A Quick-Start Approach for Implementing Lean in Job Shops

Dr. Shahrukh Irani, Director, IE Research,
at Hoerbiger Corporation of America

In the August issue of *Gear Technology*, we examined the lean tools that will and will not work in high-mix, low-volume manufacturing facilities. Now, we will examine how to implement the tools that will work in the job shop with an approach that expands the capabilities of value stream mapping.

A Quick-Start Approach for Implementing Lean in Job Shops

Figure 1 presents a flowchart for a "Quick-Start" (Q-S) approach for implementing lean in job shops. Perhaps the biggest departure from value stream mapping is the use of product-process matrix analysis of the entire product mix to find a clear-cut, significant and stable part family. Using a sample of routings from this particular part family, several industrial engineering analyses are done: (1) a spaghetti diagram to understand the flow disruptions due to the layout and building architecture, (2) a process flow chart to break down the product flow into activity elements and delays that are not captured in a value stream map, (3) a material handling analysis chart to understand the flow disruptions due to the material handling equipment and containers being used, (4) absence of Line-Of-Sight between key workcenters, (5) communications and logistics that support schedule execution, etc. The use of a video camera to make a live video recording of a "gemba walk" of the entire value network for the routings that were selected is strongly recommended.

Another unique feature of this approach is that in a job shop, where batch-and-queue flow is often the norm, it is advisable to use Theory of Constraints (TOC) to focus the initial Continuous Improvement events (kaizens) on the bottleneck work center used by this family of parts. There is a good chance that the bottleneck for this single part family could very well be the bottleneck for the entire facility. In which case, efforts to improve process yield, standardize tools and fixtures, error-proof machine settings, apply 5S, improve materials delivery schedules, reduce setup times, etc. on this workcenter will have widespread benefits. The bottleneck splits the value stream (or network, if the part routings are not identical) and helps to break up the material flow logistics into two parts: [Receiving → Bottleneck] and [Bottleneck → Shipping]. These two portions of the value network for the part family can be controlled using multi-product multi-machine pull scheduling mechanisms like CONWIP (CONstant WIP), drum-buffer-rope and finite capacity scheduling (my favorite method). By integrating the part family concept and TOC, the Q-S approach has always been an effective investment for evey job shop that has hired a student intern to implement JobshopLean during a three-month appointment.

A Comprehensive Approach for Implementing Lean in Job Shops

The real challenge is to implement JobshopLean in a comprehensive manner, unlike the quick-start approach. Figure 2 presents a flowchart for a comprehensive approach for implementing lean in job shops. At the core of this iterative approach is the expectation that (1) a job shop will utilize production flow analysis and/or group technology to identify the stable part families

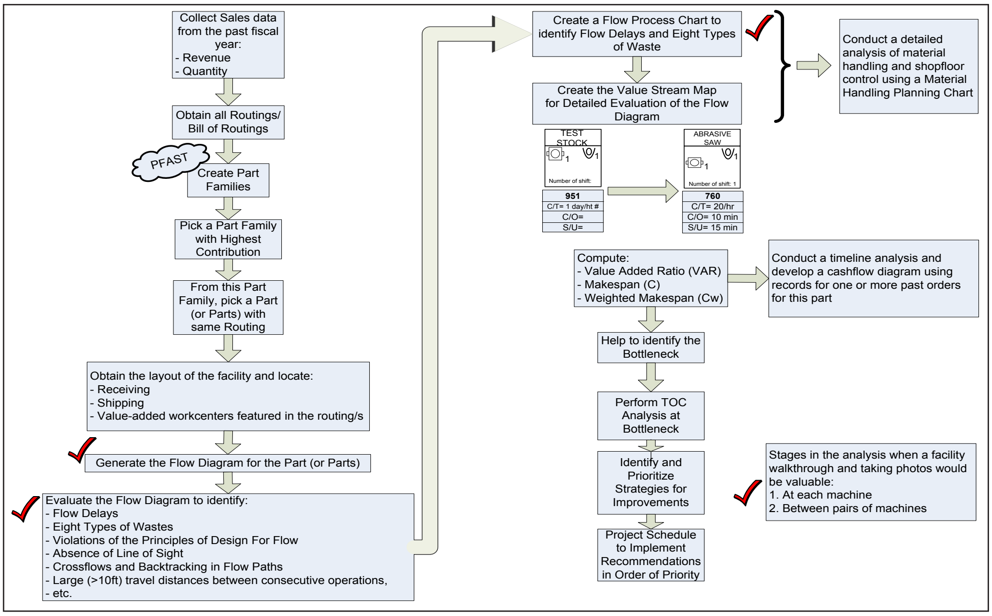

Figure 1 A Quick-Start Approach for Implementing JobshopLean.

FORGED NET and NEAR-NET GEARS

- Save Time and Money
- Dedicated State-of-The-Art Net and Near-Net Gear Manufacturing Facility
- .008 - .060 Stock Allowance on Gear Flanks
- ISO 9001:2008
- TS 16949:2009

Presrite Corporation
Phone: (216) 441-5990
www.presrite.com

in its product mix, and (2) will implement a flexible manufacturing cell to produce each part family. In theory, each iteration of the design process will result in a standalone flexible manufacturing cell dedicated to producing a part family. In reality, numerous constraints in the current state will need to be broken (e.g., operators will need to be trained to operate multiple machines in a cell and suitable group incentives put in place to ensure that the cell's team becomes autonomous) or will remain unbreakable (e.g., raw material single-sourced from China or heat treatment furnaces that cannot be placed inside a cell next to a CNC grinder). After a few iterations of this approach, a job shop would typically end up being divided into at least two areas: one area consisting of flexible manufacturing cells, with each cell dedicated to a product family and the other area being a "remainder shop" where the spare parts, prototypes and one-off orders are produced. By dividing the job shop into these two areas, two benefits are gained: (1) the cells provide unquestionable quick response, high quality, teamwork and other advantages that lean has amply demonstrated are gained from mixed model assembly cells and (2) instead of the entire business being managed as a complex job shop, a smaller portion of the same business now remains a complex job shop.

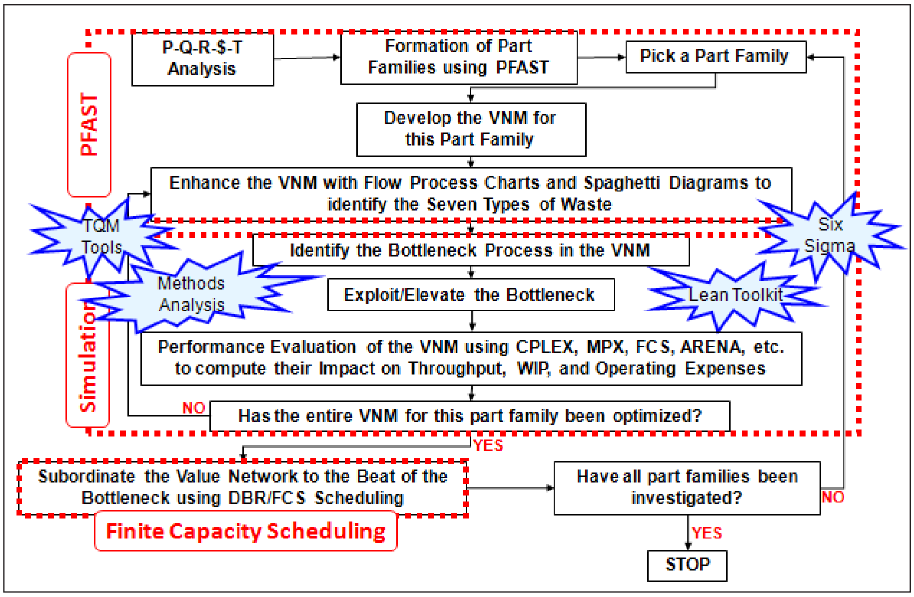

Figure 2 Comprehensive Approach for Implementing JobshopLean.

Cells: Building Blocks of JobshopLean

The cells are "mini job shops" and not mixed-model assembly cells, so they may not allow perfect one-piece flow. Still, due to increased proximity between consecutively used workstations, small batches of parts can be easily moved by hand or by using wheeled carts, short roller conveyors or Gorbel cranes. Recall that the amoeba and paramecium are single-cell organisms that are self-sufficient. Similarly, a manufacturing cell must be empowered to operate autonomously as a multi-prod-

uct multi-machine job shop. This is where lean tools, such as 5S, SMED, TPM, Poka-Yoke, Standard Work, etc. dovetail with JobshopLean *(Editor's Note: These were listed as "Tools that will work in any job shop" in the previous article that appeared in the August 2012 issue of* Gear Technology*)*. They ensure that the cell can become a self-sufficient business unit whose operations are not disrupted by defective materials, machine breakdowns, long setups, etc.

Key Steps in the Comprehensive Approach

This section briefly describes some of the key steps in the comprehensive approach for implementing lean in a job shop (Fig. 2). Product mix segmentation is the first step. The method used is PQR$T analysis (P = products, Q = demand, T = time over which the demand was recorded, R = routings, $ = sales). Segmentation helps the job shop to focus on a manageably large portion of its entire product mix that accounts for at least 80 percent of the total quantity of parts that were shipped and 80 percent of total earnings.

The sample of products selected by PQ$ Analysis is then analyzed using product-process matrix analysis to identify part families and the machine group that would constitute a flexible manufacturing cell to produce each part family. Each part family and its corresponding machine group appears as a block. The result of this analysis helps to identify the part families and machine groups that will constitute the flexible manufacturing cells (Fig. 3) where each cell would be dedicated to a product family. Now this is where the problem arises --- this analysis will highlight which resources will need to be shared resources by two or more cells. Not to worry! That problem becomes the "guiding light", the very basis for breaking the constraints that prevent the implementation of any cell. This product-process matrix analysis, which helps to visualize hundreds of value streams at the same time, is how any job shop could routinely pursue continuous improvement.

Finally, what does one do about the remainder of the product mix that was ignored by the PQ$ analysis? There is no cookie-cutter strategy that can be recommended. This is where each job shop's leadership team can exercise their creativity to develop unique, innovative strategies that they are willing to invest in implementing and sustaining. But, in a nutshell, here are some options: eliminate or outsource their manufacture, even if your company is listed as their supplier; seek additional business for them so they can be moved into one of the existing cells or utilize unused capacity in the cells to produce them.

Finally, having implemented the cell, it is required to schedule daily operations in each cell as well as coordinate the schedules of the cells with those for the shared resources, and, far more crucial, the vendors. This is best done using Gantt charts (Fig. 4) which was produced by a commercial finite capacity scheduling (FCS) tool, Preactor, that downloaded the firm orders and their due dates quoted to customers obtained from an ERP system (SAP). After the schedule generated by Preactor is released to the shop floor, it is monitored in real-time using our MES (Manufacturing Execution System) tool, Factoryviewer, to achieve shop floor control. Interested readers can contact the author to receive the contact information for the person who

Need lots of small teeth fast?

Toolink
Engineering, Inc.
303-776-6212
www.toolink-eng.com

The New GHO-80 (80mm/3.1") high production hobber by S&T Dynamics

has implemented this system at the Pompano Beach facility of Hoerbiger Corporation of America.

Lean and IT-Enabled Automation Must Co-Exist

Despite the incorporation of computer-aided data analysis, flexible automation, IT enablers, etc., people and the standard lean tools are absolutely essential for successful implementation of JobshopLean. IT-enabled systems, flexible automation, etc. demand an even greater reliance on a process of continuous improvement to eliminate the myriad problems that arise when computer-aided process execution is disrupted by the vagaries of the dynamic shop floor. For example, one vagary that will disrupt any computer-generated schedule is the non-availability of an operator to run a job on a machine right at the time when the schedule requires it. Why? For reasons such as skill grade, absenteeism, breaks, etc. Add other vagaries such as machine breakdowns, missing tools, defective parts requiring rework, scrapped parts, vendor delivery failures, etc. At my company, IT is an enabler and supporter, not a replacement, for the minds of our employees!

(Editor's Note: The original draft had to be edited due to space constraints. Readers interested in receiving the full-length version of this article may contact the author at shahrukh.irani@hoerbiger.com*).*

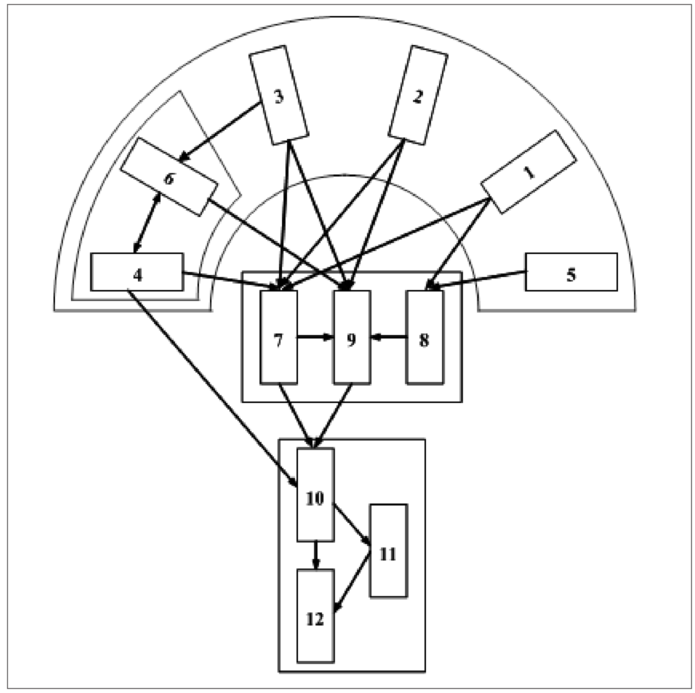

Figure 3 Example of a Flexible Machining Cell.

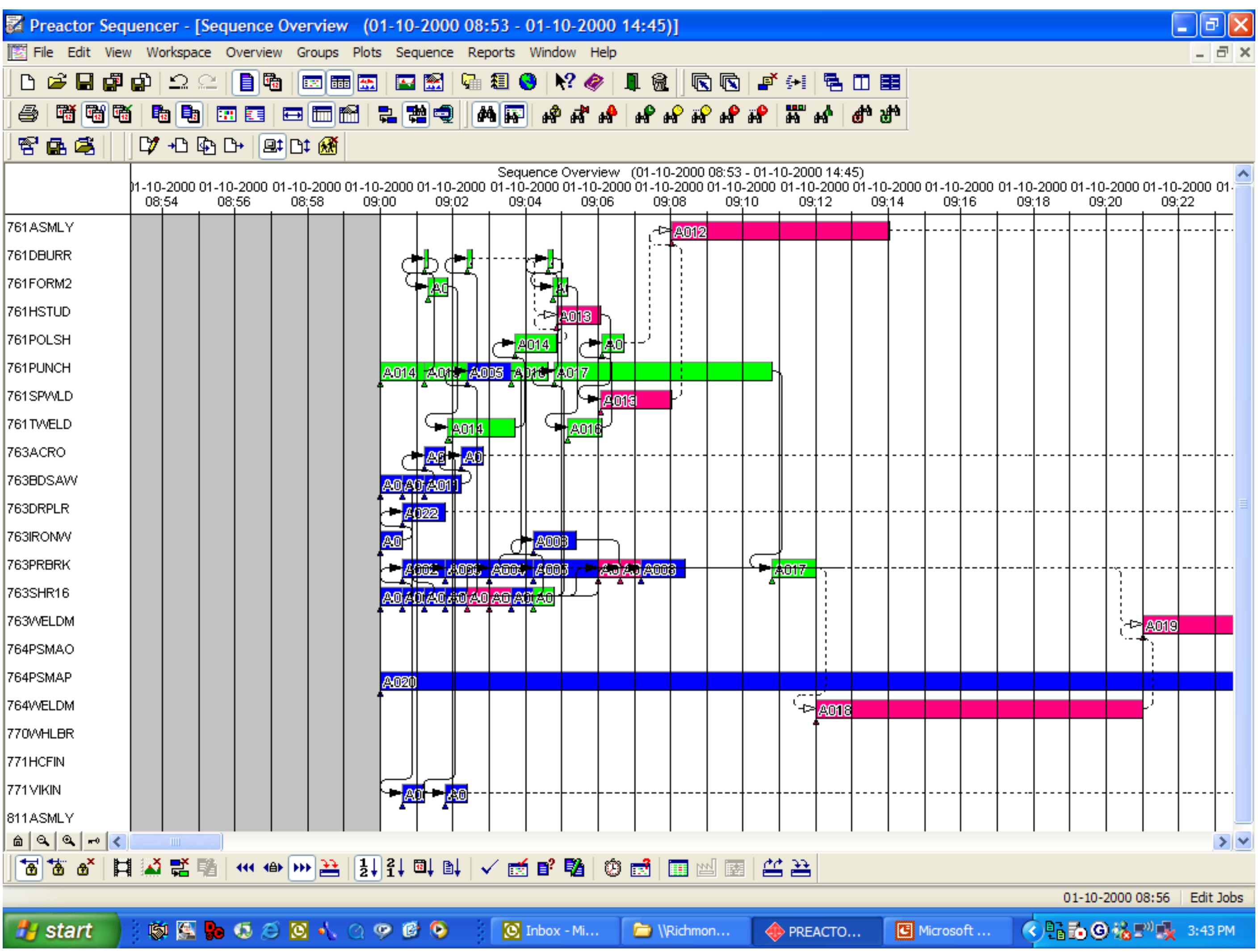

Figure 4 Finite Capacity Schedule displayed as a Gantt Chart.