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Agile Software Development

Part 4: The Lean Memeplex*

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* The term *memeplex* was coined by *P. Kruchten*. See his article *Voyage in the agile memeplex* in ACM Queue, Vol. 5, No. 5, pg. 38 for details.

The Lean Memeplex

Origins of lean production – Japan in the 1940s

In the 1940s Japan was devastated from the war.

> Japan had in fact in 1950 negative net worth. Japan was, as now, devoid of natural resources - oil, coal, iron ore, copper, manganese, even wood.
>
> Moreover, Japan had a well-earned reputation for shoddy consumer goods, cheap, but worth the price.
>
> Japan must export goods in return for food and equipment. This battle could be won only with quality.
>
> Source: W. Edwards Deming: *Out of the Crisis*, MIT Press, 2000

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Origins of lean production – Japan in the 1980s

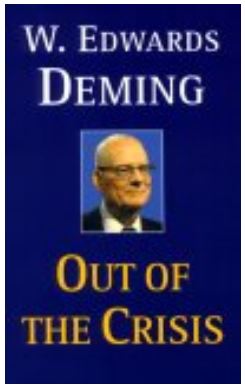
By using management techniques of *W. Edwards Deming* and others, Japan transformed itself into a world class economy.

- On June 24, 1980 at 9.30 p.m., NBC broadcasted the documentary

> If Japan Can..... Why Can't We?
>
> Source: Swiss Deming Institute, www.deming.ch

What happened ?

- Literature recommendation:



W. Edwards Deming. *Out of the Crisis*. MIT Press 2000, (originally published 1986)

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Origins of lean production – TPS

The innovations in Japan were most visible through its automotive industry, in particular the approach pioneered by Toyota *(Toyota Production System, TPS)*.

> One way to avoid the large penalty for a change during final production is to make the right design decision in the first place and avoid the need to change later. That was the Detroit approach.
>
> Toyota and Honda had discovered a different way to avoid the penalty of incorrect design decisions: Don't make irreversible decisions in the first place; delay design decisions as long as possible, and when they are made, make them with the best available information to make them correctly.

Source: M. Poppendieck, T. Poppendieck: *Lean Software Development – An Agile Toolkit*, Addison-Wesley, 2003

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Lean Production

The basis of the Toyota production system is the absolute elimination of waste. The two pillars needed to support the system are:

- just-in-time
- autonomation, or automation with a human touch.

Just-in-time means that, in a flow process, the right parts needed in assembly reach the assembly line at the time they are needed and only in the amount needed.

Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 4

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Waste *(muda)*

> Muda. It's the one word of Japanese you really must know. It sounds awful as it rolls off your tongue and it should, because muda means "waste," specifically any human activity which absorbs resources but creates no value [...].
>
> Taiichi Ohno (1912-1990), the Toyota executive who was the most ferocious foe of waste human history has produced, identified the first seven types of muda [...]

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 15

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Waste

The preliminary step toward application of the Toyota production system is to identify wastes completely:

- Waste of overproduction
- Waste of time on hand (waiting)
- Waste in transportation
- Waste of processing itself
- Waste of stock on hand (inventory)
- Waste of movement
- Waste of making defective products

Eliminating these wastes [...] completely can improve the operating efficiency by a large margin.

Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 19

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Just-in-time

Managing parts made too early, however, means carrying a lot of intermediate workers. The word "just" in "just-in-time" means exactly that. If parts arrive anytime prior to their need – not at the precise time needed – waste cannot be eliminated.

In the Toyota production system, overproduction is completely prevented by kanban. As a result, there is no need for extra inventory and, consequently, there is no need for the warehouse and its manager.

Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 28

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Kanban

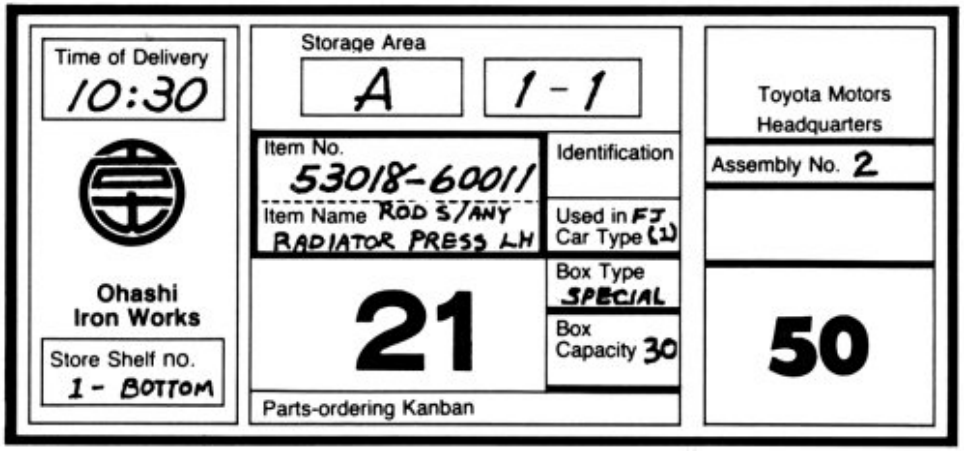

Image source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 27

> Basically, a kanban is a simple and direct form of communication always located at the point where it is needed. In most cases, a kanban is a small piece of paper inserted in a rectangular vinyl envelope. On this piece of paper is written how many of what part to pick up or which parts to assemble.
>
> Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 123

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Autonomation - I

I think a business should have reflexes that can respond instantly and smoothly to small changes in the plan without having to go to the brain. [...]

The larger a business, the better reflexes it needs. If a small change in a plan must be accompanied by a brain command to make it work [...], the business will be unable to avoid burns or injuries and will lose great opportunities.

Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 46

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Autonomation - II

At Toyota, we began to think about how to install an autonomic nervous system in our own rapidly growing business organization. In our production plant, an autonomic nerve means making judgments autonomously at the lowest possible level; for example, when to stop production, what sequence to follow in making parts, or when overtime is necessary to produce the required amount.

Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 45

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Autonomation - III

Autonomation means transferring human intelligence to a machine. The concept originated with the auto-activated loom of Toyoda Sakichi. [...]

At Toyota, this concept is applied not only to the machinery but also to the production line and the workers. In other words, if an abnormal situation arises, a worker is required to stop the line.

Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 121

Compare that with the adaptive concepts. Any similarities ?

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Andon

Andon, the line-stop indicator board hung above the production line, is a visual control. The trouble indicator light works as follows:

When operations are normal, the green light is on. When a worker wants to adjust something on the line and calls for help, he turns on a yellow light. If a line stop is needed to rectify a problem, the red light is turned on. To thoroughly eliminate abnormalities, workers should not be afraid to stop the line.

Source: T. Ohno. *Toyota Production System*. Productivity Press, 1988, pg. 121

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More than tools and techniques? Yes!

> In the Toyota Way, it's the people who bring the system to life: working, communicating, resolving issues, and growing together. From the first look at excellent companies in Japan practicing lean manufacturing, it was clear that the workers were active in making improvement suggestions. But the Toyota Way goes well beyond this; it encourages, supports, and in fact demands employee involvement.
>
> Source: J. K. Liker. *The Toyota Way*. McGraw-Hill, 2004

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More than tools and techniques? Yes!

> The more I have studied TPS and the Toyota Way, the more I understand that it is a system designed to provide the tools for people to continually improve their work. The Toyota Way means more dependence on people, not less. It is a culture, even more than a set of efficiency and improvement techniques. You depend upon the workers to reduce inventory, identify hidden problems, and fix them.
>
> Source: J. K. Liker. *The Toyota Way*. McGraw-Hill, 2004

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The 14 Toyota Way Principles

J. Liker identifies the following 14 Toyota Way principles:

1. Base your management decisions on a long-term philosophy, even at the expense of short-term financial goals.
2. Create continuous process flow to bring problems to the surface.
3. Use "pull" systems to avoid overproduction.
4. Level out the workload *(heijunka)*. (Work like the tortoise, not the hare.)

Source: J. K. Liker. *The Toyota Way*. McGraw-Hill, 2004, pg. 37 ff.

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The 14 Toyota Way Principles

5. Build a culture of stopping to fix problems, to get quality right the first time.
6. Standardized tasks are the foundation for continuous improvement and employee empowerment.
7. Use visual control so no problems are hidden.
8. Use only reliable, thoroughly tested technology that serves your people and processes.
9. Grow leaders who thoroughly understand the work, live the philosophy and teach it to others.

Source: J. K. Liker. *The Toyota Way*. McGraw-Hill, 2004, pg. 37 ff.

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The 14 Toyota Way Principles

10. Develop exceptional people and teams who follow your company's philosophy.
11. Respect your extended network of partners and suppliers by challenging them and helping them improve.
12. Go and see for yourself to thoroughly understand the situation *(genchi genbutsu)*.
13. Make decisions slowly by consensus, thoroughly considering all options; implement decisions rapidly.
14. Become a learning organization through relentless reflection *(hansei)* and continuous improvement *(kaizen)*.

Source: J. K. Liker. *The Toyota Way*. McGraw-Hill, 2004, pg. 37 ff.

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Lean Thinking

> [T]here is a powerful antidote to muda: lean thinking. It provides a way to specify value, line up value-creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively.
>
> In short, lean thinking is lean because it provides a way to do more and more with less and less – less human effort, less equipment, less time, and less space – while coming closer and closer to providing customers with exactly what they want.

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 15

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Value

The critical starting point for lean thinking is value. Value can only be defined by the ultimate customer. And it's only meaningful when expressed in terms of a specific product (a good or a service, and often both at once) which meets the customer's needs at a specific price at a specific time. Value is created by the producer. From the customer's standpoint, this is why producers exist.

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 16

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Value Stream

The value stream is the set of all the specific actions required to bring a specific product (whether a good, a service, or, increasingly, a combination of the two) through the three critical management tasks of any business: the *problem-solving task* running from concept through detailed design and engineering to production launch, the *information management task* running from order-taking through detailed scheduling to delivery, and the *physical transformation task* proceeding from raw materials to a finished product in the hands of the customer.

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 19

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Example – Value stream for Cola cans

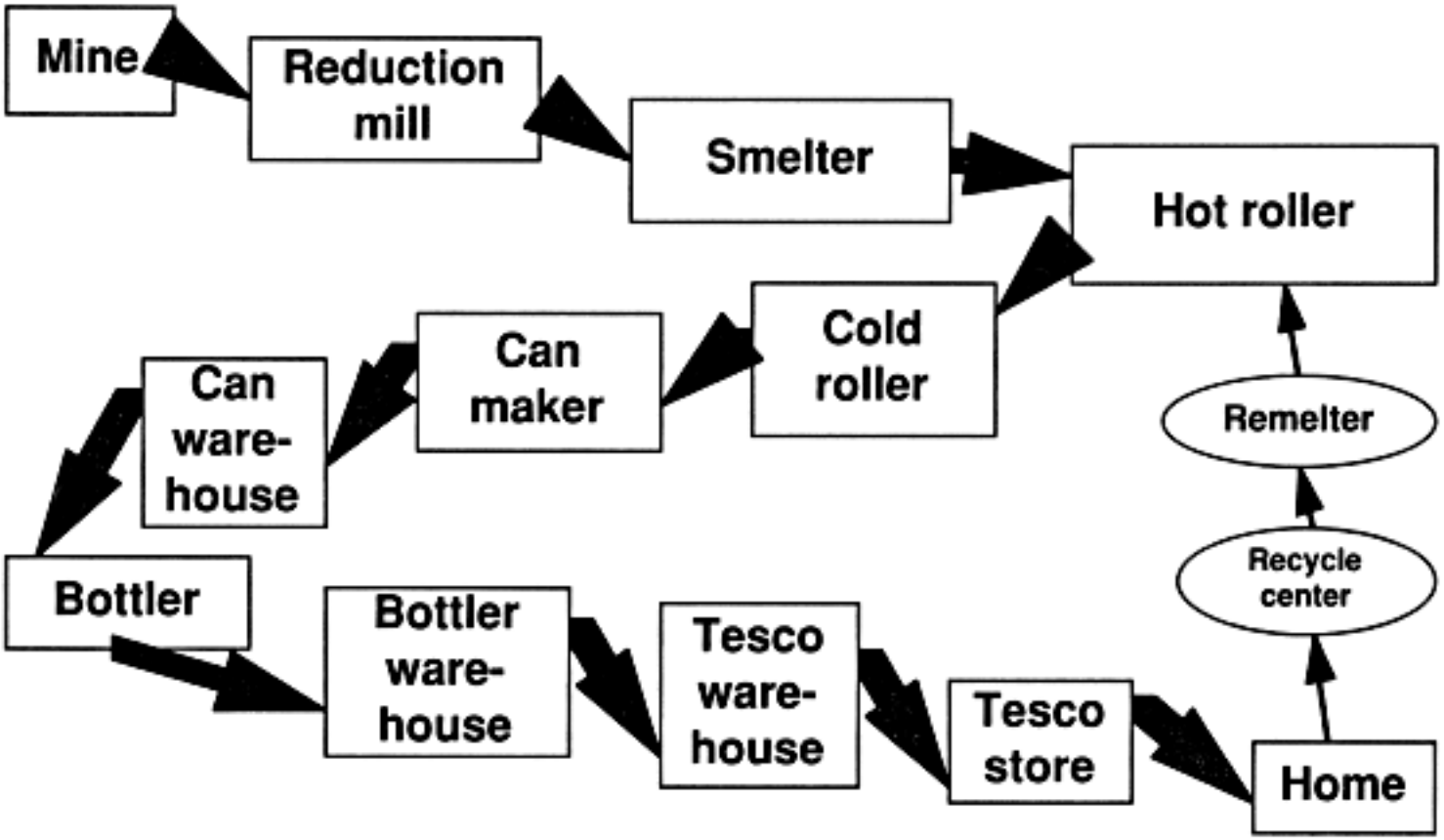

Image source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003, pg. 39

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Example – Confluence of Cola value streams

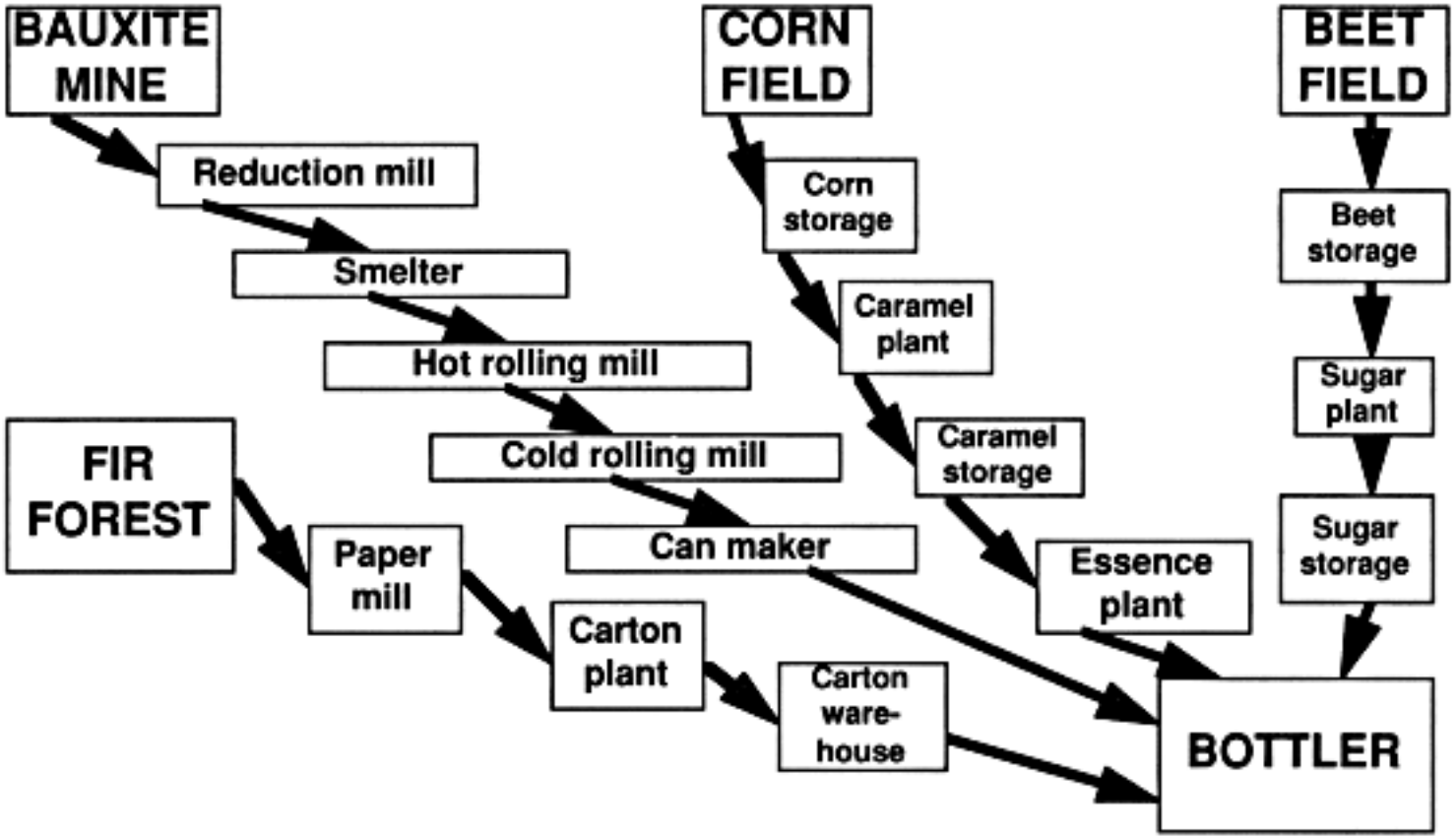

Image source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003, pg. 42

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Identifying the entire value steam for a product

> [V]alue stream analysis will almost always show that three types of actions are occurring along the value stream: (1) Many steps will be found to unambiguously create value: welding the tubes of a bicycle frame together [...]. (2) Many other steps will be found to create no value but to be unavoidable with current technologies and production assets: inspecting welds to ensure quality [...] (we'll term these Type One *muda*). And (3) many additional steps will be found to create no value and to be immediately avoidable (Type Two *muda*).

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 19

Examples for Type 1 and Type 2 muda in software development ?

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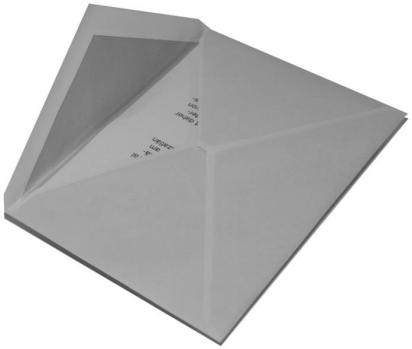
Flow



[T]he next step in lean thinking [is to make] the remaining, value-creating steps flow. [...]
We are all born into a mental world of „functions“ and „departments,“ a commonsense conviction that activities ought to be grouped by type so they can be performed more efficiently and managed more easily. In addition, to get tasks done efficiently within departments, it seems like further common sense to perform like activities in batches.

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 21

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Flow

Taiichi Ohno blamed this batch-and-queue mode of thinking on civilization's first farmers, who he claimed lost the one-thing-at-a-time wisdom of the hunter as they became obsessed with batches (the once-a-year harvest) and inventories (the grain depository). Or perhaps we're simply born with batching thinking in our heads, along with many other "common sense" illusions [...].

The most basic problem is that flow thinking is counterintuitive; it seems obvious to most people that work should be organized by departments in batches.

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 22

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Counter-example: monumental software development

Typical example of monumental software development in the late 1970s:

> Start at the top of the organization; translate business needs into detailed models, particularly data models; implement those data models in databases; and then build applications. Take a year or more for planning, several years to build the databases, and then several more years to build the applications.
>
> Source: J. Highsmith. *Adaptive Software Development*. Dorset House Publishing, 2000, pg. 6

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Pull

The first visible effect of converting from departments and batches to product teams and flow is that the time required to go from concept to launch [...] falls dramatically. When flow is introduced, products requiring years to design are done in months [...] [T]he ability to design, schedule, and make exactly what the customer wants just when the customer wants it means you can throw away the sales forecast and simply make what customers actually tell you they need. That is, you can let the customer *pull* the product from you as needed rather than pushing products, often unwanted, onto the customer.

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 24

Examples ?

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Perfection

As organizations begin to [apply these four principles] perfection, the fifth and final principle of lean thinking, doesn't seem like a crazy idea.

Why should this be? Because the four initial principles interact with each other in a virtuous circle. Getting value to flow faster always exposes hidden *muda* in the value stream. And the harder you pull, the more the impediments to flow are revealed so they can be removed. Dedicated product teams in direct dialogue with customers always find ways to specify value more accurately and often learn of ways to enhance flow and pull as well.

Source: J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003 (originally published in 1996), pg. 25

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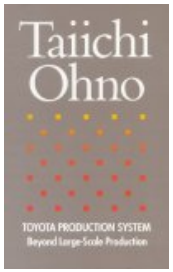
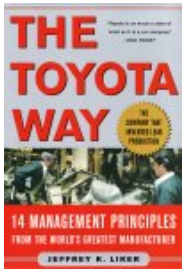
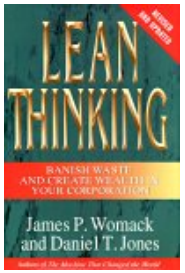
Further Reading



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



J. K. Liker: *The Toyota Way*. McGraw-Hill, 2004



J. P. Womack, D. T. Jones. *Lean Thinking*. Free Press, 2003

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Homework

Read the following paper:

- P. Hines, M. Holweg, N. Rich. *Learning to evolve. A review of contemporary lean thinking*. International Journal of Operations & Production Management, Vol. 24, No. 10, 2004, pp. 994-1011.

  Search for the paper title at http://www.emeraldinsight.com/

Learning target: Within the context of this paper you should be able to discuss the evolution of the lean concepts.