"Kanban — Do It Now but Do It Right" Workshop Illustrates the Importance of Kanban as a Tool in Lean Production

Helping to empower and motivate employees.

Jeff Schaller, Ph.D.

Just-In-Time (JIT) production is one of the pillars of lean. Kanban inventory management is one of the tools of JIT. A definition of Kanban is: a visual replenishment technique which utilizes standard containers, each of which has a card designating what and when to purchase or produce an item. The concept seems simple and has been shown to produce dramatic results in organizations for the past 25 years.

Yet many organizations are still trying to decide whether or not to adopt Kanban and many of those who have adopted it are struggling with implementation. Steve Brown, former vice president of operations at Respironics Novametrix, and Brian Montanari,¹ former operations manager at the company, first learned about lean while working for the Wiremold Company in West Hartford, CT. Then they implemented lean at

In Brief

Have questions about Kanban sytems and implementation? This article offers the basics for effective Kanban use in a lean organization. Added bonus: helping to engage and motivate employees as you rack up productivity and other performance improvements.

the C&M Company in Wauregan, CT and Respironics Novametrix in Wallingford, CT. This article reflects a number of the lean concepts offered by Brown and Montanari during AME workshops titled, "Kanban — 'Just Do it Now.'" Typical workshop questions are: Where in a lean implementation does Kanban fit? Should Kanban or MRP/ERP (Material Requirements Planning/Enterprise Resource Planning) be used? What specific Kanban techniques should be used in my plant or with my suppliers? What are some of the keys to successfully and quickly implementing Kanban? How can our organization use pull system/Kanban methods to reduce stock outages and increase productivity? What techniques should be used to train company personnel? How can technology be used to enhance a Kanban system? This article discusses some points of interest based on the author's recent attendance at an AME workshop in Hartford, CT.

Kanban and Lean Implementation

Many people think of Kanban as just an inventory control system. While it is used to control and manage inventory, this tool is also an important part of the philosophy of lean and should be used as a tool for enhancing a lean culture. The philosophy of lean is to eliminate waste through continuous improvement (CI). Waste is defined as any activity that does not add value to the organization. Inventory and overproduction are two major wastes that exist in most manufacturing companies. Some of the primary causes of these wastes are batch production, long setup times, building to a forecast (due to a long leadtime), lack of continuous flow of product and people, unnecessary product flow, bottlenecks, and traditional productivity measurements.

Inventory is an important measure of the success of a lean implementation. Inventory is used to buffer operations against the problems discussed above. The rocks in the materials river analogy is frequently used to describe the relationship between operations problems and inventory. In this analogy, water in the river represents inventory and covers up the problems. If there is a high level of inventory, the business can operate and produce products for shipment but at the expense of carrying inventory and poor productivity (caused by not addressing the problems previously mentioned). If inventory levels are reduced, problems then become visible and

efforts can be focused on improving operations by eliminating the problems (rocks in the materials river).

A problem with this analogy is that if inventory is managed by a centralized production planning and control group using an MRP system and held in a central stockroom, the visibility between inventory and the specific problems causing the inventory become blurred. Brown and Montanari suggest that a key to successful Kanban implementation is to store material at point of use. When inventory is stored at the point of use, the unnecessary inventory becomes more visible to everyone. Once it is identified, people can then focus on eliminating the problems. Brown stated, "At Respironics Novametrix, we had a day's worth of inventory in a cell. This enhanced visibility. At the end of the day, there was very little inventory or there was a problem causing the cell not to produce to schedule."

When Brown and Montanari started to implement lean at Respironics Novametrix several years ago, about 60 percent of the floor space was dedicated to the stockroom. Brown felt the stockroom was a barrier that hid excessive inventory from employees responsible for the planning and actual production of products. This process of "hiding" excess inventory in the stockroom minimized the visibility of the problem(s) and therefore they were never addressed. Changes included eliminating the stockroom and sending raw materials to the cells using them, utilizing Kanban to manage the inventory, and assigning buyer/planners to support specific cells. These changes increased the visibility of problems and created teams of employees with the knowledge and experience to solve them.

Kanban is more than just an inventory control system. It is also a tool that can be used to direct CI activities as well as to empower employees and motivate their involvement in lean activities and CI. Brown and Montanari recommended that Kanban should be one of the early tools used in a lean implementation. At both Respironics Novametrix and C&M, Kanban was one of the first lean tools implemented and was credited with rapidly reducing inventory. More importantly, it was an integral part of instilling a lean culture at both companies.

Kanban Signals and Methods

Kanban is a Japanese term for "card" or "signal." The signal means it is time to produce or move material. Some of the types of signals that can be used are marked spaces (the vacant space is the signal), card (the card is the signal), and light (the customer-controlled light is the signal). Combinations of the signals can be even more effective. For example, an automated system utilizing cards and lights with the extra visibility of an empty space is particularly effective.

Kanban systems can be classified as internal or external. In an internal system, signals are generated and fulfilled within the same organization and product does not physically leave the building. An example of an internal system is material moving from one cell to another cell within the same plant. In an external system the signal is fulfilled outside the physical building. The signal can be from within the same corporation but typically is the result of a supplier/customer relationship.

The Kanban methods discussed during the workshop include: min/max - one-bin system, two-bin system, and multiple card system.² When selecting a Kanban method for an item, Brown noted that each method has its strengths and it is important to "pick the methods that work best for your own situation." All of the methods mentioned are used at Respironics Novametrix. For example, the min/max - one-bin and two-bin systems tend to require more inventory than a multiple card system so these methods might be more appropriate for low-dollarvalue items. You do not want to spend a lot of time managing items that have minimal value.

The multiple card system is particularly important in terms of inventory reduction and driving CI. With this method, a signal is generated and product is ordered as soon as a box or package is opened. There are several advantages to this method. This is the most flexible form of Kanban. For example, if there are changes in the rate of use of an item it is easy to just add or subtract a card. The multiple card method should utilize the supplier package quantity as the standard container size whenever possible. This is important because the process of taking a product out of a supplier's box to put it into a company bin or package is a non-valueadded (NVA) activity. The multiple card method is the most disciplined for employees. It is easy to reduce inventory levels by taking away a card. If your company has excess inventory it can be reduced by simply not putting cards on some of the boxes and using those boxes first (therefore product is not ordered). Montanari pointed out that as inventory is being reduced it is important to let the supplier know what is happening and to work on developing long-term agreements with suppliers.

To determine the number of kanban cards (kanban level) required for an item using the multiple card methodology, the following information is needed: 1) average daily demand, 2) leadtime from the supplier, and 3) supplier's package quantity. The following formula is used to compute the number of kanban cards:

method used, it is important to monitor the levels and reduce the number of kanban cards when appropriate. The formula presented on this page is essentially the same as the formula that can be found in any operations management text book for calculating the reorder point in a continuous review system. The difference in the approach

The number of cards = average daily demand x leadtime + buffer supplier's package quantity

The first part of the numerator is the minimum inventory level (or base level) required for the item (average daily demand x leadtime). This allows an operation to continue while the item is being replenished. In addition to the minimum inventory level, a buffer is needed to cover potential problems such as the supplier not being on time, a sudden increase in demand for the item, or rejected parts.

Montanari recommended that when an item is first set up on a multiple card kanban system, a higher buffer should be used than what will normally be needed (an additional percentage based on experience, or additional days of inventory, or a specific quantity). If the buffer is too high, cards can always be removed to reduce the inventory level. Initially a higher buffer is used to compensate for Kanban being a new and different process, errors in calculations, vendor performance, etc.

Asked why a statistical calculation based on variability of demand could not be used to develop the level of buffer inventory, Montanari responded that it is also a method that can be used to set the buffer level for an item. He stressed that regardless of the

is that a reorder point system is typically managed by a central inventory control group with inventory held in a central stockroom. In a Kanban system, stock is held at point of use and managed by those who use the material. Therefore there is a more direct line of sight between the inventory and the causes of inventory. If improvements can be made, for example, reducing setup times or leadtimes, then inventory can be reduced. One of the keys to successfully utilizing Kanban to drive CI is the use of kanban visual boards.

Kanban Visual Boards

Kanban visual boards show: desired inventory level, if material has been ordered, supplier of the material, when material is due in (leadtime), if material is late, and the location of the material.

Figure 1 shows how color coding was used to enhance the effectiveness of the visual boards at the Respironics and C&M companies. Each item has an area on the visual board for its kanban cards. As standard packages of an item are used, the kanban card is removed and placed on the visual board. The item's area on the visual board is divided into green, yellow, and red

Kanban Visual Board



Figure 1. Kanban visual board color coding: "Normal" (green), "Caution" (yellow), and "Critical" (red) indications.



Figure 2. Kanban continuous improvement cycle.

Target Volume 21, Number 2

sections. The first cards are placed in the green area, then if more packages are used, cards will be placed in the yellow area and finally in the red area. As packages are replenished from the supplier, a card is removed from the board. This provides a quick visual for everyone on the floor. It allows the employees to see problems and take actions to correct them, adjusting inventory levels as needed. If an item is always in the red area on the visual board, then the kanban level may be too low and a card should be added to increase inventory. If the item is always in the green area on the visual board, the kanban level may be too high and a card can be removed to reduce the inventory level. At Respironics and C&M, initially dividing the total number of kanban cards for an item by three yielded the allocation of spaces for cards to the green, yellow, and red areas. The number of cards allocated to each area can easily be changed based on experience with the item and using the visual boards. Montanari feels that using the visual kanban boards is a key to managing Kanban and helps provide a closed loop system.

Figure 2 depicts a process that can be used to reduce inventory by monitoring the visual boards in conjunction with CI.

Technology and Kanban

One of the strengths of Kanban is that it is simple and does not require complex and expensive information systems to be effective. Technology such as software systems can be used to enhance it, however. These systems are relatively inexpensive, typically costing between \$2500 and \$15,000 with some extra fees for implementation consultants. The kanban software systems can also be implemented quickly, usually within one month.

A kanban information system can reduce much of the manual effort involved in calculating kanban levels, making kanban cards, placing releases, and monitoring the system. Kanban levels traditionally have been calculated using spreadsheets. This requires a spreadsheet to be set up, information to be entered, and then kanban levels are calculated. The process can be cumbersome when changes are required. For example, if it is decided a two-bin system should be used instead of a multiple card system, then changes to the spreadsheet must be made so the item's kanban level can be recalculated. With an automated software system it is easy to change the method for calculating the level and then the item is automatically updated. The printing of bar-coded kanban cards and labels for visual boards can also be easily automated. The bar-coded kanban cards can then be scanned and an automated release can be created, saving manual labor and time.

As mentioned earlier in the article, the monitoring of a Kanban system is a key to success. The following were items that Brown and Montanari suggested be monitored: ordering pattern, lowest kanban level hit, slow-moving items, inventory turns, on-time deliveries, late orders, and the real-time status of a part. Keeping track of this information manually would be very difficult, but automating the collection and tracking of this information allows for quick identification of problems as well as opportunities for improvement and information that can provide direction for action.

A good example is automating the visual boards. If a supplier reduces the leadtime of an item,



Figure 3. Supply chain status.

then the kanban levels for that item can be reduced. Without automation, the visual boards must be continuously monitored to identify items for inventory reduction and then each item's kanban level must be manually recalculated.

Figure 3 shows a supply chain status screen used at Respironics Novametrix. For the items in each cell, the screen shows whether the item is in the green, yellow, or red area of the visual board. The screen also shows the lowest level hit (depicted by the house) for each item so it can be used to identify opportunities for inventory reduction. This information can also be viewed on an exception basis. An example of an exception report is showing only those items with inventory in the red area.

Other automated reports used by Respironics Novametrix include

performance reports such as kanban turns, supplier on-time delivery, and a linearity of orders report (history of purchases sorted by planner). By automating the Kanban process, the company was able to develop the closed loop system depicted in Figure 4.

Kanban or MRP?

A fundamental difference between Kanban and MRP is the way materials are replenished. With an MRP system the purchasing of raw materials is based on projected demand regardless of consumption levels. With a Kanban system materials are given a predetermined quantity to keep on hand and consumption triggers replenishment. Brown and Montanari consider MRP systems to be a liability. They have experienced the following problems when MRP was used: 1)

47

Update on Excellence



Figure 4. Kanban closed loop system.

The process of implementing weekly forecast changes (push out/pull in/cancel purchase orders, cancel work orders, reallocate inventory) took one to five days and then it would have to be done all over again the following week; 2) there were so many work orders and changes that planners had to prioritize work orders for the stockroom; 3) A large amount of inventory allocated to work orders that were partially complete, but production could not produce due to incomplete work orders; 4) a huge amount of transactions required seven people in the stockroom; 5) engineering change orders caused more transactions, changes to purchase orders, and work orders.

MRP systems were designed to plan in an environment of batch and queue with long leadtimes, poor quality, poor vendor relationships, and a focus on local optimization as opposed to minimizing NVA activities across the supply chain. MRP results in numerous transactions. Each transaction has a cost attached to it and these transactions are NVA. Montanari recommended that, "Rather than change your business processes to match best practices of an MRP package, find a software package that matches your current practice." On the other hand, Kanban aims to improve efficiency, eliminate product backlogs, and synchronize production to customer demand. This is done to improve response time and customer service, and reduce procurement and plant floor costs.

MRP still has a role in a Kanban system. It is used for long-term capacity planning and vendor negotiations. Because Kanban and MRP are so different, Montanari suggested not using Kanban and MRP for the same part because the systems can provide conflicting signals.

There are several advantages to using a Kanban system:

- It is a simple technique with low total cost
- Material outages are reduced
- Inventory is reduced
- Leadtimes are reduced
- Throughput increases because of inventory availability
- Visual boards add awareness and ownership.

Common negative assumptions about Kanban addressed by Brown and Montanari include: 1) Kanban is less effective in shared resources — they suggested storing materials at the point of use; 2) spikes in demand can cause poor on-time delivery (the solution is to use buffers to protect against demand variability); 3) unplanned downtimes can cause missed deliveries (buffers can be used but it is better to use kaizen (improvement activities) to limit or eliminate downtimes); 4) quality problems that cause scrap resulting in idle people or equipment (a Kanban advantage is that it shows where improvement is needed).

The following question was asked at a recent workshop: What if an item has a six-month leadtime? Isn't it better to use MRP on an item like this? The response to this question included the following points: It is a management decision to stay with a vendor that has a six-month leadtime. With this leadtime, inventory will have to be carried for the item whether MRP or Kanban is used. It may be possible to work with the vendor to reduce the leadtime. If the vendor is overseas and the leadtime cannot be reduced, then management must evaluate whether it is better to use that vendor or beneficial to find an alternate vendor.

48

Aero Ace Simulation Roles

- 1. Material ID/kitter
- 2. Fuselage assembler
- 3. Nose assembly #1
- 4. Nose assembly #2
- 5. Wing assembly
- 6. Paint

Figure 5.

Phyllis Papa, a buyer planner at Respironics Novametrix and a former master scheduler, had the following comment about switching from an MRP system to a Kanban system: "Wow, MRP was a lot of work. Kanban is so much easier. We thought it would never work. Now I look back and can't believe we had to do all those stupid steps."

Plant Simulation Training Exercise

Training and education required to effectively implement Kanban has many components. It is important to demonstrate to managers and employees how the philosophy behind lean and Kanban results in benefits, said Brown and Montanari. They use an experiential exercise called the Plant Simulation to illustrate some of the lean and Kanban concepts. Teams of 12 participants are created to build paper airplanes. There are two types of planes (products): blue planes and yellow planes. Each team consists of 12 players who take on the roles shown in Figure 5. To produce a plane, material is received from a supplier (colored

- 7. Material handler
- 8. Supervisor
- 9. QC inspector
- 10. Supplier/trucker
- 11. Customer
- 12. Buyer/planner.

sheets of paper) and it progresses through six production operations (performed by the first six people in Figure 5) and is shipped to a customer. The demand for each color plane varies from a low of one unit to a high of three units each period. Teams are evaluated based on the profit or loss achieved during the simulation. The profit or loss is calculated based on revenue for good planes shipped to the customer minus the cost of producing the planes. Costs are assigned based on the data in Figure 6. Each team's productivity is also measured by dividing the number of planes produced by the number of people required to produce the plane (including indirect workers such as the supervisor, material handler, material ID/kitter, and QC inspector).

The simulation is run under four situations: 1) functional organization with a push system using batch sizes of six units, 2) functional organization with a push system using batch sizes of three units, 3) U-shaped cell with a Kanban system and single-piece flow, 4) same as 3 except teams are allowed to kaizen the operation.

As the teams progress through the four situations, the performmeasures dramatically ance improve. For example, the productivity figures during a recent workshop improved as follows: Cutting batch sizes from six to three resulted in a 180 percent improvement, converting to U-shaped cells and single-piece flow with Kanbanmanaged inventory resulted in an additional 81 percent improvement, and the kaizen effort resulted in another 61 percent improvement. Progressing from a traditional functional layout with a push system and batch sizes of six to a U-shaped cell with single-piece flow and inventory managed with Kanban increased productivity 715 percent! Also, when the structure of the simulation was changed from traditional production to lean production, the atmosphere of the workplace changed. When the functional layout with batch sizes of six and a push system was used the workplace was chaotic, noisy, and driven by impending crises. The supervisor, material handler, and QC inspector ran around attempting to prioritize what problems to address next. When lean production with a Kanban system was used, the workplace became well organized and quiet.

This simulation is a good exercise for companies that are in the beginning stages of lean or Kanban. It can illustrate to employees the benefits of making the transition as well as key concepts used to obtain the benefits.

Results

What results can be expected from a lean/Kanban approach? A key area where results should improve is the dollars of inventory required. At the C&M Company inventory turnover improved 700

Revenues and Costs (\$000s) for Aero Ace Simulation

Revenue:

1. 2000 for each good plane received by the customer

Costs:

- 1. 50 per person
- 2. 100 per unit of raw material inventory held at the end of the simulation
- 3. 500 per unit of WIP inventory held at the end of the simulation
- 4. 1000 per unit of finished goods inventory held at the end of the simulation
- 5. 50 per unit shipped as a partial
- 6. 100 per unit of raw material scrapped
- 7. 500 per unit of WIP scrapped
- 8. 1000 per finished unit scrapped
- 9. 100 per unit not filled.

Figure 6.

percent over a three-year period. At Respironics Novametrix inventory was reduced by 24.5 percent in the first six months of using Kanban.

Kanban also helps to drive CI and this, combined with the reduction of inventory, results in reduced floor space required, production leadtimes, and scrap plus increased productivity. At the C&M Company floor space required was reduced 30 percent, leadtime for production decreased by over 86 percent, and scrap was reduced by 50 percent. Brown explained that before Kanban was started, "In many cases the company had material but could not find it, so more was ordered from suppliers. You know it is bad when you know you have the material but it is quicker to get it from the supplier."

Floor space was reduced by 33 percent at Respironics Novametrix over the first ten months that Kanban was used. This allowed the company to shelve a \$4 million dollar expansion plan. Leadtime required for production was reduced by over 99 percent in some cases. Seventy percent of their shipments occurred at the end of the month before Kanban was implemented. By implementing Kanban and producing at the rate of customer demand (takt time), overtime was reduced by 88.1 percent.

Keys to Success

To summarize, there are several keys to a successful implementation of Kanban: 1) Implement this

tool (Kanban) early to support the lean production culture; 2) use signals and methods as appropriate and combinations of signals where possible to enhance effectiveness; 3) work with suppliers on improvement activities and let suppliers know when inventory is being reduced or increased; 4) monitor the system and try to increase visibility wherever possible through the use of visuals; 5) use technology to support the Kanban system and to create a closed loop process with additional visibility; 6) try to simplify so that MRP is not needed except for long-range planning; 7) use experiential exercises to demonstrate why lean and Kanban will help and why a different philosophy and culture are required; and 8) tailor the Kanban system to your company's specific environment. Kanban can be implemented quickly and a lean culture can be developed to generate dramatic results in a relatively short period of time.

Jeff Schaller, Ph.D., is an associate professor of operations management at Eastern Connecticut State University, Willimantic, CT.

Footnotes

1. Steve Brown and Brian Montanari are now with the company Lean Depot, LLC which specializes in Kanban automation and implementation as well as other lean services and products (http://www.leandepot.com).

2. Definitions: 1) min/max-one bin system inventory for an item is stored in a single bin, and when inventory drops below a pre-determined level, production is authorized to bring inventory up to the pre-determined maximum level; 2) two-bin system — inventory for an item is stored in two bins, and when one bin is used up, an order for another bin is placed; and 3) multiple card system — a box or package of an item is ordered as soon as a box or package of the item is opened.

^{© 2005} AME® For information on reprints, contact: Association for Manufacturing Excellence www.ame.org