FactoryPhysics

WHITE PAPER SERIES

TO PULL OR NOT TO PULL, WHAT IS THE QUESTION?

PART I: WHAT IS LEAN?

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1 Introduction

The world of manufacturing management seems to affirm Newton's Third Law of Consultants: *"For every expert, there is an equal and opposite expert."* Within Lean Manufacturing circles, this is especially true. Even the basic definition of push and pull has been confused.

In these two papers, we will provide a short history of Lean Manufacturing detailing its roots at Toyota and how it has evolved since. We also separate the myth from the science to determine the true reasons for the successes (and the failures) of Lean Manufacturing. The reader, armed with this knowledge, will be able to apply these basic principles to create a "lean" production system that might or might not look like that of Toyota but will be uniquely suited for his particular plant.

2 A Brief History of Lean

Before the computer, most manufacturing control was done using reorder-point/reorder-quantity (ROP/ROQ) methods of inventory control. During the 1960's, Joseph Orlicky, working for IBM, developed a new system: Material Requirements Planning or MRP. During the 1970's MRP caught on like wildfire, fueled by the "MRP Crusade" of the American Production and Inventory Control Society (APICS). Orlicky reported 150 implementations in 1971. By 1981, the number had grown to around 8,000. Soon, MRP was replaced by Manufacturing Resources Planning (MRP II) which combined MRP with Master Scheduling, Rough-Cut Capacity Planning, Capacity Requirements Planning, Input/Output Control and other modules. In 1984 alone, 16 companies sold $400 million in MRP II software. In 1989, over $1.2 billion was sold to American industry, constituting just under one-third of the entire software industry (see Hopp and Spearman, 2001, for a more complete history of MRP/MRP II).

On the other hand, history took a different course in Japan. The computer took far longer to take hold of production control and several Japanese companies, most notably Toyota, developed the ROP/ROQ methods to a high level. Taiichi Ohno, starting in the 1940's began to develop a system that could compete with America that would not depend on efficiencies resulting from long production runs. This system, now known as the "Toyota Production System," was based on the desire to "make goods, as much as possible, in a continuous flow." (Ohno 1988). According to Ohno, the Toyota Production System rests on two "pillars:"

1. "Autonomation"
2. Just-in-time production

Autonomation, or "automation with a human touch," is the practice of determining the optimal way to perform a given task and then making this the "best practice" standard method. Autonomation also involved "fool proofing" or "*poke yoke*." Devices to quickly check dimensions and other quality attributes were developed to allow a worker to be responsible for his own quality. If problems were found, production stopped until the problems were corrected. This eliminated the need for rework lines and, eventually, eliminated most scrap. "5S," *Seiri, Seiton, Seiso,* and *Shitsuke*, are housekeeping techniques aimed at achieving Autonomation and Visual Control.

Just-in-time production involved two aspects: kanban and level production. Kanban or "pull production" became the hallmark of the Toyota Production System (also known as Just-In-Time) to the point where many thought they were synonymous. But kanban was just a means to achieve an end. Ohno's motivation for kanban came from a visit to the U.S. in the 1950's in which he was more impressed with American supermarkets than with American manufacturing. The idea of having all goods available at all times was, to Ohno, novel and revolutionary. Ohno describes the development of kanban from this experience:

> *From the supermarket we got the idea of viewing the earlier process in a production line as a kind of store. The later process (customer) goes to the earlier process (supermarket) to aquire the needed parts (commodities) at the time and in the quantity needed. The earlier process immediately produces the quantity just taken (re-stocking the shelves).* (Ohno, 1988, p. 26)

To do this, Ohno had to make some major system changes. If the supermarket was to replenish what was just taken, lot sizes had to be drastically reduced. To achieve the efficiencies needed, Ohno embarked on ways to reduce change over times. In 1945 these setups were 2-3 hours. By 1962 they were 15 minutes and by 1971 some were down to 3 minutes. With such short change overs, Ohno could achieve "one piece flow" and just-in-time production.

In a 1990 interview, Ohno claimed that Toyota considered the system so powerful that they deliberately coined misleading terms and words to describe it. "If in the beginning the U.S. had understood what Toyota was doing, it would have been no good for us." (Myers 1990).

During the early 1980's, American manufacturers became enamored with everything Japanese. While MRP sales continued to climb, many were thinking that MRP had been a mistake. A 1980 survey showed that less than 10% of the firms interviewed had recouped their investment within two years (Hopp and Spearman, 2001). Soon, MRP was out and JIT was in. At this time, many books appeared on Just-In-Time. One of the first was Schonberger's, *Japanese Manufacturing Techniques: Nine Lessons in Simplicity* in 1982, followed in 1983 by Monden's *The Toyota Production System* and Hall's *Zero Inventories*. Singo published a book on setup reduction in 1985, *The SMED System*. Ohno's book finally appeared in 1988.

Despite the success of JIT at many firms, it was soon eclipsed by a new innovation—Enterprise Resources Planning or ERP.

With the development of the client/server information technology architecture, it became feasible to integrate virtually all of the business applications of a corporation with a common data base. The attraction was increased with the enticement of "best of breed" software. Of course, ERP was much more complex than MRP II and implementation costs soared with some companies spending as much as $250 million. In spite of the price tag and the growing number of implementation horror stories, ERP continued to grow in popularity. As fear of the Millennium Bug increased, ERP was installed at a feverish rate.

At the same time, the Toyota Production System continued to attract attention. In 1990, a landmark case study was published in *The Machine That Changed the World* by Womack, Jones and Roos. This study compared American, European, and Japanese automobile manufacturing techniques with the Japanese, and particularly Toyota, coming out on top. JIT was recast as "Lean Manufacturing" and again people began to study the system created by Taiichi Ohno.

3 What is Pull?

"Pull production" has become the hallmark of Lean production. However, Ohno discussed pull only in very general and strategic terms.

> *Manufacturers and workplaces can no longer base production on desktop planning alone and then distribute, or push, them onto the market. It has become a matter of course for customers, or users, each with a different value system, to stand in the front line of the marketplace and, so to speak, pull the goods they need, in the amount and at the time they need them.* (Ohno, 1988, p. xiv)

In other words, one should not simply make a large amount of stock and then try to go and sell it. One needs to be aware of the market and pay attention to the customer. While this might sound like common sense today, it was revolutionary for the mid 20th Century.

Unfortunately, during the JIT craze, this strategic kind of pull became mixed up with tactical pull methods such as kanban. By the mid 1980's, MRP was known as the archetypical push system while kanban was the archetypical pull system. Equating just-in-time with the Toyota Production System created even more confusion especially with Ohno's declaration that "kanban is a tool for realizing just-in-time."

By the 1990's there was no clear definition. The success of *The Machine That Changed the World* was followed by a second book by Womack and Jones, *Lean Thinking* in 1996. While Ohno's book was short on details, it was clear in basic philosophy. *Lean Thinking* had many details of the author's experience but gone was the simplicity and clear thinking of Ohno. In fact, much of the thinking became downright muddled. For instance, in the chapter titled, "Pull" Womack and Jones begin,

> Pull *in simplest terms means that no one upstream should produce a good or service until the customer downstream asks for it, but actually following this rule in practice is a bit more complicated.*

If we compare this with Ohno's supermarket experience, we see that following this rule would indeed become "a bit more complicated" given that the grocer would now have to wait for the customer to ask for his groceries before stocking them. The book was the first of many books and articles that began to confuse the meaning of pull. Many authors now state that pull is make-to-order while push is make-to-stock. During Ohno's tenure, Toyota maintained a level production schedule that was far from made-to-order. They spent a great deal of time determining what the customer wanted, limited the options, and then fixed the final assembly schedule for months at a time. This is why Ohno gives so much importance to level production and why Monden provides an algorithm for smoothing production.

Nonetheless, many today believe that MRP is make-to-forecast while Lean is make-to-order. Of course, if the Master Production Schedule is made up of firm orders, MRP is completely make-to-order. A quick search on the Internet is replete with examples such as Turbide, in "Flow Manufacturing–A Strategy White Paper" (1999) which states, "In a pull environment, the customer order triggers production, not a forecast or a plan." Exactly the opposite is true. In Ohno's plant, the level production *plan* was made from a *forecast*. At Toyota, production was triggered to "restock" the shelves so that whenever the part was needed it would be available.

In the next installment of this paper, we will "get back to basics" and then describe the way the Toyota Production System really works using a new science of manufacturing called *Factory Physics.*

Bibliography

1. Hall, R.W., *Zero Inventories*, Dow Jones-Irwin, Homewood, IL, 1983.
2. Hopp, W.J. and M.L. Spearman, *Factory Physics: Foundations of Manufacturing Management*, McGraw-Hill, New York, 2001.
3. Karmarkar, U.S. "Push, Pull and Hybrid Control Schemes," Working Paper Series No. QM8614, Graduate School of Management, University of Rochester (1986).
4. Meyers, F.S., "Japan's Henry Ford," *Scientific American* 262 (1990):5, 98.
5. Monden, Yasuhiro., *Toyota Production System: Practical Approach to Management*, Industrial Engineering and Management Press, Norcross, GA, 1983.
6. Ohno, T. *Toyota Production System: Beyond Large Scale Production*, Productivity Press, Cambridge, Mass, 1988.
7. Schonberger, R.J. 1982. *Japanese Manufacturing Techniques: Nine Hidden Lessons in Simplicity*, New York: The Free Press.
8. Shingo, Shigeo, *A Revolution in Manufacturing: The SMED System*, Productivity Press, Cambridge, MA (1985)
9. Turbide, D.A. "Flow Manufacturing—A Strategy White Paper," at www.powercerv.com/downloads/flow.p 1999.
10. Womack, J.P., D.T. Jones and D. Roos, *The Machine That Changed the World: The Story of Lean Production*, HarperCollins Publishers, New York, 1990.
11. Womack, J.P. and D.T. Jones, *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Simon & Schuster, New York, 1996.