KANBAN!

scheduling system

By Quarterman Lee

The challenge of simplicity

What is Kanban scheduling?

Kanban scheduling systems are among the most simple, effective and inexpensive means for manufacturing production and inventory control.

The concept is proven. From Nagoya to Wichita Falls; from Windsor to Geelong; from microelectronics to heavy steel – Kanban scheduling systems reduce inventory, eliminate stockouts, displace massive computers and slash overheads. They improve both service and quality.

So why doesn't every manufacturer employ this miracle?

In many situations, it is inappropriate – other methods work better. Even when Kanban is an excellent choice, firms may ignore it. Kanban scheduling often evokes strong emotional responses from both proponents and detractors and sets a variety of organisational phenomena at work against it.

Kanban scheduling systems operate like supermarkets. A small stock of every item sits in a dedicated location with a fixed space allocation. Customers come to the store. They visually select and purchase their items. An electronic signal goes to the supermarket's regional warehouse which details which items have sold. The warehouse prepares a (usually) daily replenishment delivery of the exact items sold.

In large, modern supermarkets, Kanban signals come from checkout scanners. They travel electronically (usually once each day) to the warehouse. Some stores still use a visual system. Here, a clerk walks the aisles daily. From empty spaces he deduces what was sold. The clerk then orders replacements. This signal might go by telephone, FAX or courier. Often it travels on the returning delivery truck.

Another variation is the bread truck. Here drivers follow a fixed route from store to store. They have a supply of bakery items in their truck. At each stop, they examine the stock and replenish what has been sold.

A manufacturing example

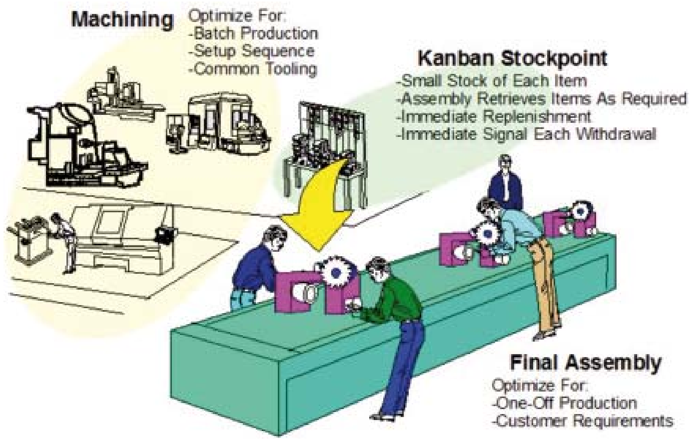
Kanban scheduling in manufacturing works in the same way. The essential elements of a system are:

- Stockpoint(s)
- Withdrawal Signal
- Immediate Feedback
- Frequent Replenishment

In the manufacturing Kanban system shown on the next page, a machine shop supplies component parts to final assembly. Assembly is a manual operation with little setup. Assembly can produce in lot sizes of one, according to customer requirements.

Machining is more automated than assembly and has significant setup costs. Machining must produce in batches to amortise the setup and sequence parts to minimise tool changes.

A small quantity of every part is maintained at the machine shop. By observing the remaining quantities, the machinists know what products need to be made next.



Kanban and other methods

Production control coordinates multi-step processes, often with multiple products. Kanban is just one of several ways to achieve this coordination.

Physical Linking is another way to coordinate. Here, each part in the process moves in synchronisation and each step starts simultaneously. Processes must have the same lot size and co-location.

In Broadcast, a final assembly operation builds directly to schedule. The schedule is simultaneously 'Broadcast' to upstream sub-assembly and supply operations. They build the needed parts in 'Line-Set Order' with a small time offset for delivery. This system does not require co-location. It does require identical lot sizes (usually one) for all processes.

Kanban scheduling systems are useful when lot sizes differ between process steps, processes are unbalanced or when distance introduces time lag or variability. These systems slightly de-couple the processes.

Materials Requirements Planning (MRP) works from Bills Of Material (BOM), routings, inventory records and forecasts. It plans each process step for each product, subassembly and item. The system accumulates demand for each work centre and each time period. MRP allows effective scheduling under the most difficult conditions.

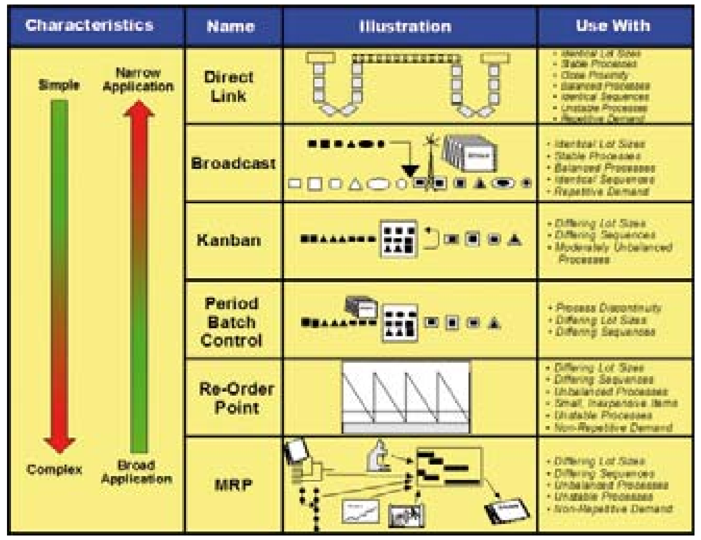
This ability to connect a disjointed production comes with a price. MRP permits some forms of sloppy engineering. The administrative costs are high. Throughput times are long and inventory turns low. Errors in inventory, BOM's or lead times disrupt the system. About 50%-80% of installed MRP systems do not meet their user's needs.

Re-Order Point (ROP) systems store each item and issue to downstream work centres on request. ROP signals a resupply when the inventory is just sufficient to cover the resupply time.

ROP systems are simple. They require steady and predictable withdrawal rates and predictable replenishment times. But, these conditions are rare. Typical systems have very high inventories and experience frequent stockouts.

A hierarchy of methodology

The figure below shows how the methods form a hierarchy of simplicity and flexibility. The best system is the simplest.



Where the process allows, Physical Link is the system of choice. Broadcast, Kanban, MRP and ROP follow in desirability.

A system designer would examine each process and each product group in turn. He/she attempts to apply physical linkage. If the necessary conditions do not exist and process change is impractical, Physical Linkage is rejected and Broadcast is considered. This process follows down to the least desirable system, ROP.

In practice, Kanban scheduling systems are often a good choice. They can be a transition between MRP and ROP approaches and Physical Linkage.

Designing the Kanban system

Preparing for a Kanban scheduling system can be formal with elaborate analyses and simulations. It can also be very informal with fine-tuning done on the production floor.

We suggest the following steps:

1. Analyse product-volume for upstream work centre
2. Analyse downstream order patterns
3. Identify Kanban products
4. Identify appropriate lot sizes
5. Identify containers
6. Identify signal mechanism
7. Specify stockpoint(s)
8. Specify initial Kanban quantities
9. Develop upstream scheduling algorithm

10. Operate fine tune

Designing each connection and product using the above methods could be very elaborate and time consuming if followed rigorously. With experience, however, most designers or design teams learn to perform most steps mentally and informally.

In our online seminars, we initially stress the formal approach and insist on complete documentation of each step. Once participants understand the process, they can perform the steps informally and very quickly.

Daily operations

In the best systems, operators or teams schedule their own work. They have current and accurate information of downstream production needs. The scheduling bucket is rarely larger than a day. In some systems, it may be only minutes.

Operators examine returning Kanban cards or signals to determine where stock is low or high. Aids such as boards with red, yellow and green zones can assist. Knowing the most favourable sequence for changeovers, the operator first schedules items in the red zones. Products in the yellow and green zones then follow. Operators might also have a list of incoming orders. With this, they identify any unusually large order(s) that will overwhelm the stock.

How many Kanban?

The number of cards or containers is a key issue. Excess cards and inventory encourage sloppy scheduling and a laissez-faire attitude. Insufficient cards adversely affect customers. Several methodologies can determine an optimum level:

- Boundary Analysis
- Predetermined Formula
- Factor Analysis
- Computer Simulation
- Trial and Error

In Boundary Analysis, key people mentally step through system operation using Product-Volume and other data. With simplified methods and risk estimates, they put upper and lower limits on the stock.

Predetermined formulae are available. Such formulae usually contain 'guess' factors and unavailable data. They often apply to specific situations and have limited usefulness.

Factor Analysis identifies the various factors that affect stocks. Examples are setup costs, order volatility, quality issues, stockouts consequences and gross volume.

Computer Simulation uses specialised software to build a model of the system. The analyst can vary parameters and arrive at desired levels. Simulation is expensive to do properly. Oversimplified simulations rarely show true operation, the role of human intelligence or effects of continuous improvement.

With Trial and Error, you set up the system and go. If it operates poorly, add more stock. If it operates too smoothly, take some away. At the ideal Kanban level, the system operates 'near the edge' and sometimes demands extraordinary measures.

In practice, most designers use a combination of Boundary Analysis, Factor Analysis and Trial and Error. Since most systems are easy to modify, this works quite well.

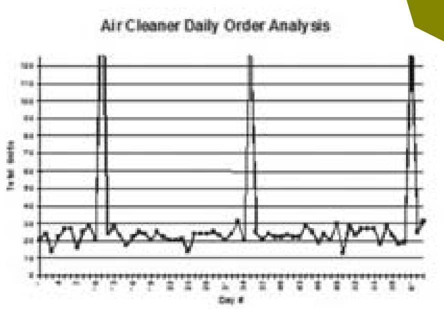
A Kanban system case study

A Kanban system schedules the production of six people assembling industrial air cleaners from sheet metal and purchased parts.

They build 15 basic units and many variations. Ten assembly cells have fixtures, tools and parts ready at all times.

Each cell produces one or two basic models. One to three people can staff any cell. An adjacent warehouse holds a small finished stock of each standard model.

The charts below display the data that was the basis for system design.



The Product-Volume Analysis shows each basic model and the average number of units sold each day. These are long-term averages and do not reflect the daily order flow. Three models represent the bulk of demand. Five additional models have medium demand levels. Seven models have extremely low demand.

The designers decided to have a stockpoint in the warehouse where orders could be quickly pulled and shipped. Only the high and medium demand items would have a Kanban stock.

When a unit was withdrawn from the Kanban stock, a card would go back to the production area to signal that withdrawal. If a low-volume item appeared on an order, a special one-time Kanban card would immediately go to production where the item would be built before the day's end.

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The Daily Order Profile shows the total number of units ordered each day for a two-month period. It appears that on most days, the demand is fairly constant at about 25 units. However, very heavy days seem to punctuate this steady pattern at about three week intervals.

The Order Profile is another way to present this same data. It shows that on most days, order volume clusters around 20-25 units with a few days of very heavy volume.

If the Kanban system was designed to satisfy the heavy order days, inventories would be huge. There was some doubt within the design team about the feasibility of Kanban.

Weird order patterns like this should and, in this case did, raise questions:

- Why the sudden increases?
- Why are they somewhat regular?
- Where does this volume originate?

Upon investigation, the designers found that most orders came from domestic distributors. These distributors ordered in very small quantities but there were many distributors around the US. The cumulative daily volume from these many small orders tended to be steady at about 20-25 units.

The large spikes resulted from a single, overseas distributor that ordered large quantities for ocean shipment. This was a different market and different distribution channel. Fast delivery of these large orders was necessary for the domestic market but not for the overseas distributor.

It was decided to design the Kanban system for the domestic orders and make special arrangements for the overseas distibutor. When an overseas order arrived, it would be mixed with the domestic production over a period of several weeks. This approach smoothed production and reduced the need for Kanban stock.

Daily operations

The team leader scans incoming orders. He prepares one-time cards for large orders and customised items. The leader sorts cards coming from the warehouse. All cards then go on a board arranged by assembly cell. Cells with cards in the red zone have priority. If necessary, additional people work an overloaded cell.

The warehouse picks standard orders from stock and sends cards to production. They combine standard items with any customised items arriving from production and ship the orders.

In a second phase of this project, sheet metal and welding operations moved directly adjacent to the assembly cells. They have dedicated people and equipment. The welding team leader examines each assembly cell for stocks of welded cabinets. He also checks the board.

This daily checking constitutes the signal for replacement. Operators weld the necessary replacement cabinets and place them on a paint line. This replenishment is normally 24 hours. It may be as little as four hours.

The welding department stocks sheet metal components in large wiretainers. Each wiretainer has special shelves and brackets. It holds a fixed number of each item on a particular cabinet. A minimum quantity signals operators or the team leader to send the basket to sheet metal for replenishment. The sheet metal team sets up and builds components to replenish the basket and returns it to the welding department. This normally occurs within 24 hours. Higher volume cabinets may have several identical baskets to maintain welding production during replenishment.

This complete system uses Kanban, Direct Link and Re-Order Point. A Broadcast system overlays the other systems since all team leaders have access to the final assembly Kanban board.

This Kanban system eliminated 96% of finished goods inventory, simplified scheduling and eliminated losses from obsolescent product.

About the Author

Quarterman Lee ('Q') started his career at the fountainhead of lean manufacturing, Ford Motor Company. He has worked in foundries, paper mills and a window manufacturing plant in positions from Engineer to Plant Manager. Since 1977, he has been consulting, training and writing. Mr Lee has authored two books and hundreds of articles and programmes. He is currently President of Strategos, Inc *www.strategosinc.com*.