12.2.4 Poka-yoke

In a Mass Production System, one of the characteristics is the high output rate of production. Supported with the moving assembly line and division of labors, the line can produce output in high speed.

The Prototype – Inspection and Rework

With output rate as its main concern, it become something in common for a company that adopt Mass Production to focus on the quantity, and put aside the concern of the quality of the products.

During its peak production in 1910s, there were hardly any inspections of finished automobiles in Ford’s Model T assembly line at Highland Park. There was no engine checking until the vehicle was finished, and no products were ever road-tested. The company did not deliver the product at the highest quality, mostly because there was no urgency for it at that time. The cosmetic failures such as gaps in the fender panels, stumbled engines or electrical problems did not bother the customers.

However, as the market competition became tighter, the demand of the quality of the vehicles was increased and automobile companies usually put Final Inspection Station at the end of the assembly line to check for quality problems. This was because the companies wanted to keep the production line running to achieve the output target without having to stop for errors.

The defects then multiplied and accumulated from station to station and cause burden for the workers in the Final Inspection and Rework Stations. Because the errors did not tried to be fixed, the errors keep continued and created defects in subsequent products.

Defective products needed to be inspected, reworked or even scrapped and it required allocation of man-hour and product replacement, which meant additional waste of cost.

fig. 12.54. Reworking activity at an automobile assembly line

The Result of Contradiction Analysis

The "plus-state" of the "inspection and rework" concept can be determined as in A_S-Matrix as **number 22 (speed)**, because each station would be able to run in high speed and did not need to stop for inspecting products for defects. The "minus-state" of the "inspection and rework" can be determined as in A_S-Matrix as **number 05 (precision of manufacture)**, because the defects produced in each station would be accumulated and give burden to the Final Inspection Station and consume a lot of effort and cost for rework.

Inventing Idea

Combining the plus and minus state factors above, the results will show several points in A_S-navigators. The target is to make it possible to inspect and monitor the quality of the products in each process so that the defective product will accumulated in the Final Inspection and give burden to the workers in the Rework Station. The new alternative will give possibility to the system to do monitoring without sacrificing the productivity. After combining the A_S-Matrix 22 and 05, the idea navigators resulted:

- **Navigator 02 (preliminary action)** – according to this navigator, the machine need to be prepared by implementing partial change in it so that it can detect any defects or non-conformances.
- **Navigator 29 (self-service)** – according to this navigator, the machine need to serve itself with auxiliary to detect defect / non-conformance and stop automatically.

The Result-artifact (Solution) – Poka-yoke System

Lean Production System considers quality as one of its goal. In order to achieve highest quality of products (zero defect), lean company shall realize that defects must be prevented from occurring. To do so, inspections need to be done – not merely to find defects after it happened – but it must prevent defects.

For a complete elimination of defects, 100% inspection must be adopted. Sampling inspection is not enough, because it can not guarantee product quality. However, the traditional 100% inspection in the Final Inspection Station is not suitable to be implemented since it will cause accumulation of products in that station, increase the waiting time and throughput time of a product.

Inspection by workers also not in line with TPS' principle of *jidoka* (autonomation / pre-automation / automation with human touch), where workers need to be separated from machines through the use of mechanisms to detect production abnormalities.

There are said to be twenty-three stages from purely manual work to full automation (s. Shingo). To be fully automated, a machine must be able to detect and correct its own operating problems. Since it is very difficult and not feasible to build an equipment that can correct its error by itself, then it is preferable to limit the machine capability to pre-automation stage, where it can detect its error automatically by using a simple mistake proofing device (*poka-yoke*).

Ninety percent of the result of full automation can be achieved at relatively low cost if machines are designed to merely detect problems and leave the correction of problems to the workers.

Successive, self, and source inspection can all be achieved through the use of *poka-yoke*. *Poka yoke* can achieve 100% inspection through mechanical or physical control.

There are two ways in which *poka-yoke* can be used to correct mistakes:

- Warning type: when the *poka-yoke* is activated, a buzzer sounds or a lamp flashes to alert the worker.
- Control type: when the *poka-yoke* is activated, the machine shuts down.

The warning *poka-yoke* still have weakness since it allows error to continue if workers do not respond to the warning. The control *poka-yoke* is the strongest corrective device because it shuts down the process until the error has been corrected.

Arawaka Shatai supplied car doors for Toyota. One of the production processes was to put a board covered with leather as a back lining plate for the door, which was attached by 20 retainers. Workers sometimes forgot to attach one or two retainers that caused defects on the products. They were advised to be more careful and the rate of defects dropped for a while but then returned to previous level.

Since this appeared to be a recurring problem, twenty proximity switches were installed in the equipment as warning *poka-yoke*. If a retainer was left off, the equipment would stop and a buzzer sounds to alert the workers about the problem.

With the use of the *poka-yoke*, the problem could be eliminated and the defect dropped to zero. In this case, a contact type *poka-yoke* performs 100% successive inspection.

fig. 12.55. Proximity switch: a sample of poka-yoke device

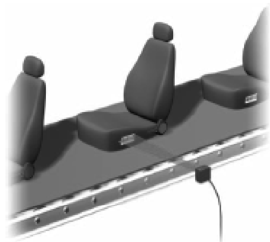
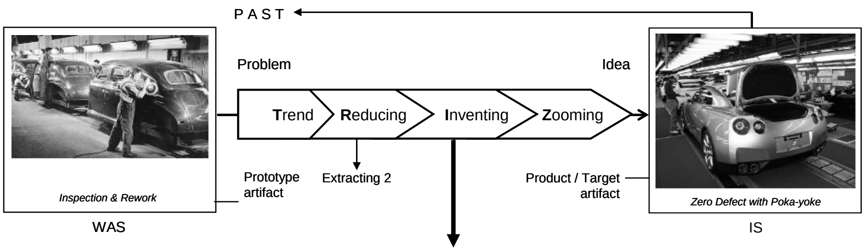


fig. 12.56. Barcode Reader, a poka-yoke system used in automobile industry to check completeness of the components need to be mounted to the passenger seats (belt buckle, side air bag, passenger check module, seat weight sensor and seat position sensor)

fig. 12.57. Toyota 4Runner: award recipient for 2011 Most Dependable Vehicles for Midsize Crossover/SUV), based on J.D. Power surveys

fig. 12.58. A result of jidoka (build-in quality) concept by Toyota: Lexus GS, award recipient for 2010 Initial Quality Study for Midsize Premium Car, based on J.D. Power surveys to provide feedback on quality during the first 90 days of new-vehicle ownership



Extracting-1

LC*	No.	Navigator	Substantiation for the Extracting
++	02	**Preliminary action**	Prepare the machine by implementing partial change in it so that it can detect any defect or non-conformance.
+	04	**Replacement of mechanical matter**	Use of devices with electrical / magnetic / electromagnetic / optical principle as sensors.
+	12	**Local property**	Change the structure of the machine s that there is one part of the machine that can detect defect automatically.
+	18	**Mediator**	Use another object to transmit an action of detecting defective parts or non-conformance process.
+	21	**Transform damage into use**	Use the “damaging factor” of stopping machine (stop production) for a useful effect (eliminate the cause of the problem).
+	28	**Previously installed cushion**	Install an additional object in the machine that can detect failure of process / defect on products.
++	29	**Self-servicing**	The machine service itself with auxiliary to detect defects/non-conformance and stop automatically.
+	36	**Feedback**	Install a device that can maintain and adjust a process to work in the given limits.

Extracting-2

Standard Contradiction: Inspection and Rework practice in the Final Station made it possible for the assembly line to run fast and achieved high productivity, but this concept would produce defects that could not be caught during process.

Radical Contradiction: The assembly line should run continuously to achieve high output, but should also be stop periodically so that the process and product can be monitored.

FIM: X-resource, together with available or modified resources, and without making the object more complex or introducing any negative properties, guarantees attainment of the following **IFR**:
[*automation of inspection*].

fig. 12.59. Extracting: Poka-yoke System

TREND

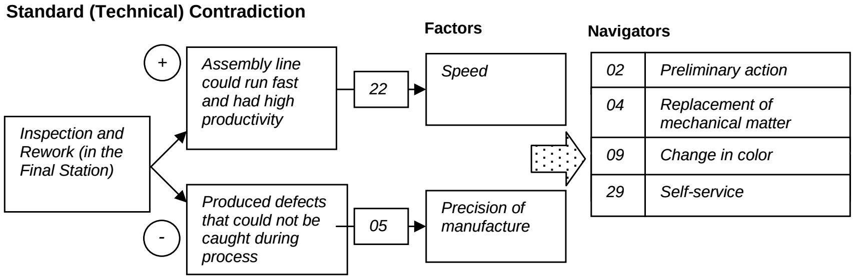
In a Mass Production System, it was a common sense that the goal was to achieve high output of products. The process run in high speed and the workers did not have time and concern to check the quality of the products. Defects could only be caught in the Final Inspection Station, which caused many products needed to be reworked or scrapped. This was a kind of waste of money and material that needed to be eliminated by Lean Production System.

PROBLEM: How could we catch the defect before Final Inspection Station without stopping the machines to perform periodic inspection in every station ?

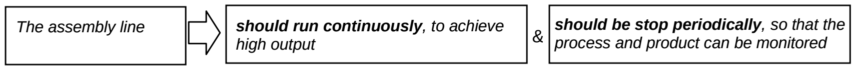
REDUCING

FIM: X-resource, together with available or modified resources, and without making the object more complex or introducing any negative properties, guarantees attainment of the following **IFR**: [*automation of inspection*].

Standard (Technical) Contradiction



Radical (Physical) Contradiction



INVENTING

Group of navigators to model the idea for the '*Poka-yoke*' concept:
02. Preliminary action:
Prepare the machine by implementing partial change in it so that it can detect any defect or non-conformance.
29. Self-service:
The machine service itself with auxiliary to detect defects/non-conformance and stop automatically.

ZOOMING

Have the contradictions been removed? – Yes. – ~~No~~.

Super-effects: Yes. It increased the precision of parts manufactured

Negative effects: Cost for providing dedicated machine tools to manufacture the parts

BRIEF DESCRIPTION

***Poka-yoke*:** *Poka-yoke* is a Japanese term that means "fail-safing" or "mistake-proofing". *Poka-yoke* is a part of *jidoka* (autonomation – automation with human touch) concept introduced by Toyota. Basically it covers low cost, highly reliable devices used in machines that will stop processes in order to prevent the production of defective parts. One example of the *poka-yoke* device is proximity switch that used as sensor to detect presence of material / parts during production process.

fig. 12.60. Reinventing: Poka-yoke System

12.2.5 Andon System

The Prototype – Passing-on Defect

> We expect the men to do what they are told. The organization is so highly specialized and one part is so dependent upon another that we could not for a moment consider allowing men to have their own way. Without the most rigid discipline we would have the utmost confusion.[168]
>
> *Henry Ford*

As has been mentioned earlier in section 12.2.4, in a Mass Production system there was a tendency to pass on errors to keep the line running that caused errors to multiple endlessly. Every worker assumed that errors would be caught at the end of assembly line. Even if the worker wanted to stop the machine due to errors, he had no access or tools to inform it to the responsible line managers, who had the authority to stop the line.

This kind of discipline was assured as the managers at Ford posted the production output of each man on production board. The figures[169] were "posted hourly, and the records of those who equal or better quota set are written down in the colored crayon". This standard measure was taken to stir up "competition among workers, who performed the same operation".

So, rather than leaving his station and losing productivity, the operators preferred to pass on the defective product to next station and continue to process subsequent products. Hence, the so called "passing-on defect mentality", was commonly practiced that avoided line stoppages at any price and emphasized repair in the end of assembly line.

fig. 12.61. An example of Final inspection area in an Austin Automobile assembly line (1950s). Cars received an inspection and final polishing before went to test drive.

The Result of Contradiction Analysis

The "plus-state" of the "passing-on defect" mentality can be determined as in A_S-Matrix as **number 25 (loss of time)**, because the production process could take place continuously that would increase the productivity. The "minus-state" of the "passing-on defect" can be determined as in A_S-Matrix as **number 12 (loss of information)**, because the operators did not have chance and access to inform the defect occurred in the line. It also caused the defects multiply from station to station and created enormous amount of rework effort and cost to fix them.

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168 McNairn, W. and McNairn, M. (1978) *Quotations from the Unusual Henry Ford.* – Quotamus Press, Redono Beach, CA

169 Porter, H. F. (1917) *Four Big Lessons from Ford's Factory.* – System, 31 (June 1917)

Inventing Idea

Combining the plus and minus state factors above, the results will show several points in A_S-navigators. The target is to enable the workers to stop the process that produce defect as immediately as possible so that the defective product will not be pass on to the next station and accumulated in the Final Inspection and Rework Station. The new alternative will give possibility to stop the machine and inform the responsible persons only when the defect is occurred so that it will not sacrifice the productivity and manpower effort to do machine monitoring all the time. After combining the A_S-Matrix 25 and 12, the idea navigators resulted:

- **Navigator 09 (change in color)** – according to this navigator, it is advised that the machine that creates problem can "change its color".
- **Navigator 18 (mediator)** – according to this navigator, it is needed to use an object to transfer information about problem in certain machine/station.
- **Navigator 35 (unite) –** according to this navigator, instead of leaving the problem to the operator in a problematic machine, the whole responsible team need to come and work on the problem.

The Result Artifact (Solution) – Andon System

At TPS, *jidoka* also means build-in quality. It means achieving highest quality during processing the materials[170]. One concept of *jidoka* – separating man's and machine's work has been mentioned earlier by the use of *poka-yoke*. The other concept of *jidoka* is to stop the work if found abnormality.

According to TPS principle, passing on defective products to the end of assembly line is also one type of waste, since there will be human effort and cost involved to rework or scrap the product. Moreover, since there is no corrective action performed to the problematic process or machine, similar defect will be produced from time to time.

To avoid these wastes, it is necessary to stop the operation or machine if there is trouble with machine operation. When problem occurs, visual control or *andon* (indicator lights) show the workers, supervisors, technicians and other related personnel where the trouble is. The troubles are then being able to be immediately communicated to everyone.

One of the important mentality to support this tool is the urgency to stop the production line and fix the problem. Top management need to commit itself to halt the machines or production lines when there is trouble. This is the key that makes *jidoka* concept with *poka-yoke* and *andon* tools become famous as autonomation – automation with a human touch.

fig. 12.62. Andon system to communicate problems in machines

[170] Liker, J. K. (2004) *The Toyota Way*. – McGraw-Hill, New York

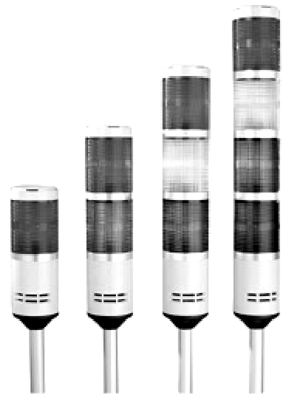
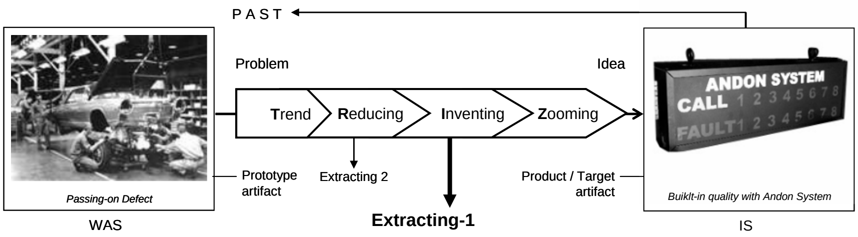


fig. 12.63. A type of andon lamp. Red colour (top) means machine error, yellow (second from top) means machine needs attention, green (third) means normal operation, blue (fourth) means short of material.



LC*	No.	Navigator	Substantiation for the Extracting
+	01	**Change… aggregate state of an object**	Change the degree of flexibility to stop the production line whenever there is problem.
+	02	**Preliminary action**	A device is provided in advance so that the worker can inform problem in the production line.
++	09	**Change in color**	Change the color of the machine / station that give problem.
+	11	**Inverse action**	Instead of implementing “passing-on defect” mentality, the company needs to encourage the workers to stop and inform for any kind of problems.
+	12	**Local property**	Change the structure of the working station to add a device that act as information board for management.
++	18	**Mediator**	Use an object to transfer information about problem in certain machine / station.
+	21	**Transform damage into use**	Use the “damaging factor” of stopping machine (stop production) for a useful effect (eliminate the cause of the problem).
++	35	**Unite**	Instead of leaving the problem to worker in a problematic machine, the whole team need to come and work on the problem.

Extracting-2

Standard Contradiction: Passing-on defect mentality made the machine can work with low stoppage time, but it gave no access and tools to inform the defect that cause high rework and scrap rate at the Final Station.

Radical Contradiction: The assembly line should run continuously to achieve high output, but should also stop periodically so that the error could be fixed.

FIM: X-resource, together with available or modified resources, and without making the object more complex or introducing any negative properties, guarantees attainment of the following **IFR**:

[*low rework rate*].

fig. 12.64. Extracting: Andon System

fig. 12.65. Reinventing: Andon System

12.2.6 Just-in-Time (JIT)

In Mass Production that adopted economic of scale principle, it is necessary to maximize output in order to reduce the production cost. This principle emphasis the maximum usage of the machines and "push" the material to the end of assembly line and encourages buildup of finished goods inventories. These inventories were considered as assets for the company, rather than accumulated waste of capital.

The Prototype – "Push" Production Control

The production process[171] with "push" concept can be analogous by the water flow in the river with many rocks (fig. 12.66). The river is the material movement, the depth of water represent the inventory and Work-in-Process (WIP), and the rocks represent the problems encountered in assembly line. The "push" concept use high inventory (high level of water) as safety buffer to deal with quality problems (defective products), long production time (due to batch processes and machine problems), long set-up time (due to complex machine), or long delivery time from suppliers.

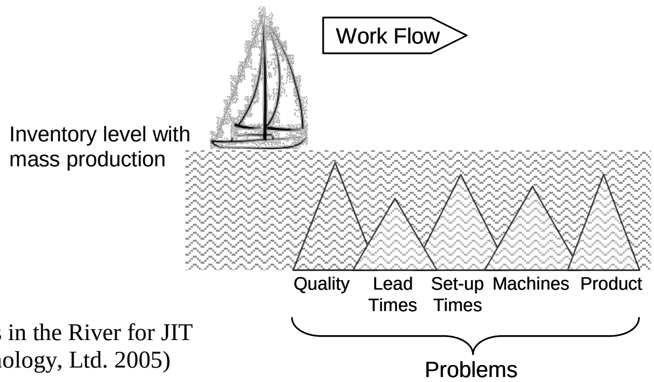


fig. 12.66. The Rocks in the River for JIT (after Tangram Technology, Ltd. 2005)

When Eiji Toyoda[172] and his managers from Toyota went to Ford's plant in 1950, to their surprised, they found that the company had many flaws. They saw the discrete process steps were based on large volumes, with interruptions between these steps causing large amounts of material to sit and wait in WIP-inventory. They saw the massive and expensive equipments.

The company tried to maintain efficiency in reducing the cost per piece, with workers keeping busy by keeping the equipment busy, resulting in a lot of overproduction and an uneven flow, with defects hidden in large batches that could go undiscovered for weeks.

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171 Silver, E. A., Pyke, D. F. and Peterson, R. (1998) *Inventory Management and Production Planning and Scheduling* (pp. 592 – 623, 631 – 653). – John Wiley & Sons, Inc., New York

172 Eiji Toyoda (b. 1913) – a Japanese engineer, cousin of Kiichiro Toyoda (founder of Toyota Motor Corp.). He became the President (1967 – 1981) and Chairman (1981 – 1994) of Toyota

Entire workplaces were disorganized and out of control. With big trucks moving materials everywhere, the factories looked more like warehouse than an automobile plant.

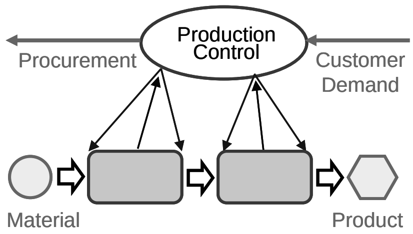


fig. 12.67. Push Production Control Principle usually adopted by Mass Production System

fig. 12.68. Unsold Dodge SUVs sat at the Atlantic Marine Terminal at the port of Baltimore, Maryland. More than 57,000 cars waiting for buyers during Q1-2009. Maryland paid USD 5.26 million for almost 10 hectares of additional car storage space near the port

The Result of Contradiction Analysis

The "plus-state" of the "push production control" can be determined as in A_S-Matrix as **number 09 (ease of manufacture)**, because each station needed to think only of their own production pace. The "minus-state" of the "push production control" can be determined as in A_S-Matrix as **number 02 (universality, adaptability)**, because this concept was not flexible in dealing with the fluctuation of the customer demand. Accumulation of inventories between stations or in the final storage could be expected.

Inventing Idea

Combining the plus and minus state factors above, the results will show several points in A_S-navigators. The target is to avoid accumulation of inventories between stations and in the final storage that consume cost and area. The new alternative will give possibility to have low stock of products without sacrificing the fulfillment of customer demands. After combining the A_S-Matrix 09 and 02, the idea navigators resulted :

- **Navigator 11 (inverse action) –** according to this navigator, instead of using "push" concept, the production can be controlled by ‘pull’ concept;

- **Navigator 02 (preliminary action)** – according to this navigator, the production line can be prepared in advanced so that they can adapt the change in customer demand without loss of time;
- **Navigator 18 (mediator)** – according to this navigator, a mediator is required to transfer information from customer / downstream stations to upstream stations and supplier in order to have a quick response without accumulating stocks.

The Result-artifact (Solution) – Just-in-Time

Just-in-Time (JIT) is a production planning system that first introduced by Toyota Motor Company during 1960s. It was created as Toyota's answer for the inventory management and control system that were commonly used by major automotive industries at that time, especially in the United States (s. Womack).

The JIT was said to be inspired by supermarket concept. The supermarket customers may go to the shelves and buy what they want, when they need it. The shelves then are refilled as products are sold. This concept gives an easy system for suppliers to see how many products have been taken and avoid overstocks. Thus, the most important feature of a supermarket system is that stocking is triggered and maintained by actual demand. Toyota has used this concept to create a flexible production system that is characterized as the "pull" system of order-based production.

There are two kinds of known definitions of the Just-in-Time concept:

1. JIT in production (production when it is called for): produce parts just in time; all production activities are performed when the customer requires it.

2. JIT in delivery (stockless inventory): All external supplies are delivered exactly at the moment they are required, at the correct quantity with the correct type. It can be said that the inventory is taking place on the road.

So, the objective of JIT is to produce and deliver right quantity of products with the highest quality at the right time. During this process, it is necessary to gain it with minimizing inventory and lead time, and suppress failure and defects (s. Silver, [175]). In other words, JIT system tries to pursue zero inventories, zero transaction, and zero disturbances.[173]

In connection with "river and rocks" analogy mentioned in fig. 12.66 (s. Silver), as JIT requires low inventory (low level of water, fig. 12.69), the problems (rocks) will be revealed and draw attention to be solved, otherwise the production can be stopped. This concept is in contrast with "push" system implemented by Mass Production which implement high inventory (high level of water) to cover the problems.

JIT system gives several important advantages (see Silver):

- Reduction of inventory space and cost

[173] Vollman, T. E., Berry. W. L., Whybark, D. C. and Jacobs F. R. (2005) *Manufacturing Planning and Control for Supply Chain Management*. – McGrawHill, New York

- Less material movements in/out of storage
- Reduced transactions
- Simplified manufacturing and planning control systems.
- Reduction of production throughput time
- Greater responsiveness to market demands
- Improvement of quality and reduction of quality cost.

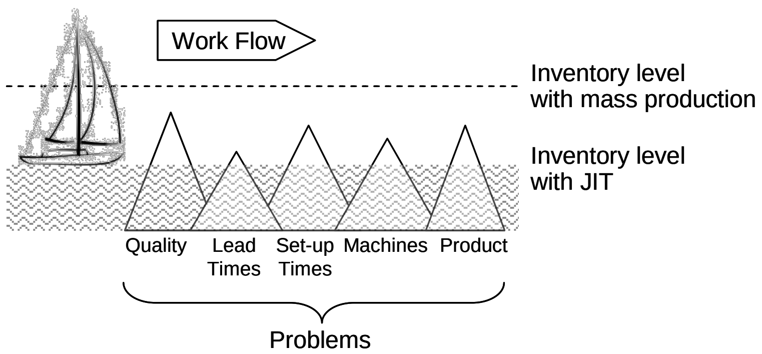


fig. 12.69. The Rocks in the River for JIT (after Tangram Technology, Ltd. 2005).

As JIT is a "pull" system, it uses a unique mechanism of information flow which is called *kanban* (Japanese term for "card"; s. Shingo). When TPS started receiving international attention in the seventies, many people were wrongly understood JIT as the "*kanban* method".

Kanban is actually tools used in JIT to help implement the "pull" principles of TPS. A *kanban* can be a variety of things, most commonly it is a card, but sometimes it is a cart, while other times it is just a marked space. In all cases, its purpose is to facilitate flow, bring about pull, and limit inventory. It is one of the key tools in the battle to reduce overproduction.[174] One important *kanban* rule requires that all materials and products be accompanied by a *kanban* card. Thus, *kanban* connected the material and information flow between working station. The downstream station gives signal for required parts to its upstream center using *kanban* cards.

The *kanban* used in the TPS serves three main functions (s. Shingo):

- identification tag: indicates type of the product;
- job instruction tag: indicates process type, quantity and delivery time required for the product;
- transfer tag: indicates from where and to where the product should be transported.

[174] Wilson, L (2010) *How to Implement Lean Manufacturing*. – McGraw-Hill, New York

Basically *kanban* system can be applied in plants involved in repetitive production. *Kanban* system are not applicable in one-of-a-kind production based on infrequent and unpredictable orders.

With development in technology, the manual information system using *kanban* cards now is started to be improved by integrating the computer network system called *e-kanban*. This system gives simpler, more accurate, and more responsive flow of information between customer and suppliers, and within the organizations themselves.[175]

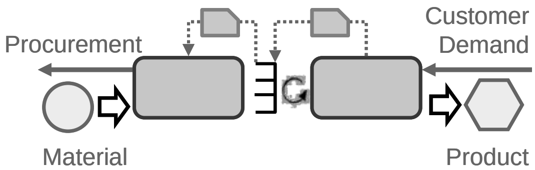


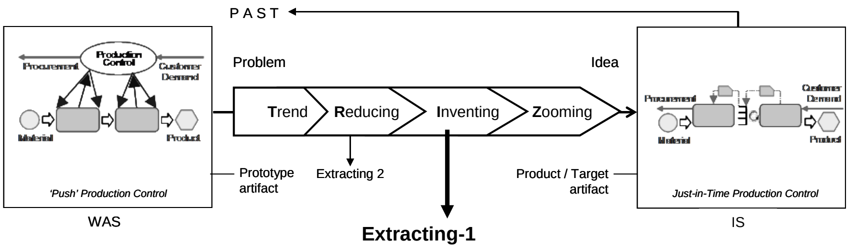
fig. 12.70. Pull Production Control Principle adapted by Lean Production System

fig. 12.71. A conventional kanban card

fig. 12.72. Kanban card supplemented with barcode for simpler checking

fig. 12.73. Wireless Kanban Replenishment System, a kanban system that eliminates kanban card

175 Drickhamer, D. (2005) *The kanban e-volution*. – Material Handling Management (March), 24-26



Extracting-1

LC*	No.	Navigator	Substantiation for the Extracting
++	02	**Preliminary action**	Prepare the production line in advanced so that they can adapt the change of customer demand without loss of time.
+	05	**Separation**	Separate the "buffer stocks" unneeded by customer by producing only the required ones.
++	11	**Inverse action**	Instead of using "push" concept, the production can be controlled by 'pull' concept.
++	18	**Mediator**	Need a mediator to transfer information from customer / downstream station.
+	36	**Feedback**	Use "feedback" (order) from customer to define the quantity of products need to be produced.

Extracting-2

Standard Contradiction: Mass production with "push" concept made each station only need to think of their own pace of production, but it was not flexible in dealing with fluctuation of customer demand / downstream station condition.

Radical Contradiction: The product stock should be exist to serve customer order, but should not be exist so it would not cause problems (holding cost, etc.)

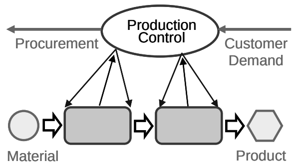
FIM: X-resource, together with available or modified resources, and without making the object more complex or introducing any negative properties, guarantees attainment of the following **IFR**:

[*production control with less inventories*].

fig. 12.74. Extracting: Just-in-Time

TREND

In a Mass Production System, every station in assembly line had to "push" each product to next station as quickly as possible. This "make-to-stock" concept was not flexible in adapting the customer demand fluctuation and condition of the downstream stations. This caused many semi-finished/finished products waited between stations / in the final storage as inventories. These inventories were considered as problems since they were restrained capital, consumed area and holding cost and they could be worn-out / damaged over time.



Scheme of 'Push' Production Control Principle

PROBLEM: How could we cope with problems created by "push" control?

REDUCING

FIM: X-resource, together with available or modified resources, and without making the object more complex or introducing any negative properties, guarantees attainment of the following **IFR**:

[*production control with less inventories*].

Standard (Technical) Contradiction

Mass production with 'push' concept

(+) *Each station just needed to think of their pace of production* → 09 → Factors: *Ease of manufacture*

(-) *Not flexible in dealing with fluctuation of customer demand/downstream station condition* → 02 → Factors: *Universality, adaptability*

Navigators

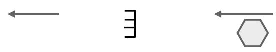
05	*Separation*
07	*Dynamization*
11	*Inverse action*
02	*Preliminary action*
18	*Mediator*

Radical (Physical) Contradiction

The product stock ⇒ ***should be exist**, to serve customer order* & ***should not be exist**, so it would not cause problems (holding cost, etc.)*

INVENTING

Group of navigators to model the idea for the "Just-in-Time" concept: **11. Inverse action:** Instead of using "push" concept, the production can be controlled by 'pull' concept; **02. Preliminary action:** Prepare the production line in advanced so that they can adapt the change of customer demand without loss of time; **18. Mediator:** Need a mediator to transfer information from customer/downstream station.



Scheme of 'Pull' Production Control with Just-in-Time Principle

Kanban Card, coordination tool used in Just-in-Time principle

ZOOMING

Have the contradictions been removed? – Yes. – ~~No~~.

Super-effects: Yes. It reduced the inventories.

Negative effects: Needed reliable machines / suppliers to ensure smooth fulfillment of customer demands.

BRIEF DESCRIPTION

Just-in-Time (JIT): JIT is a "pull" concept developed by Toyota as an answer of "push" concept that creates problem of accumulation of inventories. The system was realized by using *kanban* (visual card) that acted as mediator to inform the customer demand from downstream to upstream station. In order to support this concept, Toyota also needed to prepare its line so that the material could flow smoothly from suppliers until the finished goods area.

fig. 12.75. Reinventing: Just-in-Time