Implementing Lean Manufacturing in a Custom Forge Shop
1:45 – 2:30 p.m.	(George Schriver, Pratt & Whitney AutoAir Inc.) 4000 Part Numbers, Lot Sizes of One
2:30 – 2:45 p.m.	BREAK
2:45 – 3:30 p.m.	(Bill Kirchmier, Data Based Systems) Finite Capacity Scheduling (FCS) for Jobshops

[1] **PFAST (Production Flow Analysis and Simplification Toolkit)** is a software package for comprehensive analysis of material flows to support deployment of Lean Manufacturing in high-variety low-volume (HVLV) manufacturing facilities. For further information on PFAST, please visit http://www-iwse.eng.ohio-state.edu/ISEFaculty/home.html and click on "Irani, Shahrukh" to access the literature under "Research: Future Manufacturing and Production Facilities".

3:30 – 4:15 p.m.	(Mark Symonds, Plexus Systems) Utilizing an ERP/FCS System for JIT Shopfloor Control in a Custom Forge Shop
4:15 – 4:30 p.m.	**Forum Discussion:** Challenges, Opportunities and Successful Strategies for Deployment of JSLEAN in Custom Forge Shops (Chair: Doug Brown)
4:30 p.m.	**Adjourn**