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When asian industry influences western factories: kanban origins

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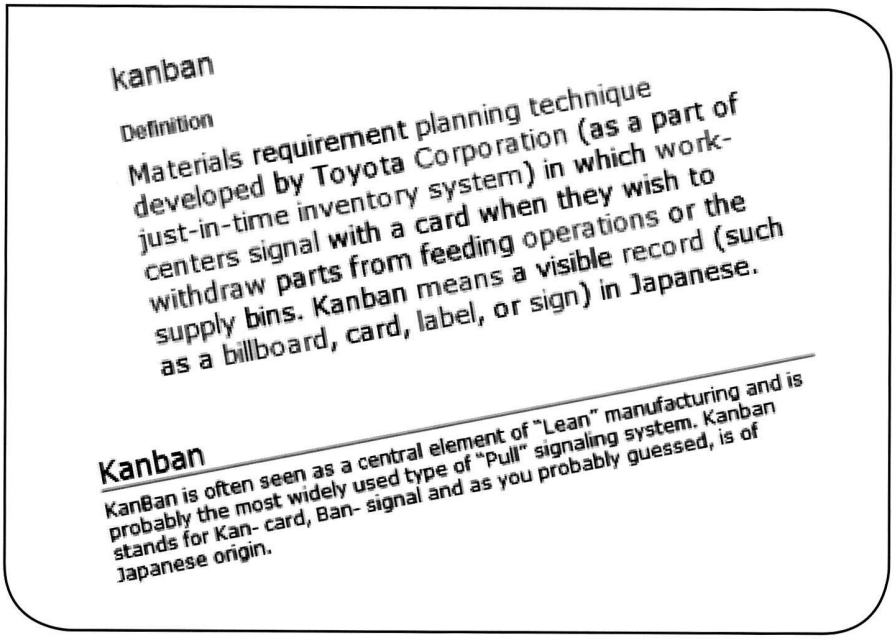


Der Beitrag befasst sich mit dem sogenannten Kanban-System. Kanban (jap. 看板, dt. «Karte», «Tafel», «Beleg») ist eine Methode der Produktionsablaufsteuerung nach dem Pull-Prinzip (auch Hol- oder Zurufprinzip) und orientiert sich ausschliesslich am Bedarf einer verbrauchenden Stelle im Fertigungsablauf. Autonome Regelkreise auf Workflow-Ebene bilden das Kernelement dieser flexiblen Produktionssteuerung. Es ermöglicht eine langfristige Reduzierung der Bestände bestimmter Zwischenprodukte. Zudem ermöglicht es auch die Reduktion/Optimierung von Beständen auf der Endproduktebene.

The article concerns what is referred to as the Kanban system. Kanban (Jap. 看板, Engl. «sign» or «billboard») is a method of production scheduling according to the push-pull principle, which is orientated exclusively to the demand of a consuming point in the production process. Autonomous feedback control loops at the workflow level form the core element of this flexible means of production control. It enables reducing inventory of specific intermediate products in the long term. Furthermore, inventory at the end product level can also be reduced and optimized.

«The more inventory a company has, the less likely they will have what they need.» (Taiichi Ohno)

Origins

The Western origin of Kanban, meaning «Card Signal», came from Japan in the 1970s, although similar systems were used beforehand without being as strongly established, ideally it is designed to help manage inventory.

As the method is specific to the item to be produced, the amount, when and where it must be delivered, it creates a constant flow and low inventory levels. Toyota was one of the first to pioneer the famous kanban method. The Toyota Production System (TPS), focused on a lean manufacturing process management philosophy implementing kanban as the control method with the main focus on reducing lead time, operating costs and freeing storage space. The factory, similar to a supermarket, stocks only what is forecasted to be sold in a specific period of time. Moreover, customers only take what they think they need, since supermarkets rarely run out of inventory. Bearing this in mind, the industrialist thought of manufacturing only needed components and consequently replaces only those needed components. More specifically, the pace at which we replace necessary goods, or inventory, is determined by kanban. By the year 1953, Toyota had started to use the Kanban system in their main plant. A diagram from the official company website, depicting the Kanban system, is seen on plate 1.

Definitions and rules

A Kanban is a card, a labeled container, a computer order or another device used to signal that more products or parts are needed from previous process steps. It is a two-card system,

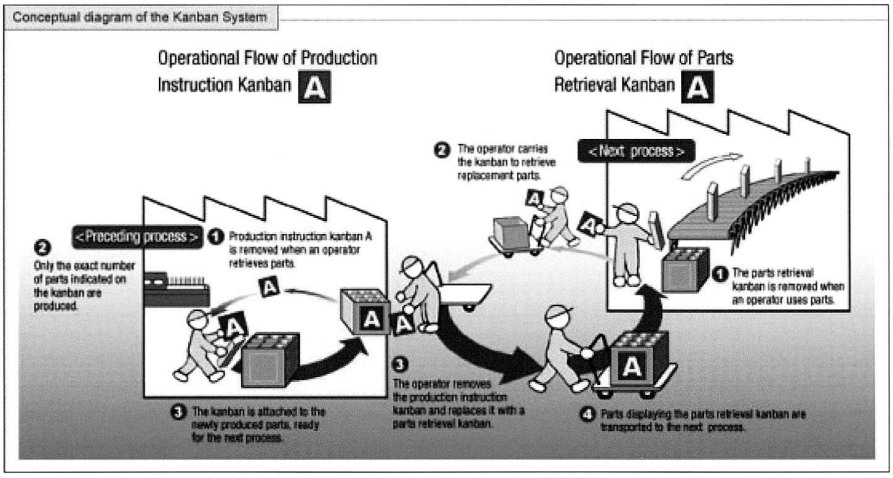


Plate 1: First used by the Toyota Company after they were impressed with the way supermarkets used to ensure that the right product was available to the right customer, using product control cards, which can range from such things as actual cards, trolleys, balls (i.e. golf balls) or signs, the use of Kanban resulted in a more efficient delivery with pull replenishment. Essentially, as the production vision at Toyota claims, this method helps to supply «what is needed, when it is needed, and in the amount needed.» (http://www2.toyota.co.jp/en)

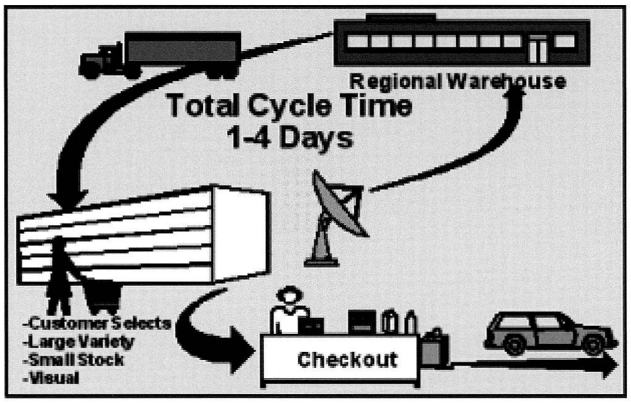


Plate 2: «Codename KB workflow». (http://www.strategosinc.com)

the production card and the withdrawal card. These cards are set by management policies. The Kanban contains the information needed to localize the exact product or part needed. Kanban can be used to track work-in-progress (WIP), production and inventory flow (Just-in-Time/Kanban, 2009).
Three different types:

- Supplier Kanban
  Indicates orders given to outside parts suppliers when parts are needed for the assembly lines.
- In-factory Kanban
  Used to locate parts between processes in a factory.
- Production Kanban
  Indicates operating instructions for a process within a line.

Definition

Kanban is a «pull» type of production system because the number of goods made or distributed depends on the customers demand for the product. It is a system which uses product controlled cards on which product information such as product name, product code, and storage location is entered.

Rules

- **Upstream to downstream in production process:** Customers order, the number of products withdrawn are instructed to do so by the Kanban. This helps to ensure that what has been ordered is what will be processed.
- **100% defect free products within production line:** In this case each step which locates an error will correct the defect before additional products are made with defects.
- **Upstream processes produce only what has been withdrawn:** The items which have been used or bought are then produced in the same order in which the Kanban has received them as well as only producing the number indicated by the Kanban.
- **Decreased amount of Kanban through-time:** By ensuring a reduction of Kanban the result is a continuous improvement in reducing the level of stock in production.

Details: «Pull systems to get parts to the line from a parts supermarket» (J.K. LIKER)

This visual communication tool has been used throughout the supply chain or the manufacturing assembly line to control production since 1953. At times, signals such as the presence or absence of a part on a shelf, marked areas, color coded bins, cards or flags are used. The signal triggers the production or the supply chain for the replenishment of an item. It takes the concept from the supermarket method, as supermarkets have a wide variety of products and specific storage space, hence needing to be restocked constantly on a daily basis according to the consumption of every item.

$$\gamma = \frac{\overline{DL} + w}{a}$$

γ is # of Kanbans

$\overline{D}$ is 'average' demand

L is lead time (proc+wait+travel+others)

w is buffer stock/set by policy

typically 10% of $\overline{DL}$

a is container cap. < 10% of daily demand

Plate 3: Algebra.

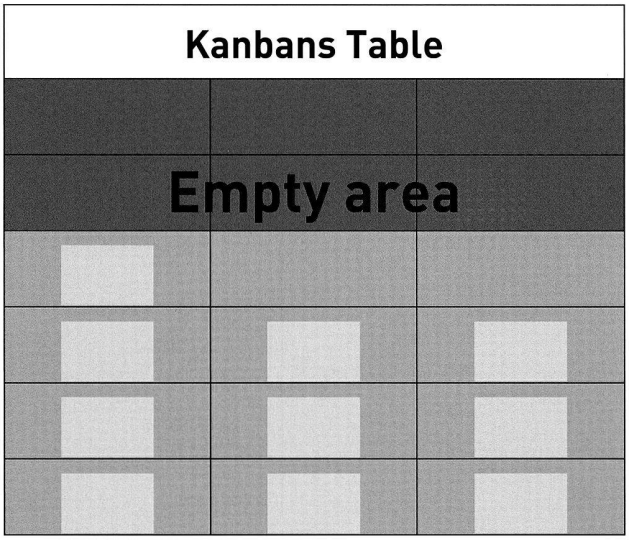


Plate 5: A visual aid.

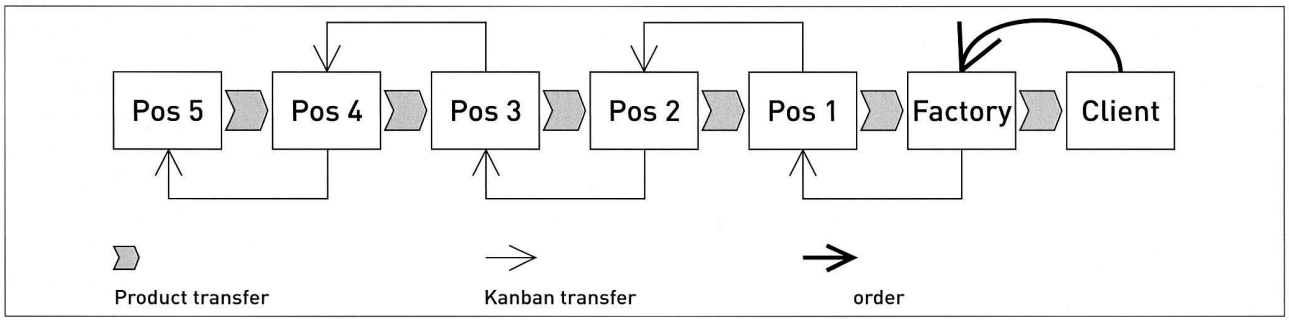


Plate 4: Principle.

Kanban is a production strategy that is related to just-in-time production. Its visual cards are like visual aids in form of a colored box, the distinctive design of a case, barcodes and so on. Kanban is a flagship model representing the Japanese automotive industry and its name is historically derived from how items were produced by a triggered signaling system.

More details

The pull system, as a strategy, is done in such a way that manufacturers produce quantities actively in «real time» according to market demand and not on the forecasts. Herve (2009) suggests that Kanban «is a system for the continuous supply of components, parts, supplies and finished goods, so that workers have what they need, where they need it and when they need it». It requires suppliers to engage in the daily activity of making an order in accordance to everyday market demand which directs the firm to determine its supplies, manufacturing and logistics. Automotive industry is just one of the many industries who clings to the pull system whereby its supply chains are fed by suppliers, through manufacturers, and then on to the retail network. What is a visual card? It is a visual aid that triggers action: like the color of a box, the specific design of a case or specific colored bar codes, etc.

Kanban has some constraints to which the supplier has to pay close attention and which are the timing and product diversity. Suppliers must not only ship the order within three to four hours after receiving it but also have it delivered to the manufacturer's location. Sorensen, Kanigal, and Lacey (1997) propose three logical solutions for suppliers to overcome constraints:

1. Locate the factory close to the manufacturer's plant; however, this is considered to be a risky solution if the contract is cancelled.
2. Secure stocks of finished parts and prepare for various scenarios. This solution is possible if the company is able to manage a number of possible combinations, as it is difficult and costly to manage various combinations.

3. Redesign products and the manufacturing process according to the products. The advantages of this process are that products for which manufacturing is more «flexible» are designed, appropriate transportation equipment which enhances the loading and unloading time and open packaging. In addition, the company can benefit from the multitasking of employees and new production planning methods.

Kanban handles the system very flexibly and is dependent on the needs of the manufactured process. Kanban is not a stand-alone system, but is an integral part of 5 S and Kaizen. The 5 S program is a a simple but systematic approach which targets high productivity, efficiency, quality and safety standards for all types of businesses. It is a main component in establishing a visual workplace which is a strategic method for reaping maximum profitablity for a firm. Hence, the 5 S are made up of the following:

1. **Sort:** the first step in cleaning things up and organizing.
2. **Set in order:** organize, identify and arrange everything in a work area.
3. **Shine:** regular cleaning and maintenance.
4. **Standardize:** make it easy to maintain – simplify and standardize.
5. **Sustain:** maintaining what has been accomplished.

This logic aims for perfection and consistent enhancement and that is where Kaizen should be introduced. Kaizen was founded in Japan following World War II and reflects its eagerness to rebuild a demolished country. It derives from the Japanese words kai which means «change» or «to correct» and zen which means «good». It is a call to continuous improvement in quality, technology, process, company culture, productivity, safety and leadership. It can be applied to all social activities from the improvement of personal life to business sectors. Kaizen encompasses many of the components of Japanese businesses that have been seen as a part of their success. Quality circles, automation, suggestion systems, just-in-time delivery, Kanban and 5S are all included within the Kaizen system of running a business.

Once again, this whole strategy includes industrial «reengineering». In other words, production areas might be changed from locating machines by function, to creating «cells» of equipment and employees. The cells allow related products to be manufactured in a continuous flow (Sorensen, Kanigal, Lacey, 1997). It involves the employees as team members who are responsible for specific work activities. Teams and individuals are encouraged to participate in continuously improving the Kanban processes and the overall production process which are components of setting up a lean manufacturing system.

History backgrounds

The origins of the word Kanban can be traced all the way back to the 17th century where the word was used to describe an embellished wooden or metal sign used as a trademark. The Kanban method, in Japanese («カンバン方式»), the literary Japanese translation «visual board» or «billboard» meaning «visual card» or «visual board» is a specific production concept, is very closely linked to the just-in-time concept.

Historically these were cards, used to demonstrate the need for additional inventory, once the necessary inventory of goods was out of stock, or had expired. This trademark was used to define the type of business or trade and class of a businessman or tradesman. In the present day the word Kanban has become somewhat synonymous with demand scheduling. This relation can be traced back to the late 1940s where it was developed by Taiichi Onho for the Toyota production system.

The Toyota people also recognized that the Ford system contained contradictions and shortcomings, particularly with respect to employees (Toyota, 2009). As General Douglas MacArthur had actively promoted labor unions during the years of occupation, Ford's harsh attitudes and the demeaning job structures were unworkable in post-war Japan. They were also unworkable in the American context, but that would not be evident for some years to come. America's «Greatest Generation» carried over attitudes from the Great Depression that made the system work in spite of its defects.

Toyota soon discovered that factory workers had far more to contribute than just muscle power. This discovery probably originated in the Quality Circle movement. It culminated in team development and cellular manufacturing. Another key discovery involved product variety. The Ford system was built around a single, unchanging product. It did not cope well with multiple or new products.

All of this took place between around 1949 and 1975, the main milestones being 1960, then 1973. To some extent it spread to other Japanese companies with the government's support following the economic recession after the 1973 first oil shock. When the productivity and quality gains became evident to the outside world, American executives traveled to Japan to study it. They brought back, mostly, the superficial aspects like Kanban cards and quality circles. The first introductions in Switzerland were to be seen at the end of the 1980s (Busch industries in Chenevez JU as seen by the author for example), whereas the system was already taught at EPFL (Lausanne Federal Institute of Technology) at the beginning of the 1980s.

Methods

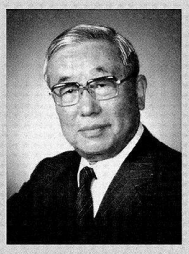
There are different types and therefore many different ways to implement Kanban. This section will outline the six main

Kanban players

In 1924 **Sakichi Toyoda** (1867–1930) created the world's first automatic loom with a non-stop shuttle-change motion, the Type-G Toyoda Automatic Loom. He believed that accumulated waste impacted the management of the corporation. Sakichi improved both productivity and work efficiency, thus creating Toyota's philosophy of «the complete elimination of all waste». (TPS)

Shigeo Shingo (1909–1990)
In 1955, Dr. Shingo began a long association, this time with Toyota, in addition to his many consulting assignments in other industries. It is during this period that he first started work on setups by doubling the output of an engine bed planer at Mitsubishi's shipyard.
In 1969, SMED originated when he cut the setup time on a 1000 ton press at Toyota from 4.0 hours to 3.0 minutes. (Strategosinc)

In 1927 **Kiichiro Toyoda** (1884–1952) introduced a flow production method by using a chain conveyor into the assembly line of a textile plant with a monthly capacity of 300 units. By eliminating waste between operations, lines and processes he created the JIT («just-in-time») method and Toyota Motor Corp. in 1937. (TPS)



Eiji Toyoda (*1937) implemented the JIT method, increased workers' productivity in adding value and achieved the Toyota Production System. (TPS)

Shingo, at Taiichi Ohno's suggestion (see below), went to work on the setup and changeover problem. Reducing setups to minutes and seconds allowed small batches and an almost continuous flow like the original Ford concept. It introduced a flexibility that Henry Ford thought he did not need.

Finally **Taiichi Ohno** (1912–1990) helped to establish the Toyota Production system and created the basic framework for the JIT method (TPS). Onho developed this system in order to control production between processes and to implement «just-in-time» (JIT), an inventory strategy aimed at improving a business's return on investment by reducing the amount of inventory held, thereby reducing storage cost. Ohno modeled this strategy after the American-style supermarkets where customers can obtain the products they need at any given time. These methods of managing production and inventory where not globally accepted until the recession in the 1970s. Today, Toyota continues to use this system and has lately found many more applications such as using it to identify impediments to flow and opportunities for constant improvement. Taiichi Ohno, who became Toyota's Vice-President, simplifies its model by comparing it to the supermarket concept; «the key to this process is in the customers, like going to a supermarket, they retrieve the necessary parts when they need them and in the amount they need. This is a winning tactic as it vastly contributed to the existing production system changing the inefficient into efficient, unnecessary to necessary, pulling the nation's old-fashioned production cycle to another quantum level.» (Sorensen, Kanigal, Lacey, 1997)

What is Just-In-Time?

Just-in-time (JIT) means making «only what is needed, when it is needed and in the amount needed». It is necessary to produce the right amount of the right product in the right amount in the given time. This is the case with any marketable goods from car parts to perishable goods like groceries. JIT is derived from the original Japanese Kanban system; the goal is to reduce WIP inventories to an absolute minimum. The request for an item is only initiated when there is a request from a higher level; therefore units are «pulled» through the system by request (Just In Time Manufacturing, 2009). It is considered to be an «Americanization» of the Toyota production system. Inventory stocks the items needed by customers when they are requested in the quantity needed, and has all of these items available for sale at any time. As the Toyota case study explicitly suggests, «just-in-time» meaning, supplying «what is needed, when it is needed, and in the amount needed». According to this production plan, it can eliminate waste, inconsistencies and unreasonable requirements, resulting in improved productivity.

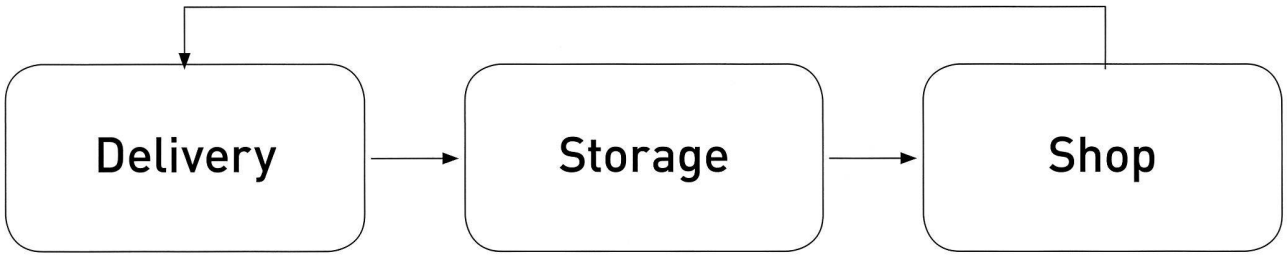


Plate 6: Three Bin System.

types, some used in production lines and some used mainly in managing inventory.

One-Card System

This is when a signal is sent back to the supplier or inventory to send or produce more. This can be done visually with colored cards on a production line, or when dealing with inventory, by an electronic signal (e-mail). In this case, in order to avoid confusion, the signal is kept separate from the initial stimulus suggesting the need for a signal. For an example, on a production line it is not the empty container that causes it to be filled, in the one-card system it is separate, in which a yellow card would appear, in order to avoid confusion.

The Kanban system might be visualized as a «Three bin system» for the parts brought out (where there is no in-house manufacturing) – one bin on the factory floor, one bin in the factory store and one bin at the supplier's store (see illustration). The bins usually have a removable card that contains the product details and other relevant information – the Kanban card. When the bin on the shop floor is empty, the Kanban card is removed and given to the store. The store then replaces the bin on the factory floor with a full bin which also contains a removable Kanban card. The store then contacts the supplier and indicates the need to replenish the card. The product, also containing a card, is delivered to the factory store, completing the final step to the system.

Input / Output Control

This system, sometimes known as ConWip (Constant Work in Progress) is an automated procedure which transforms a chain of events into one. Technically, this is when a signal travels automatically from the end of the production line to the beginning every time the process is completed, resulting in constant production. Applied to inventory management an example would be the use of barcodes. Barcodes are an electronic way to track inventory levels. When the items are scanned, software records the number left in inventory and sends an automatic signal to the supplier when inventory levels hit a predetermined re-order point.

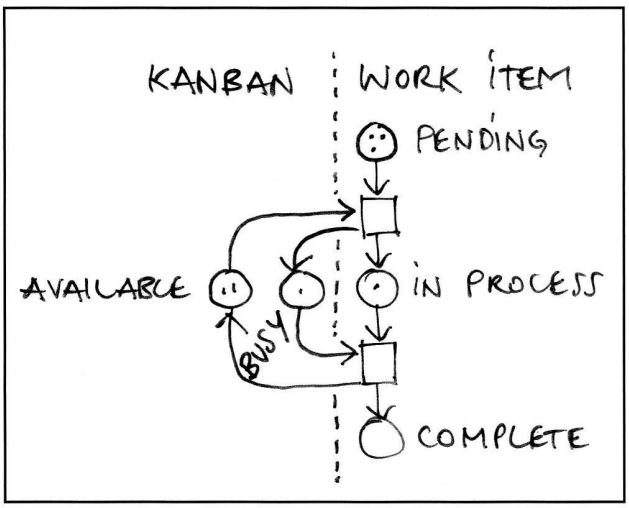


Plate 7: Milestones on the workflow. (Image drawn by A. Wasserfallen, based on internet quoted sources)

Kanban Accumulator

This is when signals are accumulated by the supplier until orders reach a certain batch size. Regardless of production lines, this process can sometimes be applied by chains looking to cut down on costs. For example, if a filling-station company is looking to cut down its costs by improving the delivery schedules, the supplier may wait to collect ordering signals for a specified number of items before carrying out the delivery.

Dual Card System

This system was first used by Toyota and is more suitable for more complex and flexible systems. This is when there are two different signals within one system, one to initiate production and the other to initiate transport, also sometimes known as withdrawal Kanban (from the production factory). This system is often used on production lines where materials not only need to be produced or re-ordered, but they also need to be transported from production or inventory to the general assembly line. This method can usually deal with a

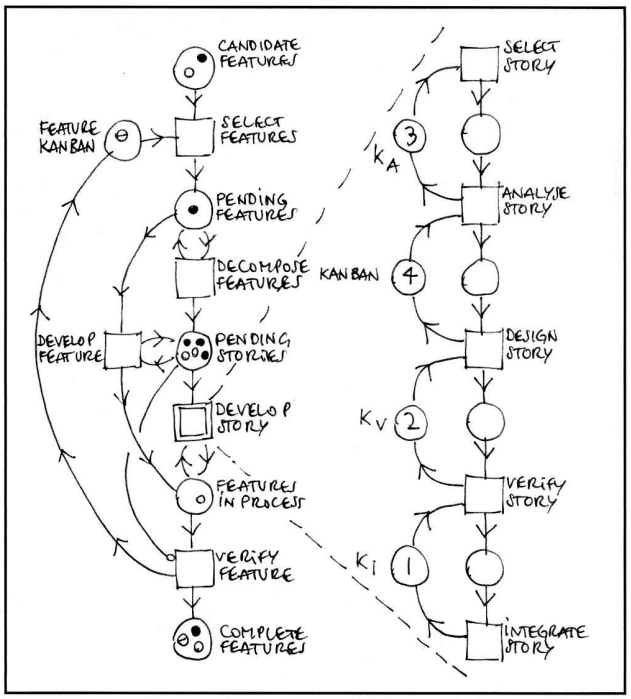


Plate 8: Russian puppets. (Image drawn by A. Wasserfallen, based on internet quoted sources)

larger mix of products and greater batch sizes. Delivering parts in bulk usually means that the same step is carried out many times for all the items before moving on to the next step. When used efficiently, this system has been proved to save time.

Variable Quantity

The Variable Quantity System is mostly used when there is a fixed frequency in deliveries. The quantity merely replenishes the stock that has been used, bringing inventory levels up to a predetermined maximum. Therefore, if a shop receives stock twice a week without fail, the quantity will change with every delivery, as only the items that were recently removed from the inventory will be reordered.

POLCA System

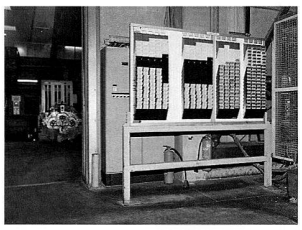
The Paired-Cell Overlapping Loops of Cards with Authorization (POLCA) system is most often used when manufacturing products that require a high level of customization. It combines the best features of the «push and pull» systems, while complementing their drawbacks. Although tricky to implement, it was first created as part of the Quick Response Manufacturing strategy which works towards reducing lead times and therefore cost, as well as increasing customer satisfaction.

Applications, conclusions

When making the decision to implement Kanban in any given company, the first step is to research the different options it has to offer. This is necessary as not all parts of this method will be applicable to the process in question. The next step will be the selection process of the elements to be implemented. For instance in some cases, it may be easier to implement a manual method, while in other cases an automated tool may be the best option. It is important to bear in mind that the Kanban system will not only involve the manufacturing process, but the business as a whole. The following areas will all be integrated: purchasing, warehousing, shipping/receiving, quality control, transportation, accounts payable and engineering. The goal of the planning system is to have exactly what is needed, where it is needed and when it is needed. Based on the plan, a number of goals must be set in order to track the progress of the facility after implementation. A basic

Kanban	
Advantages	Disadvantages
• Eliminates most storage costs • Easily transfers information • Able to respond quickly to changes • Delegates responsibilities to line workers • Low technology costs • Reduces lead times • Eliminates waste • Prevents overproduction • Improves flow • Minimizes risk of inventory obsolescence	• Less effective in shared resource situations • Fluctuations in demand can cause many problems • Does not eliminate variability • Not suitable for short production runs • A breakdown in the system can stop the entire line • Inflexible

Plate 9: Comparison table.



Plates 10 and 11: Kanban Information at GF. (Georg Fischer, source: Weingang.de) «Now throughout the world, companies are learning the power of the kanban system. They are turning away from sophisticated computer schedules for many parts of the process.» (Liker J.K., The Toyota Way)

outline must be made of what is going to be measured and how it will be measured. These elements must also be evaluated prior to the introduction of Kanbans in order to compare the outcomes. To start implementation it is recommended to begin with many different descriptions and to eliminate them slowly; boxes, pallets, containers, etc. The number of containers must then be reduced to the point where the supply of products/materials is in balance with the usage rate. One way to approach this elimination of containers is by trial and error until the pattern between demand and time can be more or less estimated for future production. The final factor is that the containers must be easily identifiable, with their content, by the staff. A common approach to this is color coding and labeling making the containers easily recognizable and therefore minimizing lost time.

A supermarket of parts

What did the Western economy learn from Asian Industry? Indeed the Eastern and Western regions of our world are faced with a flow of ideas bouncing off each other: Asian industry looks for ideas, perfecting a discovery in inventory management, and then re-exports the method, as technology, to the West as inspired by the XIXth Century that was eager to adjust to outside competitors. Can we really say that we are seeing a 100% Japanese invention? Not completely. Can we observe that Europe and America would not have introduced lean management techniques without Japan? Yes, perhaps. The strength of this powerful method is that it was developed in an exchange of competing mindsets, with different speeds of momentum. This whole development occurred mainly while adjusting to crisis and recessions. It happened in different locations all over the world. The creators of such methods were various inventors and engineers. Is it the perfect example of the Yin and Yang pursuit of human excellence?

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(This article is based on a class analysis by 100 EHL Facility Management students 2009–2010 and on numerous quotes by them and myself – see above. I wish to thank my students for gathering crucial information.)