GORDIAN
TRANSFORMATION PARTNERS

EXPLORING THE MYSTERIOUS CONCEPT OF PULL

"A Moving Experience"

by Phil Rodgers | December 15, 2004 |

10 Glenlake Parkway, Suite 130 | Atlanta, GA 30328 | tel. (678) 353-3378

Executive Insights
Gordian Transformation Partners Inc.

Overview

A Pull Production System has been hallmarked as a means to solve many production-related problems in an industrial environment. This belief is based on the concept of producing only in accordance with the needs of a company's internal or external customers. If true, this would have a substantial impact on a company's profitability. But, this benefit has a price. To be effective and efficient, specific production processes must be affected and ultimately improved. Only then will a Pull Production System satisfy the strict demands and criteria of its methodologies.

To better understand the specific production processes that will have to be affected, let's look at a few variables in play:

- Machine set-up and die changeover times.
- Production schedules.
- Equipment downtime and Product rework.
- Production batch sizes.
- Bottlenecks within specific production processes.
- Lead times from suppliers.

A valid Pull Production System demands a significant improvement in each of the prerequisites. Efforts to implement a Pull Production System before making the necessary improvements will simply fail.

Getting to specifics, let's start with *Machine Set-up and Die Changeover Times.* These have to be shortened significantly in order to be effective in responding to any production signal. Further, with changeover costs being proportional to changeover times, improvements to this process will directly impact overall operational costs. In addition, a shortened machine set-up and die changeover time requires a reduced finished goods inventory position due to increased responsiveness to demands. And a reduced machine set-up and die changeover time provides additional equipment uptime -- resulting in an increase to overall production throughput. Finally, by obtaining the capability for "quick" set-up and changeover times, the affected production processes will be more responsive and flexible to Customer demands.

The next improvement would be minimizing the variability of the *Production Schedule*. Since a Pull Production System starts production only when there is a demand for a product by an internal or external customer, large variations in demand will cause production levels to fluctuate greatly. This also strains the manpower and material resources needed to meet these demands. By stabilizing or "freezing" the daily production schedule, fluctuations are minimized, which directly impacts levels of raw and W-I-P inventories as well as other related production resources and expendables.

The third obstacle to the successful implementation of the Pull Production System is excessive E*quipment Downtime and continual Quality Stops requiring Product Rework*. Each production

process must be made to be "robust" in design. This allows it to perform at peak efficiency as well as at a higher degree of process repeatability in order to eliminate product variability. This reduces unnecessary product rework created by quality-related issues. Further, the "wellness" of critical production equipment will directly increase the uptime of each production process; thus, equipment capacity is provided. This can only be achieved through a structured and reliable Equipment Maintenance Program; one that encompasses extensive Preventive Maintenance Program and a Maintenance Work Order System with a controlled "backlog" of Work Orders. The reliability and repeatability of each production process is essential to respond to any production signal.

The fourth obstacle is *Production Batch Size*. It is critical to have a production batch size that is small and manageable in order to provide the flexibility that the Pull Production System dictates. By this, the resources of materials and manpower could be controlled; thus, reducing unnecessary expenditures to the company.

The fifth obstacle concerns *Critical Bottlenecks within a Production Process*. Applying the Theory of Constraints to overcome this barrier, the bottleneck will be scheduled first with subsequent as well as prior to processes being forced to meet its scheduling requirements. This is how the production line becomes "balanced" in material and manpower resource utilization; thus, unnecessary expenditures of resources are reduced.

The sixth and final obstacle addresses *Lead Times from the Suppliers*. When lead times are long and/or cover vast spans of distance, on-time delivery of critical parts and/or subassemblies will be difficult to maintain. In general, being physically close to suppliers reduces these lead times.

Concept

Part of the difficulty in assessing the effectiveness of Pull Production Systems is no a common understanding of what the term "pull" actually within a manufacturing environment. We can clarify this understanding by considering these rules:

- Pull production control is a consumption-based replenishment system based on the concept that production is only scheduled or authorized to replenish material that has been consumed by a downstream operation or by an internal or external customer.
- The concept is not a zero-based inventory system, since it replenishes what has been consumed. There must be some inventory present at all times within the system.

- There is always a finite limit to the work-in-process inventory throughout the system.

- Pull systems control work-in-process; it is an observed production parameter. Further, output rates are continually being measured throughout each shift and evaluated for effectiveness to the total production process daily. There is immediate feedback on the output rate of the process.

- Pull production control should not be compared to the concept of make-to-order. Instead, it is a consumption driven process.

- A pull system is a closed, balanced process; thus, incoming material does not enter the system until outgoing material has exited.

In a Pull Production System, the system pace is determined by the slowest workstation in the overall system. A worker cannot pass on any work to the next station until the next station has passed its work on to its subsequent station. Is this a waste of vital resources? Not at all, since it is impossible to produce any faster than the slowest workstation in the system anyway. The only thing that happens when workers produce at their individual pace is that work-in-process inventories begin to build and could become out of control. The Pull Production System keeps the process more visible and controlled, making the production environment cleaner. A paramount principle that should be remembered with this is that work-in-process inventory can hide process problems and create messes that always cause confusion.

Benefits to be realized

With a successful implementation, the following benefits are achievable in varying degrees:

- Reduced Work-in-Process Inventory and Cycle Time – by regulating the amount as well as frequency of releases into the system, the level and value of WIP becomes lower. Explosions in the volume and value of WIP are controlled by its increased visibility throughout the entire production process. This also translates into a shorter manufacturing cycle time, providing critical capacity to the overall production process.

- Smoother Production Flow – by dampening the fluctuations in the WIP level, a steadier, more predictable output stream of product is achieved.

- Improved Quality – a system with short queues cannot tolerate high levels of yield loss and rework because these will quickly shut down the production line. Additionally, short queues reduce the time between creation and detection of a defect. This system creates pressure for enhanced quality and provides an environment in which it can be achieved.

- Reduced Cost – by improving each production process in the following problem areas:
  - Machine set-up and die changeover times.
  - Production schedules.
  - Equipment downtime.
  - Production batch sizes.
  - Bottlenecks within each production process.

Current Applications and Future Development

Because stabilizing effects on the production flow and many other process-related benefits derived from the Pull Production System, it is an integral component of an overall lean manufacturing system. As such, you can expect pull systems to be frequently used during the early stages of a lean transformation.

But this is often not the situation. Many managers consciously avoid implementing pull systems. And for some, pull systems are among the last practices instituted. One major reason for such reluctance is that the manufacturing manager must conceive their operation in a totally new way; change can impede many things. Specifically, the profitability of the overall process must take precedence over the profitability of individual departments or processes.

Another reason for the lack of adoption is the inability to implement the required improvements outlined by our six obstacles. In their joint paper, Charles Standard and Dale Davis state:

> "There is nothing about any of these improvements that uniquely prepares a factory for pull system implementation. By portraying these as prerequisites, we are actually discouraging manufacturing managers from pursuing pull systems at all, denying them the multiple, and in many cases immediate, benefits associated with the implementation".

A specific benefit that can be realized within the implementation of a well-designed pull system is the virtual elimination of stock-outs throughout the production process. By this, there would be fewer interruptions within the material flow which would impact cycle times by being reduced.

An additional point that Standard and Davis present:

> "The greatest strengths of pull production control are its robustness and insensitivity to implementation errors and unsatisfied assumptions. Pull systems work well in the presence of variability and uncertainty, and they provide many of the same benefits that are associated with the 'prerequisites' listed above. Implementing pull production control is an excellent way for a manufacturer to realize those benefits while the more general operational improvements are being pursued in parallel".

In order to properly control a Pull Production System, an effective Shop Floor Control is critical. To achieve this, each Shop Floor Control must satisfy the following 4 objectives:

- It must efficiently *coordinate manufacturing resources* (material, knowledge, manpower, and information) throughout the production process.

- It must provide *real time control* in the following areas:
  - Quantity and location of materials between different workstations.
  - Capability of monitoring not only the status and condition of critical production equipment, but also the utilization of manpower resources applied to the production processes.
  - Throughput tracking which measures the output from a production line against a pre-determined production quota or customer due date.

- It provides must provide *capacity feedback* that is based in the collection of data to continually update capacity estimates.

- It must enable *quality control* authority by the receiver or downstream operator, as dictated by pre-determined quality standards.

The implementation of a Pull Production System can be a successful way to increase productivity through the elimination of production disruptions and reduction of cycle times. A structured Shop Floor Control provides a mechanism to monitor, give immediate feedback, and yield critical performance data to this system. Additional operational performance measurements will be

directly effected when the six obstacles have been surmounted. As a result, service will be enhanced to not only the internal, but external customers of the system.

Bibliography

Hall, R.W. *Zero Inventories*, Dow Jones-Irwin, Homewood, IL, 1983.
Hopp, W.J. and M.L. Spearman, *Factory Physics: Foundations of Manufacturing Management*, McGraw-Hill, New York, 2001.

Inman, R.R. "Are You Implementing a Pull System by Putting the Cart Before the Horse?" *Production and Inventory Management Journal*. Vol. 40, No. 2 (1999). pp 67-71.

Kimura, O. and H. Terada. "Design and Analysis of Pull Systems, A Method of Multi-stage Production Control". International Journal of Production Research. Vol. 19, No. 3, (1981). pp 241-53.

Monden, Yasuhiro. *Toyota Production System: Practical Approach to Management*, Industrial Engineering and Management Press, Norcross, GA, 1983.

Ohno, T. *Toyota Production System: Beyond Large Scale Production*, Productivity Press, Cambridge, MA, 1988.

Shingo, Shigeo. *A Revolution in Manufacturing: The SMED System*, Productivity Press, Cambridge, MA, 1985.

Standard, Charles and Dales Davis. *Pull Systems: Implementation Experience in American Manufacturing*, Twelfth Annual Conference of the Production and Operations Management Society, Orlando, FL, 2001.

Womack, J.P., D.T. Jones and D. Roos. *The Machine That Changes the World: The Story of Lean Production*, HarperCollins Publishers, New York, 1990.

Womack, J.P. and D.T. Jones. *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Simon & Simon, New York, 1996.