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Exploring eKanban: Push v. Pull Manufacturing

InSync Solutions Paper

CONTENTS

As the economy begins to refocus, so too do manufacturers. More and more analysts and industry experts are writing about the digitization of manufacturing and the enablement of demand-driven technologies that synchronize people, processes, materials, machines and data to drive velocity and on-time production while effectively managing the inevitable constraints. Legacy ERP and Push-based MRP systems are hard-pressed to support the Lean and demand-driven Pull-based production environments of today. And while Pull-based systems are more and more becoming a way to bridge the old and the new, they require a shift in philosophy as well as a shift in IT systems. Flexible, plug-in solutions like eKanban systems, however, are an efficient (and non-disruptive) way to bridge the gap for those looking to gain greater control by implementing or expanding upon Lean principles.

This is the first in a series of papers exploring the nature of Pull-based manufacturing systems and specifically, Kanban/eKanban systems. The focus of this paper is at the system, or workflow level, while subsequent publications will review Pull/Kanban systems from a management, customer and competitive standpoint. After reading this paper, you will have a good understanding of both Pull and Push-based manufacturing systems and your choices for systems within a Pull environment. After reading the collection of papers, you should have a 360-degree perspective of the impact of a Pull/Kanban system in an organization.

Push v. Pull Planning and Execution Systems in Manufacturing

The contrast between Push and Pull-based systems starts at the planning phase. In traditional Push-based MRP/ERP environments, a plan is developed and pushed through the system. The assumption for planning in a Push environment is that everything remains constant; the company has the capacity on hand, along with the inventory and decision support staff to execute the plan. And while seemingly proactive, the plan often becomes obsolete before it is executed as it cannot easily accommodate changes in market conditions or adjust to variations inherent in manufacturing environments.

PUSH: Doesn't account for variability. A production plan is developed and pushed through the system.

PULL: Production is based on actual customer demand (or consumption). Operates in real-time to easily adapt to variability.

Pull/Kanban systems are driven from a high-level perspective that focuses on capacity and material planning based on actual customer demand. The assumption for planning here is that the design of the system is balanced according to the demands placed on the company.

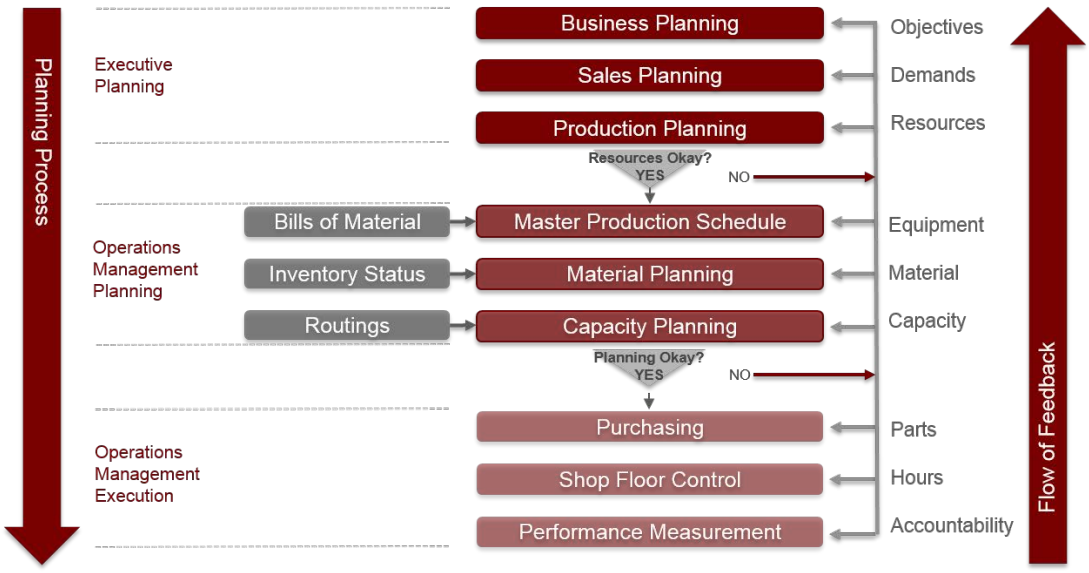
So, while Push-based systems are front-loaded in planning and rigid in execution, Pull-based systems focus on the execution of the customer order and are designed to be agile enough to respond quickly to changes in demand. Next, we'll review both systems in greater detail.

Plan-Driven Push-Based Systems

Planning in a Push environment is most often executed from an MRP or ERP system and starts when senior management sets the near and long-term financial goals for the company. These goals create the foundation for the company's business plan. (Figure 1.)

Based on high-level strategic goals, the business plan establishes budgets and identifies resources required to execute the plan. The plan is then handed off to the sales, operations and supply chain teams to validate the goals and determine how they will be met.

Figure 1



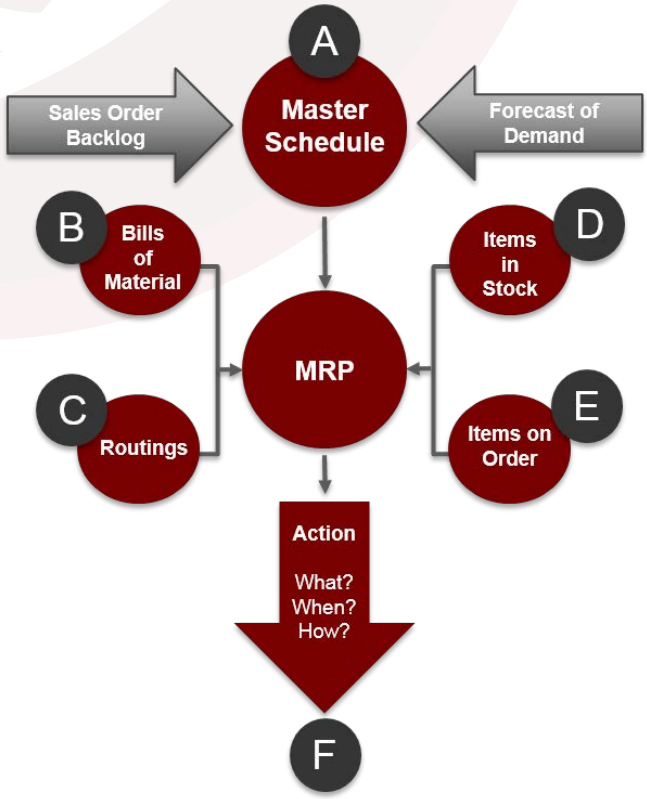
Basic Model for Resource Planning and Control

The contrast between Push- and Pull-based systems starts in the planning phase.

As would be expected, a large component of the process revolves around forecasting customer demand across the plan's horizon. Methods for forecasting vary greatly in Push environments, ranging from complex modeling techniques to SWAGs on customer demand.

Once developed, the forecast plans are loaded into the MRP/ERP system and a rough cut capacity plan is created to verify if the plans will be able to produce the desired results. The forecast is then joined with actual sales and current activity into a Master Production Schedule. (Figure 2.)

Figure 2



Developing a Master Production Schedule (MPS)

A. **Master Schedule** - what you plan to do.
B. **Bills of Material** - what you need to do it.
C. **Routings** - how you will do it.
D. **Inventory Status** - what you have in stock.
E. **Open Purchase Orders** - what you have on order.

(A)(B)(C)-(D)-(E)=(F)

F. **Planned Work Orders** - what you need to make.
Dispatch List - when you need to make it.
Planned Purchase Orders - what you need to buy.
Purchase Order Action - when you need to buy.

Master Production Schedule

This is an iterative process, but once the plan is agreed upon, the MPS pushes out resource requirements to the production planning and purchasing/supply chain functions for more detailed planning, resource allocation and spending approvals.

A brief History of Push-Based Planning Systems

In the 1940's, the government started using computers to help speed up complex calculations; manufacturing was a natural offshoot and led to the digitizing of manufacturing data in the 1950's and 1960's.

MRP was designed to work in complex environments where production times were long and the supply chain was extended. The planning process relied on planning all the levels of production with the Bills of Material for the products, resources to produce and cost allocations to simplify the accounting functions. Prior to MRP, figuring out how much inventory was needed was done entirely by manual calculation, which could take months.

When MRP was written, it was meant to optimize each step and function of the company. The thought being that if each step is optimized, we will have an optimal result. And as computing power grew, so did MRP. First managing just materials, then time-phased materials, capacity and finally, accounting. Today nearly all of a company's transactional, financial and back office data are managed by ERP systems.

Demand, like the weather, becomes more difficult to forecast the further you look into the future. There are many changes that can happen once the plan is put in place and the longer or more diverse the supply chain, the more variation can play upon the plan. This is a key reason why more flexible, Pull-based systems are gaining traction today.

Inventory, open work orders and open purchase orders are taken into account and actions are pushed to purchasing, production control, inventory control and shop floor control personnel in the form of suggestions for new work orders and purchase orders. If there is work-in-process (WIP) or open orders (purchase orders and work orders), there may be a great deal of adjustment required to the current state to realign resources and activities to accommodate the new plan.

The execution phase follows the planning stage. This is the phase where the rubber hits the road. Here, work is performed through resource dispatch reporting, labor transactions for direct labor, work order completions, purchase order requisitions, purchase order receipts and inventory transactions. Materials are stored, allocated, pulled from stock, issued to manufacturing and returned to stock in a new form.

Material, machines and people are told what to do, when to do it and how much to do. This is dictated by the parameters set up within the item master, purchasing-supplier and routing data within the MRP/ERP system.

Most often there are average values for the lead time of items and process-time calculations throughout the master data. Likewise, there are many queuing and optimization models that assess the average variability of the

Figure 3

Push Planning Cycle

process. Anytime there is some degree of variability in execution outside of the planning parameters, the MRP engine re-plans and makes suggestions to operations (manufacturing and supply chain) to adjust the previous planning orders based on the new current state.

If you have worked in this environment, you are aware that by the time the plan is put in place, variability in actual customer demand and variability in execution to the plan has made it mostly meaningless. The effort then turns reactionary to accommodate actual customer demand and a controlled environment can turn to chaos. (Figure 3.)

Each time the plan changes, there is a great deal of effort by planning, procurement, supply chain, logistics and shop floor personnel to adjust all work in process and move to the new plan. This becomes a perpetual cycle that eventually results in too much for the system - too much investment in inventory, too much expediting and too much overtime and/or premium transportation costs. In the worst cases, the process directly impacts the customer. If customers have no tolerance for missed deliveries, the goals of the financial plan will not be met.

In summary, a Push-based system is a command and control structure for planning and execution that is pushed out from the top. Plan results are adjusted and reported back up the chain. This slow and often arduous feedback loop doesn't offer much flexibility to quickly respond to the inevitable variation in customer demand and execution to the plan. Rather, it often leads to a negative spiral of adding inventory, clogging up production and leading to diminished capacity and loss of control. This is the very opposite of what we are trying to achieve with our systems.

Customer Order-Driven, Pull-Based Kanban Systems

Pull-based systems represent the other end of the spectrum. Pull systems are based on the Toyota Production System (TPS) and its western interpretation, "Lean Manufacturing". The Pull method from TPS is often referred to as a Kanban system – a method for planning, execution and inventory replenishment that enables flow through greater control.

Pull/Kanban systems are based on actual customer demand. And while simple in nature, there is a great deal of effort required to change the system, or set the pieces in place so that the company can be responsive to customer demand. Determining costs and establishing budgets, developing the inventory supplier network and assessing manufacturing capabilities and capacity are still required regardless of the type of planning used. The real difference in a Pull/Kanban-based system is in the execution process.

Under the Push method, charging/feeding the system is done by the forecast. In Pull/Kanban, it is the consumption of inventory that authorizes activity (procurement, supply chain and manufacturing). The activity is authorized when a customer order pulls a part or finished good from inventory. When pulled, a signal is passed from the source of the demand through manufacturing and on to the suppliers for replenishment. The basic assumption for planning here is that the design of the system is balanced according to the demands placed on the company.

This is accomplished through a simple signaling method where K-Loops® (see sidebar) are inserted at strategic points in the supply-chain. These strategic points can be between supplier and work cell (raw material), between work cells (semi-finished) and between work cell and customer (finished goods). The K-Loop sends a signal in the form of a Kanban Card. The Kanban Card is the authorization to replenish inventory once it has been consumed. When an inventory/Kanban Card is pulled, the Card is returned to the previous operation or supplier to signal/authorize the holder of the Kanban Card to resupply the inventory. No less and no more.

The supplier process in this environment is considered more of a partnership than an oppositional relationship as both supplier and manufacturer know that they only succeed when the end customer is satisfied.

There are several other important aspects to a Kanban system, but we will limit these to just the essentials for the purpose of this discussion. Two of the more important factors to define are the Supermarket and the K-Loop.

eKanban

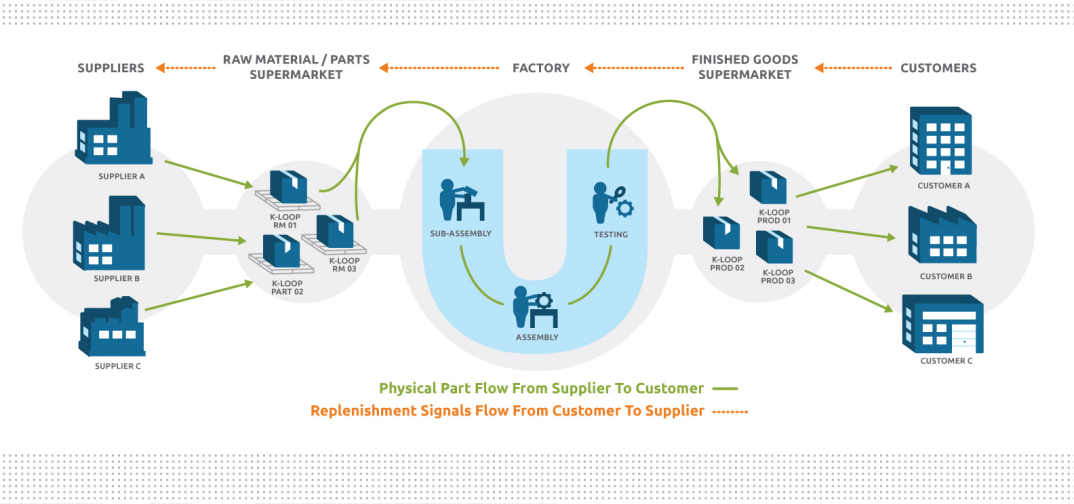
The automation of the manual Kanban, Supermarket and K-Loop processes.

K-Loop®

The K-Loop is the replenishment model for a Kanban system. It determines how many Kanban Cards are in a process, where they are sourced from and how the demand signal will be communicated.

Supermarket

A grouping of K-Loops that provides immediate access to inventory (raw materials, subassemblies or finished products) at strategic points in the manufacturing process and extended supply chain.



Kanban Process with Raw Materials and Finished Goods Supermarkets

Supermarket

The Supermarket is the concept of having inventory available for the internal/ external customer so that they do not have to wait for what they require. For internal customers, the Supermarket should be located close to the area of need, for example, beside the assembly line. The important factor is that suppliers are signaled when usage occurs and are responsible for replenishing what has been pulled. These two signals occur with the use of Kanban Cards. The concept is also useful for external customers pulling the finished product. As such, a company may have several Supermarkets.

K-Loop®

A K-Loop (Kanban-Loop) is the number of Kanban Cards in the replenishment and usage cycle of an item. The K-Loop is created as a closed loop of activity between all involved in the use and supply of materials.

There are many factors that may be used to calculate the size and quantity of Kanban Cards, including:

- Expected demand
- Batch sizes
- Container sizes
- Safety factors
- Service levels
- Supplier lead-times
- Transportation times

Suppliers are signaled when usage occurs and are responsible for replenishing what has been pulled

Also consider the amount of variation in all these factors when determining Kanban Card sizes and the number of Kanban Cards the K-Loop® will contain.

Reduce Waste and Inventory

With Supermarkets and K-Loops working together to reduce the amount of waste and disruption in the system, the level of control gained allows you to reduce the total amount of inventory. The method is simple to follow and is easily synchronized with actual customer orders. K-Loops are defined for each part/unit to ensure consistency of supply. Both suppliers and work cells are synchronized to maximize flow through the operation and its extended supply chain.

One of the great benefits of the process is the level of control gained through immediate feedback and the ability to make quick adjustments. If demand increases, the Kanban signals increase. In the cases where demand slows, the system slows as the frequency of the Kanban needed is reduced. This process is very nimble in the current state both visually and across the entire supply chain.

There is not a great deal of effort required to adjust/synchronize the system continually as in the Push method. And, unlike the Push system, there is no second guessing of what is a real change versus changes that are just noise. In Pull environments, communication of the change is clear, precise and quickly acted upon.

More specific information and examples of how Kanban systems reduce waste can be found in *8 Forms of Waste in Lean Manufacturing* and *Get Lean on Scrap.*

Manual and Electronic Kanbans

In Lean Manufacturing, there are many tools that are part of a Lean journey. A Kanban system is one such tool that represents a visual and functional step in the transition from Push to Pull processing. While there are Kanban systems for a variety of purposes (software development, project management, even

Insight into the History of Kanban

The Kanban process was developed in apan during the country's period of reconstruction. Due to a shortage of factory workers, they needed a system that was easy-to-use and produced the desired results, but didn't require an extensive command and control structure to manage. The Kanban system was the result. Efforts in Kanban date back to the late 1940's, and became widely used by Toyota and their suppliers by the late 1950's.

personal productivity Kanbans), in the manufacturing world, we make the distinction between manual and electronic – or eKanban software systems.

Manual Kanban Systems

In a manual Kanban system, there are physical Kanban Cards for each unit of inventory (or batch) that are located in item bins, shelves, palettes, etc. The Card indicates a replenishment signal for that item. Typically, there is also a large Kanban board located on the plant floor that tracks work items as they move through the production process. The drawbacks of manual Kanban systems are that they are prone to data entry errors and cards can be lost or misplaced. Manual Kanbans also have a threshold; it's been recommended that they only be used in environments with less than 200 items to track.

The largest drawback of the manual Kanban system, however, is that it is not automated, nor does it provide real-time demand signals across the organization. As such, communication challenges surface:

- Across departments within a company.
- Between the purchasing organization and suppliers where there are mixed methods (e.g., some products are utilizing Push forecasts while other products are using Kanban signals).
- When parts pass between multiple divisions or locations.

The big difference between a Pull and Push-based system, is that a Kanban system "pulls" inventory and work through the system based upon ACTUAL customer demand.

Many times, a Kanban system is implemented manually to start. This can help ease the organizational transition to the Pull signaling method for more change-resistant environments and provides the opportunity to implement Kanban as a pilot program to test the process and work out the issues. Usually, simple processes are used in this approach. And, like all new processes, there are valuable lessons to be learned:

- How to size the K-Loops® (number of Kanbans in the process).
- How to use Spike Kanban Cards when demand increases. (A Spike Card is used to quickly increase inventory to account for sudden and temporary increases in demand.)
- When to remove Kanban Cards as demand trends downward.
- Identifying data that is important for monitoring line performance.
- Understanding how changes in supplier performance and lead-times impact K-Loop sizing.

For some, however, the immediate benefits of an eKanban system far outweigh the choice for implementing manually first, then transitioning to an electronic system. The paper, *Going eKanban*, provides guidance on when and how to transition from a manual to an automated eKanban system.

Next, we will take a closer look at eKanban software systems.

eKanban Software Systems

eKanban (electronic Kanban) is a software signaling system that drives the movement of materials within a manufacturing, assembly or warehousing facility. In contrast to the physical Kanban Cards used in a manual Kanban system, eKanban software uses barcodes and electronic messages to signal inventory replenishment.

An eKanban system only requires intervention when there is a problem, greatly reducing the amount of attention required to have the K-Loop function.

This is in sharp contrast to an ERP system, where action is required at every stage of the process of planning and execution.

eKanban systems can take the form of a spreadsheet, packaged software or a Cloud-based application. Some eKanban systems are best suited for single sites, but may be adapted to connect multiple sites with additional software. And more robust eKanban systems with automated identification equipment (bar code transactional systems) can accommodate more complexity. For example, environments with tens of thousands of SKUs, interplant transfers, overseas locations and large, extended internal and external supply chains. When utilized globally - and across multiple company locations - an eKanban system can eliminate the supply chain bullwhip effect (distortion of information from one end of the supply chain to the other) and significantly enhance the benefits and performance of Lean enterprise efforts.

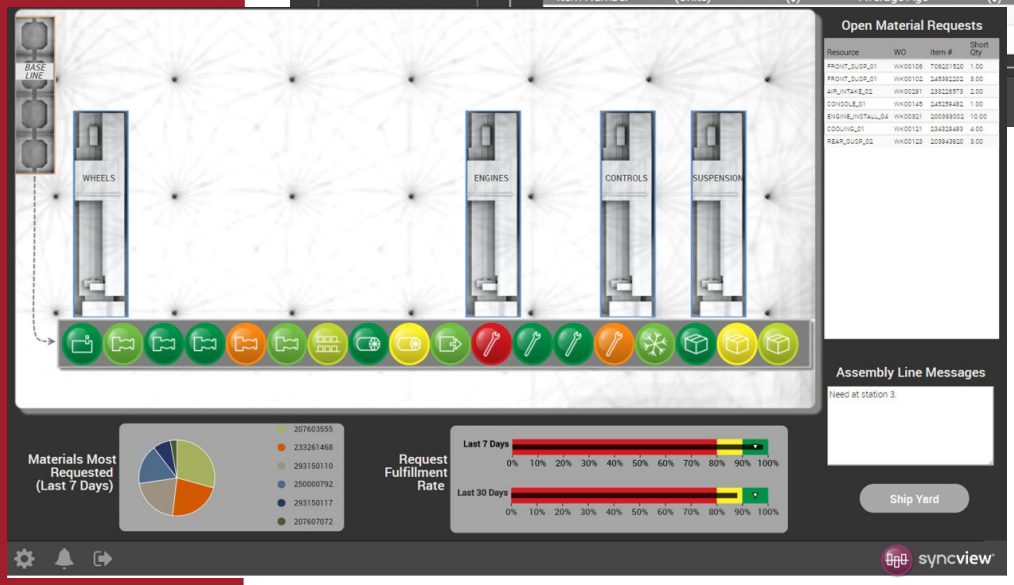
While there is a great benefit in providing a simple method to manage the supply network, some of the more specific benefits of having an eKanban system include the ability to:

- View and track supermarket and kanban status in real-time.
- Make instantaneous adjustments based on demand.
- Communicate across the supplier network in a fast and consistent manner.

- Right-size inventory through automated K-Loop® sizing that takes into account changes in demand and supply.
- Provide a closed-loop process that can signal where problems need attention.
- Free buyers and planners from the administrative grind of executing the K-loop so they can focus on strategic sourcing, long-term strategy and continuous improvement.

Other benefits are found in the tools that collect data - data used for analysis of performance metrics as well as data used to automate K-Loop adjustments and Kanban sizing. Analytics can also help supply chain managers to quickly adjust the system to take into account spike demands, increasing demand trends and conversely, decreasing demand trends.

SyncKanban® software provides a wealth standard reporting. Data from the software may also be visualized in SyncView® software as shown here.



Gaining Control through Transparent Communications

The best systems are systems where signals are not lost, misunderstood or misinterpreted. That is why eKanban systems are so appealing. The loss of dexterity in manual systems only requires one person to be distracted, one card to be misplaced or turnover of a key individual to create a hole in the process. Systems that have a great deal of human interaction such as manual kanban systems require a stringent system of checks and balances to ensure that communication is always taking place.

We can point to a wealth of case studies that demonstrate the value of eKanban systems. They reduce inventory which can lead to significant cost savings; they shorten lead times, purchase order cycles and more. A hidden and often untold benefit, however, is an elevated level of communication across the plant floor. And while the capabilities of eKanban software packages differ, consider the value of those that provide instantaneous demand signals across the organization and extended supply chain – signals that are visible and can be tracked by all. Everyone is on the same page. Even suppliers have a portal into the system that empowers them to replenish items based on the parameters you have set.

Communication creates control and helps to reduce variability. Next are a couple of examples that illustrate this point.

Minimizing Physical Interactions and Variability

The more physical interactions that occur within the requirements of a supply chain, the greater the distortions that are added to each step that encounters the requirement (e.g., data entry, order policy decisions, stock decisions, transactions and nodes). Given that, each step in the supply chain process attempts to protect itself from variability which can lead to increased inventory, lead-times and delays.

Therefore, the more physical interactions between each step in the supply chain, the greater the distortion of information and requirements. These exaggerations can create artificial problems because the decisions at each stage are constantly second guessed or adjusted based upon incomplete

"Kanban is like the milkman. Mom didn't give the milkman a schedule. Mom didn't use MRP. She simply put the empties on the front steps and the milkman replenished them.

That is the essence of a pull system"

Ernie Smith, Lean Event Facilitator in the Lean Enterprise Forum at the University of Tennessee

information. These types of adjustments can create great variation throughout the supply chain when made simultaneously, or when a slight delay in one area has the effect of a greater delay in a later step.

An eKanban system sending real-time demand signals and providing continuous status updates that are visible throughout the plant, can greatly reduce the need for physical interactions and ultimately, variability. In one case study example, Dynisco, a Roper Company manufacturing sensing and polymer test equipment, was able to reduce their replenishment process from 66 to just 6 steps. In another example, aerospace and defense manufacturer, Northrup Grumman Innovation Systems (formerly Orbital ATK), was able to consolidate 16 replenishment processes in one division, using SyncKanban® eKanban software.

Building Trust in the System

eKanbans can serve to create one source of truth throughout the system. As eKanban signaling is utilized, the amount of variability throughout the process is reduced and each step begins to trust the previous step. This reduces the need to add extra protection everywhere in the supply chain. eKanban communication eliminates the noise of the previous Push signals in the supply chain.

eKanban communications also build trust among suppliers. In a Push environment, there are countless and continuous calls to suppliers to move orders, move out orders, combine orders and to “really, really please” expedite deliveries – only to call back later and cancel the order. Understandably, at some point, the validity of these requests may be questioned. When communication is fluid and transparent through the use of an eKanban system, interactions with suppliers can turn into more positive and collaborative relationships.

When working well, a Kanban process will yield:

A significant reduction in the amount of inventory (company inventory and amount of inventory held by suppliers).

Increased inventory turns.

Ability to focus improvement efforts.

Increased goodwill by customers.

Suppliers experience much less oscillations in demand.

Supplier communication improves greatly.

Summary

Push and Pull are methods both designed to bring control to the supply side of demand. And while ERP takes a top-down approach, Lean Kanban takes a customer demand-based approach. Yet, these two methods can coexist in today's supply chain network. If your organization is slow in adopting a Lean process, eKanban solutions like SyncKanban® from Synchrono® can offer quick results that reinforce the desired outcomes of Lean Manufacturing:

- Optimized inventory levels.
- Reduced purchase order cycles.
- Increased inventory turns.
- Shorter lead times.
- On time performance.
- Real-time communication up and down the supply chain.
- The ability to function in multi-plant, multi-site, multi-distributed environments.
- Leveraging existing MRP/ERP systems and data.
- Reporting tools and analytics for decision-making and monitoring performance.
- Focused Continuous Improvement (CI) efforts.
- Reduced administrative costs in executing the replenishment loop.

eKanban systems offer a tremendous upside in cost savings, organization-wide visibility, increased capacity and on time performance. eKanban systems can offer control and predictability while fostering a culture of moving from supply chain and manufacturing management working *in* the system to a mode of working *on* the system.

In this paper, we have explored the nature of Push and Pull systems and more specifically, manual and eKanban systems within a Pull environment. In our next paper in this series, we will explore Pull/Kanban systems from a management perspective, outlining the benefits of a more predictable environment along with the decision-making power gained through a deeper access to data and analytics.

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About SyncKanban®.

SyncKanban® software from Synchrono® keeps instantaneous supply chain signals moving through your organization at lightning speed. This automated, pull-based inventory replenishment system sends signals to suppliers to deliver materials, helping you reduce the costs and waste associated with excess inventory and replenishment process administration. For many, that means up to a 50% reduction in inventories, on-time production, improved cash flow and a distinct competitive advantage. See for yourself; try SyncKanban® for free.

About Synchrono®.

Synchrono® is leading the movement in demand-driven manufacturing software with a portfolio of applications that focus on enterprise and operational management – from supply chain and eKanban to production and execution systems. All delivered through a real-time, dynamic and web-based technology platform.

Bringing Lean and constraints management principles to life, the company's inclusive, yet modular approach allows for continuous, real-time information integration and flow throughout the plant and beyond to the extended supply chain ecosystem. With Synchrono®, manufacturers gain visibility across their organization for greater clarity while enterprise-focused tools help control costs and variability driving on-time performance and a clear competitive advantage. Sync with us at www.synchrono.com.

Layer Your Existing Systems with Modern Demand-Driven Technology

Transitioning to a Modern Demand-Driven Manufacturing environment doesn't mean you need replace all your existing systems. Web-based Synchrono® solutions were developed to work with your existing ERP and other systems/data sources, helping to preserve those investments and extend their value.

Request a software demo at Synchrono.com.

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