QAD Enterprise Applications
Standard & Enterprise Edition

## Training Guide

# Lean Manufacturing

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# About This Course

# Course Description

QAD designed this course to cover the basics principles of Lean Manufacturing and preparing to implement Lean Manufacturing in QAD Enterprise Applications.

The Course Includes

- An introduction to fundamental concepts of Lean Manufacturing
- An overview of basic functionality of QAD Lean
- An overview of some advanced functionality of QAD Lean
- Instructions on how to set-up the Lean functionality
- Instructions on how to operate the Lean functionality
- References to other QAD materials, such as on-line help
- Activities and exercises throughout the course (for student practice of key concepts and processes)

## Course Objectives

In this course you learn how to:

- Identify some fundamental concepts of Lean Manufacturing
- Set up the basic functions for Lean in QAD Enterprise Applications
- Set up some advanced functions for Lean in QAD Enterprise Applications
- Use Lean Manufacturing in QAD Enterprise Applications

## Audience

- Implementation consultants
- Members of implementation teams
- Operators

## Prerequisites

- Initial QAD Enterprise Applications Setup training course
- Basic knowledge of:
  - Theory of Lean Manufacturing
  - QAD Enterprise Applications as it is used in the business
- Working knowledge of the manufacturing industry in general

***Note*** Students that are unfamiliar with QAD Enterprise Applications should read the User Interface Guide before attending this class.

## Course Credit and Scheduling

This course is valid for 12 credit hours and is typically taught in two days?

## QAD Web Resources

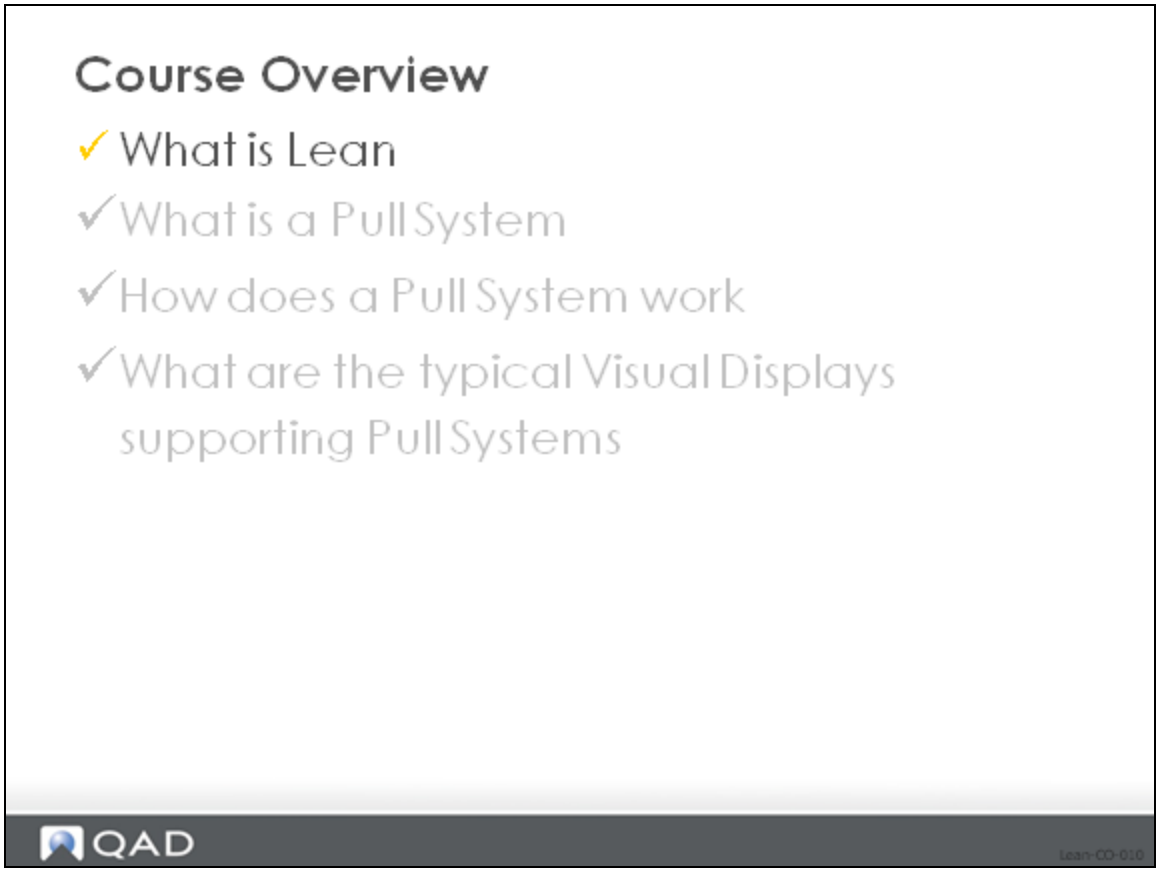
From QAD's main site, you can access QAD's Learning or Support sites.

http://www.qad.com/

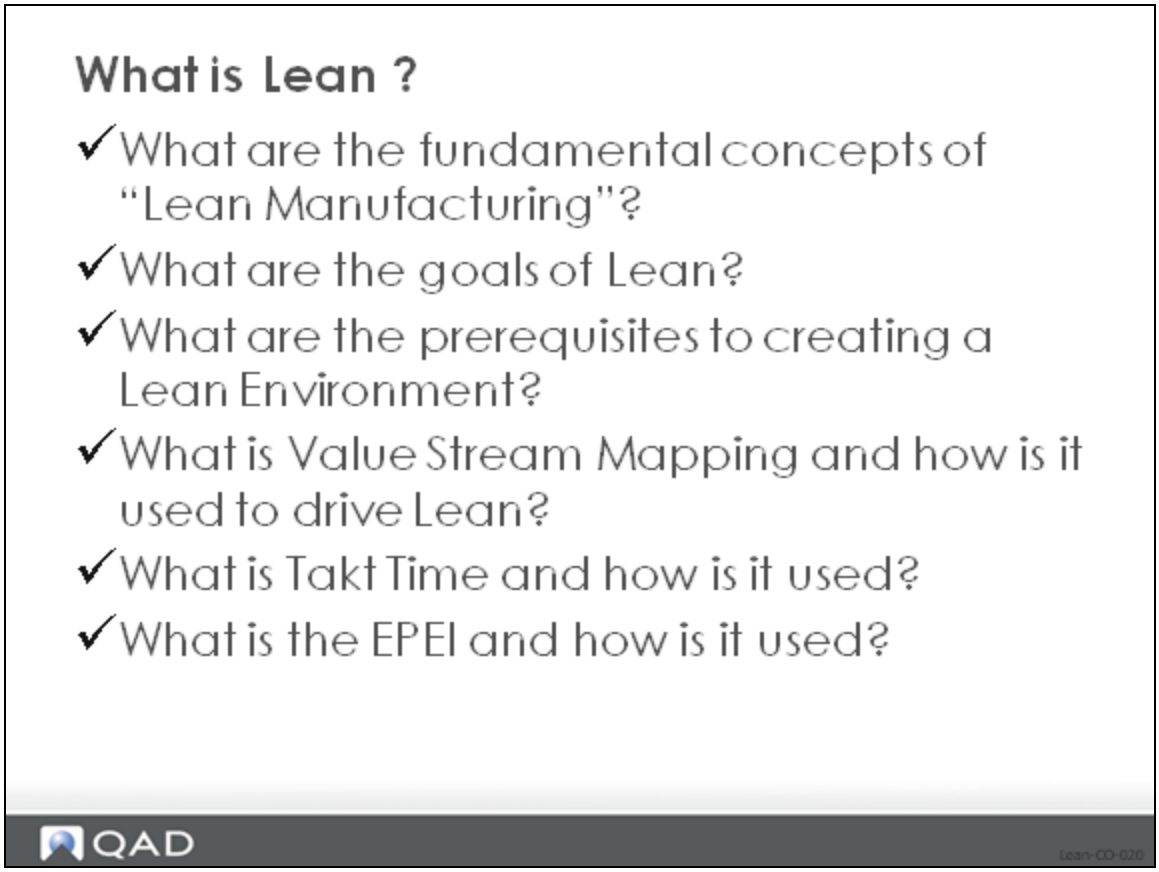
Chapter 1

# Lean Manufacturing Concepts

## Course Overview



## What is Lean?


What is Lean ?
✓What are the fundamental concepts of "Lean Manufacturing"?
✓What are the goals of Lean?
✓What are the prerequisites to creating a Lean Environment?
✓What is Value Stream Mapping and how is it used to drive Lean?
✓What is Takt Time and how is it used?
✓What is the EPEI and how is it used?
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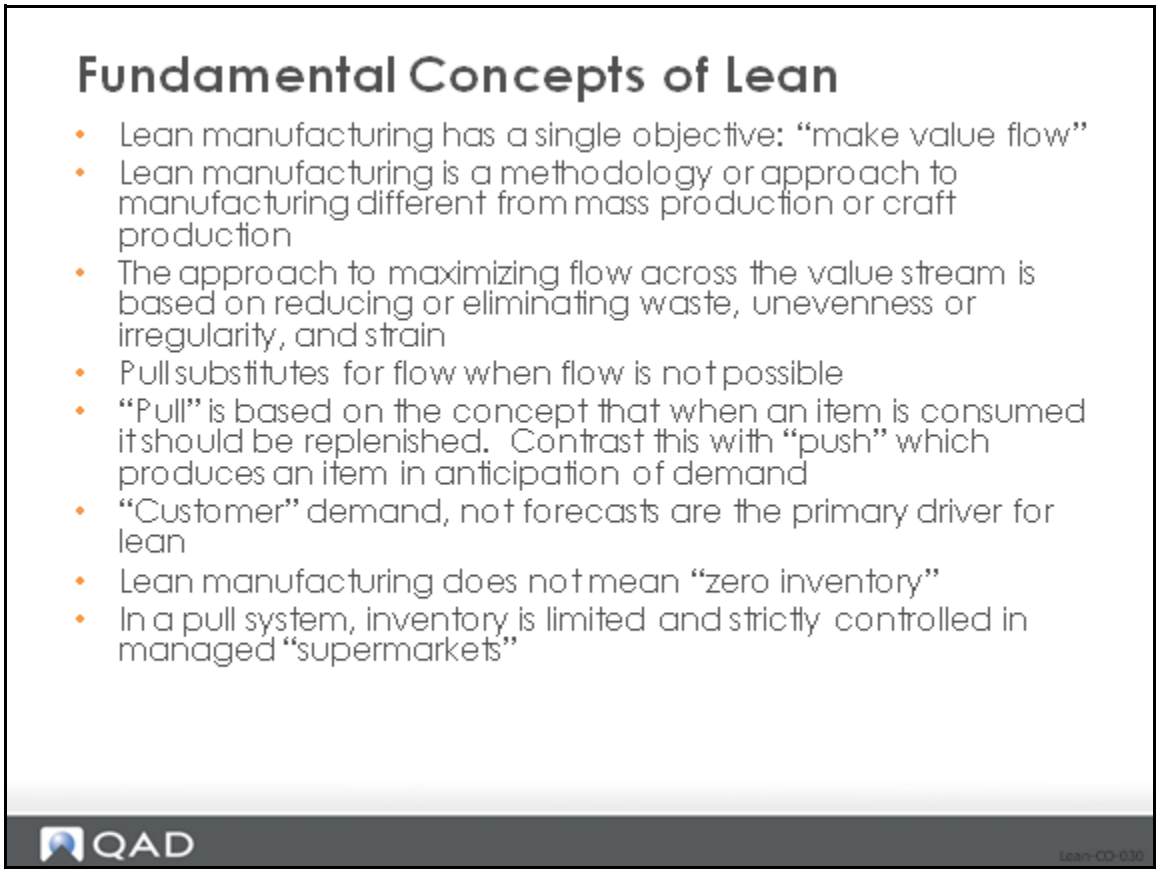
## Fundamental Concepts of Lean Manufacturing?




### Objective of Lean:

Lean is a methodology for manufacturing that seeks to create waste-free, optimized product flow across the value stream, which is defined as all the activities, value-adding and non-value adding, required to bring a product from concept to launch and from order to delivery. In the ultimate "future state" of the value stream, each product flows from raw material to finished item to the ultimate customer without stops, interruptions or delays, and without non-value-adding steps or processing. In other words, minimal inventory exists to impede product flow, and there are no steps in the production process that are not adding value from the perspective of the customer.

### Alternatives to Lean:

"Lean production" is one of three different approaches to manufacturing that are in use today. The other two approaches are "craft production" and "mass production".

Craft production is a methodology in which each item is produced, one at a time, in a way similar to that of a skilled craftsman assisted by apprentices.Typically in craft production, each product produced is unique, as are the individual components that go into it. Craft production was the only form of manufacturing until the early 1900's.

Mass production seeks to produce large numbers of similar or identical products. Each stage of production is organized to exploit economies of scale (large volumes) and is managed by a command and control kind of hierarchy governed by strict financial controls. Some of the key ideas that made mass production possible included:

- Interchangeable parts
- Pre-hardened metals
- Standard gauging and the moving assembly line
- Standardized/simplified work
- Waste elimination

These innovations were developed largely over the late nineteenth and early twentieth centuries and were brought together and perfected by Henry Ford at his Rouge River manufacturing site.

Later, largely driven by modern accounting principles came a focus on:

- Achieving the highest possible volumes in order to achieve the maximum equipment utilization
- Reducing unit costs – not by eliminating costs themselves but by spreading them over larger volumes
- Optimizing operations not flow

The accounting focus of mass production as well as a kind of “command and control” hierarchy of management were largely developed by General Motors and Alfred P. Sloan.

In some respects lean manufacturing or lean production tries to blend the best features of craft and mass production to achieve volume production “one at a time”. It includes:

- Waste elimination
- Flow from raw material to finished product
- Pull to customer needs

The innovations of lean production, as well as the blending of key mass production and craft production methods, can be credited to Toyota and to Taiichi Ohno. In large part this kind of manufacturing was developed to respond to the market conditions faced by Toyota after World War II: small markets, the need to be competitive at smaller volumes, the need to find a way to reduce costs without increased volume, etc. These inevitably led to a focus on flow (producing in a “one-piece flow”) and environment of minimal waste.

### Muda, Mura, Muri

To achieve the objective of lean manufacturing, all waste (muda), unevenness or variability (mura), or strain (muri) must be removed from the value stream. In most factories, waste, unevenness and strain can be seen everywhere – in excess inventory sitting between manufacturing processes, inventory that is waiting for other matching sets of parts, inventory that is being reworded or scrapped, lot size inventory being stored in advance of its future usage, etc.

### Waste

Generally speaking there are seven forms of waste in manufacturing:

- Defects in products
- Overproduction of items not needed
- Inventories awaiting further processing or consumption
- Unnecessary processing
- Unnecessary movement of people
- Unnecessary transport of material
- Waiting (on equipment or upstream processing)
- Design of products that do not meet users needs

### Unevenness

Unevenness frequently takes the form of a manufacturing schedule where work surges from one stage to the next, or where capacity usage is erratic or irregular.

### Strain

Strain has to do with misuse or overloading of equipment or people, and is really the result of poor job design, poor part design, poor ergonomic or equipment choices.

Waste, unevenness and strain kill flow, so all must be minimized, reduced and ultimately eliminated.

The effect of reducing waste, unevenness and strain is to allow product to flow better. And as this happens, inventories drop, lead times collapse, quality improves, space requirements drop, and customer service typically improves.

Even in the most mature lean environment, though, there may be some wasteful activities that impede flow. To handle these situations, the concept of “pull” or “pull replenishment” was developed to avoid creating even more inventory (and waste).

### Pull Substitutes for flow when flow is not possible

Generally lean practitioners distinguish between flow (product flows from raw material to customer) from pull (which generally means the situation where material is being “pulled” from earlier processes because continuous flow is not possible). In other words, in situations where there is still inventory – generally to buffer processes that cannot work in a synchronized flow – that inventory will be replenished by some kind of pull process. Ultimately the pull systems are driven by customer demand, and support replenishment of component and intermediate inventories anytime it is not possible to flow the product from raw material to customer without stopping.

### Pull Replenishment concepts

This is a fundamental concept in lean manufacturing that is based on one core idea – inventory should only be replenished when it has been used. Rather than trying to predict when more inventory will be needed (the method used in a craft or mass production environment) and replenishing it based on this anticipation, lean inventories are replenished “on consumption”. In other words, in a lean manufacturing environment, a strictly limited and carefully managed

amount of inventory is held at various points across the value stream. When this inventory is used, it is replenished. The “signal” to replenish inventory is typically visual – a “kanban card” in many instances – rather than being based on computer reports, displays and exception messages, and does not require planner or scheduler involvement.

This idea of “replenishment on consumption” is called “pull” replenishment to contrast with “push” replenishment which is based on anticipating demand and acting on it in advance.

In effect, a lean production environment is driven by customer demand. In its simplest form, the customer order authorizes shipment of a product from the finished goods inventory. Shipment from inventory generates a pull signal for replenishing the finished goods. The finishing process uses subassemblies and component inventories which in turn signal for their own replenishment. In this way, material is pulled from the supplier and across the production process based on the customer demand.

A simple example of a “pull” replenishment system is a bread rack in a supermarket. When a customer purchases a loaf of bread, a position in the rack opens up and this is the signal for the bread supplier to fill it.

### Customer Demand, not forecasts, are the primary driver for Lean

So customer demands, not forecasts, are the primary drivers for a lean “execution” system. However, does that mean that forecasting is unnecessary?

Unfortunately the answer is “no”.

Forecasts still play an important role in the longer term planning activities that help create the conditions for lean execution. For example, forecasts of demand for family groups, often corresponding to individual value streams, drive the sales and operations plan and associated capacity planning activities. In other words, family forecasts are essential to ensuring that sufficient capacity will exist to actually execute the lean replenishment signals when they are actually generated.

Detailed forecasts also drive longer term leveling, a process synonymous with master scheduling in most production environments. In this important process, which we’ll revisit later in the course, longer term demand (forecasts and customer orders) and any inventory buffer adjustments for the mix of master scheduled products are leveled into uniform daily quantities based on takt time. This “mixed model master schedule”, after being validated to ensure that there are no problems with spiking demand against the leveled schedule, drive other planning activities, especially supplier scheduling.

In some lean producers, the backlog of customer orders is long enough that detailed forecasts are not needed for the master scheduling process. For example at Toyota, the backlog of customer and dealer orders stretches beyond the master scheduling horizon. In this situation no separate forecasts are created for the individual items.

In most companies, though, the situation will be somewhat different in that the order backlog will be much shorter than the master scheduling horizon. In this situation, the master schedule will be created from a combination of customer orders and forecasts.

### Lean Manufacturing does not mean “zero inventory”

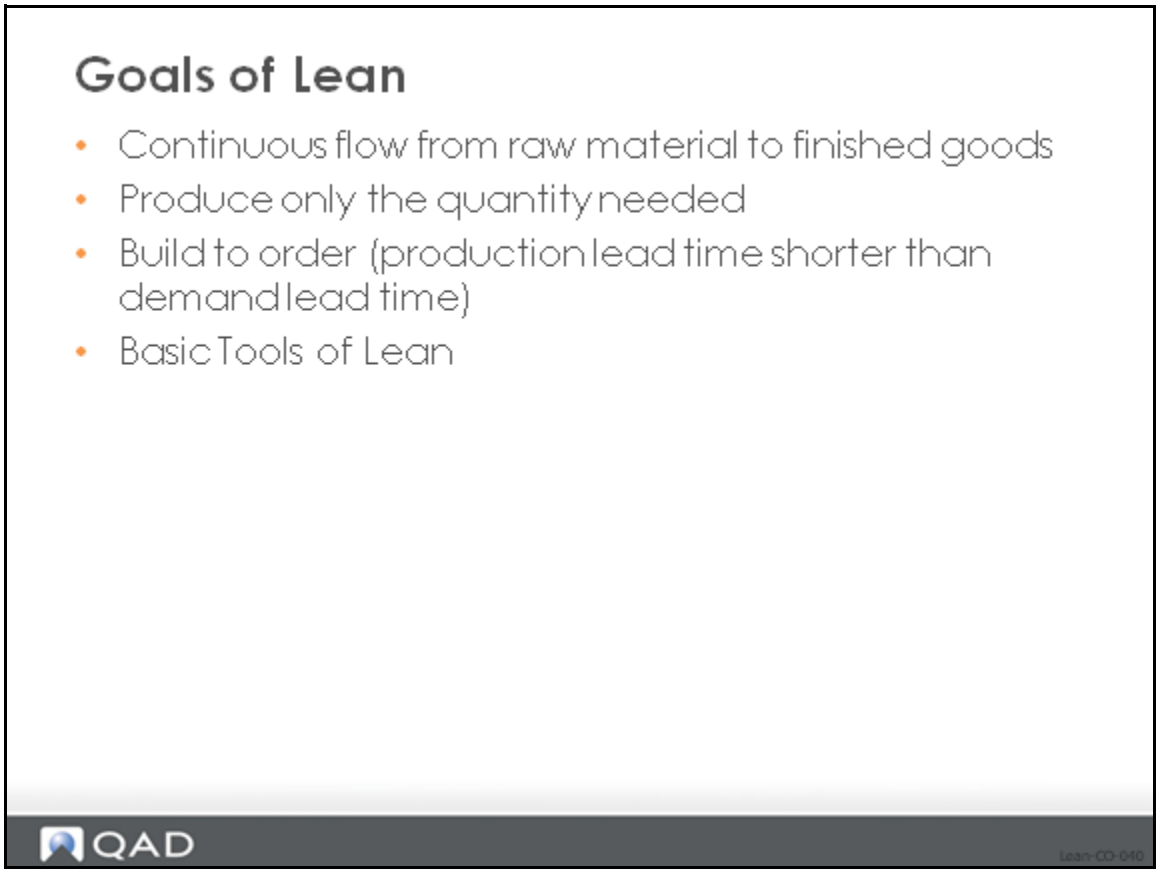
Another common misconception regarding lean manufacturing is that there will be no inventory.

This is not the case at all. While inventory is regarded as a waste, perhaps the ultimate waste, in lean environments using pull systems, the entire pull model is based on one principal assumption: that inventory will exist in limited and strictly controlled quantities and consumption of this inventory will be the basis for deciding what to make or buy next.

What is different in a lean environment is that the inventory is strictly limited and no supply activities are permitted when the inventory is at its pre-established limits.

In the balance of this course we’ll see how lean and pull systems use limited inventory to advantage in meeting customer needs and in being flexible in responding to change. Neither too much nor too little is the balance that lean producers try to achieve when it comes to inventory.

## Goals of Lean Manufacturing and the Basic Tools to get there




### Continuous flow from raw material to finished goods

As we saw earlier, the principal goal of lean manufacturing is to create a continuous flow of product from raw material to finished goods and on to the customer – no stoppages, no delays, no interruptions because of inventory, scrap or yield issues, downtime or the other problems that occur in a typical manufacturing operation.

### Produce only the quantity needed

In order to achieve this goal, most companies must address the issues – all across their value streams – that prevent them from producing what is needed, when it is needed, in exactly the required quantity, no more and no less. While there are many, many impediments to “producing on demand” nearly every company seriously implementing lean will at some point need to address setup time and the setup process. As long as setup time is more than a few minutes, it will be impossible to produce only the quantity needed.

Why is this? Why not just create a policy – “from now on we will only produce the exact quantity required and will not lot size - if we need more then we’ll set up again when we need them”?

Unfortunately the truth is that you can’t typically do this because you will quickly run out of capacity from the number of setups you’ll be doing. Your production processes have limits – a kind of natural cycle which later we’ll refer to as the “production interval” or EPE Interval – that you violate at your own risk. This cycle is determined by the volume of products that you are

producing, the standard time required to produce each one, and the setup time. It is the principal driver for lot sizing in most production environments and is a key concept in lean manufacturing and something that must be addressed in order to make real progress.

Production intervals are a primary driver of lot sizes and lot sizes determine inventory levels, which determine the lead time to bring a product through the value stream. Large lot sizes mean lots of inventory which in turn means intermittent flow and long(er) lead times. Later in this course we'll look at what you can do to address the problem of production intervals and long setups in your journey to a lean production environment.

### Build to order (production lead time shorter than demand lead time)

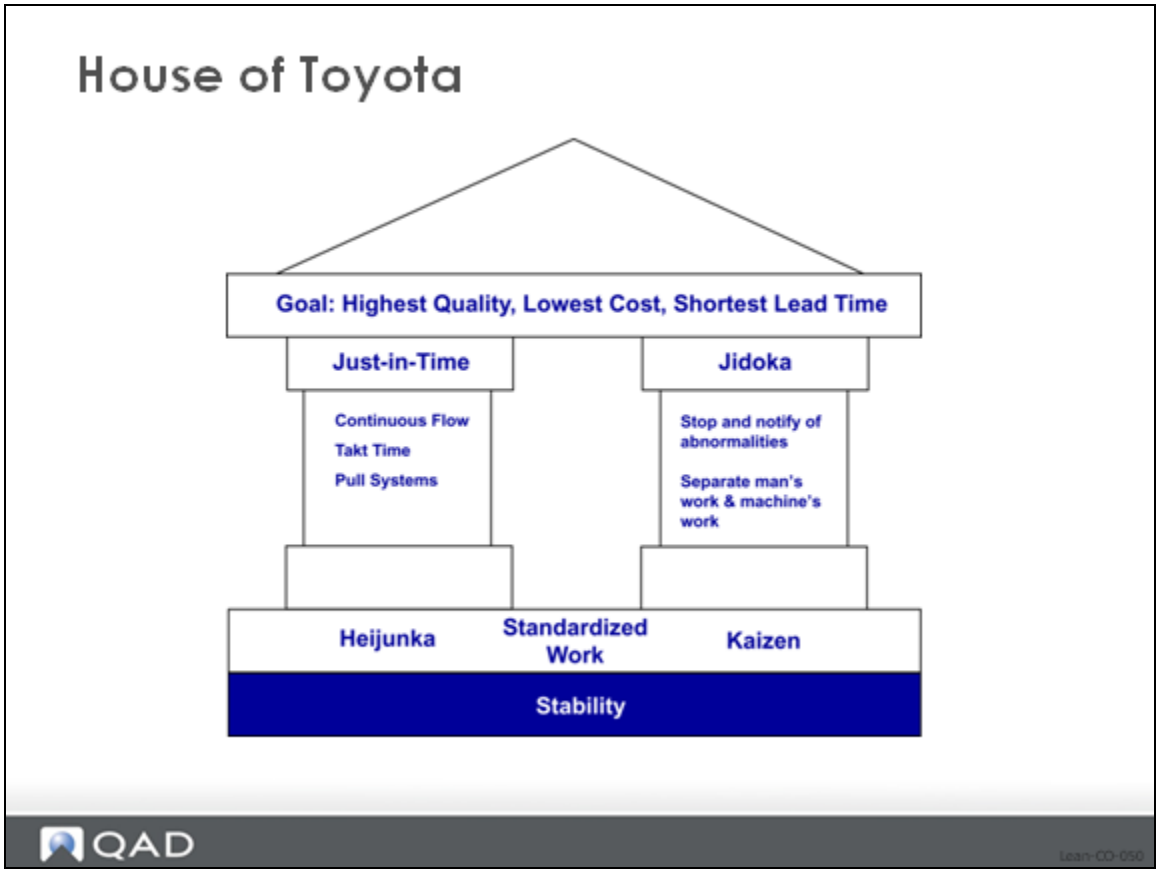
The closer and closer you move toward the goal of continuous flow, the closer you'll get to a true "build to order" kind of manufacturing environment. If you can get the elapsed time over the value stream to less than the lead time expected by the customer then you can be a true MTO producer – ordering raw materials and purchased parts only after receiving the customer order. If you can make substantial reductions in the production lead times in your value streams you can move away from finished goods stocking and towards a finish to order or assemble to order strategy.

For most companies the objective of "continuous flow" seems an impossible goal. But lean is a journey and as so many have found already, one with continued opportunities at every turn. And as these opportunities are addressed, and problems resolved inventory drops, velocity increases, and flow improves.

### Basic Tools of Lean

A typical implementer of lean will employ a wide variety of concepts and tools based on the experiences of Toyota and other lean practitioners. In the next image you can see a graphical representation of how the lean tools fit together, in what is sometimes called the "House of Toyota". In this diagram, meant to depict a Greek Temple, the foundation is "Standard Work", "Leveling" and "Kaizen". The left column corresponds to concepts related to "just-in-time" scheduling like takt time, EPEI, pull systems, etc., while the right column corresponds to concepts related to changing the physical environment – setup reduction, poka-yoke, 5S, etc. – collectively referred to as "jidoka" or automation with a human touch. On the pediment you'll see basic objectives: meeting the needs of customers with high quality, low cost, quick response (shortest lead time).

## Basic Tools of Lean: House of Toyota



## Important tools of Lean

Here are some of the most important tools of lean, ones that a typical lean practitioner must be proficient it and capable of applying.

*Value Stream Mapping.* Value stream mapping is the identification of all the specific activities (material and information flow) as well as the resulting lead times occurring along the value stream for a particular product or product family, usually represented pictorially in a value stream map.

*Takt Time.* Takt time is the rate at which product must be turned out to satisfy market demand. It is determined by dividing the available production time by the rate of customer demand. It is a calculated number, not a reflection of your capability. It sets the pace of production to match the rate of customer demand.

*EPEI.* The “EPEI” (Every Part Every Interval) represents the minimum production period for a specific process in which every part can be set up and run. Trying to run to a smaller production period or EPEI would cause an excessive number of setups against the available capacity. Running to a larger interval is possible but generates excess inventory.

*Leveling (Heijunka).* Leveling is the sequencing of orders in a repetitive pattern, and the smoothing of day-to-day variations in total orders to correspond to longer-term demand.

*Pull Systems.* A pull system is a system of production and delivery instructions in which nothing is produced by the upstream supplier until the downstream customer signals a need. Pull can operate with single units or small batches. It enables production without preset schedules.

*Visual Control Boards.* Displays designed to create a transparent and waste-free environment, visual control boards provide easily seen and easily understood information to control the environment and its activities. Visual control boards may include location indicators, signboards, status boards, one-point lessons, checklists, worksheets, diagrams, area maps, etc., and may pertain to equipment use, operations, processes, metrics, storage, safety, quality, movement in an area, or general use of the environment.

*Setup Reduction (Single Minute Exchange of Dies or SMED).* SMED is a series of operator techniques pioneered by Shigeo Shingo that result in changeovers of production machinery in less than ten minutes. The long-term objective is always zero setup, in which changeovers are instantaneous and do not interfere in any way with one-piece flow.

*Poka-yoke (Mistake Proofing).* Japanese term used by Shigeo Shingo to mean “innocent mistake-proofing,” it is an improvement technology that uses a device or procedure to prevent defects or equipment malfunction during order-taking or manufacture. Mistake proofing devices are important to the production line in several ways: They (1) enforce correct operations by eliminating choices that lead to incorrect actions, (2) signal or stop a process if an error is made or a defect created, and (3) prevent machine and product damage.

*5S.* Five S (5S) an improvement process, originally summarized by five Japanese words beginning with S, to create a workplace that will meet the criteria of visual control and lean production. Seiri (sort) means to separate needed tools, parts, and instructions from the unneeded and to remove the latter. Seiton (set in order) means to neatly arrange and identify parts and tools for ease of use. Seiso (shine) means to clean and inspect. Seiketsu (standardize) means to require as the norm that everyone sort, set in order, and shine at frequent (daily) intervals to keep the workplace in perfect condition, and also to make use of visual control systems. Shitsuke (sustain) means to maintain the five S gains by training and encouraging workers to form the habit of always following the first four Ss.

*Total Productive Maintenance (TPM).* A companywide approach and a series of methods, originally pioneered by Nippondenso (a member firm of the Toyota group), to enlist operators in the design, selection, correction, and maintenance of equipment to ensure that every machine or process is always able to perform its required tasks without interrupting or slowing down defect-free production. Total productive maintenance includes autonomous maintenance, early equipment management, focused equipment improvement, predictive maintenance, and preventive maintenance. The principal performance measure of TPM is overall equipment effectiveness.

*Andon .* A device that calls attention to defects, equipment abnormalities, other problems, or reports the status and needs of a system by means of lights.

*Self-Stop.* A fundamental principle of lean production is the ability of an operator to stop the process when there are problems that cannot be fixed without stopping. Self-stop is a key element of the Jidoka component of TPS/lean.

*Cell Design and Operator Balancing.* Cell design is the technique of creating and improving cells to optimize their one-piece flow. The basic idea is to design the cell and assign the proper number of operators to meet takt time. This effort includes designing the sequence of events and the “operator dance steps” in a way that allocates work in a way that fully loads all but one of the operators, and isolates the remaining work to a single operator so that it is visible and such that the work can be redesigned and hopefully eliminated.

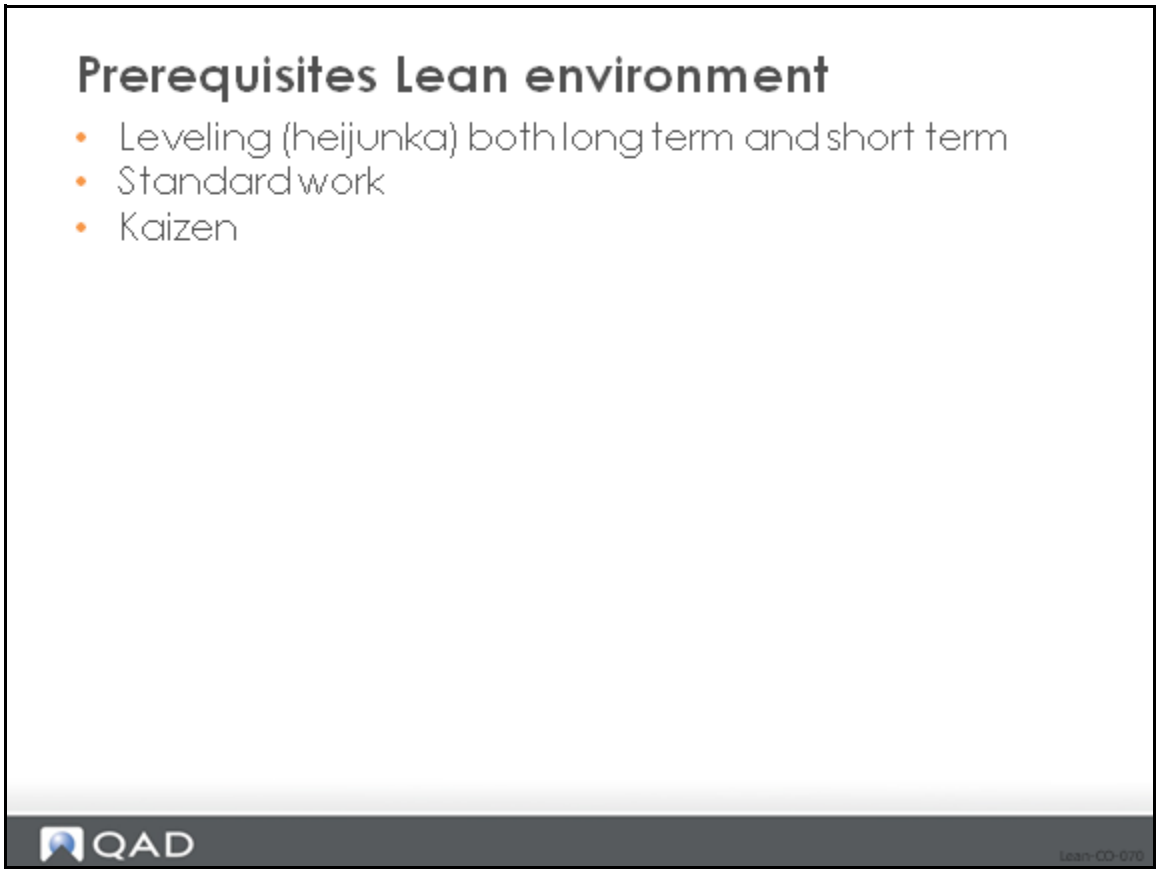
*Quality Improvement (6 Sigma).* Six Sigma is a concept/philosophy/slogan originally coined by Motorola and a methodology that provides tools for improving business processes. Six Sigma aims at a defect rate of no more than 3.4 defects per million chances. The increase in performance and decrease in process variation due to this methodology results in high quality product, better employee morale, and large improvements in profit. In practice, Six Sigma incorporates a statistical point of view and a toolkit with a leaders-developing-leaders approach to implementation in the form of the black belt certification process.

*Standard Work.* Standard work is an agreed upon set of work procedures that effectively combines people, materials, and machines to maintain quality, efficiency, safety, and predictability. Work is described precisely in terms of cycle time, work in process, sequence, takt time, layout, and the inventory needed to conduct the activity. Standard work begins as an improvement baseline and evolves into a reliable method. It establishes the best activities and sequence steps to maximize performance and minimize waste.

*Kaizen.* Kaizen is the gradual, incremental, and continual “improvement” of activities so as to create more value and less non-value-adding waste. Its success depends on the total commitment of the work force to increasing efficiency and reducing costs. Also called point kaizen and process kaizen.

In the next section we’ll discuss in more detail, the elements of lean that make up the foundation for the entire approach: standard work, leveling, and kaizen.

## What are the prerequisites to creating a Lean environment?




The prerequisites for making a lean production system work are leveling (creating a repetitive drumbeat), standard work (doing work the same way every time) and kaizen (continuous improvement. According to Taiichi Ohno, father of the Toyota Production System, “production processes must be managed to flow as much as possible. This is really the basic condition. Other important conditions are leveling production as much as possible and always working in accordance with standard work methods.”

### Leveling

As we saw earlier, leveling is the sequencing of orders in a repetitive pattern, and the smoothing of day-to-day variations in total production to correspond to the average demand over a longer period. In this process, the system must consider:

- The rate of customer demand over some specified period (plus any adjustments to inventory during this period).
- The minimum production batch size (based on the production interval or EPEI).
- The amount of time in each production day during the period being leveled.

In a lean production environment, a single process, called the pacemaker, controls the basic rate of production for a group of items with similar value-streams – it determines the rate at which all upstream processes must produce product to supply the assembly process, and since work completed in the pacemaker flows to all subsequent processes and on to the customer, it controls the pace of work for downstream activities as well. This rate must be based on customer demand

and any adjustments to inventory, and must reflect the smallest production interval possible. In other words, if the production interval dictates “small batch production” rather than a one-piece flow, it will not be possible to produce an A followed by a B followed by a C followed by an A (assuming that all the different items need to be produced to the same frequency based on demand). Instead it would be necessary to produce a small batch of A followed by a small batch of B …

The longer-term leveled schedule, which will determine supplier schedules and project capacity requirements, must be leveled in terms of mix and volume and in order to be truly “leveled” must be sequenced in a mixed model sequence based on the ratios between all the different products that need to be produced. A shorter-term leveled schedule, reflected in a visual control board called the “Heijunka box” or “leveling box”, sets the finishing schedule in increments of time that may be as small as a few minutes, but with an horizon of a day, shift, or shipping interval. It must also be leveled in mix and volume and reflect the mixed model sequence dictated by the production interval.

Longer-term leveling typically considers:

- Total volume (all items produced in the pacemaker process) leveled by day based on hours available each day and the total needed in the period.
- Mix (production for individual items) is leveled by day based on average daily demand, the volume for each day based on the prior calculation, and the production interval (how frequently each item can be produced on the line).
- Supply/demand balance.

The practice of leveling volume and mix over time, along with the process of comparing supply to demand is similar to what happens in a traditional master scheduling process. Some kind of leveled schedule – even though it may only be leveled volume – is required in every manufacturing company, unless the company has unlimited capacity and zero changeover time.

Master scheduling creates a schedule for a group of products that fits within planned capacity and where the supply of each individual product within the group satisfies the demand for that product. In many cases, the only significant differences between master scheduling and lean level scheduling are:

- In a traditional master scheduling, there is usually more emphasis on leveling volume (the overall quantity of all products) to fit within the planned capacity, and less concern for leveling individual items (leveling the mix).
- Often, master scheduling starts with supply-demand balancing and leveling is performed as a secondary process.

In lean production environments, the items that go through pacemakers are the master schedule items. This is the one place in the value-stream where a schedule exists, and this schedule controls the pace for all upstream activities and the flow to downstream processes.

The practice of leveling mix and volume over short horizons – perhaps a day, shift or hour – is similar to the finishing schedule in a traditional production environment and may include as input:

- The leveled schedule (mix and volume) dictated by the leveling process described above. This would be the case in any situations where the backlog of customers extends beyond the horizon for the leveling box.
- Replenishment signals generated from consumption from the finished goods supermarket. These would typically be generated from shipments during the prior shipping interval.

- Customer orders. New customer orders promised for the period being scheduled.
- Some combination of the customer orders, finished goods replenishment signals, and the leveled schedule.

These pull signals would typically be communicated to the plant using the leveling or “Heijunka” box.

### Standard work

Lean seeks to eliminate muda, mura, and muri. One area where “mura” (variability) can be reduced is in the work process itself. Unless work is defined and then performed, in the same way over and over, the variation in the process will create quality problems and possibly scrap and rework.

Standard work defines the agreed upon “best known” method to produce an item using the available equipment, tools, people and material. It defines key points in the production process, the sequence of activities, procedures and key criteria for those procedures (for example, in mixing: how long to mix, in tightening bolts: which one first to what torque, which one second and to what torque, etc.), safety and quality checks, etc.

The goal of standard work is to systematize how a part is processed so that it can be carried out safely in the best known sequence using the most effective combinations of resources, over and over and over again without creating variability in the process itself or in the output from the process.

The work process is normally documented in writing, with photographs and video, and examples of defective products nearby. This is done to eliminate errors that waste time and money, and ensure reproducibility from operator-to-operator.

Standard work will also go beyond the strict production process to include paint and color standards for safety elements, equipment operation instructions, floor markings, building interior and exterior, material labeling, etc.

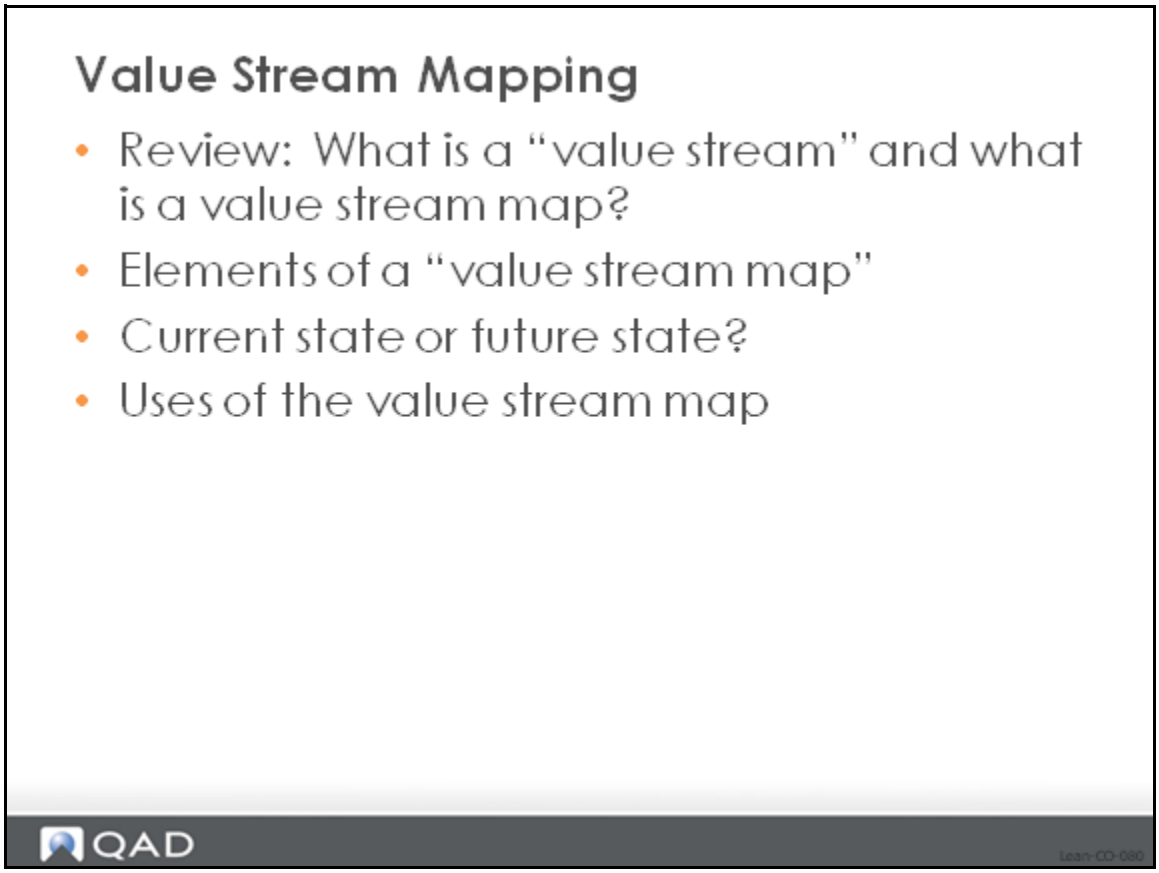
### Kaizen

Kaizen, which is the philosophy of continual improvement, is based on the belief that every process can and should be constantly evaluated, improved and upgraded with respect to what work is being done, how long it takes, how many resources are needed to do it, what the result is in term of product quality, etc.

In some sense, “standard work” sets boundaries: “don’t deviate from these procedures.” Kaizen asks the question: “how can we deviate from our existing procedures to improve our performance.” Both are necessary for creating a high performance environment.

In the next section we’ll see how “value stream mapping” can be used as an essential tool for identifying opportunities and driving improved performance.

## What is Value Stream Mapping and how is it used to drive Lean?

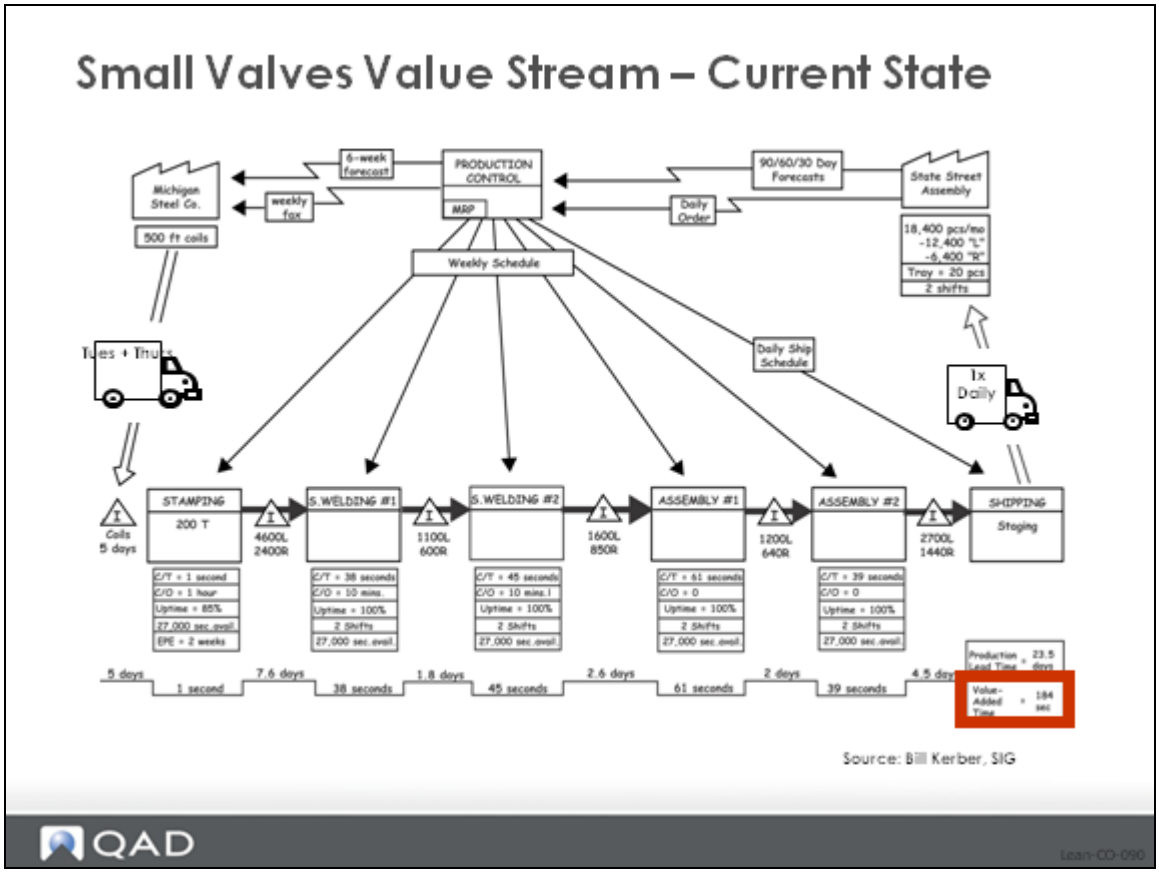



### Review: what is a "Value Stream" and what is a Value Stream Map?

A "value stream" is the set of activities, both value-adding and non-value adding that occur in taking a product from concept to launch, from order to delivery, from raw material to finished product.

Value stream mapping (of the production value stream) develops a kind of graphical diagram, showing each activity that occurs in the flow of material from the supplier to the customer as well as the information flow from the customer back to the production floor and the supplier and a lead time diagram contrasting value-adding time to elapsed time.

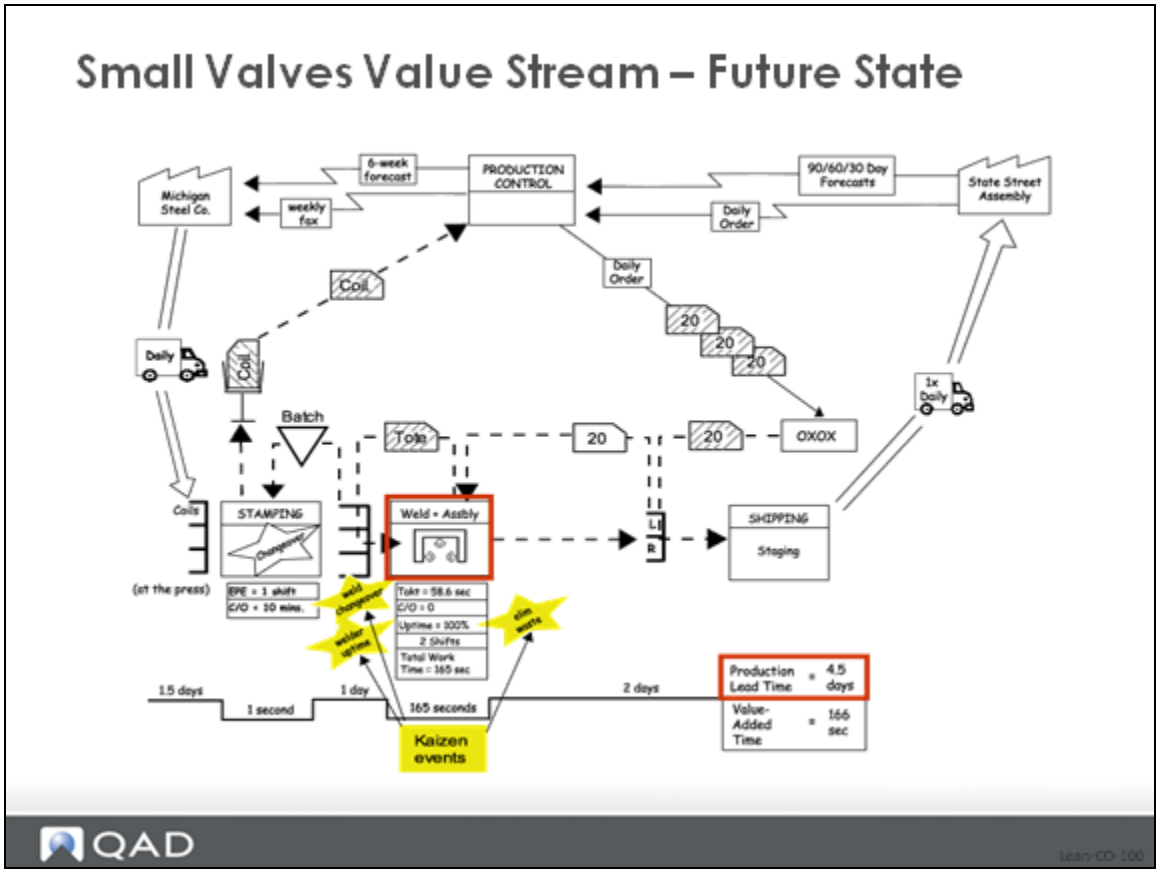
## Small Valves Value Stream - Current State




Value stream mapping is an essential lean technique which, like many others, was originally developed at Toyota. It has been disseminated and popularized by the book “Learning to See” by Rother and Shook. It is a core element of a lean transformation because it provides a basic blueprint for the kinds of changes needed to move from a disconnected, dysfunctional flow kind of environment to one where material flows smoothly from one process to the next to the next, rather than making isolated improvements to individual activities within a larger value adding process. Value stream mapping provides an overall structure for applying other tools and kaizens, and for seeing beyond the symptoms of waste to real root causes.

An example of a “current state” value stream map is shown above, and an envisioned “future state” is shown in the next image. (These figures are reprinted with permission from Lean Standard System, Christopher Gray, Trafford Publishing, 2008.)

## Small Valves Value Stream - Future State




### Elements of a "Value Stream Map"

A value stream map has three essential parts:

- Information Map – shows the basic flow of data from the customer to the production control/planning function to the production floor and back to the suppliers.
- Material Flow Map – shows the flow of material from the supplier(s) to the production floor and each of the manufacturing processes and inventory points and then on to the customer.
- Lead Time Ladder – compares the amount of time spent in value-adding activities to the total elapsed time for products produced in the value stream.

### Information Flow

In the value-stream map which depicts the current state of the value stream, observe the flow of data (Information Flow**)** at the top of the map. Here the customer communicates daily requirements to the production control organization via an electronic signal (fax, email, EDI, etc.). These are converted to schedules for each plant process on a daily basis, and once a week they are converted to supplier orders. This is a fairly traditional, mass production method of determining and communicating factory and supplier requirements. Each discrete process is scheduled, often by a computer scheduling system that attempts to keep up with changes in the manufacturing

environment. These changes would include changes in customer delivery schedules, as well as scrap, rework, inventory adjustments, engineering changes, etc. The schedule itself in this case is a daily dispatch list, although it could also be reissued each shift or partial shift.

### Material Flow

The Material Flow portion of the map (the large block of boxes and triangles in the middle portion of the diagram) depicts the movement of product from raw material to finished goods. The boxes depict individual disconnected manufacturing processes, data about which can be found immediately under the individual boxes, and the triangles represent inventory which has accumulated between the process steps and is waiting for processing in a subsequent process. The data boxes for each process record key production information: cycle time per piece, setup time, production interval, number of operators, downtime, scrap rate, etc.

Immediately below the “inventory triangles”, in the Lead Time Ladder portion of the map, is an estimate of the amount of inventory expressed in time units based on takt time for the finished products produced in this value stream. For example, if the takt time is 1 unit each 30 seconds and there are 1000 units sitting between two processes, it will take 30,000 seconds or approximately 8.3 hours before the inventory is used. Or another way to think about it is that any new material arriving from the feeding process will have to wait for about 8 hours before it will be consumed.

### Lead Time Ladder

The Lead Time Ladder summarizes the cycle times (value-added time in each process) per piece and contrasts this with total time spent in the value stream. Total time reflects both value-added time and the time spent waiting as inventory between processes. Upper steps are wait time, and the lower steps on the later are value-adding time. At the far right, you can see the total of each of these types of lead time as well as the sometimes shocking difference between the two values.

Refer to “Learning to See” for definitions of all the mapping icons commonly used in a value stream map, or refer to the reference material near the end of this course.

### Current State or Future State?

Value stream maps normally exist in pairs (or triples) – the current state map along with one or more future state maps. Generally speaking “future state” doesn’t mean far distant or far future state – instead they are meant to depict stages of improvement that can be reached in three to six months. In many cases a company will want to layout a year or more worth of work, so two or more future state value stream maps, each building on the earlier map, may exist.

For example, the value stream maps in previous images depict the current and future states for a gear assembly value stream. The “star bursts” on the future state map show the key improvements that will be required to enable the changes in information and material flow. The major change in information flow is to replace the traditional computerized scheduling logic with a pull system: scheduling only the assembly operation based on customer orders and pulling all material from upstream processes using kanban signals. The principal changes to the material flow, in this case, are to:

1. Combine work processes into cells as much as possible.
2. Determine the production interval for each new cell and reduce the lot sizes to reflect it.

3. Create managed supermarkets of component and finished product inventory and eliminate the inventories between work processes as much as possible.
4. Replace the weekly fax based ordering and delivery process to the suppliers with a daily kanban signal for ordering and a daily delivery of material.
5. Level the schedule at the pacemaker process so that demand being passed back through the value stream is as constant and repetitive as possible.

The effect of these changes can be observed in the Lead Time Ladder at the bottom of the future state map. Here, with virtually no changes to cycle times in the process, lead time drops from <x> days to <y> days: a <z>% change in lead time overall, a major improvement in product flow, and a corresponding drop in inventory investment.

### Uses of the Value Stream Map

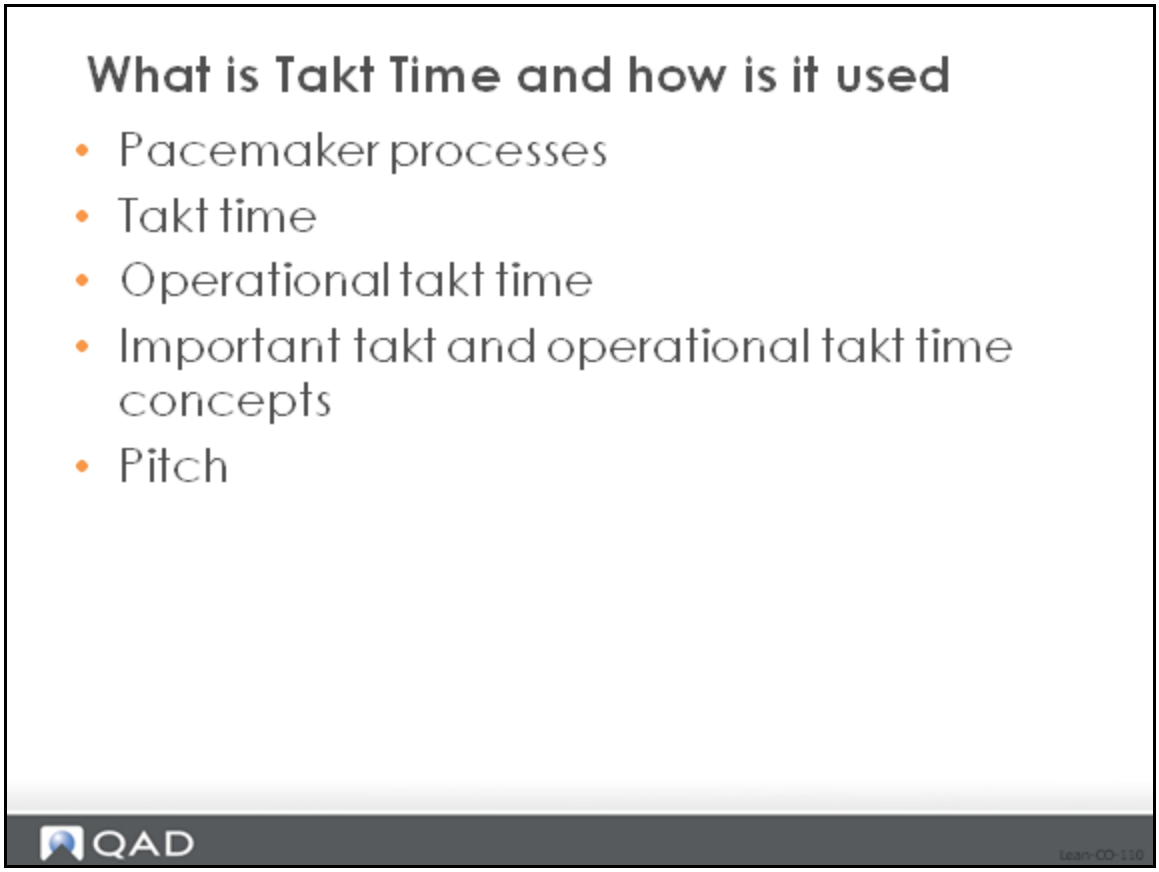
The major uses of value stream mapping can be summarized as:

> It provides a big picture of material flows, without which the tendency is to work on improving individual processes (milling, drilling, hardening, etc.) rather than on improving the overall value stream.
>
> It allows the manufacturing, materials and supply chain organizations to be structured around value streams rather than individual processes or functions. For example, rather than having individual people responsible for each process in the plant, a single person can be held accountable for the performance of an entire value stream and limited resources can be focused on eliminating the sources of waste, variability, and strain.
>
> It provides a common view for operations and accounting and becomes the basis for discussing real improvements.
>
> It makes the impact of decisions apparent in a quantitative way – in the Lead Time Ladder – rather than as spongy, “feel good” notions about what might happen.
>
> It connects information flows and material flows.
>
> It can become the basis for an implementation plan or series of implementation plans.

And from the context of the QAD Lean software, the value stream map becomes the basis for modeling processes and kanban loops so that the system can assist in some of the important calculations like takt time, EPE Interval, leveling and loop sizing. To use the software effectively, and to model your value streams in a sensible way, you’ll need to do a value stream map first.

In the next section we’ll see how “takt time” is used to set the drumbeat for all production and purchasing replenishment activities across the entire value stream.

# What is Takt Time and how is it used?




### Pacemaker processes

A basic concept of lean manufacturing is to schedule at only one point in the value-stream, pulling work from earlier processes and flowing product to the customer through all downstream processes. However, using a system for flow and pull presupposes that:

- The point that should be scheduled is identified correctly.
- The rate that products must be produced to meet the customer demand is known.
- The value stream has been designed to support the rate of customer demand (and buffer adjustment when necessary). In other words, manufacturing processes (cells) must be designed with enough equipment and labor to be able to produce to the required rate, suppliers must be capable of delivering the required volume and mix of component materials, and internal material delivery routes must be designed to operate at the same rate.

The point at which work is scheduled is called the pacemaker. Generally speaking a “pacemaker” is the point in the value stream that both a) sets the pace for the entire value stream, and b) responds directly to customer demand. The pacemaker process controls the basic rate of production for a group of items with similar value-streams. Processes upstream of the pacemaker (components) are pulled from their source processes. Processes “downstream” of the pacemaker are handled on a first-in-first-out (FIFO) basis.

In a lean production environment, items that go through pacemakers would typically be the same as the ones that are master scheduled, regardless of whether the strategy for the parts is “make-to-stock” or “make-to-order”. Although a basic objective of lean manufacturing is to produce only to customer orders, in reality, there are times when producing to a small stock, typically as a way to buffer the variability of customer demand makes more sense than flexing labor and plant processes to day-to-day order variations.

In many lean environments, the master scheduled items would be produced to a finished goods buffer (a “finished goods supermarket” in lean parlance). In other lean environments, they would be produced only when the customer order has been received.

They might be produced from stocked component parts being held in a semi-finished stores area or they may be produced truly “to order” from raw material or purchased parts. But in every case, the master production schedule would be used to establish the future plan, the rate at which components will be pulled from supplying processes and outside suppliers, and the projected requirements that can be shared with suppliers for their planning processes. The finishing schedule, which might be the same as the master schedule or which might be different based on the mix of actual customer orders, would communicate what is actually to be produced in the pacemaker process.

### Takt Time

The basic rate of manufacturing and the basis for the master production schedule and the finishing schedule is the takt time – literally the “drumbeat” for the process. Takt time expresses the sales rate – and how fast the plant must produce a product in order to be perfectly synchronized with the customer. One unit every 23 seconds in a company making visors for automobiles, one unit per hour in an organization producing large pumps, or one unit every 2 weeks for a manufacturer of fighter jets would be practical examples of the takt time in real companies. “Producing to takt time” means producing to at the rate of the customer demand.

Takt time can be calculated from the customer demand and the working time:

*Takt time = normal working time / total demand*

### Operational Takt Time

“Operational takt time” expresses the anticipated build rate, taking into consideration finished goods inventory adjustments or work time adjustments like overtime. For the examples cited above, the operational takt time might be one unit every 23 seconds (no inventory adjustment or overtime), one unit per 1 hour 15 minutes (finished goods inventory is being lowered to reduce working capital, or one unit per every 1.5 weeks (overtime has been added and the build rate increased because of a subsequent planned shutdown).

Operational takt time can be calculated from the customer demand, buffer adjustments, and adjusted working time:

*Operational takt time = adjusted working time / (total demand + adjustments to inventory)*

### Important takt and operational takt time concepts

There are several important things to recognize about takt time:

- Takt time is based on the total volume of all items being produced at the pacemaker process, not the quantity of any individual item. Takt time expresses the rate of production to match the rate of customer demand for the process. Another important and related number, operational takt time, expresses the rate of production to match the rate of customer demand and any desired finished goods inventory adjustments in aggregate and any adjustments to the work calendar needed to be able to meet the required volume. In a company which has implemented both resource planning and lean execution, takt time and operational takt time would be key outputs of the sales and operations planning process.
- When different products are produced in a single pacemaker, there will be an overall takt time, as well as a takt time for each product on the line. For example in an assembly cell in an engine factory, the takt time for the process might be one unit every 2 minutes 30 seconds while the takt time for the long block group of products is one every x min y sec, for short blocks is n min m sec, etc. The takt time by product will be used to calculate the appropriate "mixed model" sequence of engine production.
- Takt time and operational takt time are calculated numbers, not a reflection of the capability of the process. There is no guarantee that what the customer wants can be supported by the capability of the supplying process.
- Over time, the objective is to get operational takt time to equal takt item – i.e. to produce to customer demand. In the short term, an important activity associated with the pacemaker processes is to get the cycle time for each item to something less than or equal to the operational takt time, and in the longer term to get cycle time to where pure customer demand driven takt time can be supported.
- The industrial engineering activity which analyzes and adjusts the pacemaker process so as to align cycle time with takt time is called cell design or operator balancing. Other important design or planning activities related to takt time include those related to creating a mixed model schedule, creating the finishing schedule for the pacemaker process, material route design, and supermarket and loop sizing.

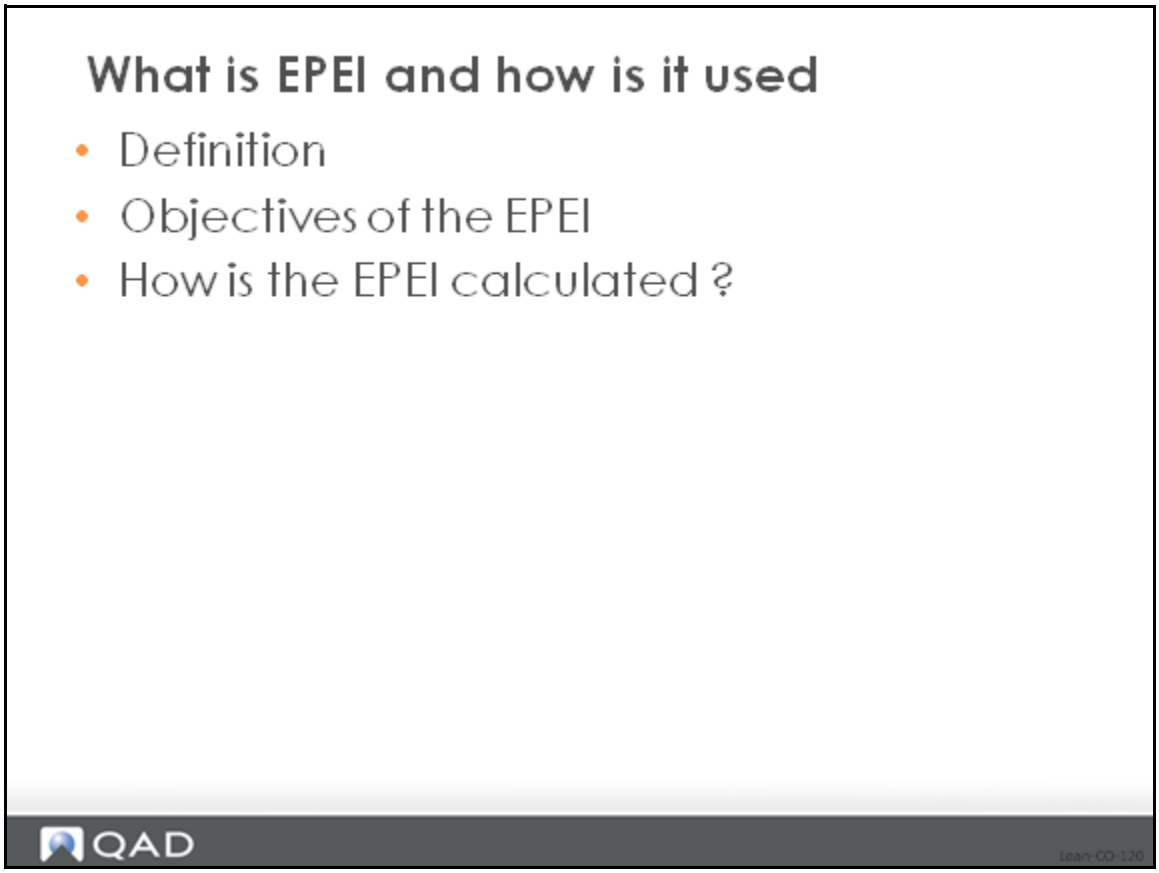
### Pitch

The finishing schedule is typically communicated to the plant using a visual control called the leveling box (heijunka box). The basic idea behind the heijunka box is to distribute the schedule evenly over time, ideally in small increments of time equal to the takt time, and then communicate the schedule to the plant in the same time increment. Typically it distributes the finishing schedule over a shift or a day, showing visually what is to be produced, when it should be produced (start and end time), and how much of each item in each time interval. It is also a principal driver of material route design for the plant since material deliveries to the pacemaker could be done in time increments based on the takt time driving the heijunka box.

However, if the takt time is very small, say 30 seconds, scheduling production or material routes based on time increments so small may be impractical. In this situation, a larger time increment called the "pitch" is used instead. The pitch for a process is some multiple of takt time, usually based on the number of units in a standard packaging unit, and typically between 10 minutes and 2 hours. It is sometimes called "takt image" because it preserves the drumbeat created by takt time, but makes it possible to support cell design and operator balancing (how many operators are needed in the cell and how should the work be distributed to those operators so as to meet takt time) as well as material route design (which parts should be delivered to each finishing cell, for what quantities and when).

In the next section we'll cover a concept and calculation that is arguably as important to the beginning practitioner of lean as the takt time is to every serious practitioner.

## What is the EPEI and how is it used?




Long setups are an impediment to flow. Longer setups imply larger lot sizes and lumpier demands, longer lead times, worse quality, more inventory and “surges” of work upstream. From a master scheduling and finishing scheduling perspective, the time to setup or changeover in a pacemaker may prevent a real mixed-model schedule and also stand in the way of implementing effective pull systems for upstream components.

Smaller lot sizes mean better flow, less overall inventory, and more responsiveness to changes in demand. So a logical question might be “if smaller is good, then why not even smaller. Why not dictate lot sizes of one piece?”

Of course if you’ve been around manufacturing for some time, and have some experience with the way the factory works, you know that there’s a limit to how small the lot size can be. If you reduce the lot size to too small a quantity, you will quickly eat up all your available capacity in changeovers. This is exactly what happened in some naive manufacturing companies who heard about all the benefits of “one-piece” flow and attempted to get there without doing the hard work to reduce manufacturing setup times.

### Definition

The smallest possible lot size for a part in a process is a reflection of the “production interval” or “EPE Interval”. This interval defines the maximum frequency that you can produce each part without running out of capacity because of too many setups on all parts. It is an expression of how frequently each item produced in a process can actually be run without incurring a capacity penalty.

It answers the key question: how often can we run every part through the process: once a month, once a week, once a day, once an hour?

The essence of the EPE Interval calculation is to compute the capacity required for running all the items that go through a process, and use that to determine how much time is available for set-up. The amount of time available for setup can be factored by the total setup time for producing every item at least once – and from this the maximum number of times you can set up every item and the order quantity for each one based on that frequency.

### Objectives of the EPEI

The benefits of running each item using the smallest valid interval include:

- Reduced lead time
- Increased flexibility and responsiveness
- Reduced in process inventory
- Reduced space requirements
- Improved quality
- Increased opportunities to ship on demand
- Fewer “surges” of usage, and in turn work, to upstream processes and suppliers

For the pacemaker process, reducing the setup and EPE Interval to less than the ship window has another potential benefit: the ability to meet small orders equally as well as large orders. With an EPE Interval of less than a day, any item can be run “on demand”. The goal of mixed-model scheduling is to get the EPE Interval to less than a day, shift or ship window.

The real question isn’t “are smaller intervals better?” The real questions are:

“How small an interval now?” and “What do we have to do to get the interval smaller?” and “How fast can we get to a smaller interval?”.

### How is the EPEI calculated?

The basic calculation of the EPE Interval is this:

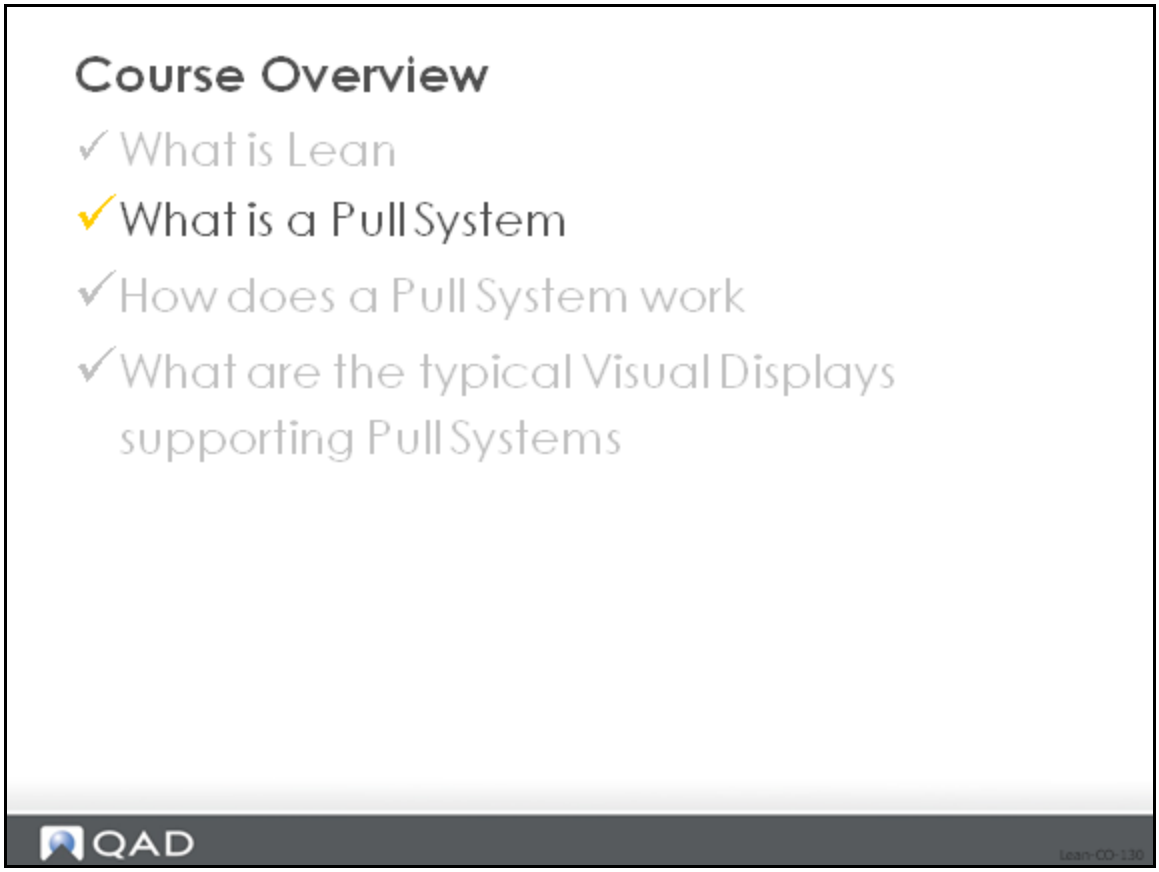
*EPE Interval = Â (setup time for each part)/time available each day.*

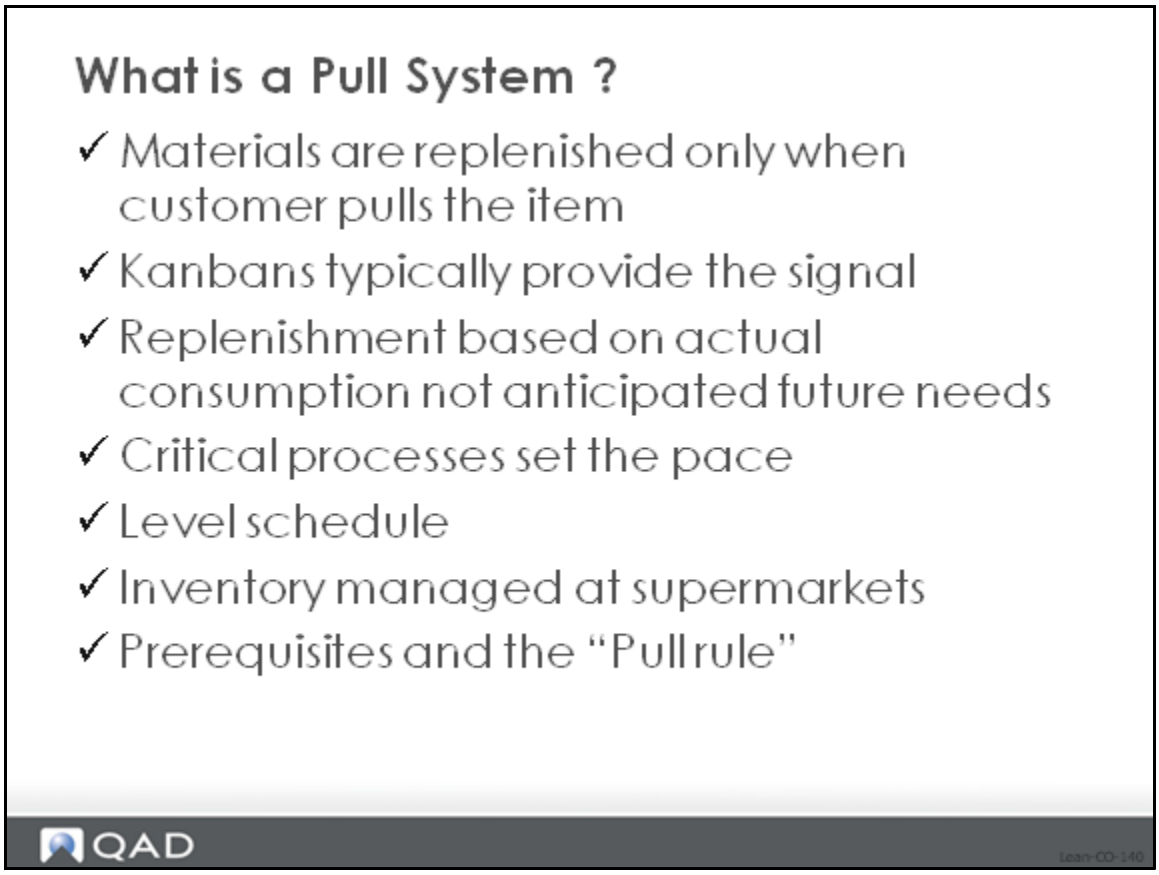
*Time available each day = total time in the day – Â (each part's average daily demand x cycle time per piece))*

Think about it this way: if you determine how much time is left each day after producing enough of every part to cover the parts daily demand, this really tells you how much time you have in an average day to do setups. Say this is 3 hours per day. If your setups across all parts produced in the process total 3 hours, this means that you can run every part every day. If your setups across all parts total 6 hours, then you can at most run every part every two days (6/3=2).

In the next section we'll cover the basic concepts and prerequisites to pull (kanban) systems.

## What is a Pull System?






### Materials are replenished only when customer "pulls" the item

Pull replenishment is based on a visual scheduling technique called kanban. Although the term "kanban" is Japanese and in this context comes from the Toyota Production System and Taiichi Ohno, the technique itself, when applied to inventory replenishment, is actually much older. Taiichi Ohno got his inspiration for the Toyota Production System, at least in part, from observing replenishment processes in an American supermarket: when the bread shelf was empty, the supplier was authorized to replenish. (His other inspiration was another American innovation: Henry Ford's manufacturing practices developed at the Rouge production complex.)For example, as early as the end of the 19th century, the iceman and the milkman in urban areas in America were receiving signals to determine whether to walk from their horse-drawn cart to the porch with ice or milk. The customer's signal was either a card (ICE) in the window or an empty milk bottle.

The way that a pull replenishment system works is quite simple. Inventory for an item is divided into equal units (kanbans). As a kanban-worth of inventory is consumed it is reported, and when the inventory level reaches a predetermined level, a signal is generated to schedule replenishment. In a company with reduced setups, small order quantities and lots of manufacturing flexibility, one kanban of consumption might signal replenishment. In a company with typical stamping processes, presses, etc., several kanban cards may have to accumulate before a lot size is reached and replenishment signaled.

### Kanbans provide the replenishment signal

The visual signal used for KANBAN might be any of the following:

- Card
- Flag
- Colored golf ball or ping pong ball (running in a race between the point of consumption and the supplying process)
- Empty bag, box, tray, pallet or container
- Empty rack or square on the floor
- Empty truck
- Fax (to suppliers)
- Electronic signal (e-kanban)

### Replenishment is based on actual consumption not anticipated future needs

Any system that replenishes inventory based on consumption of inventory is defined as a “pull system”. Any system that replenishes inventory based on predicting or anticipating future needs for that inventory is defined as a “push system”. Whether these are good definitions or not, or whether they even make sense based on the normal connotations of “pull” and “push” is really irrelevant. In the same way, the tools that are the underpinnings of push and pull concepts are neither good nor bad. Each tool and technique has situations where it works better than the other, and vice versa.

So by these definitions, a kanban-based replenishment system is “pull” and an MRP-based replenishment system is “push”. Even in cases where MRP or some similar process is being used to project future needs, if the actual replenishment activities are based on Kanban then the system is considered a pull system.

For items that are being replenished using pull, traditional techniques often associated with MRP are shut off. Examples would include “order releasing based on planned orders” and traditional shop floor control based on push dispatching rules. However, executing to a pull signal is not in conflict with MRP planning itself. Typically, MRP planning continues to run, for the purpose of projecting requirements for suppliers of purchased parts and raw materials.

### Critical processes set the pace

As noted above, the “pacemaker” process in each value stream establishes the drumbeat for all production and replenishment activities. Components produced in processes upstream of the pacemaker are pulled from their source processes based on consumption of inventory from a strictly controlled inventory. Processing beyond the pacemaker (finishing, configuration, burn-in, etc.) is handled on a first-in-first-out (FIFO) basis – as work arrives it is processed in a strict first-in first out sequence.

### Level Schedule

The level schedule creates a repetitive pattern and regularity to production activities. Without it, the surges of work to the upstream processes create erratic production, material movement, and capacity usage. By leveling total volume and each of the items to the average rate, upstream

manufacturing processes and suppliers see a relatively constant capacity requirement and a leveled stream of component usage. The average rate expressed in units of time – hours-minutes-seconds – is the takt time and it becomes the basis for all process design activities. The design of the finishing cell and all the supporting processes, the number of operators in the cell, and the distribution of work to those operators is a key output from leveling to the average rate.

In addition, material plans projecting supplier requirements will be derived from this and shown to the supplier as a supplier schedule.

Lean producers have a choice when it comes to the actual execution of the long term leveled schedule. In some cases, like Toyota, the backlog of customer orders will extend far enough into the future that longer term leveling can be based on the exact, actual flow of customer orders. However in many companies the long term heijunka – essentially a volume leveling process – will try to plan based on the anticipated average flow of customer orders. The short term leveling process – which reflects what actually will be produced, in what sequence, and when – may match the exact customer orders as they are received. This is one case where "what Toyota does" often does not dictate what other companies choose. In fact, many of the Western lean consultants, often ex-Toyota employees, advise an execution strategy different from Toyota's.

### Inventory managed at Supermarkets

Supermarkets of tightly managed and strictly limited inventory help decouple processes that run at different rates – for example, a finishing process that flows at a constant rate and a stamping or machining process that runs large lot sizes at a much faster cycle time, but requiring a substantially longer setup time. As a buffer of finished goods, a supermarket can decouple highly variable customer demand and the pacemaker process that must run at a more stable and leveled rate. And because supermarkets are set as a maximum amount of inventory with a hard and fast rule "stop production when the supermarket is full", they have the effect of limiting the amount of inventory at all stages of the lean production system. In fact, supermarkets make pull systems possible. Consumption from the supermarket sends pull signals to replenish. Full supermarkets signal that the source process must stop producing.

### Prerequisites and the "Pull Rule"

For a pull system to work effectively, however there are some basic prerequisites and some rules that need to be followed. Here are the prerequisites:

- Demand for each item must be relatively repetitive, regardless of whether the item is a finished part, subassembly, fabrication, etc.
- Lead times must be relatively short
- Components must be available so that an item can be produced "on demand" when the visual signal is generated (in other words, setups have been reduced, reducing the production interval and associated lot sizes).

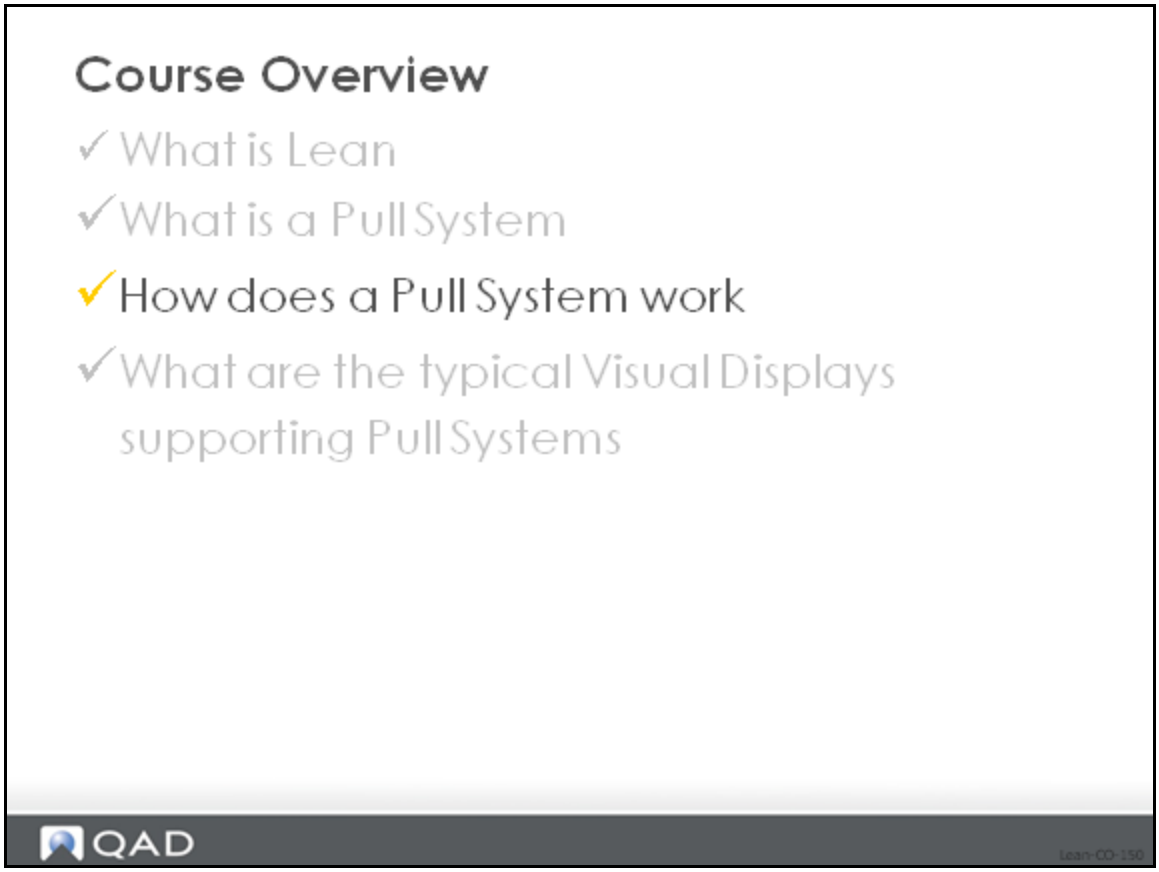
Note that of these prerequisites, one of the most difficult to achieve is often "relatively repetitive demand". As noted above, "leveling" is one of the techniques used for creating relatively repetitive demand. Using finished goods supermarkets to buffer the variability of customer ordering patterns, understanding and using the EPE Interval to establish the smallest possible lot size for each item, and focused efforts to reduce setup times so as to reduce the EPE I even further are additional methods for reducing the variability of demand being passed through the value stream.

The other essential element in making a pull system work is adherence to the “pull rules”:

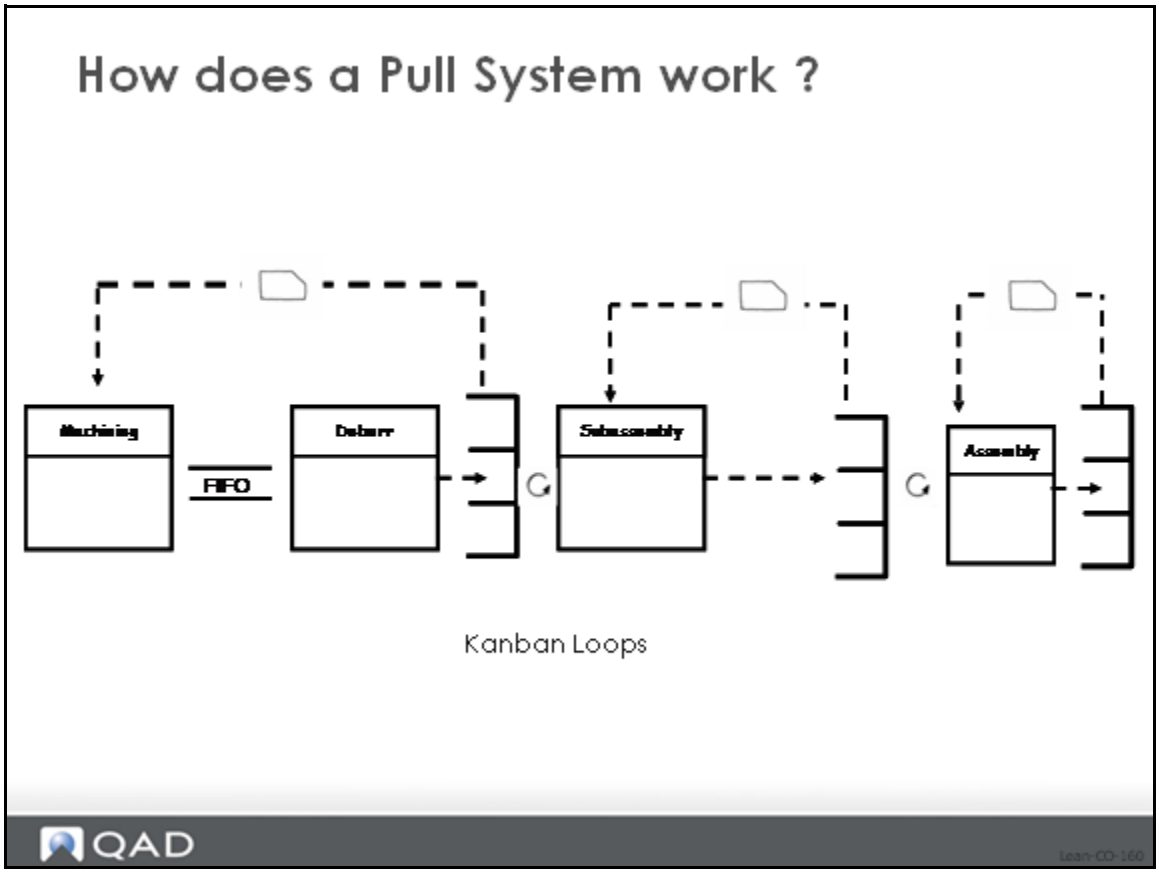
- Downstream processes may withdraw ONLY the required quantity from the supplying upstream source.
- A process may produce (replenish) ONLY the quantity withdrawn by the downstream process – in other words, stop producing when the kanbans are full.
- NEVER send defects on to the next process
- MINIMIZE the number of kanbans for each item.
- FINE TUNE the number of kanbans as fluctuations in demand occur.

In the next section we’ll restate the basic mechanics of pull systems.

## How does a Pull System work?



## Pull System mechanics




The previous image shows a series of kanban loops and illustrates how the kanban system pulls work from earlier processes. As explained before, this value stream map depicts a series of controlled inventory points (the “backward Es”), processes (the boxes), kanban loops (dotted lines showing how the kanbans circulate) and kanban cards that are associated with material as it is produced and inventoried.

The goal of the pull system is to have each supplying process produce exactly the required quantity of product at the exactly the right time. Levels of inventory in the system regulate production. When inventory in a supermarket drops below its preset maximum level, the upstream supplying process receives a signal to produce that item. (The signal is typically a card, the kanban, which has been detached from the supermarket inventory when the inventory is removed from the supermarket. The detached card is circulated back to the source process where it either authorizes replenishment immediately, or is accumulated on a control board until a full lot size of production is reached.)

The supplying process must have an authorization before it can start work. Once an authorized signal is received, the supplying process can draw component material and raw stock from its own upstream supermarket or point of use inventory, perform the work, attach the card to the finished part and put it in the downstream supermarket. The supply process may not produce more than authorized by the empty kanbans.

Another way to think of this process is this: only when the supermarket inventory is less than the preset max can the supplying process produce more. When inventory in a supermarket reaches its preset maximum level, the supplying process must stop producing the item. Notice that the number

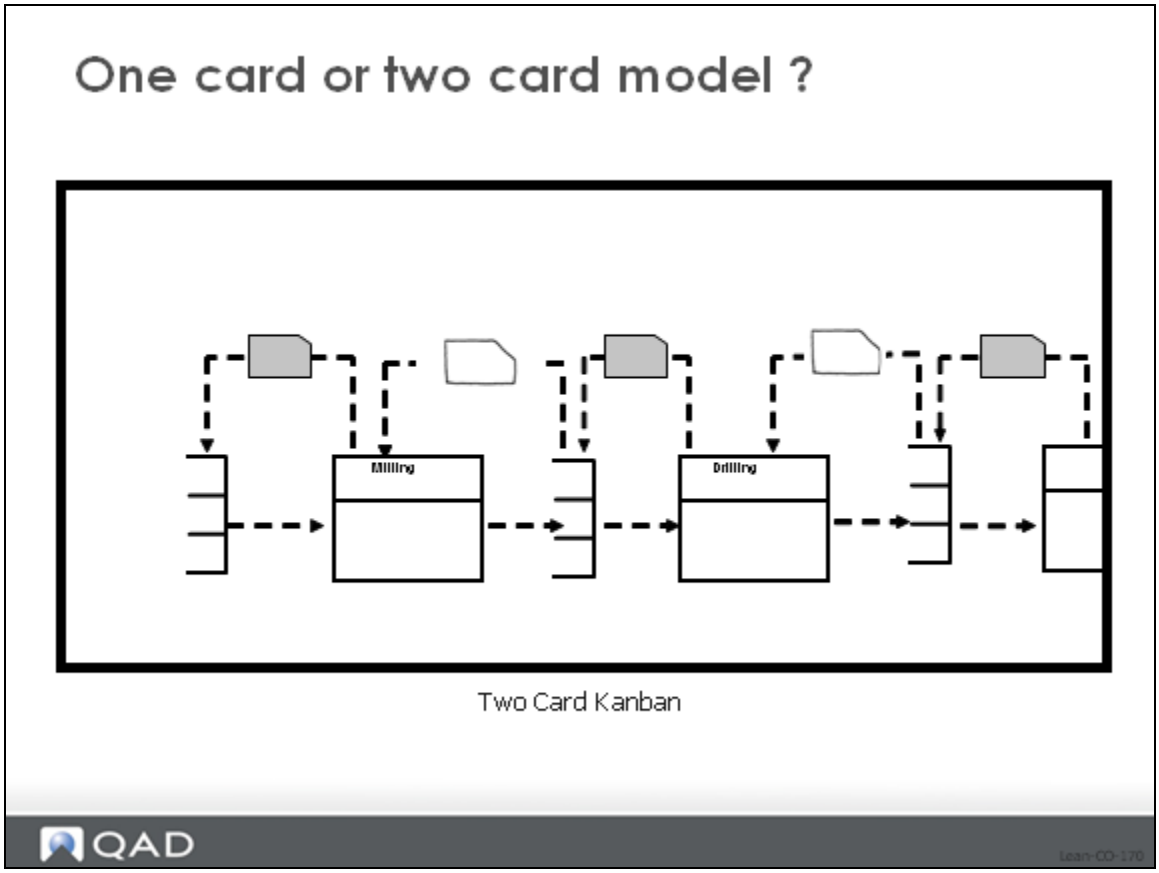
of cards or containers circulating between the source process and the supermarket determines the maximum amount of inventory in the supermarket, since once all cards are attached to parts in the supermarket, no more parts can be made.

When the supplying process draws on component parts and raw materials to make more of the item, it also detaches the card attached to that material. This kanban card circulates back upstream to signal the next upstream process to produce more. This way, a demand for a unit of finished goods percolates back up value stream to the fabrications and then to purchased parts and subsequently to the suppliers.

### One Card or Two Card Model?

The kanban model in the value stream depicted in the previous image is a so-called “one-card kanban model”. In this kind of kanban system, a single set of cards for each item represent both withdrawal from the controlled supermarket inventory and replenishment from the supplying source back to the supermarket.

## One Card or Two Card Model




This figure is reprinted, with permission, from *Lean Standard System*, Christopher Gray, Trafford Publishing, 2008.

It is also possible to have a kanban system that is based on a “two-card kanban model” which has withdrawal kanbans circulating between the supermarket and the point of use, and replenishment kanbans circulating between the supermarket and the supply source. This kind of kanban system is depicted in the image above, and is commonly used in situations where there is a significant distance between the supermarket and supermarket, or where the supermarket actually feeds multiple points of use (which are usually, although not always, also some distance away).

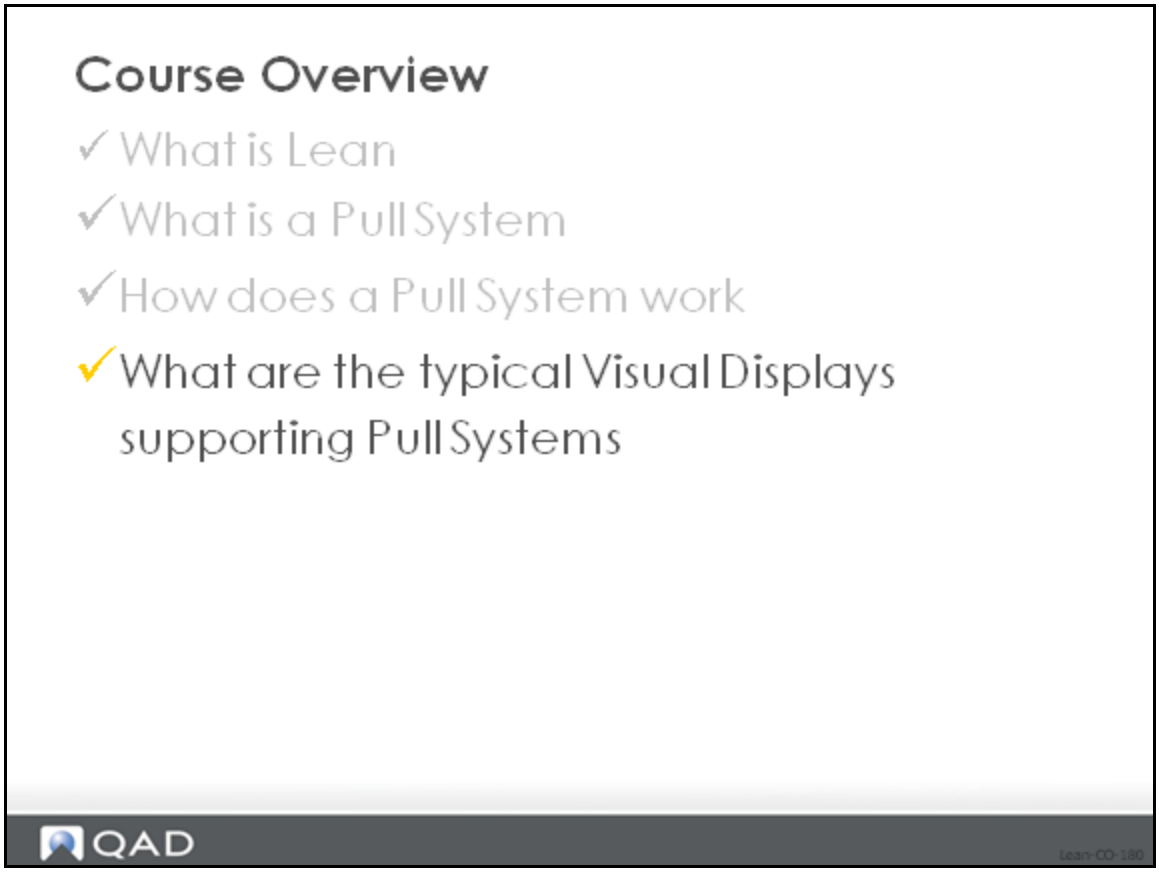
This value stream map depicts a series of controlled inventory points (the “backward Es”), processes (the boxes), kanban loops (dotted lines showing how the kanbans circulate) and kanban cards (hatched cards are “withdrawal cards” and open cards are “replenishment cards”. As explained above, the withdrawal cards circulate between the point(s) of use and the supermarket, and the replenishment cards circulate between the supermarket and the supply source.

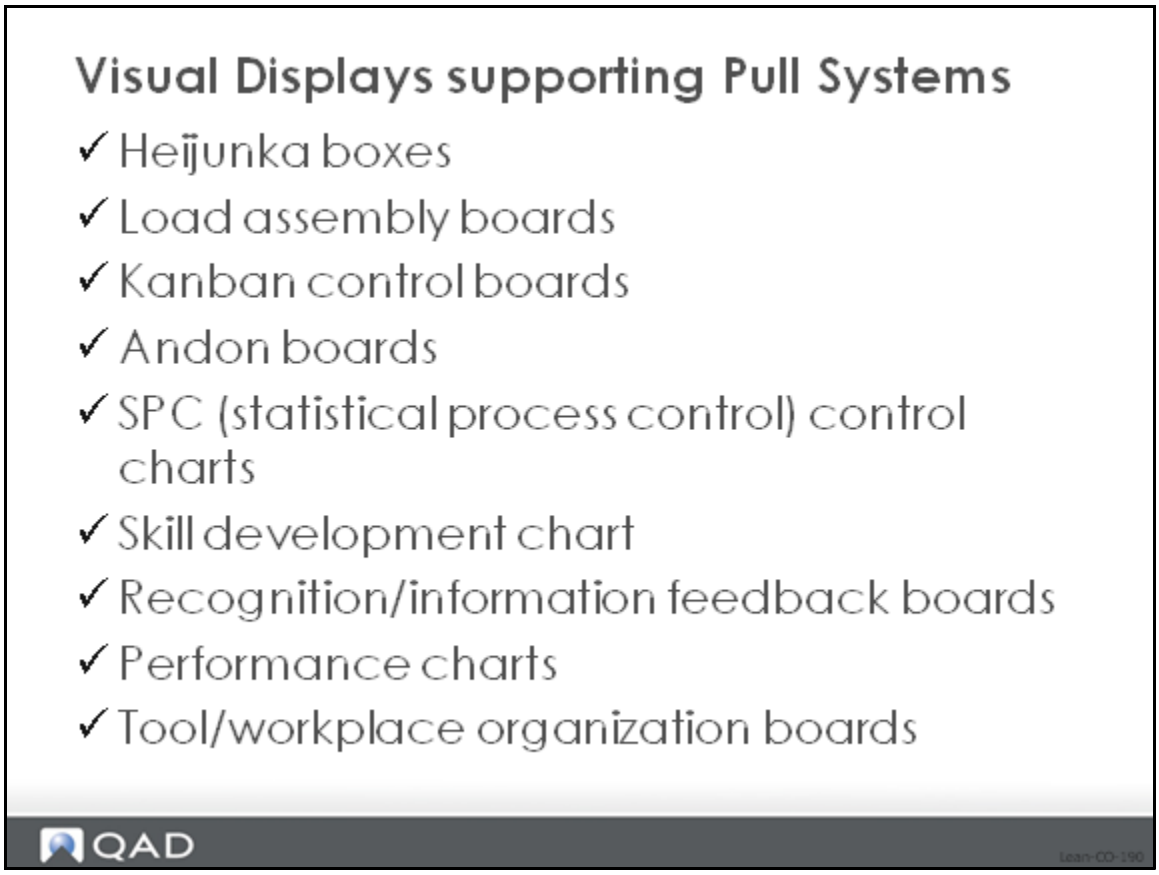
Here are the mechanics of the “two-card kanban system” starting with the process at the extreme right:

- When a component part or material is used at the point of use process, the kanban associated with the part is detached and circulated back to the supermarket.
- When the card reaches the supermarket, it is treated as an authorization to withdraw additional material from inventory and convey it to the consuming process.

- When the material is removed from the supermarket, the withdrawal kanban is attached and simultaneously the replenishment kanban is detached. The withdrawal kanban and the material are sent to the point of use. The replenishment kanban circulated back to the source process, in this case “Drilling” where it either authorizes replenishment immediately or is accumulated until the lot size can be authorized
- The supplying process can draw component material and raw stock from its own upstream supermarket or point of use inventory, perform the work, attach the replenishment card to the finished part and put it in the downstream supermarket.
- When the supplying process (drilling) uses the component parts and raw materials to make more of the item, it also detaches the withdrawal card attached to that material and sends it back to the supermarket as an authorization to withdraw additional material from stock and replenish the point of use. As earlier, when the material is removed from the supermarket, the withdrawal card is attached and the replenishment kanban detached. The withdrawal kanban and the parts are sent to the point of use, the replenishment kanban is send upstream to the source process, in this case “milling” to signal replenishment of the supermarket stock. In this way, finished goods demand percolates back up value stream to the fabrications and then to purchased parts and subsequently to the suppliers.

## What are the typical Visual Displays supporting Pull






These control boards fall into three general categories:

- Those that are used in conjunction with kanban or flow mechanisms to schedule replenishment.
- Process monitoring, performance and feedback boards.
- Workplace organization and documentation displays.

For flow, the visual scheduling mechanism is the “heijunka” or leveling box. For processes that are part of the pull system, the basic mechanism for communicating what to work on first, and what to work on second, and what to work on third is the “kanban control board”. Here the sequence of work to be done is normally based on the date of authorization (first cards authorized are the first to be produced), although in some instances the work sequence may reflect other considerations (the run-out date for each of the parts, product wheel considerations, etc.). Another important visual control board is the “load assembly board” that keeps track of the empty kanbans for each item until enough have accumulated to reach the lot size (and therefore authorize production). An andon board or andon light is another visual control used in conjunction with kanban or flow scheduling mechanisms. An andon light is a kind of “self-stop” device that signals that a process is about to go down or is down and needs assistance.

Below you can see examples of three major visual control boards related to scheduling: the leveling box, the load assembly board and the kanban control board. For many companies, these are and will continue to be purely visual, manually maintained communication mechanisms. However, for other companies who want visual displays without physical proximity – a way to see schedule status from a training or conference room, or the ability to see kanban status from a

vendor site – it may make sense to provide an electronic version of these control boards, and these are provided as part of the QAD Lean software and will be described later in this course along with the transactions and tracking required to maintain the data.

The next three examples shown, electronic versions of the Heijunka Box, Load Assembly Board, and Kanban Control Board, are reprinted with permission from Chris Gray's book *Lean Standard System*.

## Example 1: Hijunka Boxes

# Hijunka boxes

| | | |
|---|---|---|
| Day | 8/10/2008 | |
| Day of Week | Tuesday | |
| Start | 7:00 AM | |
| Takt Time | 0.333 minutes | 0:00:20 |
| Pitch Interval | 4.00 hours | |
| Type of Schedule | fixed pitch | |
| Pitch increment | 0.0 hours | 15 |
| | 20.0 minutes | |
| | 0.0 seconds | |
| Pitch increment | 60 pieces | |
| Sequence | Number of operators (descending) | |
| Setup time option | Do Not Show | |

| Start | Time Avail | Pitch Increment | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Shift 1 | 240 | Start | 7:00 AM | 7:20 AM | 7:40 AM | 8:00 AM | 8:20 AM | 8:40 AM | 9:00 AM | 9:20 AM | 9:40 AM |
| | | End | 7:20 AM | 7:40 AM | 8:00 AM | 8:20 AM | 8:40 AM | 9:00 AM | 9:20 AM | 9:40 AM | 10:00 AM |
| | | Number of Operators | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 |
| | | Pam/Cust | | | | | | | | | |
| | | Item | [illegible] | X13 | X11 | X5 | X10 | X7 | X24 | X22 | X6 |
| | | Quantity | [illegible] | 60 | 30 | 30 | 15 | 60 | 60 | 30 | 60 |
| | | Number of New Cards | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| | | Slots | 4 | 4 | 2 | 2 | 1 | 4 | 4 | 2 | 4 |
| | | Number of Operators | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 |
| | | Pam/Cust | | | | | | | | | |
| | | Item | X1 | X13 | X11 | X5 | X21 | X7 | X24 | X22 | X6 |
| | | Quantity | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 |
| | | Number of New Cards | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | | Slots | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | | Number of Operators | 5 | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 |
| | | Pam/Cust | | | | | | | | | |
| | | Item | X1 | X13 | X12 | X15 | X3 | X7 | X24 | X4 | X6 |
| | | Quantity | 0 | 0 | 30 | 30 | 15 | 0 | 0 | 30 | 0 |
| | | Number of New Cards | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| | | Slots | 0 | 0 | 2 | 2 | 1 | 0 | 0 | 2 | 0 |
| | | Number of Operators | 5 | 5 | 5 | 5 | 4 | 4 | 4 | 4 | 4 |
| | | Pam/Cust | | | | | | | | | |
| | | Item | X1 | X13 | X12 | X15 | X20 | X7 | X24 | X4 | X6 |
| | | Quantity | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 |
| | | Number of New Cards | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | | Slots | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

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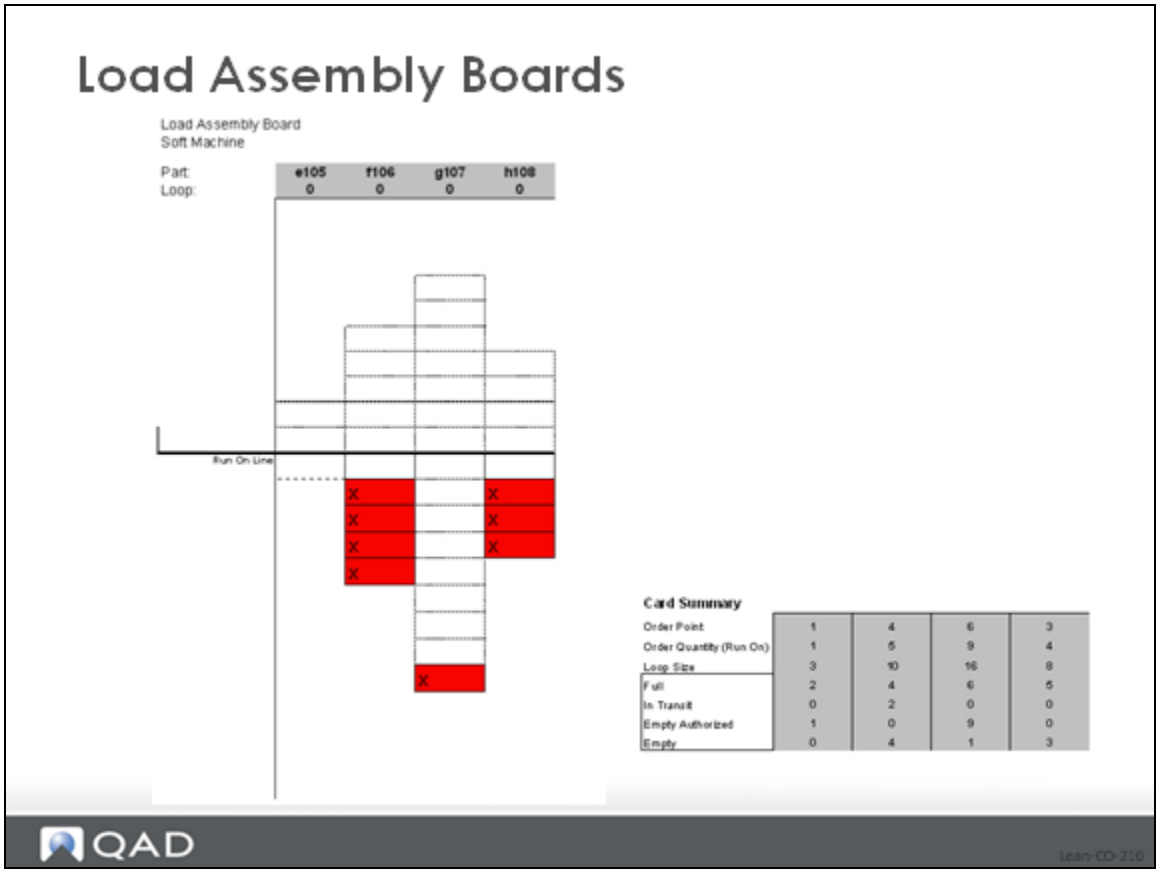
## Example 2: Load Assembly Boards



## Example 3: Kanban Control Board

# Kanban Control Board

Kanban Control Board
Soft Machine

| Authorized Cards | Part Number | Card Quantity | Cum Quantity | Authorized Date | Authorized Time |
|---|---|---|---|---|---|
| d104 | d104 | 70 | 70 | 24-Feb-08 | 11:06:01 PM |
| d104 | d104 | 70 | 140 | 24-Feb-08 | 11:06:17 PM |
| d104 | d104 | 70 | 210 | 24-Feb-08 | 11:06:54 PM |
| d104 | d104 | 70 | 280 | 24-Feb-08 | 11:07:18 PM |
| d104 | d104 | 70 | 350 | 24-Feb-08 | 11:07:38 PM |
| A101 | A101 | 65 | 65 | 24-Feb-08 | 11:08:18 PM |
| A101 | A101 | 65 | 130 | 24-Feb-08 | 11:08:28 PM |
| A101 | A101 | 65 | 195 | 24-Feb-08 | 11:08:55 PM |
| A101 | A101 | 65 | 260 | 24-Feb-08 | 11:09:09 PM |
| A101 | A101 | 65 | 325 | 24-Feb-08 | 11:09:33 PM |
| A101 | A101 | 65 | 390 | 24-Feb-08 | 11:09:48 PM |
| p116 | p116 | 15 | 15 | 24-Feb-08 | 11:10:00 PM |
| p116 | p116 | 15 | 30 | 24-Feb-08 | 11:10:32 PM |
| p116 | p116 | 15 | 45 | 24-Feb-08 | 11:10:39 PM |
| p116 | p116 | 15 | 60 | 24-Feb-08 | 11:10:53 PM |
| p116 | p116 | 15 | 75 | 24-Feb-08 | 11:11:55 PM |
| p116 | p116 | 15 | 90 | 24-Feb-08 | 11:12:02 PM |
| p116 | p116 | 15 | 105 | 24-Feb-08 | 11:12:18 PM |
| p116 | p116 | 15 | 120 | 24-Feb-08 | 11:12:29 PM |

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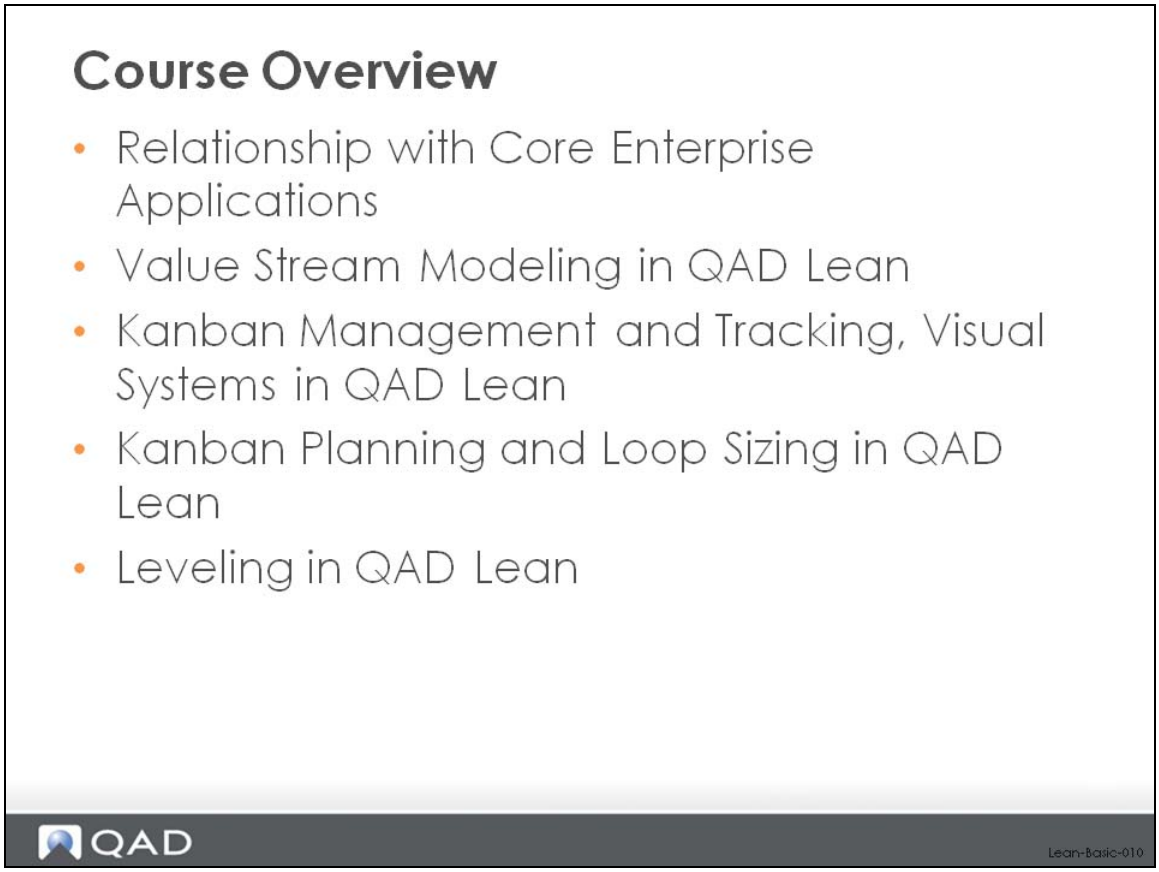
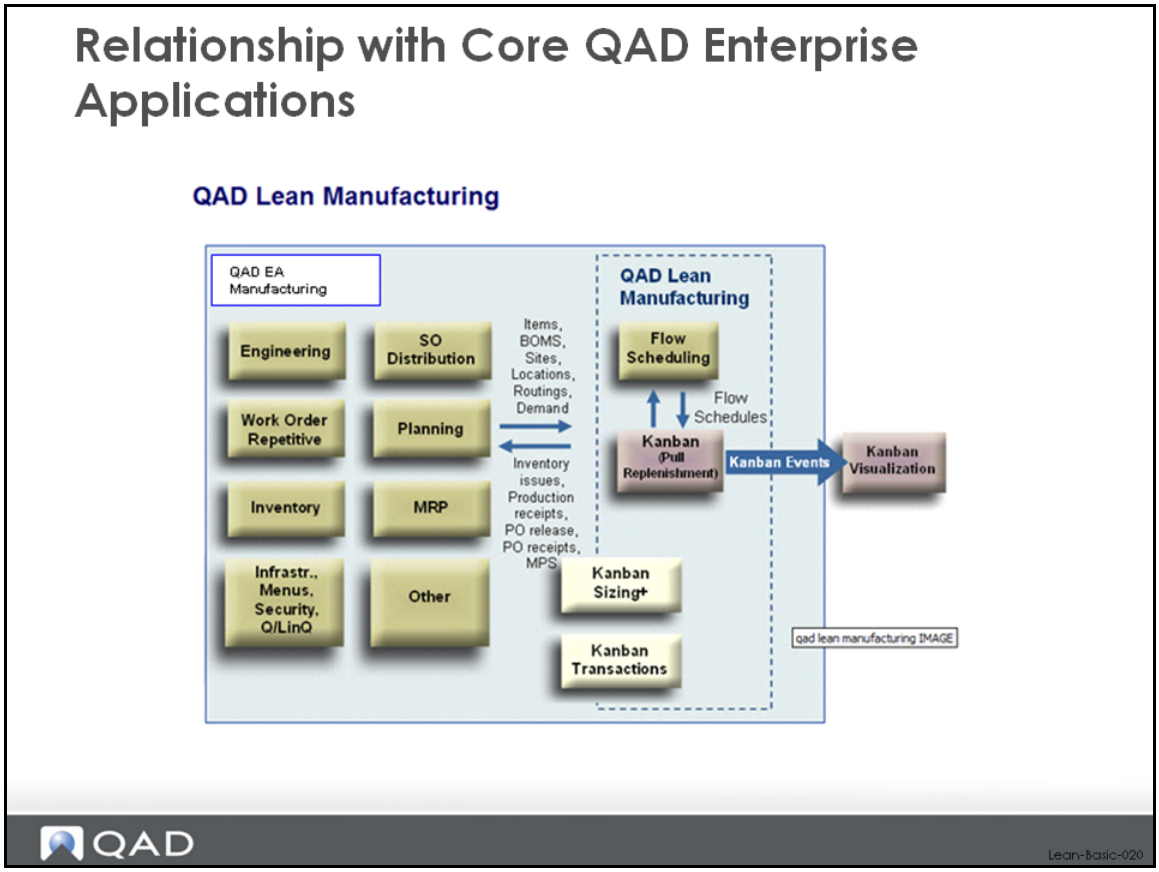
Chapter 2

# Basic Functions of QAD Lean

## Course Overview



## Relationship with Core QAD Enterprise Applications




QAD Lean Manufacturing is part of an entire suite of enterprise applications (QAD Enterprise Applications) designed to help manage manufacturing and distribution organizations and their associated supply chains more effectively. The QAD Lean Manufacturing software was developed as an “add-on module” that compliments and connects to the core functionality of the base system. The image above is a diagram of the relationship between the lean manufacturing module and the core QAD Enterprise Applications (EA), specifically showing how “pull systems” and kanban as designed in QAD Lean fit into QAD EA.

On the left side of the image above you can see the core QAD Enterprise Applications functionality which includes sales orders, distribution, planning, work orders, inventory, bills of material and routings, etc. These all *interact* with QAD Lean Manufacturing (on the right), although generally speaking the data flow is from QAD EA to QAD Lean Manufacturing to QAD Kanban Visualization (part of Supply Visualization), and not back. The QAD Lean Manufacturing functions read data from QAD EA to do basic calculations like loop sizing and leveling. The QAD Kanban visualization functions read kanban and kanban card data to produce electronic displays of kanban control boards and load assembly boards. The leveling calculations in QAD Lean can be configured to pass the leveled schedule back into EA to act as the master production schedule and drive material planning and supplier scheduling processes, and this is one major exception to the basic flow of data. The other major exception has to do with inventory record updating: kanban “fill” transactions can generate inventory receipts and backflush issues and these can be passed back to QAD EA.

This is the basic functionality provided in QAD Lean and QAD Kanban Visualization and which will be covered in detail in this course:

QAD Lean

- Value stream modeling (kanban controlled items, supermarkets, processes, kanban loops, control file defaults, process specific calendars, average demand calculations, safety stock calculations).
- Transactions and tracking (kanban card creation, management and printing; kanban status tracking (consume to fill cycle), kanban “dispatch” list, transaction history).
- Loop sizing.
- Leveling.

QAD Kanban Visualization (part of QAD Supply Visualization)

- Poller (basic connection to QAD Lean data)
- Transactions and tracking (kanban card management and printing; kanban status tracking (consume to fill cycle)).
- Visual control boards.

Relationship to QAD Enterprise Applications

The following data from QAD EA is required in order to operate QAD Lean:

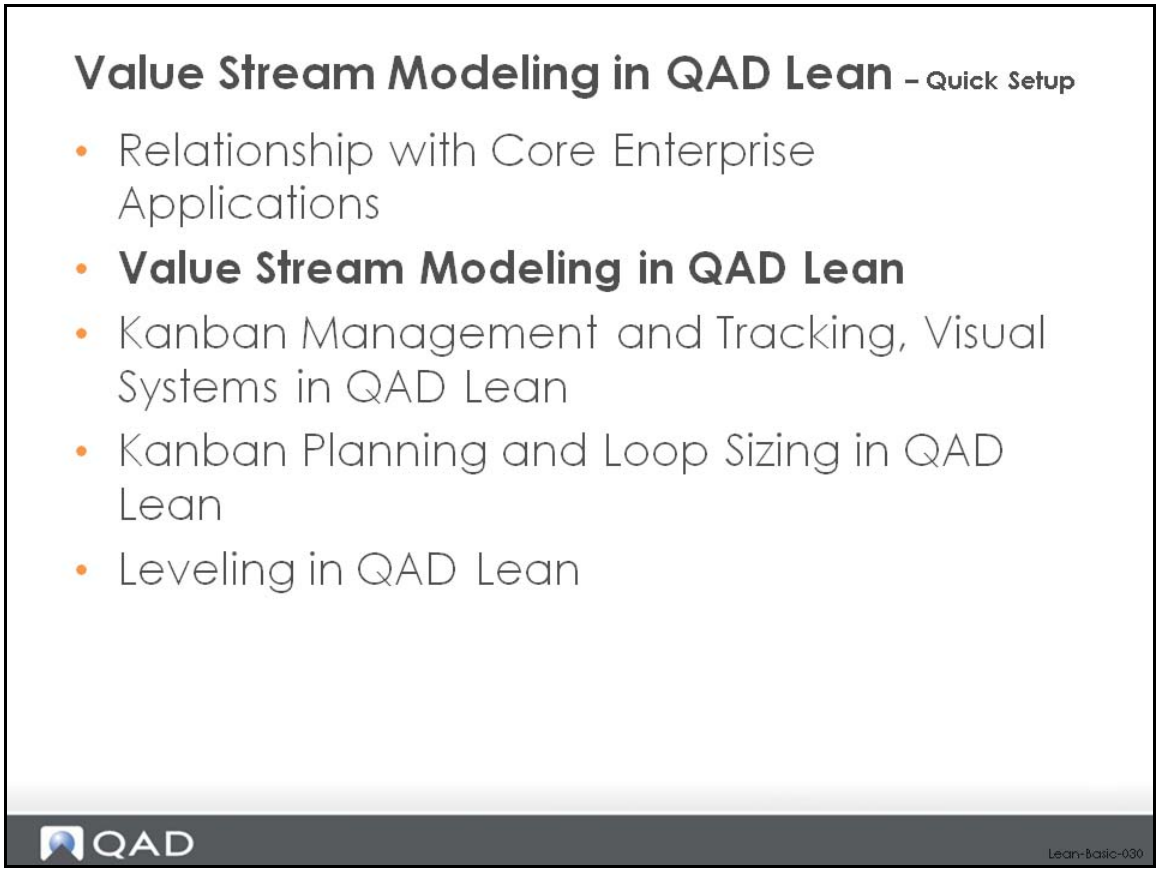
- Item master data – basic definition of each item.
- Sites – basic definition of manufacturing and supply chain sites.
- Locations – basic definition of inventory locations.
- Suppliers – basic purchasing data associated with each supplier.
- Purchase orders – purchase order data for each item that can be purchased and received.
- Calendar – default calendar data.

The following data from QAD EA is optional and can be used in, and in many case improve, QAD Lean:

- Bills of material (used for backflushing inventory when kanban cards are filled, and in the calculation of average daily demand for components).
- Routings (standard run and setup times from the routing can be used for kanban loop sizing, tracking kanban cards through subcontract operations).
- Inventory transaction history (inventory usage data can be used in calculating average daily demand as well as demand variability for safety stock calculations).
- Forecasts, customer orders, customer schedules (can be used in calculating average daily demand as well as demand variability for safety stock calculations, used in takt time calculations and leveling).
- Flow schedules (a type of master production schedule that can be used in QAD Lean as part of the leveling process).

In the next section of the class we’ll cover basic setup considerations for lean manufacturing and pull system data in QAD Lean.

## Value Stream Modeling in QAD Lean – Quick Setup



## Value Stream Modeling in QAD Lean

- Control File Settings
- Kanban Item Maintenance
- Process Maintenance
- Supplier Maintenance
- Supermarket Maintenance
- Kanban Master Maintenance/Kanban Master Copy

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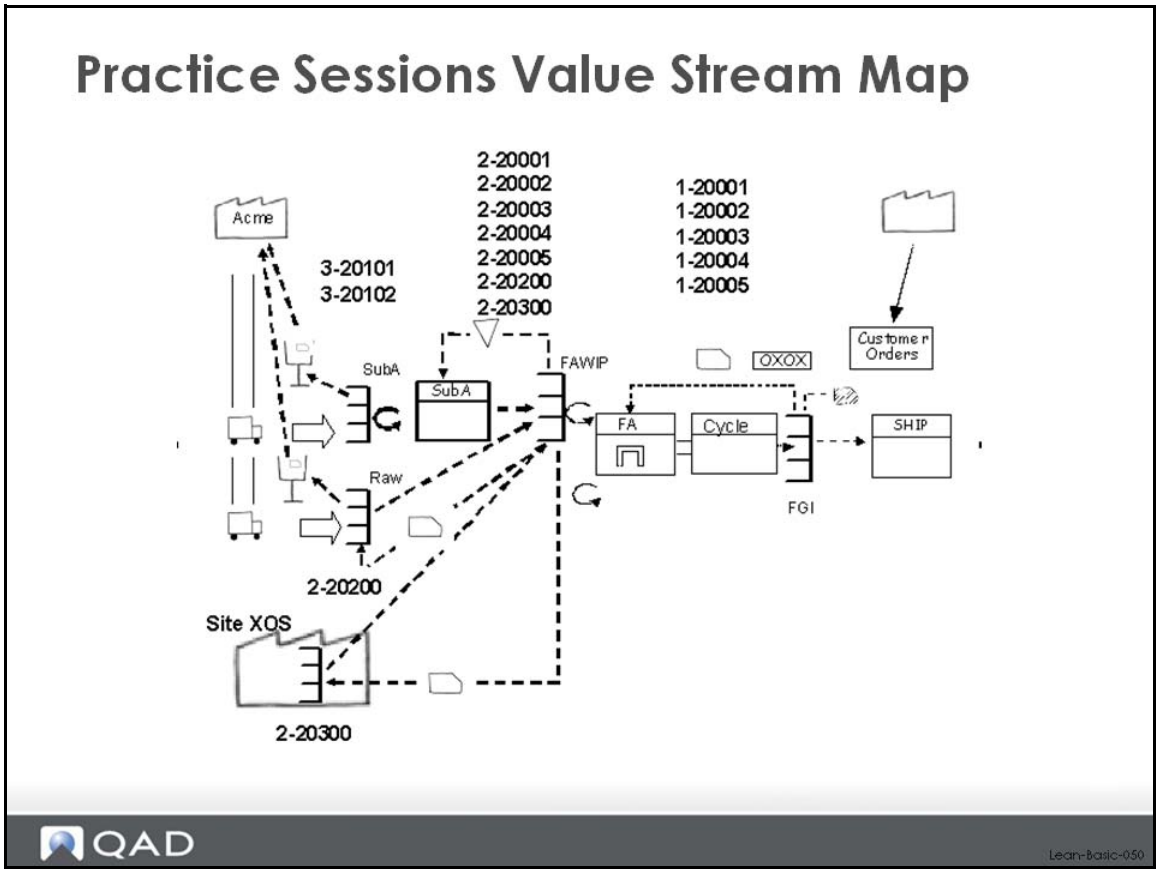
## Practice Sessions Value Stream Map




These are the basic steps required to model your value stream in the QAD Lean software, assuming that you have already generated a value stream map and created basic data in QAD EA (Normal item master setup? Sites defined? Inventory locations defined? Supplier/vendor master setup?).Typically the best way to setup a value stream in QAD Lean is to start with a value-stream map.The map can help you identify specific processes and supermarkets and structure the kanban loops appropriately for how you are or want to operate the pull and flow systems. So that you can practice setting up data in the system, we've provided you with a value stream map and it is shown in the image above. This map reflects the decisions about how to group manufacturing work centers into processes, where there should be supermarkets and where there should be FIFO lanes, and where the kanban loops are in the lean system. You will be using this value stream map to enter data into the system and demonstrate system functionality.

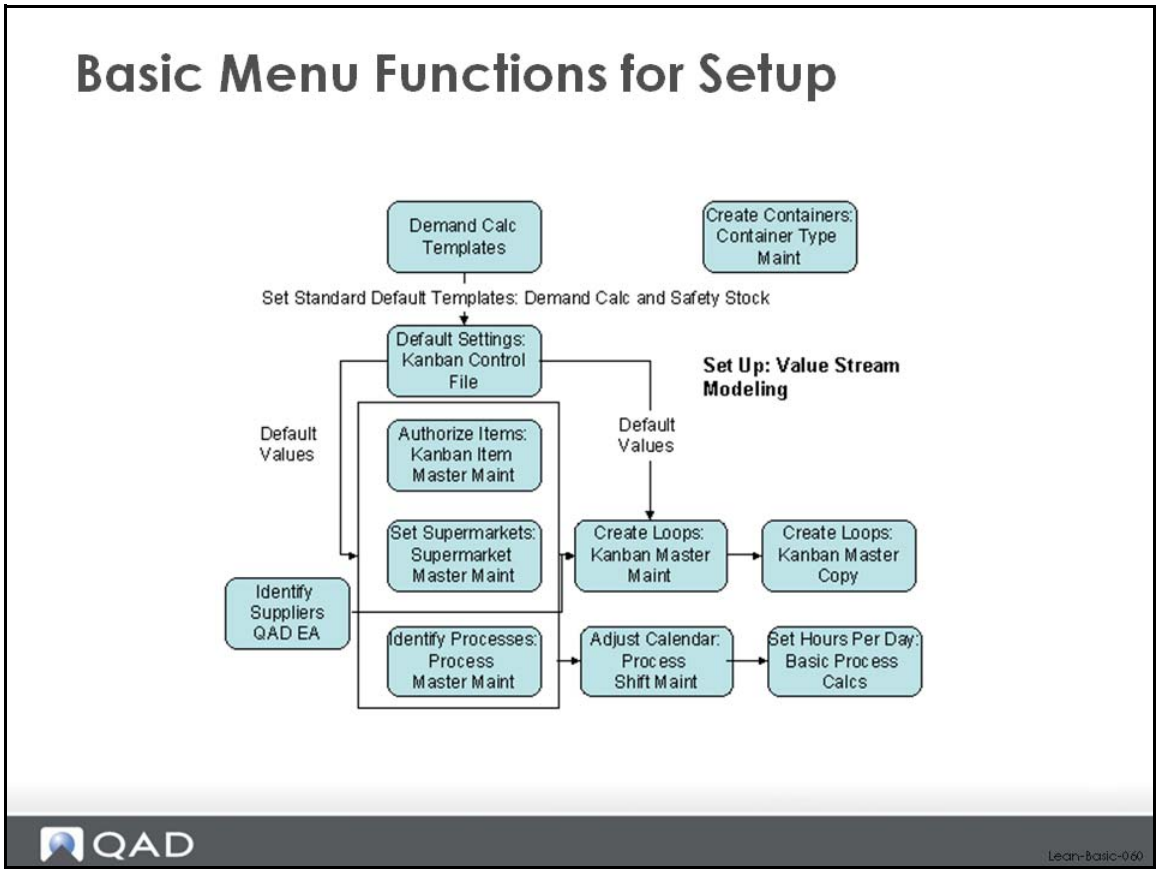
Basic setup steps include:

- Identify and set controls for default settings and default behavior
- Identify items that are "kanban controlled": Kanban Item Master Maintenance
- Identify controlled inventory points: Supermarket Maintenance
- Identify sources of supply: suppliers, processes, inventory: for manufactured parts – Kanban Process Maintenance, for purchased parts and raw material – Supplier Maintenance, for items sourced from inventory located elsewhere – Supermarket Maintenance.
- Identify kanban loops: Kanban Master Maintenance, Kanban Master Copy

As you create your value stream model in the system, there will be several key decisions that you will be asked to make regarding how you would like to operate each loop or process:

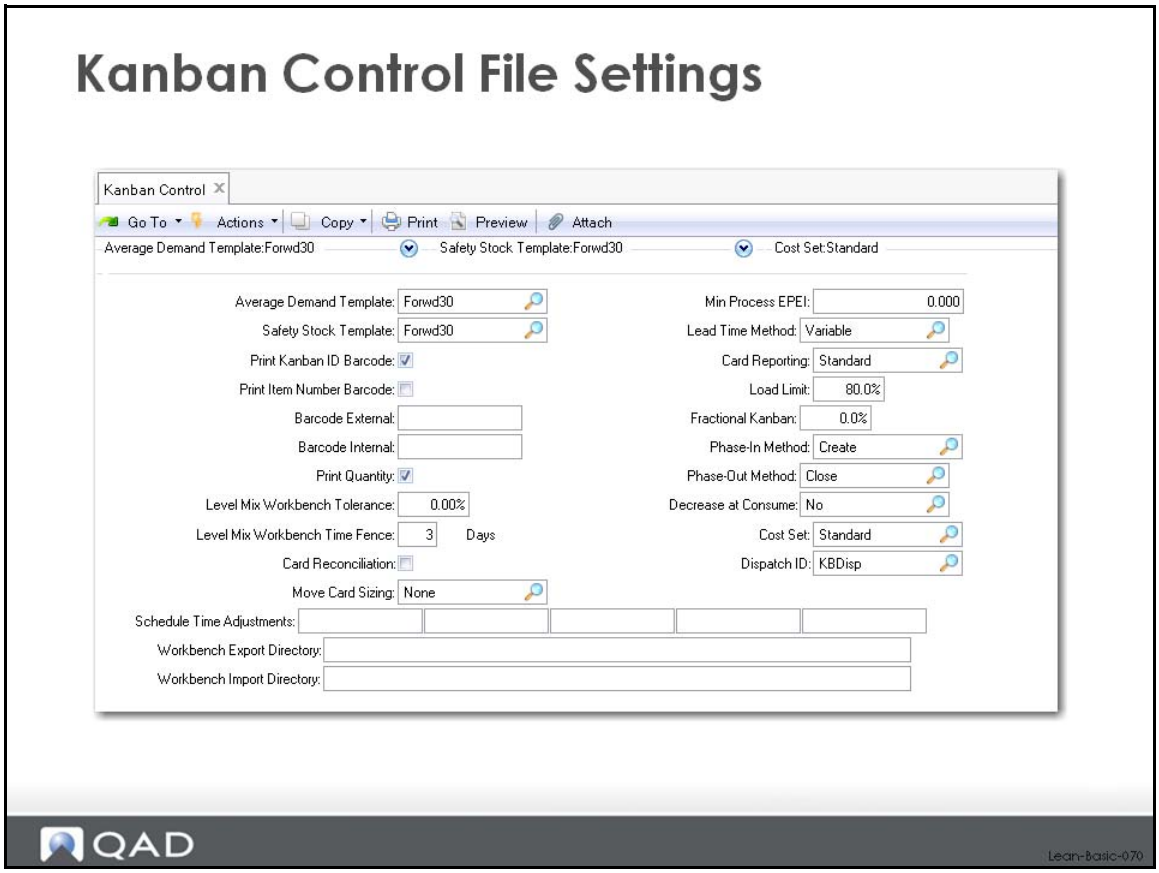
- One or Two Card System?
- Accumulators: Lot Sized? Or Fixed Interval Ordering?
- FIFO Processes or Supermarkets?

## Basic Menu Functions for Setup




This image shows the basic menu functions involved in setting up data in QAD Lean.

## Kanban Control File Settings




Default Settings: Kanban Control File.

The Kanban Control File function of the system establishes the basic default data and default behavior of the QAD Lean module. There are three distinct frames of data, covering basic kanban controls, transaction controls, and kanban event (status change) controls.

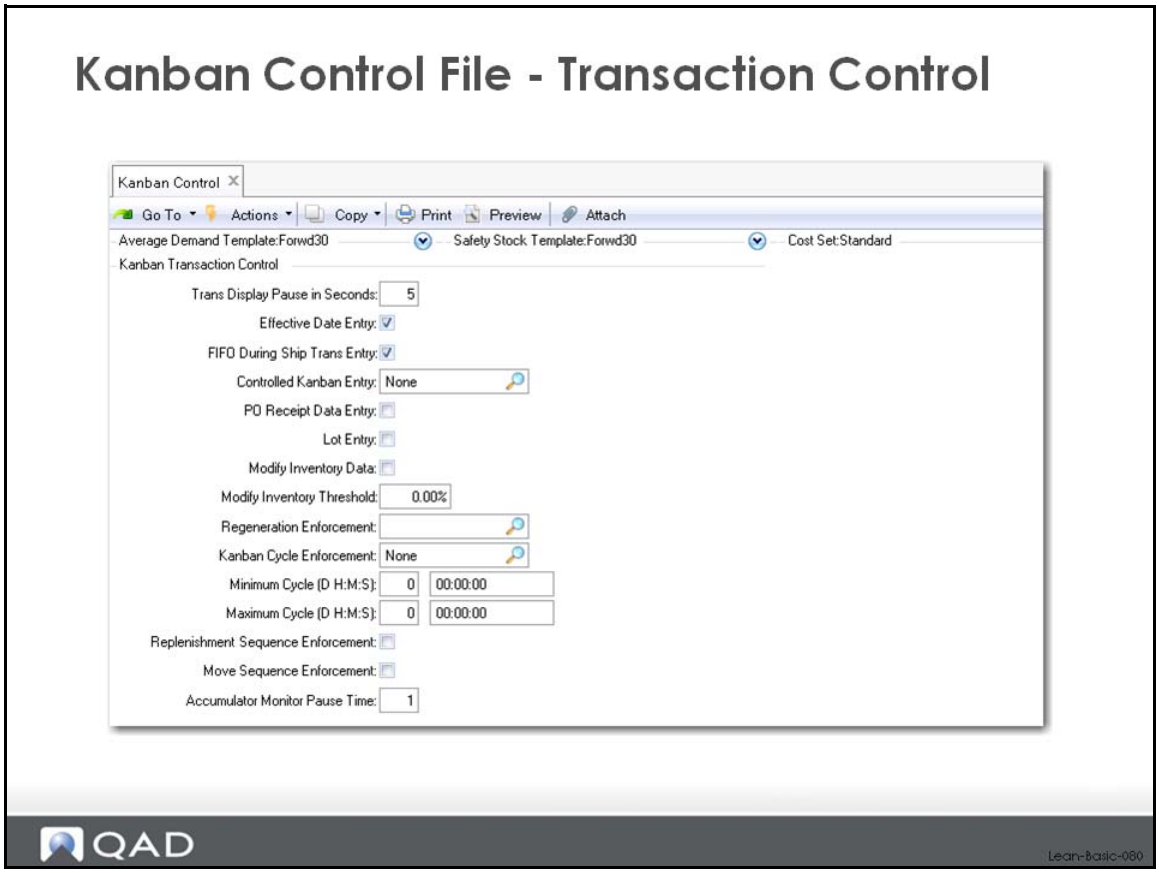
The values shown in the Kanban Control record above reflect decisions to:

- Calculate average demand and safety stocks using a template called “Fut30” (Average Demand Template, Safety Stock Template). To enter a template name here, you must first create the template using the appropriate menu function.
- Print the kanban card ID – in the form of a barcode - and the kanban quantity on the card (Print Kanban ID Barcode and Print Quantity).
- Check the leveled schedule against a tolerance of 0% (sum of the detailed schedules must exactly equal the total volume for the day because Level Mix Workbench Tolerance = 0.00%).
- Level with three days firm (Level Mix Workbench Time Fence).
- Reconcile automatically when loop sizes are changed, typically by a system card sizing calculation (Card Reconciliation).
- Calculate lead times (Lead Time Method = Variable) for manufactured parts. Can be set to “Fixed” in which case the user is responsible for stating the lead time.

- Establish a limit on loading the resource (Load Limit = 90%). The “load limit” is used in evaluating load against a process – if the load exceeds X% (the load limit) of the total available time, then the system generates an exception message.
- Phase in new cards by creating new ones (Phase-in Method = Create), phase out old cards by closing them (Phase-out Method = Close). Alternatively the Phase-in Method could be set to Activate (if inactive cards exist for the item, activate them before creating new cards), and the Phase-out Method could be set to Deactivate (immediately deactivate cards rather than closing them). These controls only apply to situations where the Card Reconciliation control has been checked.
- Require that the user confirm the cards that are being taken out of a loop (Decrease at Consume).This control only applies to situations where the Card Reconciliation control has been checked.
- Use standard cost for calculating average inventory values (Cost Set = std). Any valid cost set can be specified here.

These are generally workable values for getting started with the initial setup. Many people will probably prefer to “switch off” the automatic reconciliation process so they are in total control of their kanban cards, and come back later to adjust the values of all the settings.

## Kanban Control File - Transaction Control



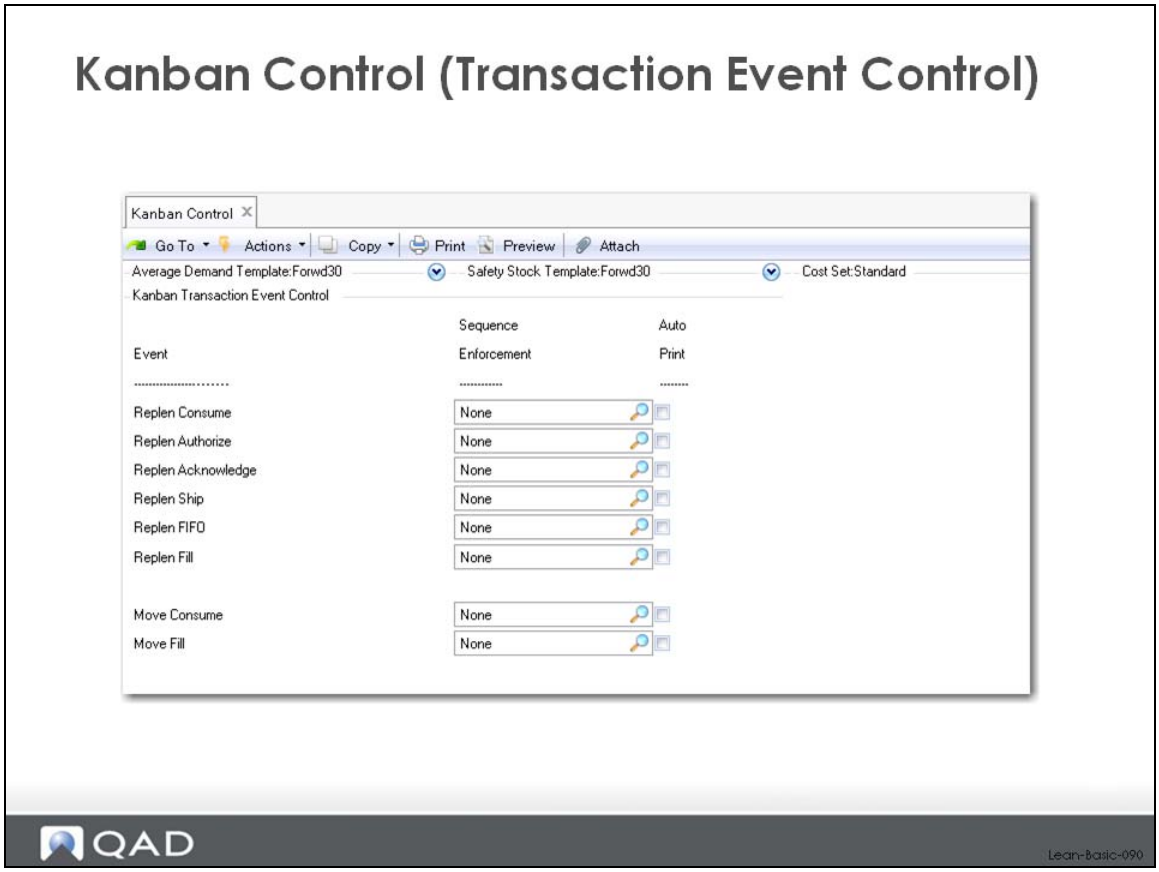

The values shown in the Kanban Transaction Control data above reflect decisions to:

- Suppress any feedback done as part of the kanban consume, authorize, acknowledge, ship or fill transactions (Trans Display Pause in Seconds = 0). This applies to situations where the transaction is being processed in a character or character-like UI format. A “character-like” UI includes bar code data collection and the associated hand-held device displays.
- Report FIFO movements using the “ship transaction” (FIFO During Ship Trans Entry). When this box is checked, the user is prompted to enter the process the parts are being shipped from. The system preloads this value, but the user can override it. If this box is unchecked, then the system simply moves the material through the FIFO lane, one FIFO process after another after another.
- Skip card regeneration (Regeneration Enforcement = None). If this is set to “Warning”, the system will generate a warning message anytime a card is being processed that needs to be regenerated. If this is set to “Error”, the system will block any transactions related to the kanban cards. The only way to process card updates for an item would require regeneration of the cards.
- Warn the user anytime the Minimum Cycle is exceeded (Kanban Cycle Enforcement). In other words if a kanban card is being processed less than some specified amount of time since the last processing, produce a message. This can be set to “None” (no message), “Warning” (warn the user but don’t block the update) and Error” (warn the user and block updating). This control is used in conjunction with the Minimum Cycle (D HH:MM:SS) field.

- Enforce the sequence (consume – authorize - acknowledge – ship – fill) for replenishment loops (Replenishment Sequence Enforcement is checked). When this control is specified, an additional frame (below) provides a way to specify which transactions are required,

These are also workable values for getting started with the initial loading of data.

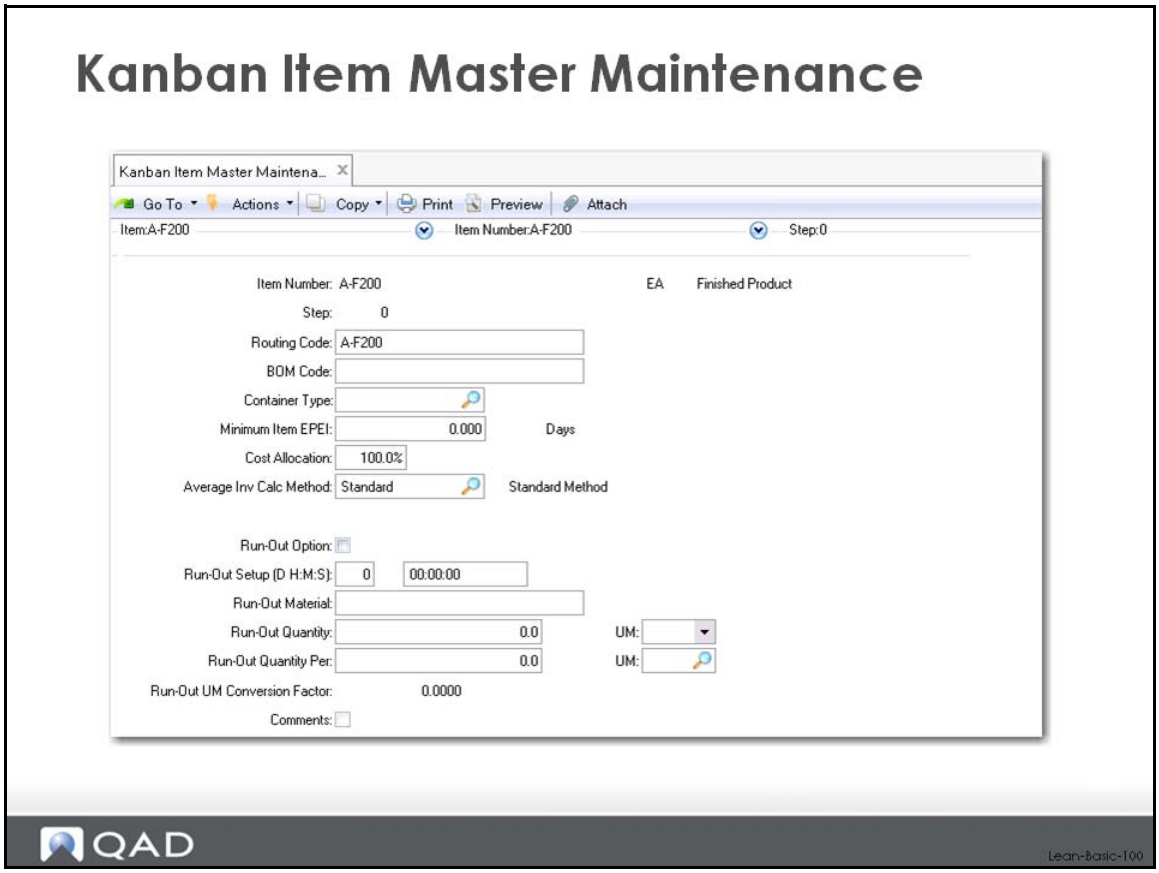
# Kanban Control (Transaction Event Control)




The settings in the Kanban Transaction Event Control Frame reflect decisions about which of the transactions (consume, authorize, acknowledge, ship/fill and fill) will enforced. The user has the choice of no enforcement (None), warn on error (Warning) or reject completely (Error). The auto print boxes allow the user to specify the point in the kanban loop where the cards are to be reprinted.

These are fairly typical values for getting started – for replenishment loops the system is enforcing the consume and fill transactions and nothing else. In other words, a user cannot report a kanban empty (consume) unless it is full. In the case of the fill transaction, the system will verify that the card is empty (consumed, authorized, acknowledged, ship, FIFO). It is not enforcing any sequence control on the authorize, acknowledge, ship or FIFO transactions.

## Kanban Item Master Maintenance




The Kanban Item Master Maintenance function of the system authorizes items for kanban control. The item must already exist in the Item Master file of the core system (in QAD EA).

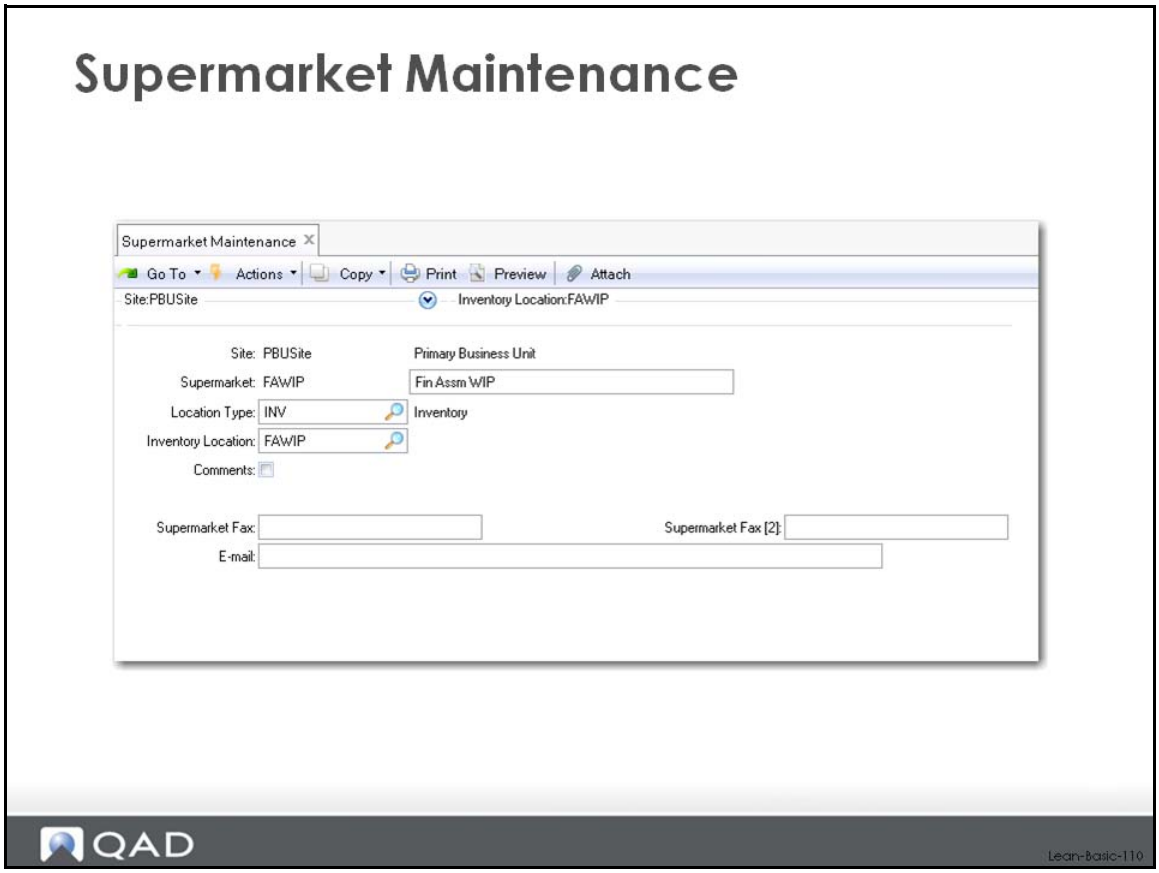
The only required data in the Kanban Item Master Maintenance screen is the item number and the step number. The item number is the part number that you use to identify something that you make or buy. The “step number” is a loop identifier that normally would be set to 0 (zero). Step number may have other values, and typically these would be set as a way to have multiple loops for the same item, either one feeding another, or where there are two sources for the item. In the case of having one loop feeding another, this might happen when there are two distinct processes each running at a different rate or with different setups and where the second (downstream) process is not treated as a FIFO lane. Here you might identify one loop as “loop 1” and the other as “loop 2”.

The BOM and Routing Codes allow you to deviate from the normal bill of material and routing. Leave them blank and the system defaults to the standard BOM and standard routing as defined in QAD EA.

The Minimum Item EPE I is a kind of “tool cycle” based production interval and we will discuss it and its use when we review the Kanban Workbench.

Container type will be used in future material route and space calculations in the system. Cost allocation and Ave Inv Calc method control the Ave Inv calculations in the workbench. Run Out fields are reference only.

## Supermarket Maintenance




The Supermarket Maintenance function of the system establishes the controlled inventory points in the value stream, as well as the default inventory location associated with each supermarket.

In creating your value stream model you need to identify any supermarkets, which as we saw before are points in the value stream where you want to maintain a strictly limited and controlled amount of inventory, perhaps because you cannot achieve continuous flow from one process to the next.

The only required data in the Supermarket Maintenance screen is the site and the supermarket name. You may name your supermarkets anything you chose with the limits of the eight character name.

Supermarkets can be:

- Destination or source
- Inventory or work in process (WIP)

In most situations, a supermarket will be the destination for a manufacturing process or for inventory coming from a supplier, or for inventory coming from another supermarket as in the case of a transfer of material from a major warehouse to a factory point of use location. In this last situation, there would be a destination supermarket (the point of use) as well as a source supermarket (the major warehouse). This would be useful in situations where the inventory needs

to be stored in two places because there's a physical distance between the two supermarkets or when you actually have material being pulled for several different source processes and it's a common component or a common sub-assembly that is used in multiple places.

You can identify supermarkets as being either inventory (INV) or work in process (WIP) supermarkets. You should identify a supermarket as an inventory supermarket (INV) if the material stored in the supermarket is part of the on-hand balance and is inventory reported as part of your financial statements. In other words if you want detailed inventory tracking across the entire value stream with an on hand balance for each purchased part, fabrication, mix, blend, weldment, subassembly, etc., set your supermarkets to INV. With parameters set properly in the kanban loops, the system will maintain the on-hand inventory balances based on the kanban transactions. In other words, the kanban fill transaction will receive material into stock and backflush any stocked components to keep the inventory balances up to date.

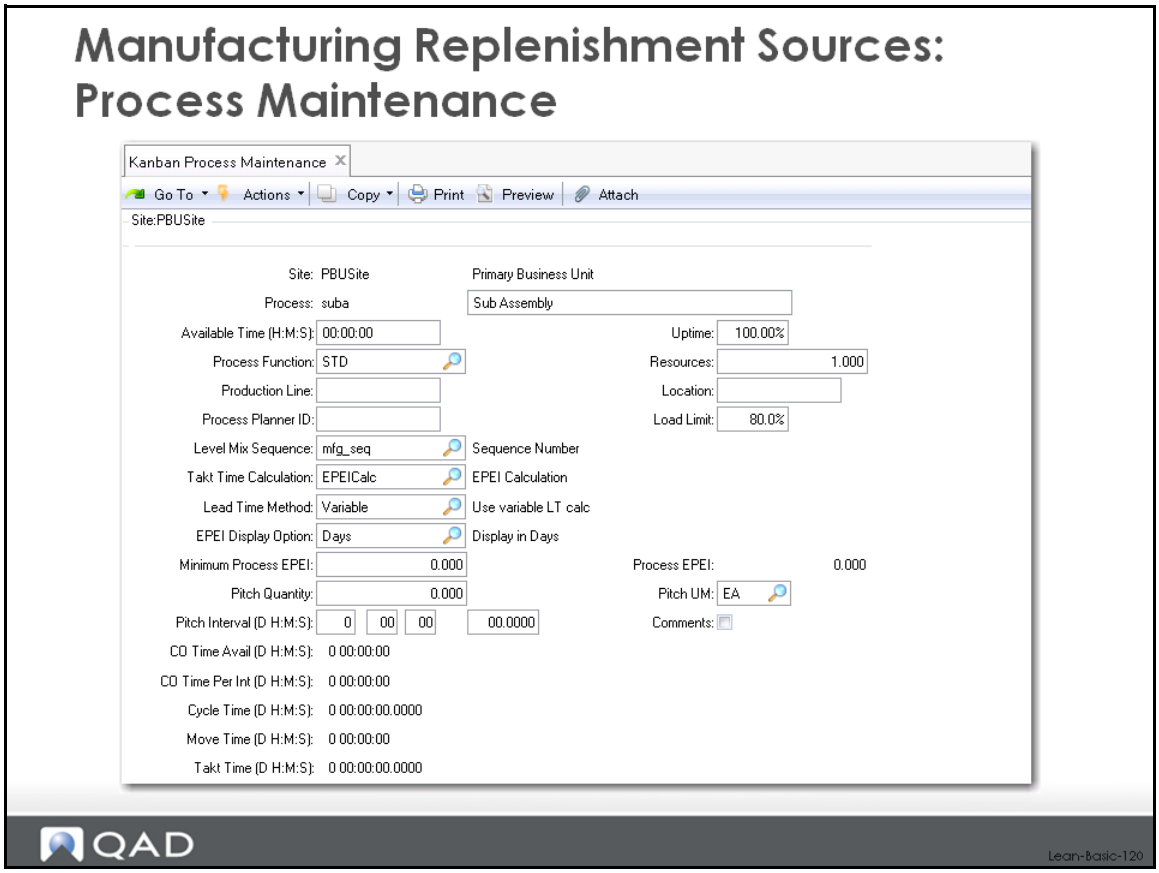
You should identify a supermarket as work in process (WIP) anytime you choose not to track inventory balances for the item or items stored there. One way to use the system, for example, would be to identify every supermarket except for the one storing finished goods as a WIP supermarket. In this scenario, material could be received from the supplier (fill kanban against a specific purchase order) and the material would be transacted into stock and then immediately issued to WIP. Regardless of how many downstream loops it passed through in its value stream it would not be recorded as on-hand inventory. Only when it reached finished goods would it be received into stock.

Here’s one situation where you might want to code most of your supermarkets as INV with some selective WIP supermarkets. If you have a specific part that you produce where it is not possible to flow the part through all of the processes associated with its routing (operations 10 and 20 operate to a significantly different rate or with a very different setup time from operations 30 – 50), you can set up a supermarket between operations 20 and 30 to hold some “semi-processed” stock. This is not finished inventory – it has only been processed through operation 20 and consequently is work in process. Use the WIP supermarket to control it even though it is somewhat “off the books”.

Like most of the other maintenance displays in the system, the Supermarket Maintenance function provides a way to attach “free form” comments to the record being maintained. Check the Comments checkbox and the system will open a frame where you can enter any amount of text that you would like to associate with the supermarket.

The Supermarket Fax, Supermarket Fax [2] and Email fields allow you to record fax numbers and an email address that can be used for directing dispatching information.

## Manufacturing Replenishment Sources: Process Maintenance




The next step in value stream modeling is to identify the distinct processes that make up the value stream. A process will be a cell, line, machine, work center, group of work centers that perform work and operate as a single synchronized unit. A process may do a single operation from the routing or a group of operations that are ideally done one after the other after the other without stop and with a one piece flow. In other words, if you run a batch in one cell and then pass the batch to the next cell for processing, then you should probably identify each cell as a separate process. However if you move material synchronously from one machine or work center to the next one at a time, then it probably makes sense to have a single process that covers both machines/work centers.

Process Maintenance has two parts, one of which is mandatory, the other optional.

The required step in process maintenance is to identify essential process data. The optional step has to do with setting up the relationship between the process and the items produced there.

Basic process data is added and maintained in the screen: Kanban Process Maintenance.

To add a process the Kanban Process Maintenance screen requires a valid site and the process name.

These are the major fields used to describe a process (reading across and then down), and which are used to control key lean functions:

*Available time (H:M:S).* This is the normal amount of time worked in an “average” day in this process. The system will calculate this for you, but you can load it directly and/or maintain it here. The “Basic Process Calculations” function of QAD Lean will calculate available time based on any calendar data you’ve entered, either for the site or for the process itself.

*Uptime.* The percentage of time that the process is actually up and running. Use with the available time to determine available hours in each day. Used in the loop sizing calculations.

*Process function.* This tells the system whether a process is a primary process (PACE or STD) or a FIFO process. A primary process is the first process in a kanban loop and it will receive the authorization signal when more of an item needs to be produced. If the primary process acts as a pacemaker for the entire value stream then it is identified through the function code “PACE”. Otherwise a primary process will be coded “STD”. A FIFO process is downstream of the primary process and is part of a FIFO lane. Work moves out of a primary process and is processed on a first-in, first-out basis in the subsequent processes until it reaches the supermarket (or the customer). FIFO processes receive work authorizations indirectly – work appears and has to be worked on, or a transaction indicates that work has moved out of the primary process and in the FIFO lane itself.

*Resources.* Number of identical (interchangeable) resources in this process. Typically used to specify the number of identical machines in a cell.

*Production Line.* This field provides a way to map processes in QAD Lean to production lines in QAD Flow Scheduling. In order to use the leveled schedule created by QAD Lean in the Level Mix Workbench you must save it as a Flow Schedule and this data required to integrate these two functions.

*Location.* This field identifies the inventory location from which component parts should be backflushed. The components may be backflushed from some other location, based on settings you’ve made in the inventory location system and based on overrides specified on the kanban transaction that triggers the backflush.

*Process Planner ID.* This field identifies the individual responsible for this process.

*Load Limit.* The “load limit” is used in evaluating load against a process – if the load exceeds X% (the load limit) of the total available time, then the system generates an exception message.

*Level Mix Sequence.* This field indicates whether there is a particular sequencing requirement that should be considered by the leveling logic in the system. Currently there are three values: *mfg_seq* which can be used to handle “product wheel” kinds of sequencing, *op_asc* which specifies that the order of items in the leveled schedule is ascending by the number of operators needed to meet takt time, *op_desc* which specifies that the order of the items in the leveled schedule is descending by the number of operators needed to meet takt time.

*Takt Time Calculation.* This field references the calculation source for the takt time data for this process. Takt time in QAD Lean is typically calculated:

- In the Level Mix Workbench. The Level Mix Workbench does the primary leveling in the system.
- In the EPE Interval calculation in the Kanban Workbench. The Kanban Workbench is the primary function for loop sizing in the system.
- In the Basic Process Calculations of the system. This is a standalone function that calculates essential lean data.

*Lead Time Method.* This field has two values:

- Variable – the system will calculate the replenishment time for the item based on the other parts and the run and setup standards. Initially it may be helpful to use this setting, and compare the result of the system's calculation to the lead time you were planning to use on the item. It may also be helpful to use this setting in situations where you work less than 24 hours in a day, since the system can automatically convert time data using available hours per day to the elapsed lead time. More on this subject later.
- Fixed – the system does not calculated lead times. The user specifies the replenishment time. The system will convert the fixed replenishment time, along with FIFO days and the fixed ordering interval, to the elapsed replenishment lead time in decimal days.

*EPE Interval Display Option.* The EPE Interval is the smallest possible production interval based on volumes, standard run times, setup times, and available hours. For a lean assembly cell, the EPE I might be 2 hours (0.083 days). For a much less lean fabrication or machining process, the EPE I might be 120 hours (5 days or 1 week). You can choose how you would like the EPE Interval to be expressed: in months, weeks, days, hours, minutes, seconds. The default value is "days" and this is what most companies prefer, although if the EPE I is substantially smaller or larger than a day, you may want to consider one of the other settings.

*Minimum Process EPE I.* The Minimum Process EPE I overrides the calculated EPE Interval in the loop sizing calculations in the system. For example, if the calculated EPE I is 0.083 days (about 2 hours) but you don't want to run any item more frequently than daily, set the Minimum Process EPE I to 1. This will set the order quantity to the equivalent of a day's usage, and size the kanban loop appropriately. If you later have a change in circumstances and the calculated EPE I changes, the system will evaluate whether the Minimum is still greater than the calculated value. If it is, then the Minimum Process EPE I will be used in the loop sizing calculation. If it isn't then the system will use the calculated EPE Interval in the calculation.

*Process EPE I.* The calculated EPE Interval.

*Pitch Quantity.* The system calculates the common packaging multiple for all parts produced in a given pacemaker process. For example, if one process produces two different products, one in trays of 6, another in trays of 9, the pitch quantity will be 18. A time increment equal to 3 trays of 6 or 2 trays of 9 would be set by the system.

*Pitch Unit of Measure.* The unit of measure used in calculating the pitch quantity.

*Pitch Quantity.* The calculated pitch.

*CO Time Available.* Calculated value shown to allow the user to validate the sizing calculations, the system determines how much time is required each day, on average, to produce that day's sales for each item (Cycle Time below). This is subtracted from the time available in the day (timer per day adjusted by the number of resources, uptime) etc. to get changeover available in a normal (average) day.

*CO Time Per Interval.* Calculated value to allow the user to validate sizing calculation and EPE Interval, the CO Time Per Period divided by the CO Time Available each day is the EPE Interval in days. CO Time Per Interval is the total setup time across all items produced in this cell, line, work center, etc.

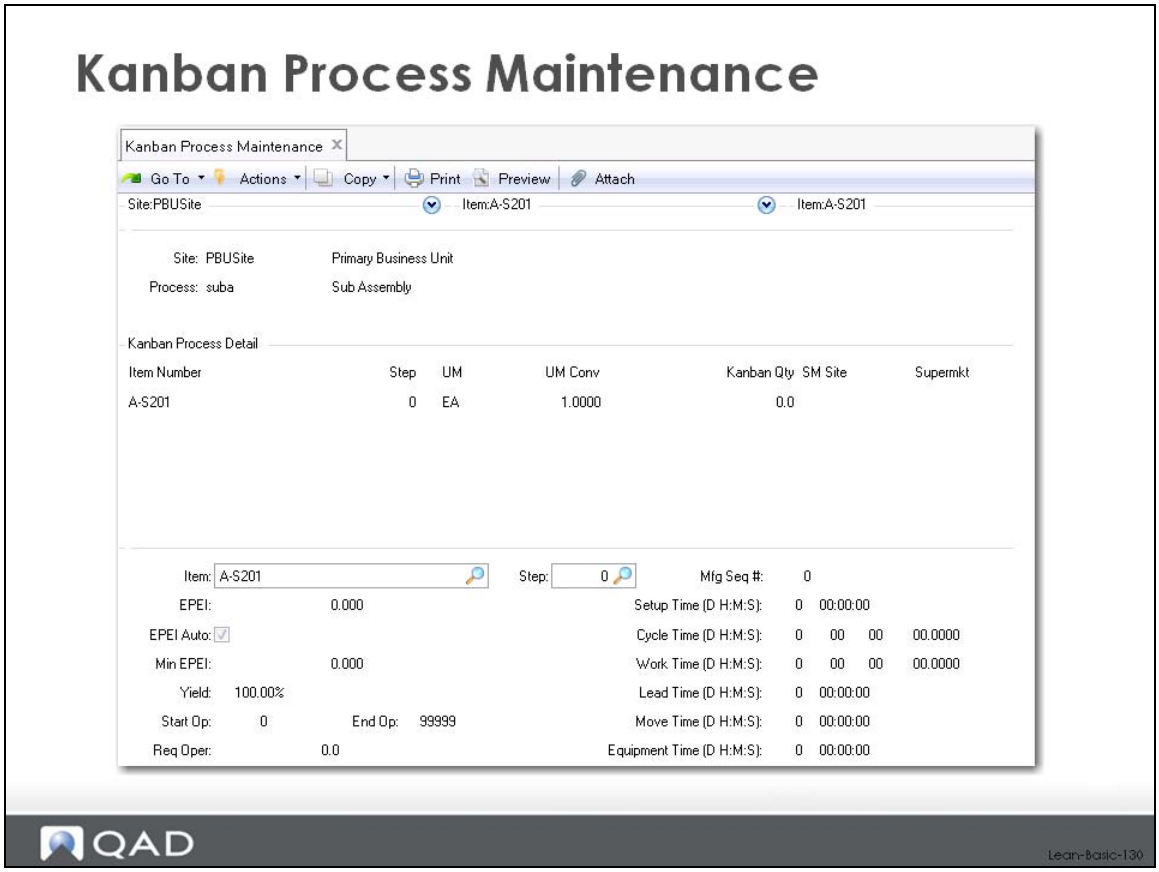
*Cycle Time.* Calculated value shown to allow the user to validate the sizing calculations, the Cycle Time is the amount of time required each day, on average, to produce that day's sales for each item.

*Move Time.* Unused.

*Takt Time.* The calculated takt time for the process: available time divided by total part volume.

Additional process data is added and maintained in the second screen of Kanban Process Maintenance.

# Kanban Process Maintenance




This maintenance screen allows you to maintain the individual items produced in the process along with key manufacturing data for each of them. You are not required to create and maintain this data since it will be done automatically for you when you create kanban loops. However, there are several good reasons for using this function:

1. Identifying the items produced in an area is the responsibility of one person while loop maintenance and kanban planning is someone else's. In this case, the manufacturing or industrial engineer responsible for the process data would maintain the data in this screen and a kanban planner would maintain basic loop data.

2. You will be bringing data from the routing into the lean system to load or update the cycle time, work content and/or setup time data, and the process does not cover all the operations in the routing. In order to bring routing data across, you must tell the system the correct starting and ending operations (Start Op, End Op) so that it picks up those and only that range of operations. The routing data will be transferred to the cycle time, work content and setup time fields stored here.

3. You don't want to use routing data and want to maintain cycle time, work content and setup time directly. There are functions for a kind of simplified maintenance to update these fields, but it is as easy to maintain the data using this screen.

In the middle frame of the screen shown above you can see a list of items already associated with the process. You can scroll up and down through this list to select an item to maintain.

After moving to a specific item and step and hitting the forward arrow, the system will open the lower frame and load the item number and step you selected. If you hit the forward arrow again the system will give you access to the detailed data in the rest of the frame. If you clear the item number or step and specify a new one, the system will add a new record and give you access to the detailed data. In each case the detail data includes (reading down the columns):

*EPEI.* The EPE I being used for this item and step. If the EPE I Auto box (below) is checked, this EPEI will be the calculated EPE I for the process. If the box is unchecked then you can override the value here and it will be used as the interval for the item.

*EPEI Auto.* Indicates whether you want the EPE Interval for this item to be based on the normal calculated production interval for the process, or whether you want to override the calculated interval.

*Yield% .* Yield from this and all subsequent processes in the loop for this item and step.

*Start Op.* Manufacturing steps for this item and step correspond to those in the routing starting at this operation. This field indicates which operations to consider when retrieving standards data (standard run time and standard setup time) for this item and step.

*End Op.* Manufacturing steps for this item and step correspond to those in the routing ending with this operation.This field indicates which operations to consider when retrieving standards data (standard run time and standard setup time) for this item and step.

*Req Oper.* Number of operators required to meet takt time (Work Content divided by Takt Time)

*Mfg_Seq.* – product wheel sequence for this part (if needed), this field is used in the sequencing of items from the leveling process in the system, and is also shown on the dispatch list to provide a visual indicator of sequencing considerations.

*Setup Time.* Setup time for the item.

*Cycle Time.* Engineered cycle time for the item and operations specified above.

*Work Time.* Total work content for the item across all the operations specified above.

*Lead Time.* Not used.

*Move Time.* Not used.

*Equip Time.* Not used.

The time and yield data can be populated from the detailed routing using the Process Item Operation Rollup program of the system.

## Supplier Replenishment Sources: Supplier Maintenance

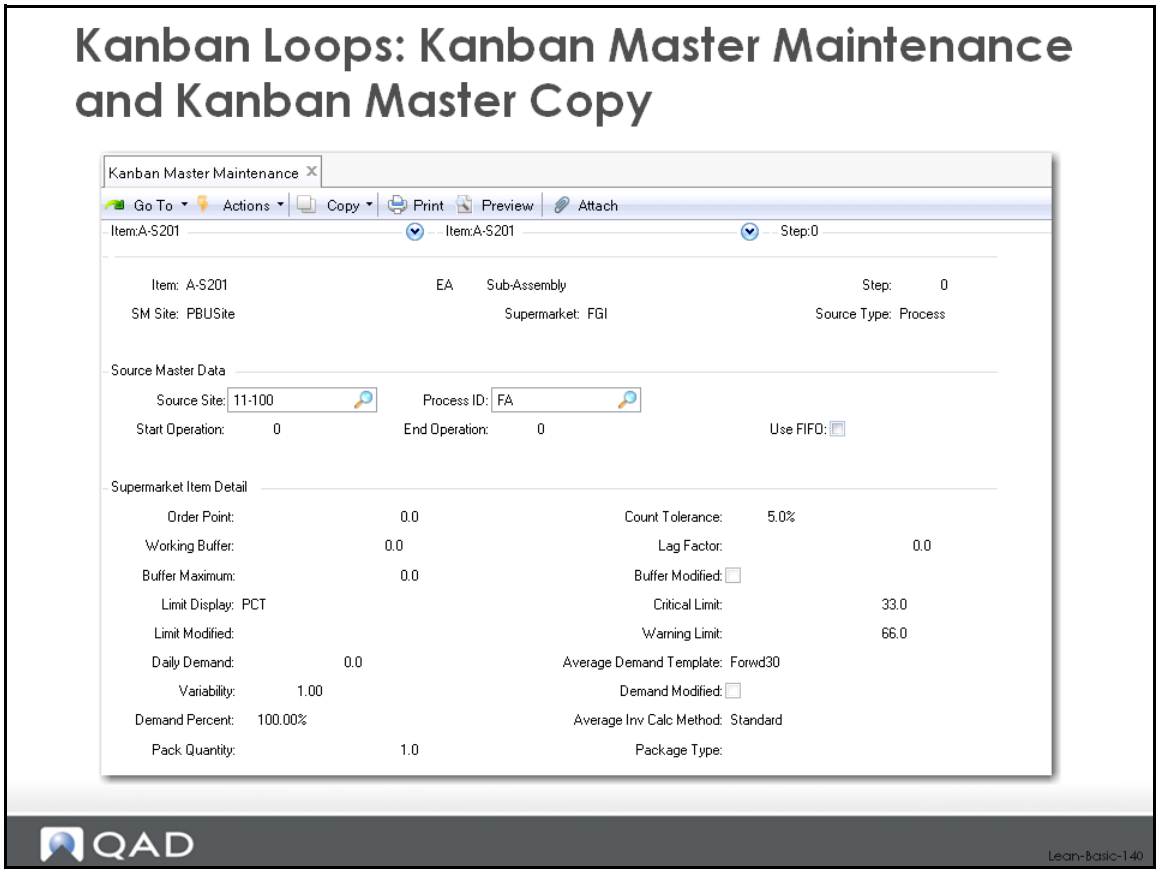
Of course, not all your inventory will come from internal processes. Raw material and purchased parts will come from outside suppliers, and these too must be modeled in the system. In addition, before you can actually receive purchased parts and raw material through the kanban system, you will need to create a purchase order, blanket order, or supplier schedule in the purchasing system.

Create suppliers in QAD Enterprise Applications using the maintenance functions there. If you can set up the purchase order, blanket order or supplier schedule before you actually create the loop in QAD Lean, then the loop record can reference that purchasing authorization so that your receiving people won't have to specify the purchase order when any kanbans are subsequently filled.

## Inventory Replenishment Sources: Supermarket Maintenance

As noted above, if you have "supermarket to supermarket" loops, you will need to create a supermarket record for the source. You've probably already done this since it's likely that same supermarket is a destination for some other loops. Use the supermarket maintenance function described above if you need to add or change supermarket data.

## Kanban Loops: Kanban Master Maintenance and Kanban Master Copy




After identifying items that will be kanban controlled, the supermarkets that items can be stored in, and the sources for replenishment, it's time to create the kanban loops themselves. This is done using either the Kanban Master Maintenance or Kanban Master Copy function of the system. The initial screen for Kanban Master Maintenance is shown above:

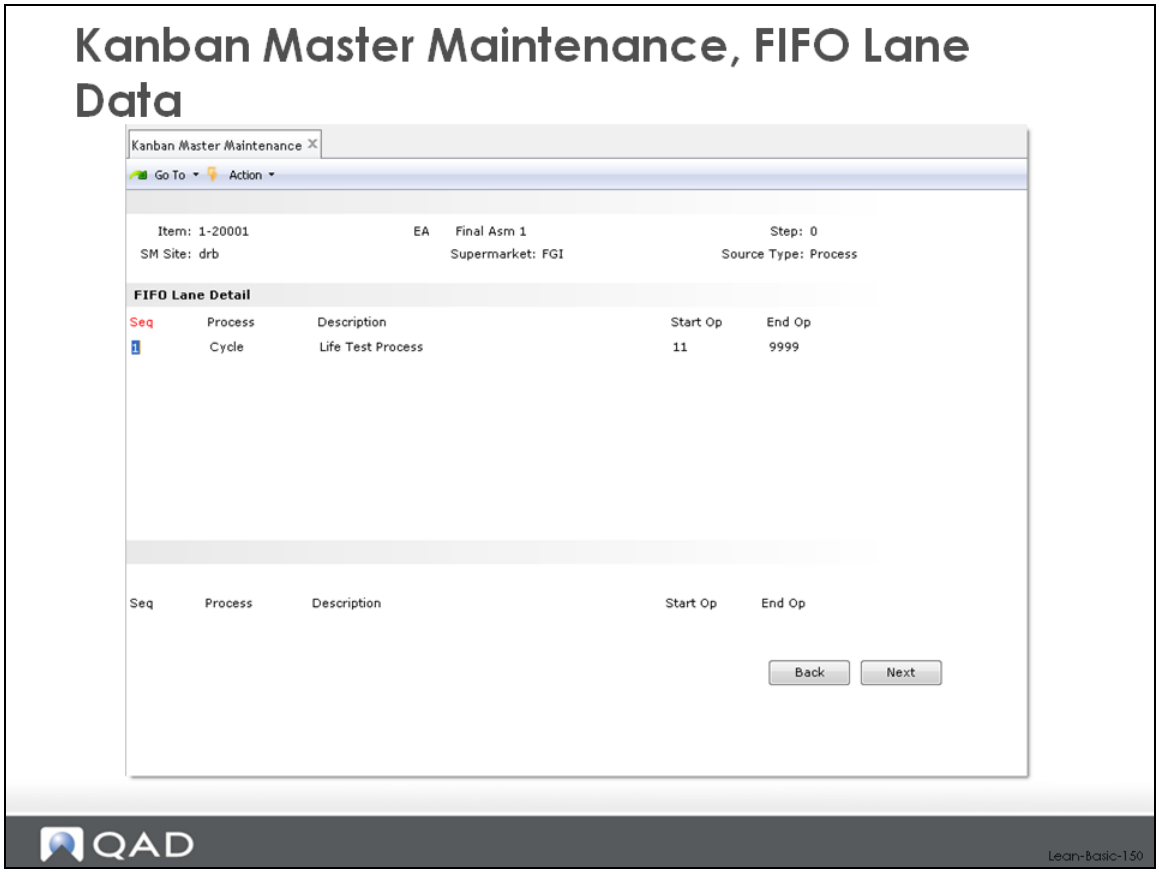
Most of the data that is required for a kanban loop (often called the "plan for every part") can be loaded from workbenches or using simplified maintenance driven by browse functionality. You could go through and create or maintain that data using this transaction, but there are nine individual screens to go through. So we'll look at a way to load a minimal amount of loop data for a representative item, copy that to other similar items, and then use the workbench/simplified maintenance screens to add or adjust data as needed.

Here is the data that you should be prepared to enter in the initial load of kanban loops:

1. To uniquely define the kanban loop
   - a. Item and step
   - b. Supermarket site and supermarket

2. Source data
   a. Source site and process, starting and ending operations, FIFO lane identifier, or
   b. Supplier ID, purchase order and line item (actually the purchase order and line item are optional, but it is good practice to enter them in loop maintenance rather than waiting for the receipt of the product and entering the data as part of the kanban fill), or
   c. Supermarket site and source supermarket.
3. FIFO data
4. Basic kanban data
   a. One or two card kanban loop.
   b. Number of kanban cards (if you want to operate the kanban system without kanban sizing functionality).
   c. Quantity in a kanban.
   d. Accumulator type (default is “quantity”, if you have loops that will operate to a fixed time interval or fixed schedule rather than to a fixed quantity.
   e. Time accumulator data (next date and time, hours per interval, fixed schedule)
   f. Transaction control parameters – behavior of kanban transactions. Most default from the control record but several must be specified here.

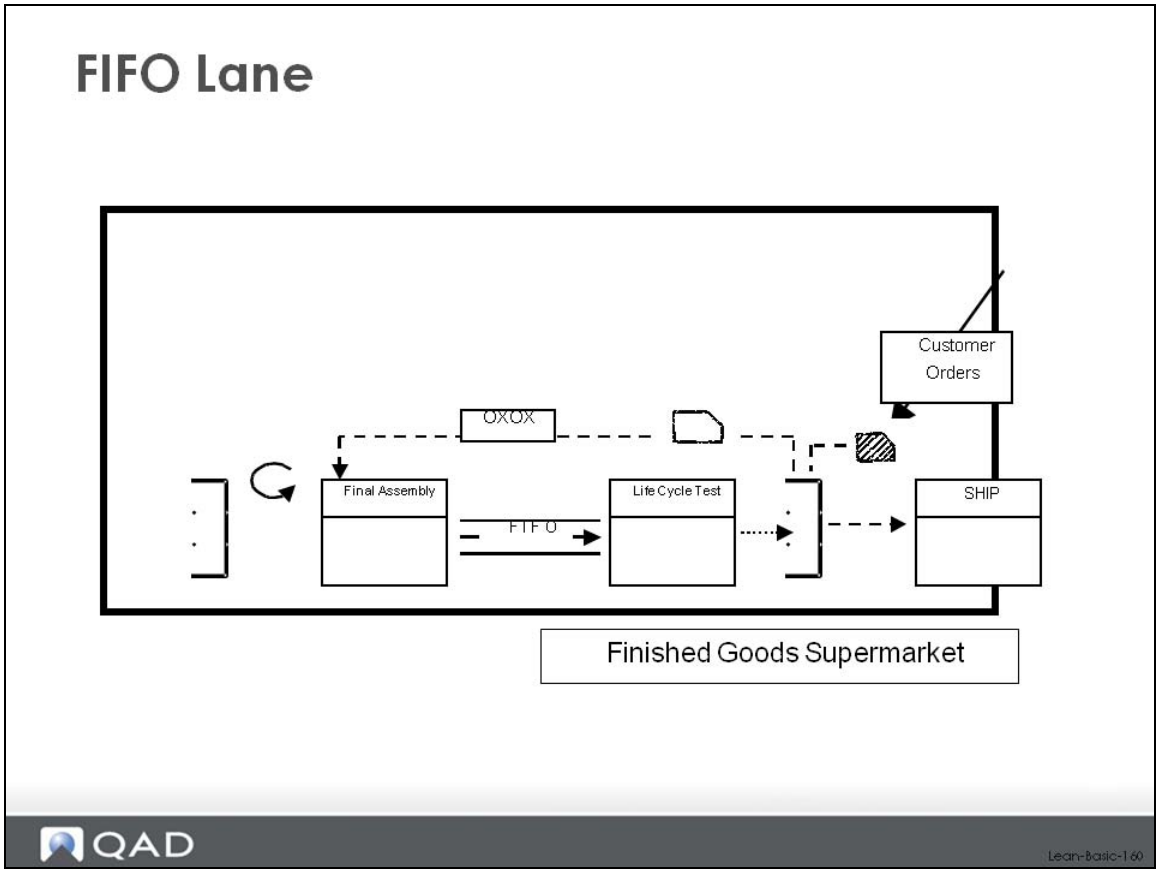
## Kanban Master Maintenance, FIFO Lane Data




The FIFO lane data for a kanban loop that includes one or more FIFO processes is typically defined here by checking the “Use FIFO” box. The system will return the following maintenance frames:

This screen shows the FIFO information associated with the current loop, a single FIFO process “Life Test Process”, that corresponds to operations 11 through 9999 of the routing. The routing data normally is loaded as start op = 0 and end op = 9999 and you must change them in the Process Maintenance: Process Item Detail Maintenance function of the system. To add a process to the FIFO lane, selecting an existing process and click on next. Clear the “Seq” field, or specify a new sequence number yourself and the system will add a process to the FIFO lane.

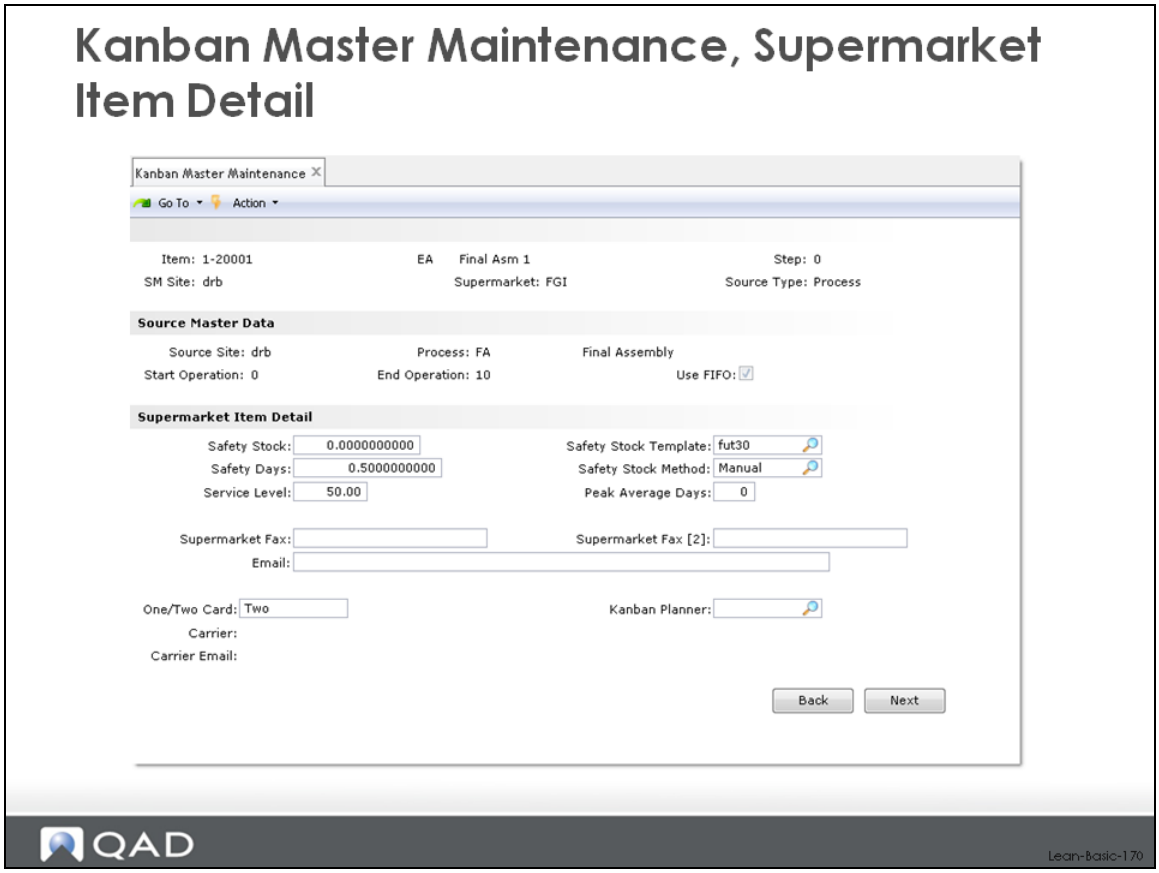
## FIFO Lane




The previous data models the following loop above.

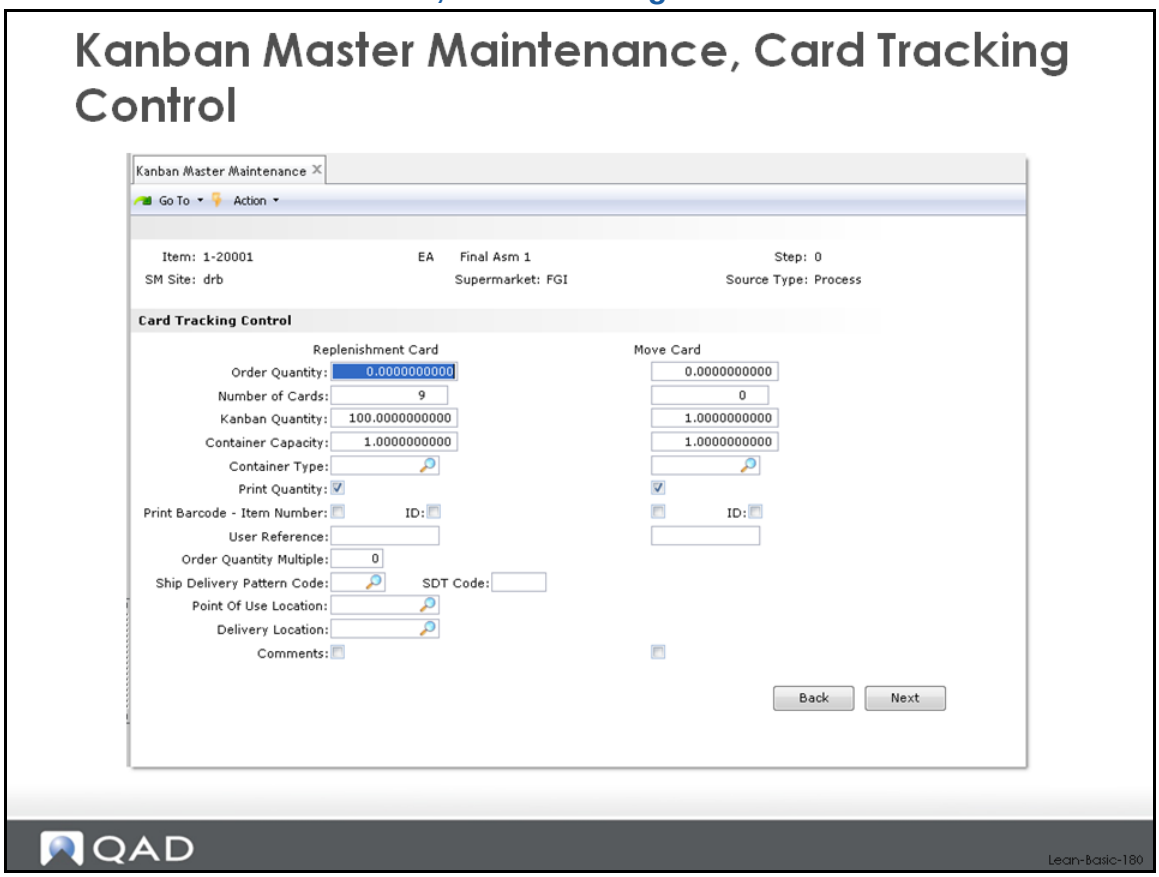
Another thing that should specify for each of your replenishment loops is whether they operate as a one card loop (a single set of cards handles movement in and movement out of the supermarket) or a two card loop (replenishment cards move material into the supermarket, withdrawal cards move material out of the supermarket). The diagram of the loop above is a two card loop and to model this in QAD Lean you would use the following control:

## Kanban Master Maintenance, Supermarket Item Detail

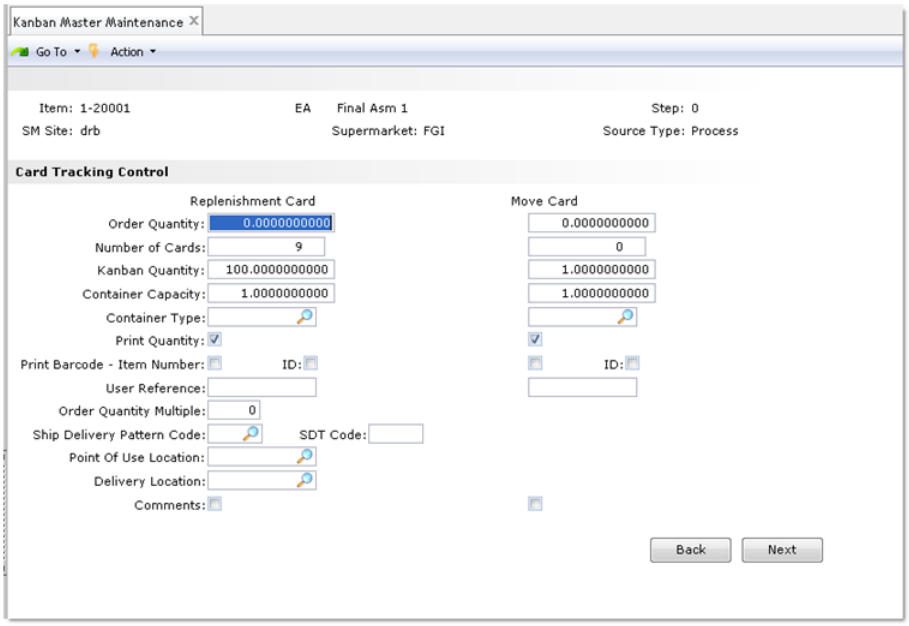



The basic kanban loop data that you should set up is shown in the following screens:

## Kanban Master Maintenance, Card Tracking Control



# Kanban Master Maintenance, Card Tracking Control

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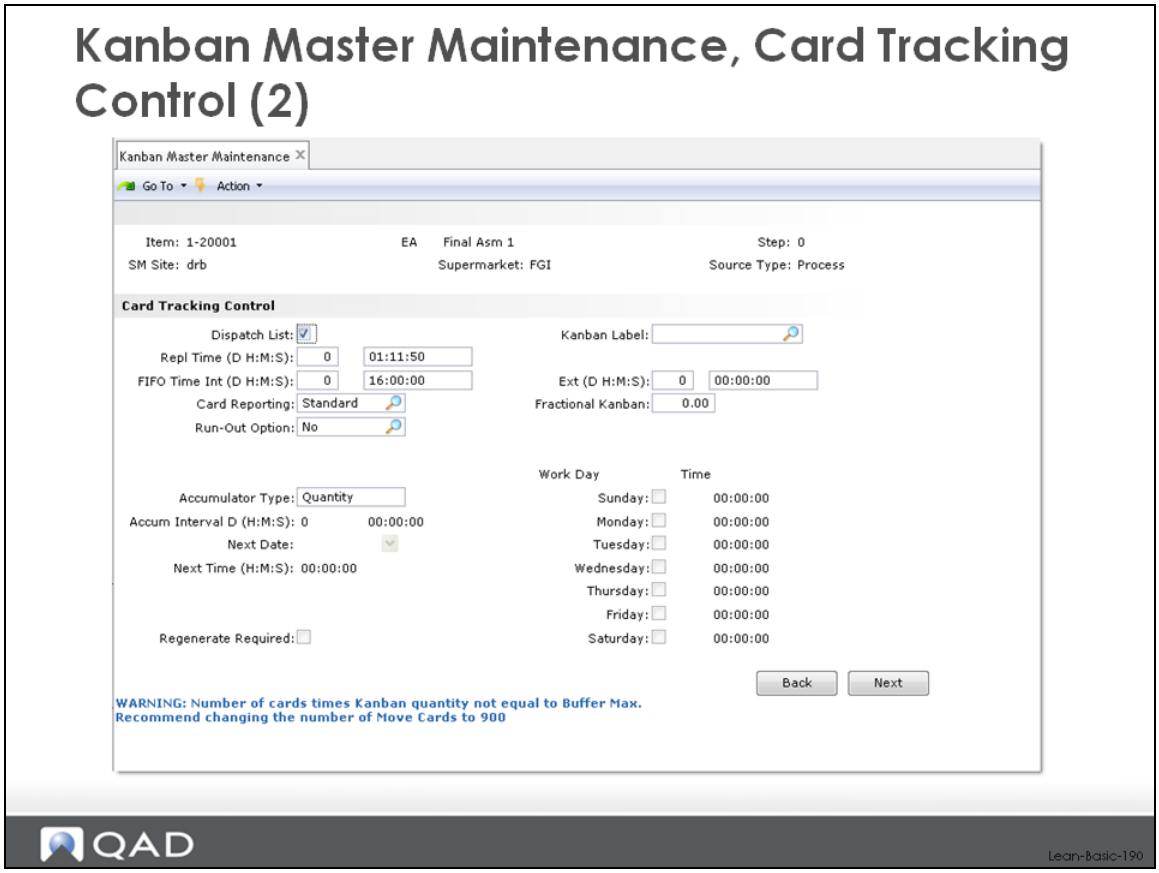
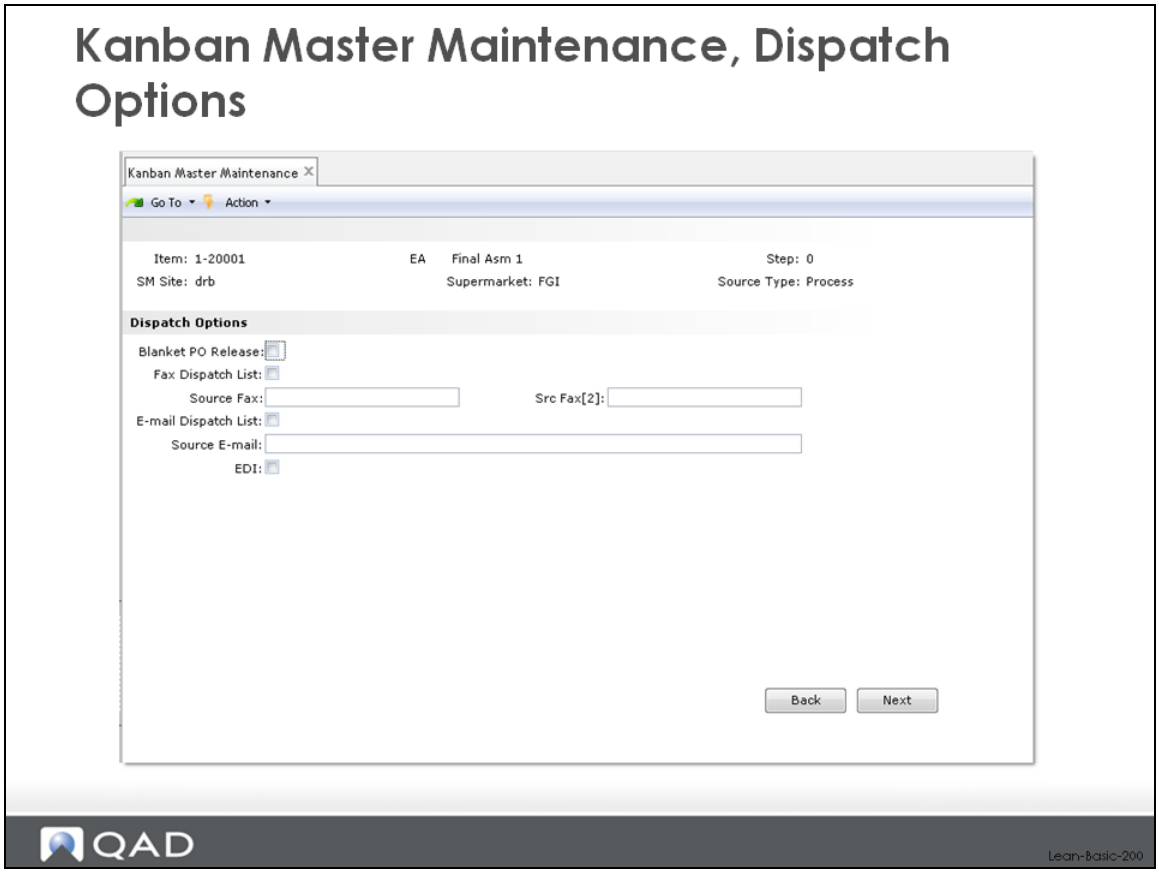
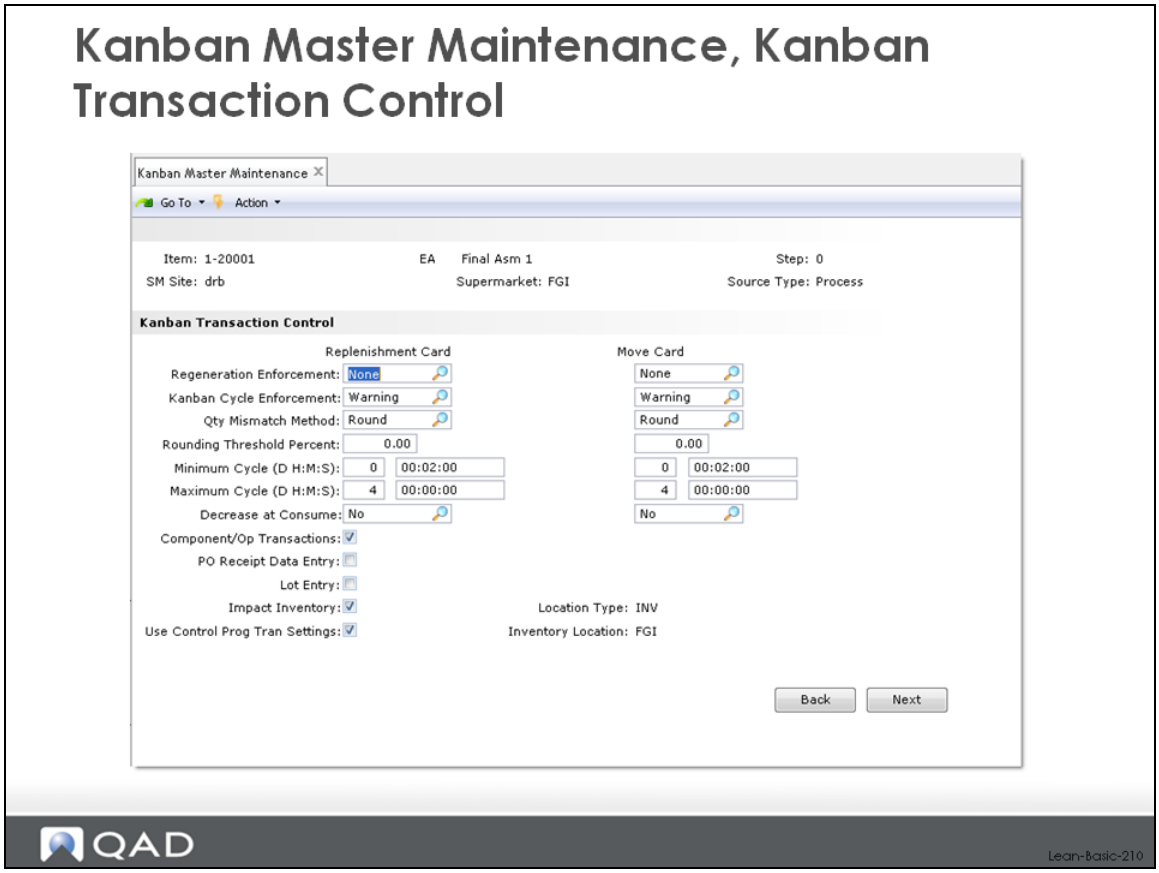
## Kanban Master Maintenance, Card Tracking Control (2)



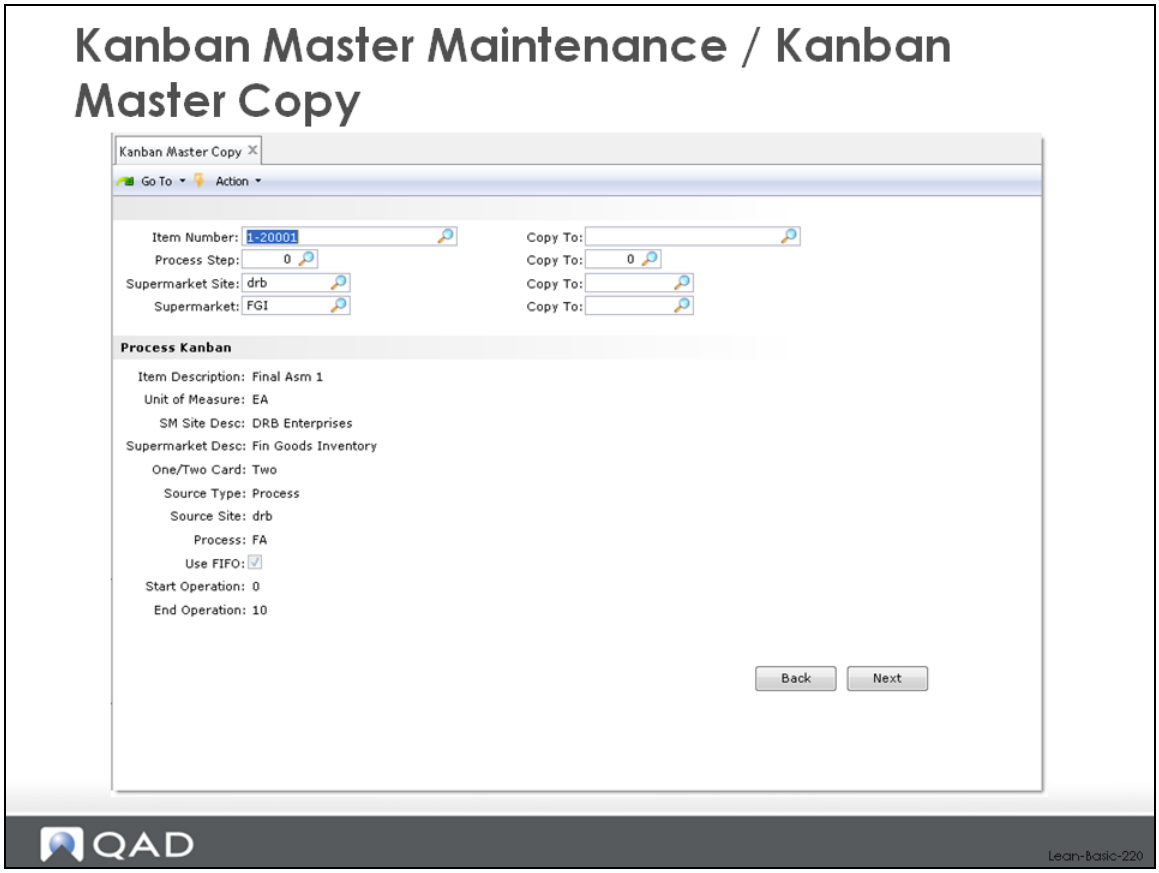
## Kanban Master Maintenance, Dispatch Options



## Kanban Master Maintenance, Kanban Transaction Control

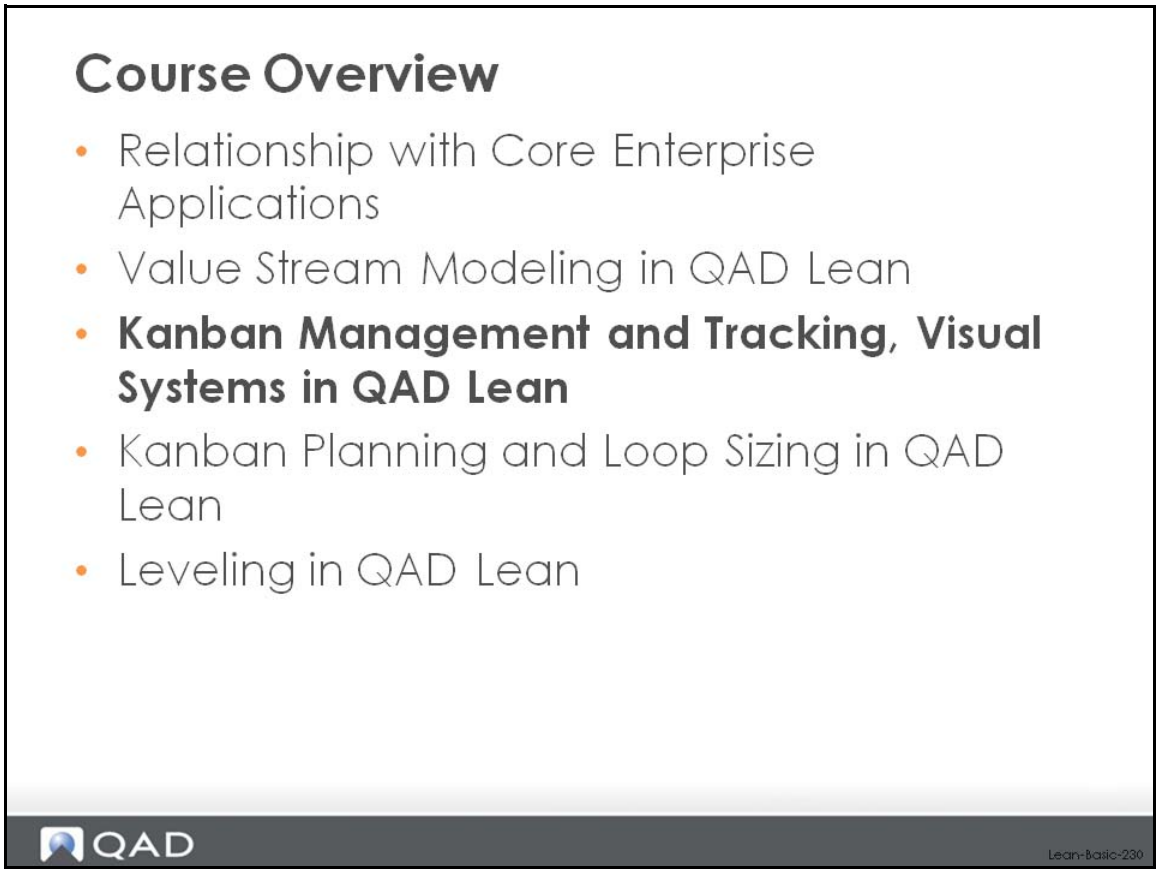


## Kanban Master Maintenance / Kanban Master Copy

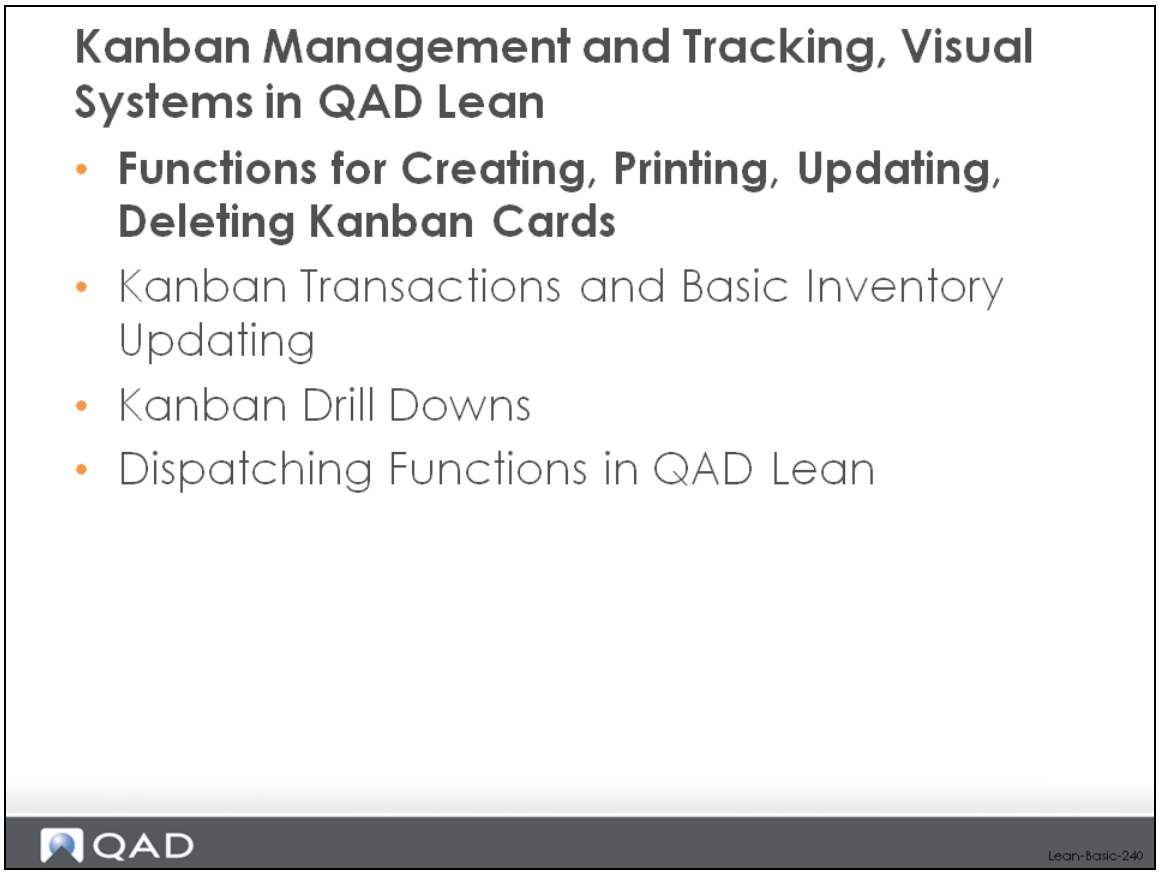



Once you've set up a single loop for a process, you can create other loops by copying the first. The basic process to do this uses a front end process that allows you to specify the loop to copy from and the loop you want to create (copy to:). After you hit the Next button the system will confirm that it has added a new loop and allow you to step through the maintenance screens corresponding to the normal Kanban Master Maintenance. In this way, you can create the majority of the data through the copy and selectively change some of the individual data items that need to be different.

## Kanban Management and Tracking, Visual Systems in QAD Lean



## Functions for Creating, Printing, Updating, Deleting Kanban Cards




So far we've looked at some of the basics of setting up the pull system in QAD Lean, including the basic control settings, how to authorize items for kanban control, functions for establishing supermarkets and specifying replenishment sources (processes, suppliers, supermarkets), and how to set up kanban loops. There are some additional important setup steps that we are going to skip for now and will return to in a later section of this course. These additional steps include rolling over cycle and setup times from your routing, calculating average daily demand, calculating safety stock, computing precise values for daily working time, takt time, pitch, EPE Interval, etc. A lot of this work is related to sizing kanban loops so that you are holding the proper amount of inventory and producing sensible lots sizes based on your manufacturing environment – critical if you really want to make pull systems work.

However, in the earlier section we set up some of the most basic kanban system, including the number of cards for each kanban loop. What we'll discuss now are the functions in the system for actually creating the cards, printing them, distributing them (attaching them to material in the shop or placing them on kanban boards), and managing them. Then, in the next section, we'll look at the basic kanban transactions available in the system.

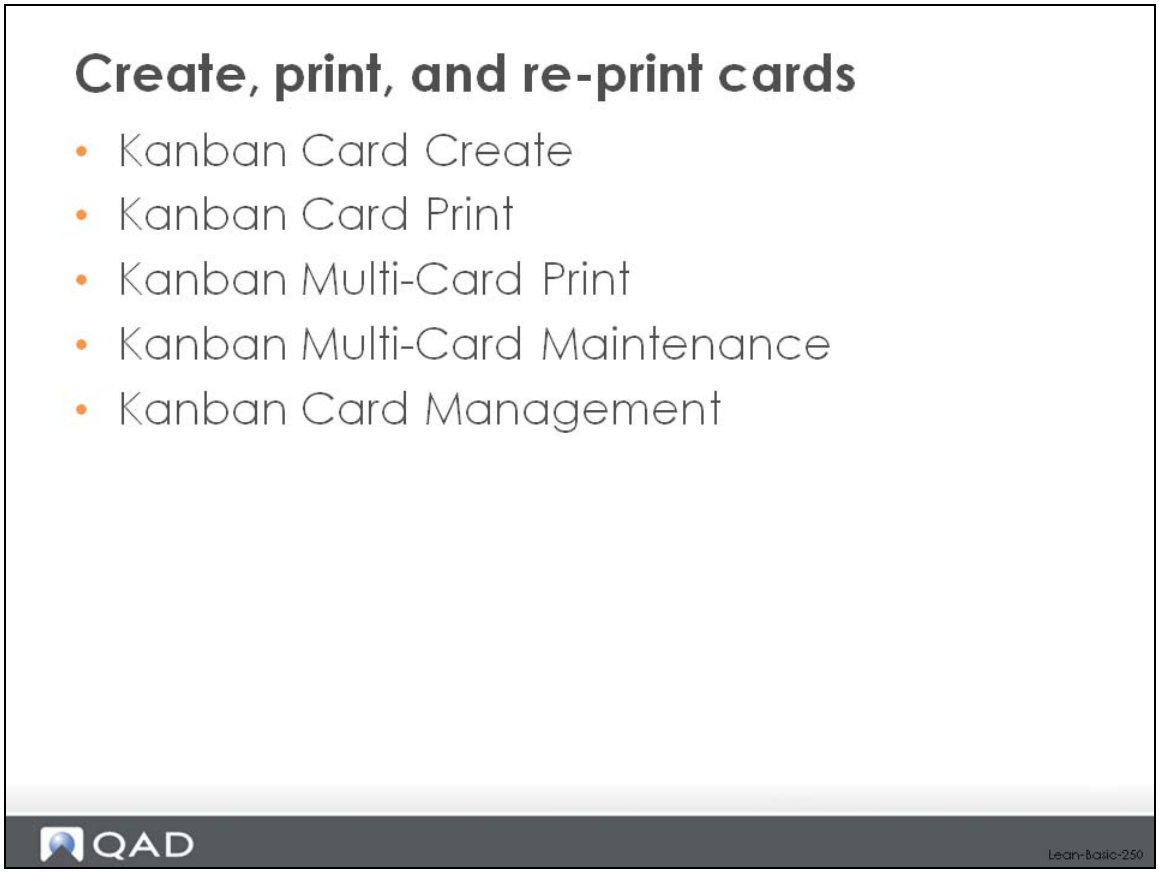
These are the functions covered in this section of the class:

- Create, print, re-print cards
- Activate, deactivate, close cards

- Delete cards from the system
- Manage limited use cards (Saturday Set, Joker Cards, and so on)
- Modify authorized date/time for dispatching
- Modify other card data

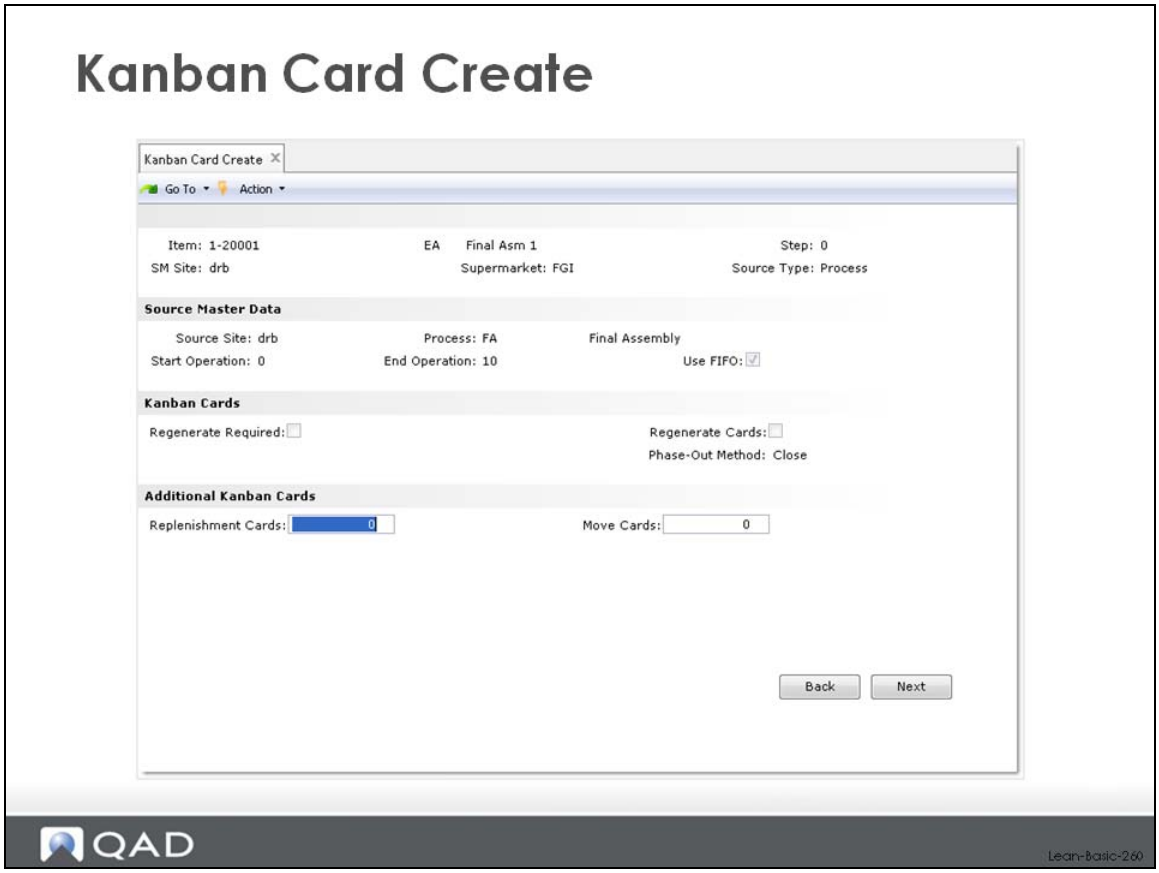
Remember that the job is not over when you create or remove cards from kanban loops in QAD Lean. Kanban cards are equivalent to inventory – either inventory that exists in a supermarket, in process going through a kanban loop, or inventory that needs to be produced to keep the loop running. If you create new cards for a loop, you need to do one of two things: find existing inventory and put the card with it or put the card on a kanban board (typically a “load assembly” board) or post so that when you do produce the item you can attach the card to the inventory.

## Create, print, and re-print cards




There are multiple functions in the system for creating and printing kanban cards. These functions can be found in the “Card Management” menu of the system.

## Kanban Card Create

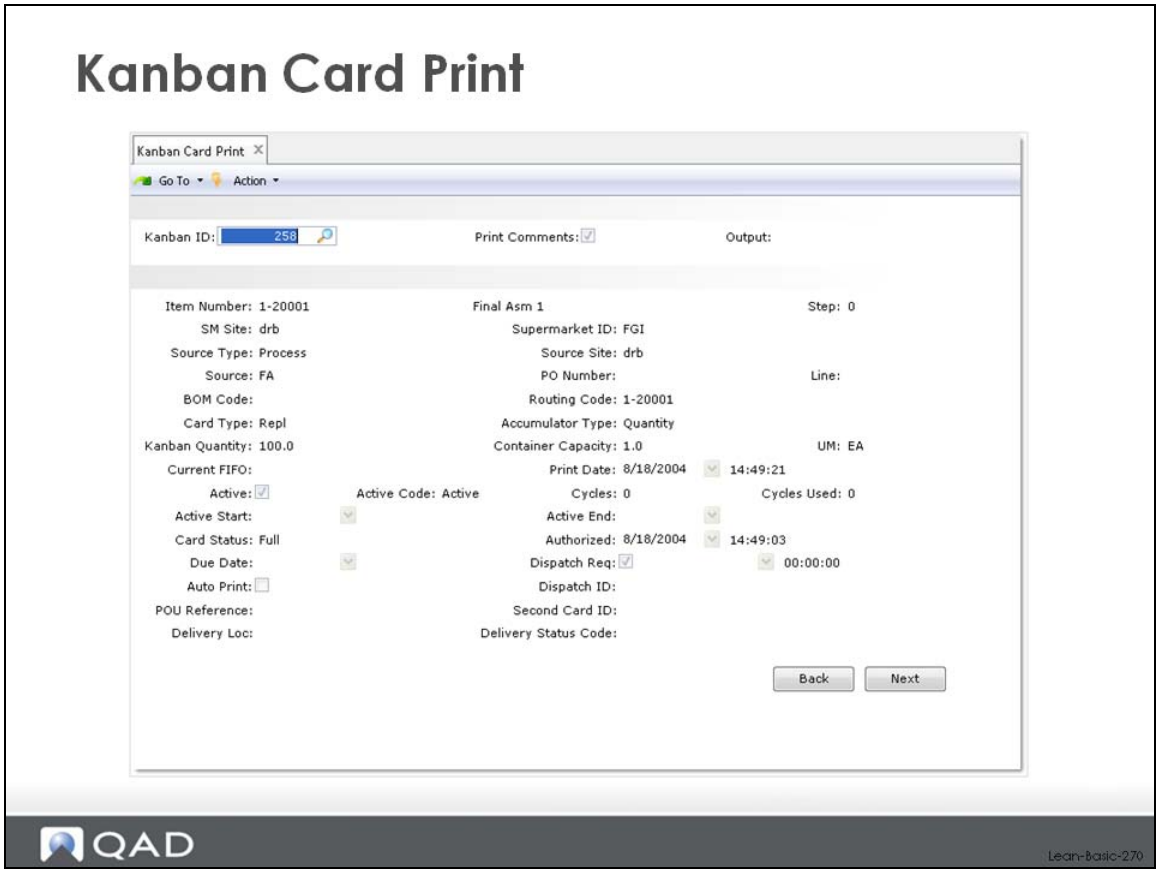



The most basic card creation function is Kanban Card Create shown above.

Use this function to create one or more kanban cards for a loop. You'll be asked for the loop identification (item, step, supermarket site and supermarket) and, after the system retrieves the source data, the number of kanban cards you'd like to create. You can create replenishment cards and, if the loop is a two card loop, move cards. If you've authorized cards for the loop (perhaps manually through maintenance or through the kanban workbench of the system), but have not yet created them, the system will preload the number of cards to be added in the "Replenishment Cards" or "Move Cards" fields in the transaction.

Once the cards have been created, the transaction continues with an additional prompt (checkbox) that will allow you to print the kanban cards it has created.

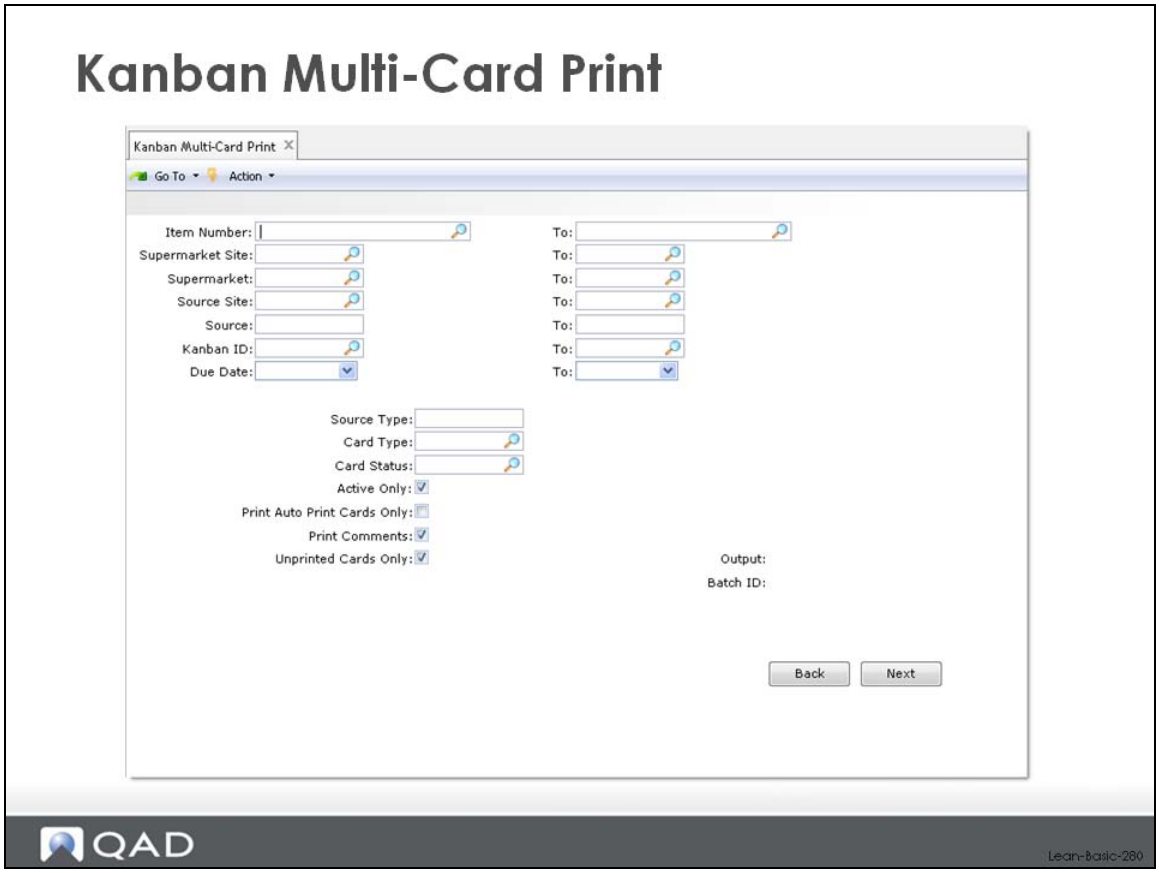
## Kanban Card Print



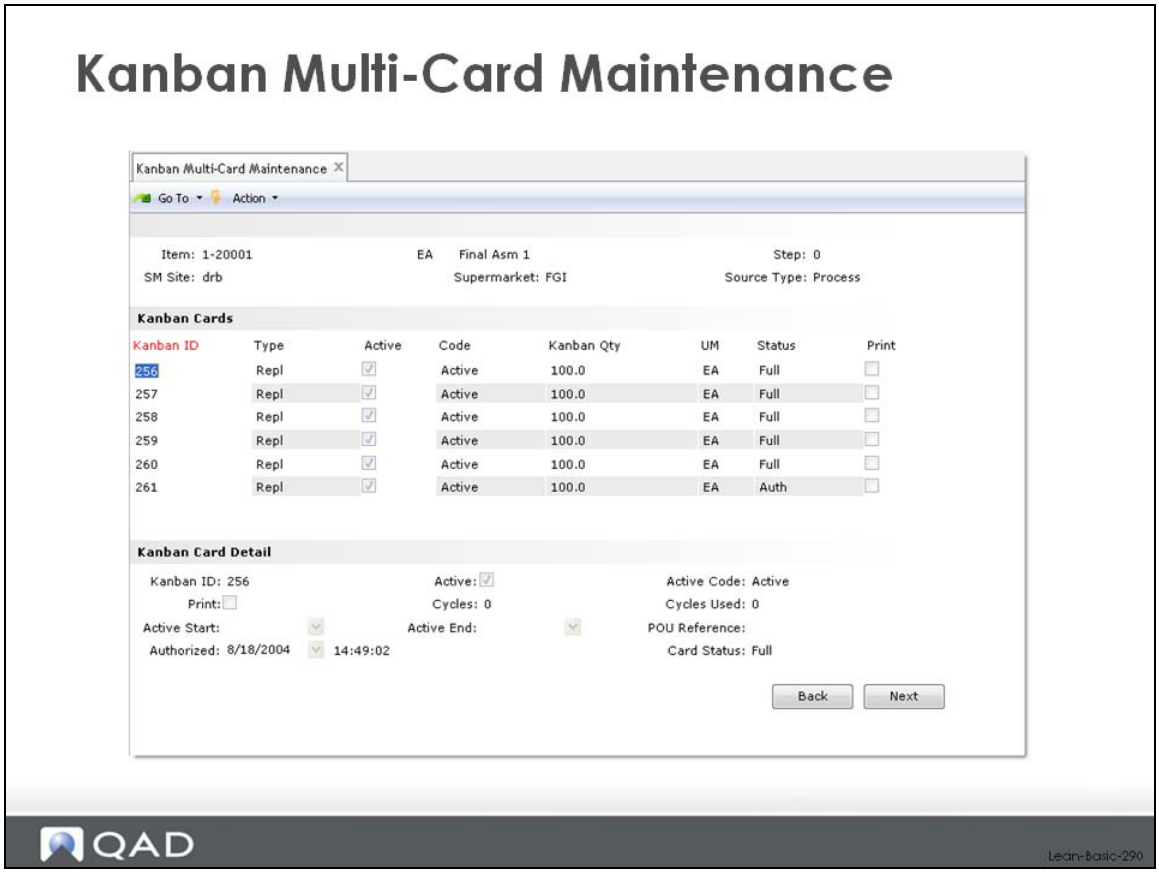

If you choose not to print kanban cards as part of the Kanban Card Create function, or you need to reprint a card sometime later, you can use either the Kanban Card Print function or the Kanban Multi-Card Print functions of the system. The Kanban Card Print function, shown immediately below, allows you to print an individual card by specifying the card number.

If you need to print several cards for an item, or cards for a range of item numbers, use the Kanban Multi-Card Print below. Here you can enter a specific range of item numbers, sites, supermarkets, sources, card numbers or due dates to select the specific cards you want to print. The selection criteria for this transaction work in the normal way for QAD EA transactions, where the second and subsequent criteria act as a qualifier to the prior criteria. Notice that you can also specify whether you want all cards selected to be printed, or only the unprinted cards.

## Kanban Multi-Card Print



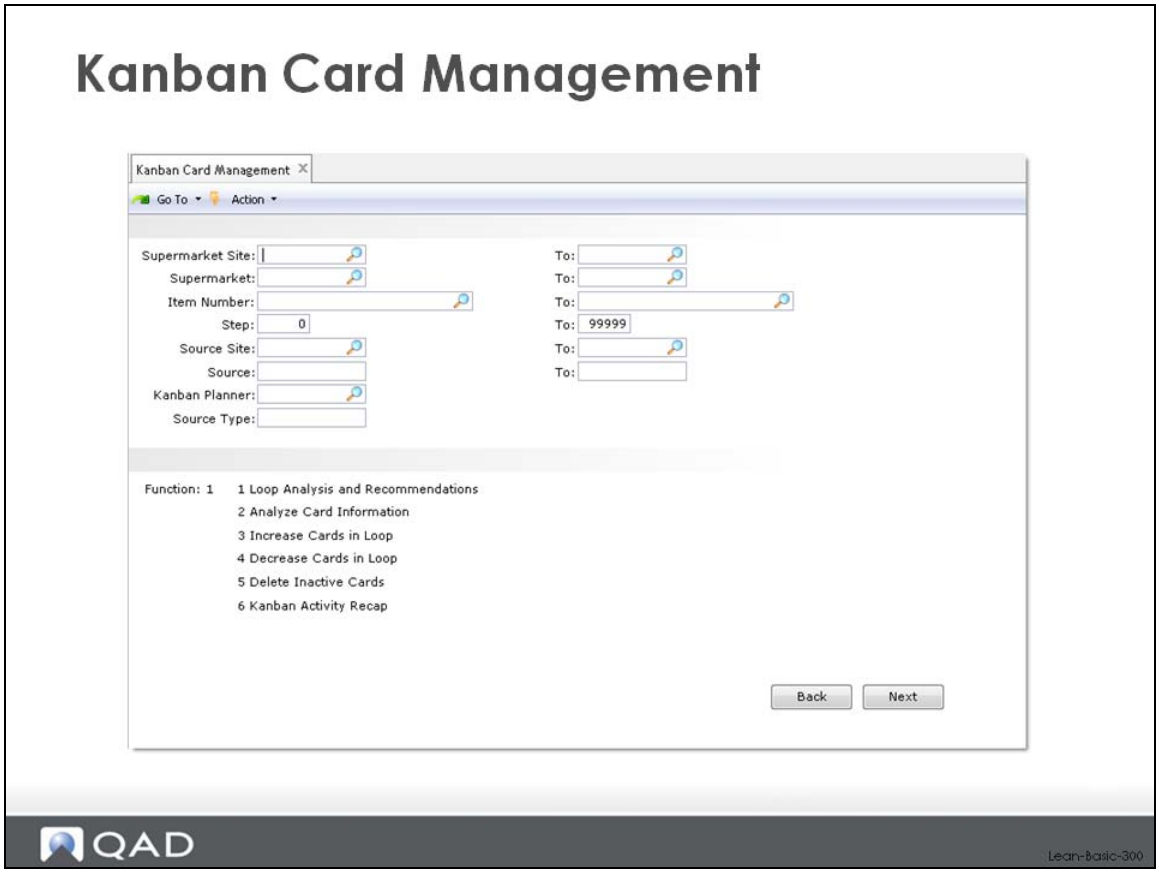
## Kanban Multi-Card Maintenance




You can also create and print kanban cards using the Kanban Multi-Card Maintenance function of the system shown above.

Make your selection by specifying the loop identification (item, step, site, supermarket). The system will return all existing kanban cards for the specified loop. If you want to print an existing card, simply select it and check the “Print” control. If you want to add a new card for the loop, select an existing card and hit enter. Then clear the “Kanban ID” field in Kanban Card Detail and hit enter again. This will select the next available card number and create a new card. Again, if you want to print it, simply check the “Print” control.

## Kanban Card Management




The most comprehensive card creation and printing function is Kanban Card Management shown above.

You can use options 1 – 3 for creating additional cards in the loops selected. Options 1 and 2 present an analysis of the selected loops and indicate which loops need additional cards, and in cases where you specify updating, will create the correct number of additional cards. For option 3, you specify the number of cards that should be added to each of the selected loops and the system will add that specific number of cards to each loop. Each option allows you to create and print cards.

These options can also be run in “simulation mode” where you can review the loops that will be changed if you actually run the function with “update” specified.

### Activate, deactivate, and close cards

There are times when you need cards for an item and inactive cards already exist in the system. Similarly you may have “downsized” a loop and need to eliminate one or more existing cards. QAD Lean provides functions to accomplish both of these.

Kanban cards, and the associated card numbers, may have been “retired” in the system without being physically deleted from it. To activate an existing card, use one of the following functions:

- Kanban Card Maintenance
- Kanban Multi-Card Maintenance

- Kanban Card Activate
- Kanban Card Management

Both the Kanban Card Maintenance and Kanban Multi-Card Maintenance functions allow you to reactivate a card by changing one or more of its status fields. Specifically, you can check the “active” checkbox to activate the card, and then you can change the “active code” to one of the valid statuses (active, period, cycle). However, the system will not allow you to reactivate an existing card if it has invalid data. For example, you cannot reactivate a card whose routing code is not consistent with the routing code currently associated with the loop. It is possible for you to correct the invalid or inconsistent data, in which case the system will allow you to reactivate the card.

Kanban Card Activate allows you to activate a specific card without changing any other data in the card. As above, the system will not allow you to reactivate an existing card if it has invalid data.

Kanban Card Management will “automatically” activate cards for loops that need to be increased in size, as long as the control file parameters are set properly, and cards already exist that can be activated. The control file setting for “Phase-In Method” must be set to Activate. In cases where there are existing cards, but some of the card data is inconsistent or invalid, the system will create new cards rather than reactivating ones needing correction.

Kanban cards can be closed, deactivated or in some cases, deleted from the system using the following transactions:

- Kanban Card Maintenance
- Kanban Multi-Card Maintenance
- Kanban Card Close
- Kanban Card Deactivate
- Kanban Card Management

Both the Kanban Card Maintenance and Kanban Multi-Card Maintenance functions allow you to deactivate a card by changing a single field. Specifically, you can uncheck the “active” checkbox to deactivate the card. Deactivated cards cannot be transacted against.

These transactions also provide you with a way to “close” a kanban card, which essentially moves the card to a status midway between active and deactivated. A kanban card that has status = “close” can be transacted against, up to the point where the card has been emptied. When a closed kanban card is emptied, the system will automatically deactivate the card.

The way you “close” a kanban card in either of these transactions is to change the card’s “active code” to close.

You can delete a kanban card completely from the system by hitting the delete button in Kanban Card Maintenance, or in Kanban Multi-Card Maintenance.

Kanban Card Management will automatically close or deactivate cards for loops that need to be decreased in size, as long as the control file parameters are set properly. The control file setting for “Phase-Out Method” must be set to either Inactive or Close. The “Inactive” setting will cause the system to immediately retire cards when the loop needs to the downsized. In the case of the Close setting, the system will move one or more cards to the Close status, and then when the card has been emptied, update the status to deactivate the card.

### Delete cards from the system

You can delete a kanban card completely from the system by hitting the delete button in Kanban Card Maintenance, or in Kanban Multi-Card Maintenance.

You can also delete a range of inactive cards from the system, using the Kanban Card Management function and option 5 (Delete inactive cards).

### Manage limited use cards (Saturday set, joker cards, system fill cards, and so on)

Kanban systems operate on a “consumption based” replenishment model that assumes inventory exists in advance of demand. However, it is possible to operate kanban for make to order products and make to order components. Joker (or temporary) kanbans can be used to handle these kinds of items.

In their simplest form, joker kanbans are one-time authorizations. They authorizes the supply source to produce (or deliver in the case of a purchased part) an item. When the part is received, the card will be attached to the container and the inventory placed in the supermarket. However, when the inventory is consumed, the card is detached and destroyed. It cannot be filled again – hence its designation as “one-time”. However, the system actually supports more complicated joker card situations: you can designate that a card will circulate for more than a single cycle, or you can indicate that it should continue to circulate as long as the date is between some start date and some specified end date. If the card has circulated the specified number of times, or the end date has been reached, the card will be retired automatically when it is emptied.

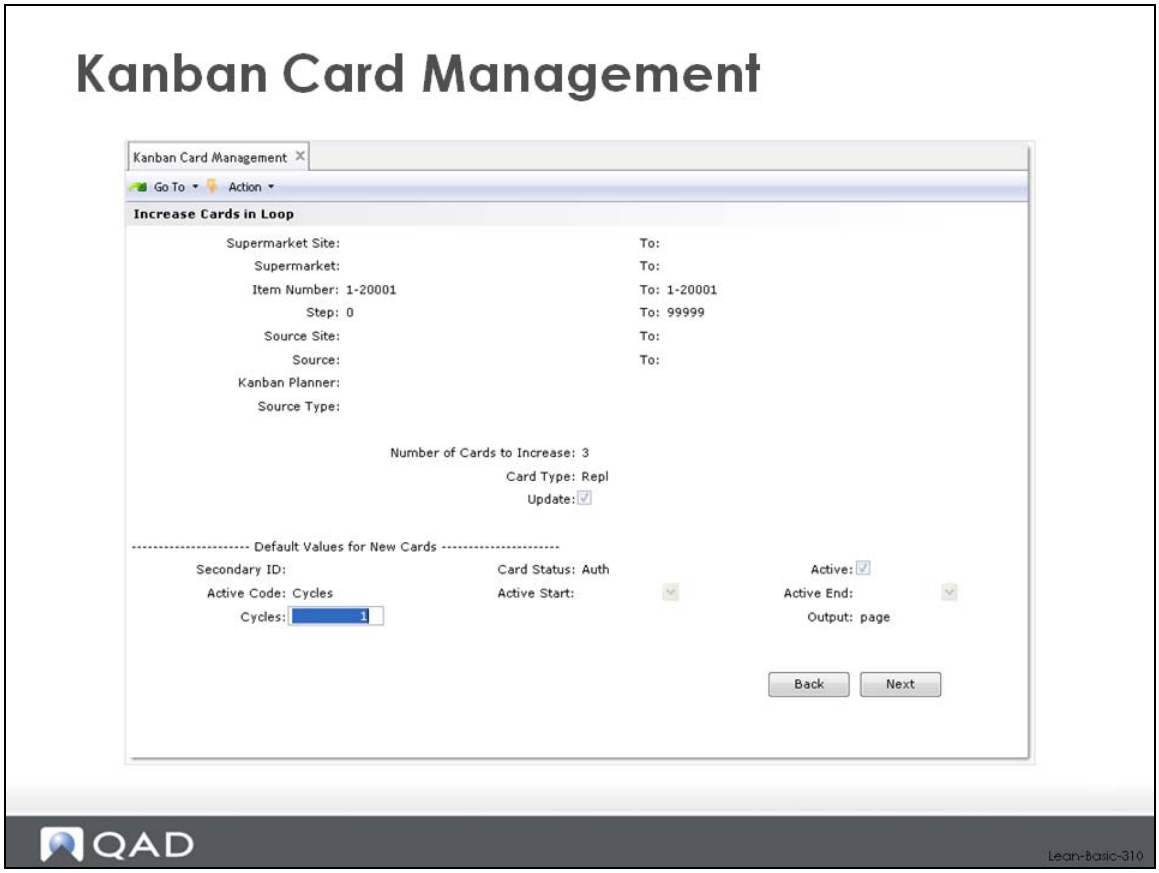
Joker kanbans can actually be used in a variety of situations: to handle MTO products and spare parts, to anticipate a temporary spike in demand and produce inventory in anticipation of it (so-called system fill kanbans), to temporarily increase the level of inventory in the supermarket for a defined period of time, to authorize specific items to be produced on an overtime day (a Saturday set), etc. The joker card is one method for handling a temporary increase in demand because of seasonality (from one date to another date). In QAD Lean, joker kanbans may exist for a specified number of cycles (n consume/fill cycles) or for a specified period of time (from date x to date y).

Joker cards can be most easily created using any of the following functions:

- Kanban Multi-Card Maintenance
- Kanban Card Management

In Kanban Multi-Card Maintenance, use the same method for creating a new card as explained above, with Active = yes (checked), Active Code = cycles (for a joker usable for n cycles) or period (for a joker usable between date x and date y). For a cycles card, specify the number of cycles which in most cases will be 1. For a period card, specify the starting and ending dates.

## Kanban Card Management




In Kanban Card Management, specify the loop or loops to which you want to add joker cards and then use option 3 to add the correct number of joker cards to the loops. Change the default values for the cards to indicate the kind of joker cards you want to create.

### Modify authorized date and time data for dispatching

One maintenance capability that you should be aware of has to do with changing the authorized date and time on kanban cards that have been authorized in the system.

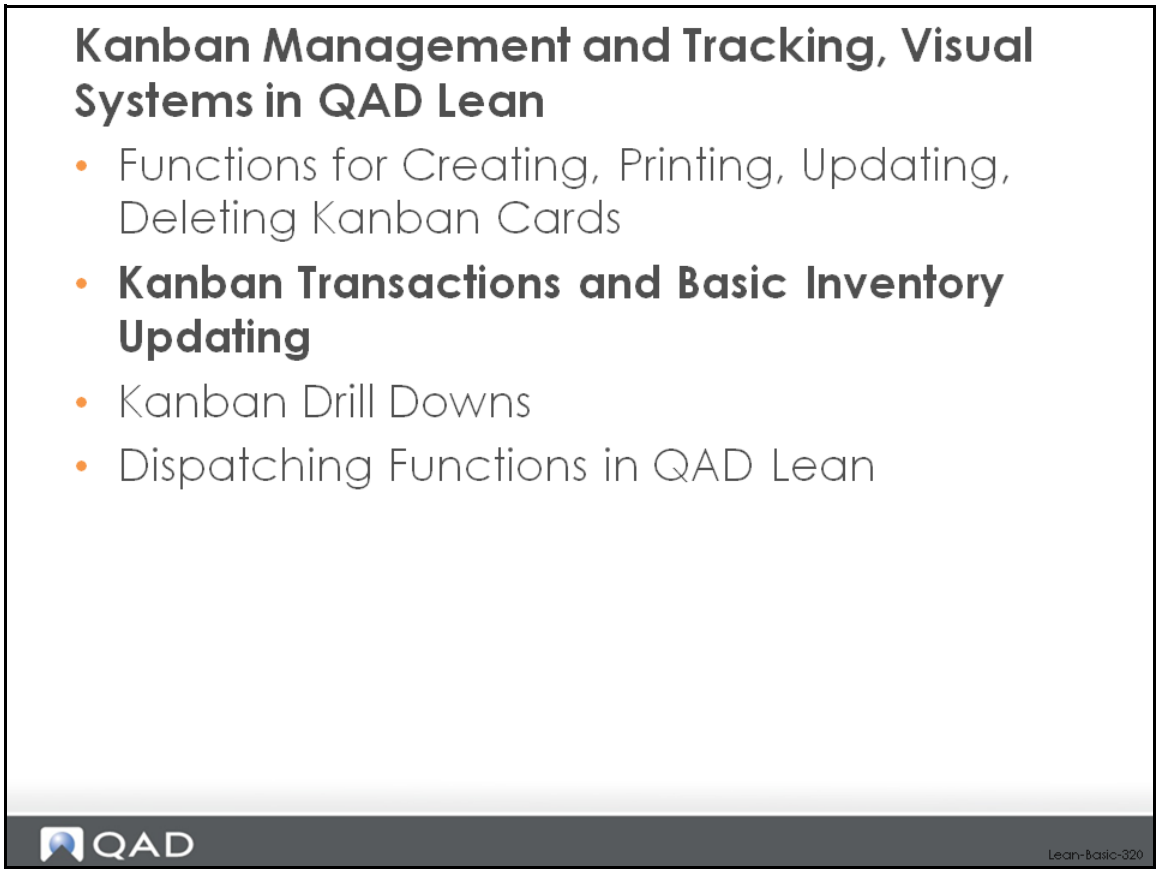
The system produces a dispatch list, a kind of electronic control board, showing the items that are authorized for replenishment, and this list is typically prioritized according to the date and time the card was authorized. Kanbans that were authorized first will appear first on the dispatch list. Kanbans authorized later will appear later. The basic assumption in the system is that if work is being pulled at a leveled rate, then an item triggered first will be needed first. The system has no other mechanism to prioritize work, although it can show the “mfg_seq”, a kind of product wheel based sequence indicator, on the dispatch list along with other part information. However, the mfg-seq indicator is shown for reference only and has no effect on the order of work shown in the dispatch list.

If you have situations where you need to override the normal dispatch list sequence, and want to indicate that on the dispatch list, use the Kanban Card Maintenance and Kanban Multi-Card Maintenance functions of the system. Using either of these transactions, simply find the card or cards that are in question and specify a new authorized date and/or time.

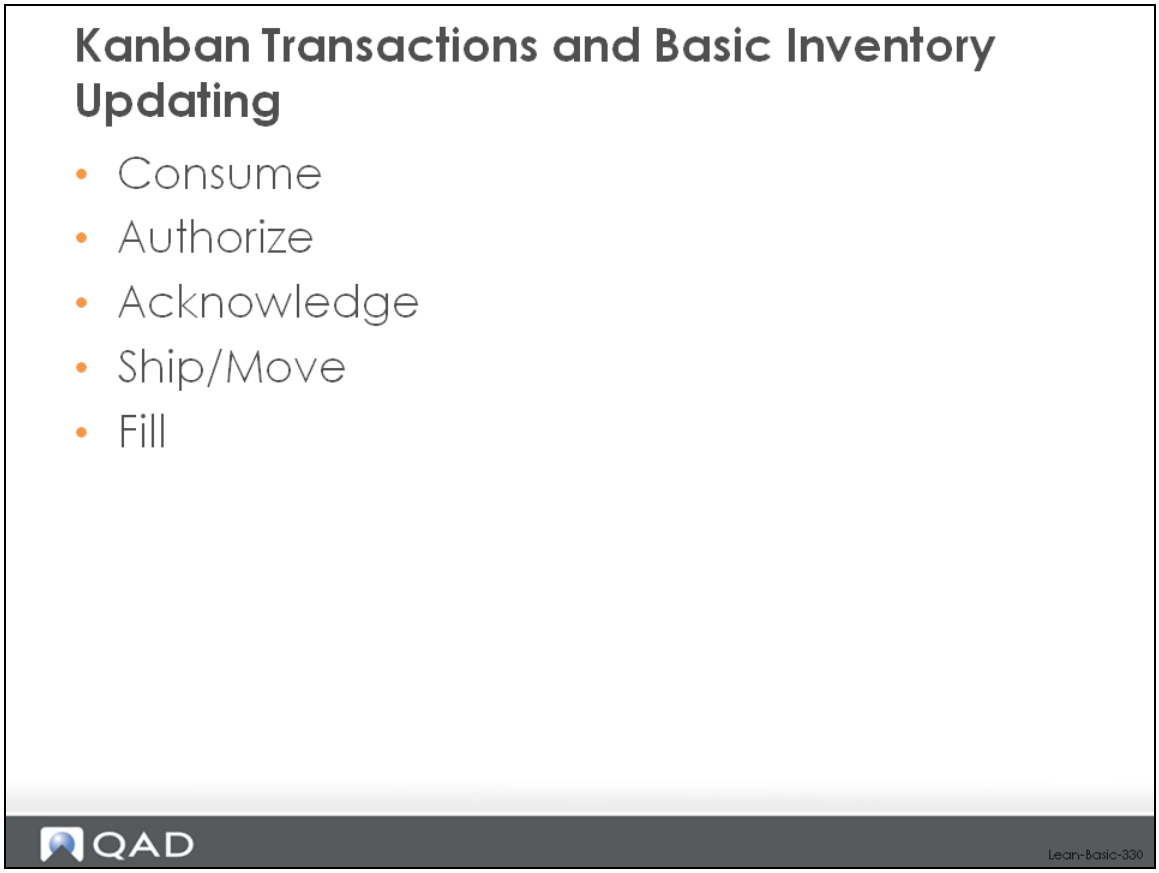
### Modify other card data

The Kanban Card Maintenance and Kanban Multi-Card Maintenance functions also allow you to change other data associated with the Kanban Card. For example, you can change the due date, the print code, secondary card references, point of use reference, delivery location, and dispatching data.

## Kanban Transactions, Status Updates and Basic Inventory Updating



## Kanban Transactions and Basic Inventory Updating




In this part of the class, we'll look at the basic "consume-fill" cycle for kanban cards in a pull system. We'll look at the basic cycle, the different kanban transactions that can happen during the cycle, and any associated inventory updating. The specific kanban transactions that we'll look at include:

- Replenishment Kanban Transactions

  Consume, Authorize, Acknowledge, Ship/Move, Fill
- Withdrawal Kanban Transactions

  Consume, Fill

The important thing to remember is that the kanban card (or cards, in the case of a part that is produced in batches or lot sizes) provides the signaling mechanism to indicate that replenishment is required. Rather than looking forward over time and evaluating where inventory is likely to run out, in a kanban system usage of inventory (consumption) drives replenishment. In its simplest form, when a kanban is emptied because the inventory was used, the source process receives a signal to replenish it. The kanban is alternately emptied, filled, emptied, filled, etc. as material is used out of the supermarket, replenished, used, replenished, etc. If there is no kanban signal (no empty card) then work stops.

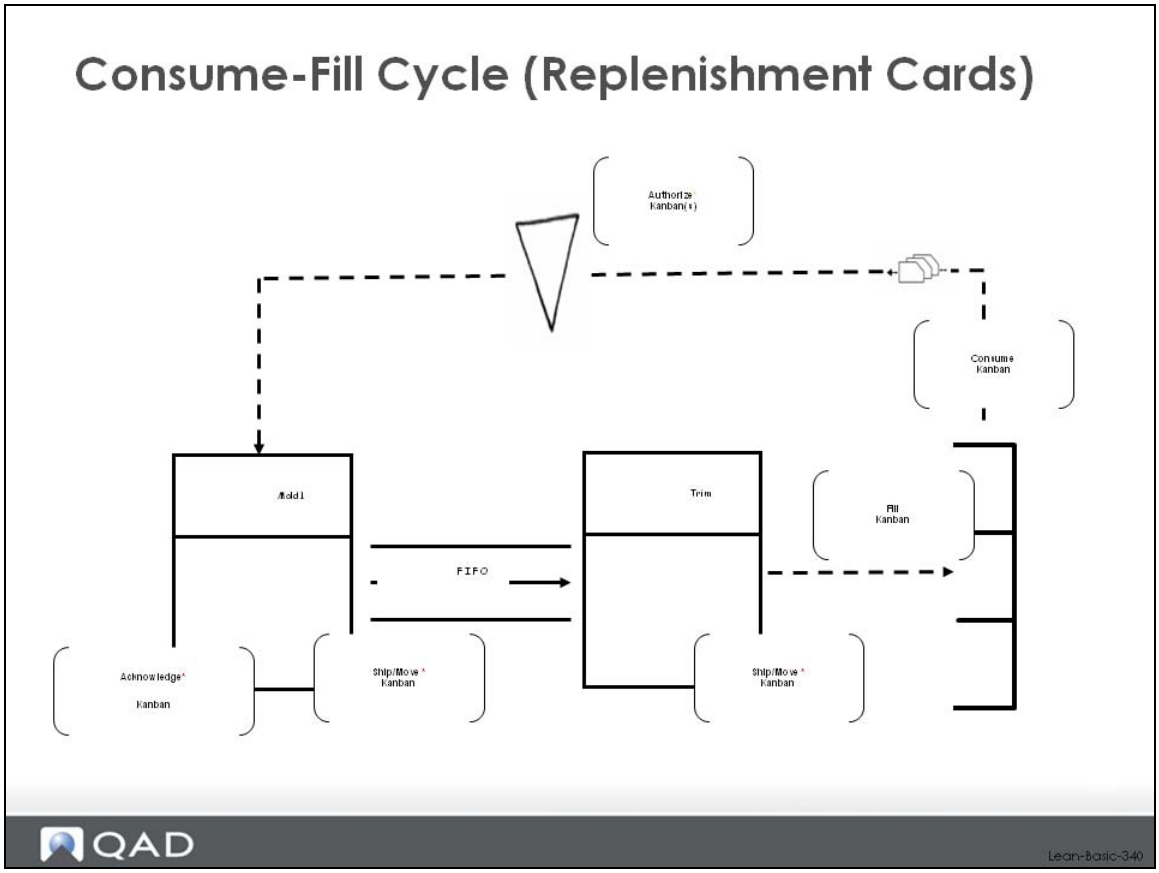
The diagram below shows a typical replenishment kanban loop, with kanban cards continuously circulating from the supermarket back to the molding process through the trim FIFO lane and back to the supermarket. Material is consumed from the supermarket, which causes a "consume kanban" transaction to be processed against the affected kanban cards.

Newly emptied kanbans are accumulated until they reach the required order quantity or the date the next signal is to be generated. At that point, the system automatically marks them “authorized”, updates the authorized date and time, and adds them to the kanban dispatch list. (Alternatively, a user can “force” authorize a smaller than normal batch by processing the “authorize kanban” transaction in the system and this would have the same effect, moving the item to the kanban dispatch list.) In a system using purely visual controls, the cards would be accumulated on a load assembly board until the order quantity was reached, at which point the cards would be transferred from the load assembly board to the kanban control board.

The “acknowledge kanban” transaction is purely optional. It provides a way for external suppliers to indicate that they have seen the pull signal and are preparing to ship against it. Some of the users of the system also have procedures where they “acknowledge” a kanban when the job has or is being set up for production. This way, someone viewing the dispatch list or a visual status display can see what is being run and what is next to run.

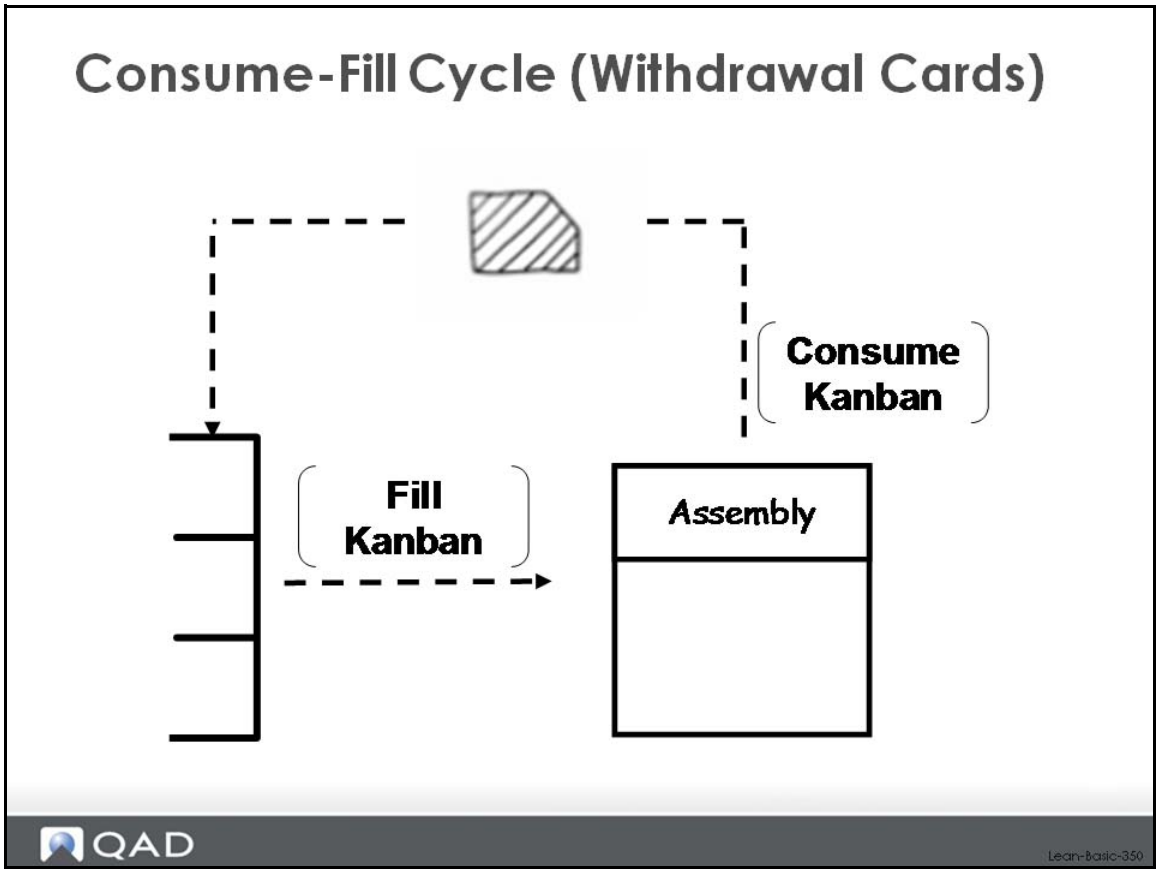
The “ship kanban” transaction has several functions. It can track material that is in transit between a supplier and the plant. It can also track material that has cleared the first (primary) process and is in the FIFO lane. As it progresses through a multi-process FIFO lane, the ship transaction can be used to update its status and location.

## Consume-Fill Cycle (Replenishment Cards)




When the material eventually reaches the supermarket, it can be received using the “fill kanban” transaction. The fill kanban transaction marks the kanban card as full and, depending upon how you’ve set your parameters for inventory processing, may also generate backflush inventory transactions for the components and an inventory receipt for the item itself.

## Consume-Fill Cycle (Withdrawal Cards)

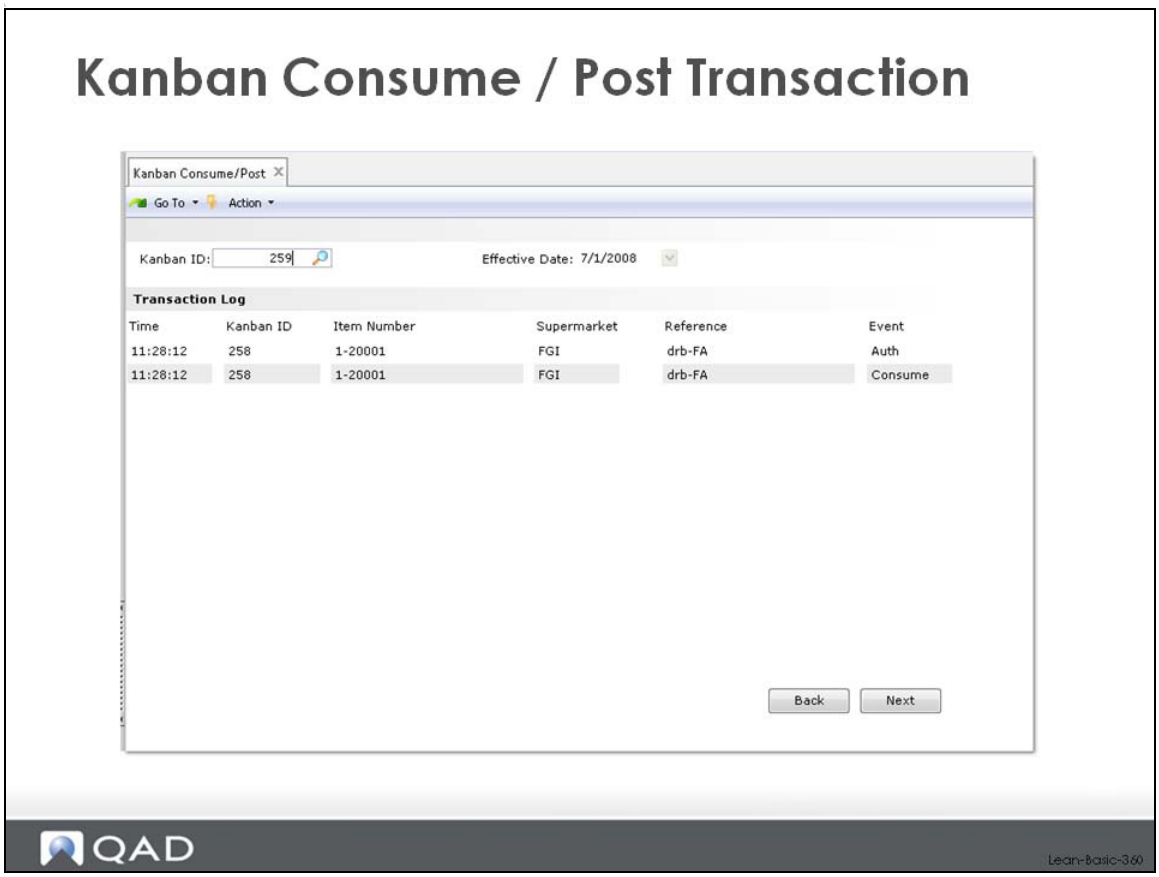



Move or withdrawal kanbans go through a similar, if somewhat simplified consume-fill cycle in QAD Lean. This is because move or withdrawal kanbans have only two transactions that affect their status: consume kanban and fill kanban. This cycle is shown in the figure above.

The diagram above shows a typical withdrawal kanban loop, with kanban cards continuously circulating from the point of use (Assembly) back to the source supermarket and then back to the point of use. Kanbans are recorded empty (they are consumed) when the material is used at the point of use. They are recorded full when material is pulled from the supermarket and moved to the downstream point of use. In the case of withdrawal kanbans there are only the “consume kanban” and “fill kanban” transactions. There are no authorize, acknowledge, or ship kanban transactions.

In the case of withdrawal kanbans, there is no inventory updating.

## Kanban Consume / Post Transaction



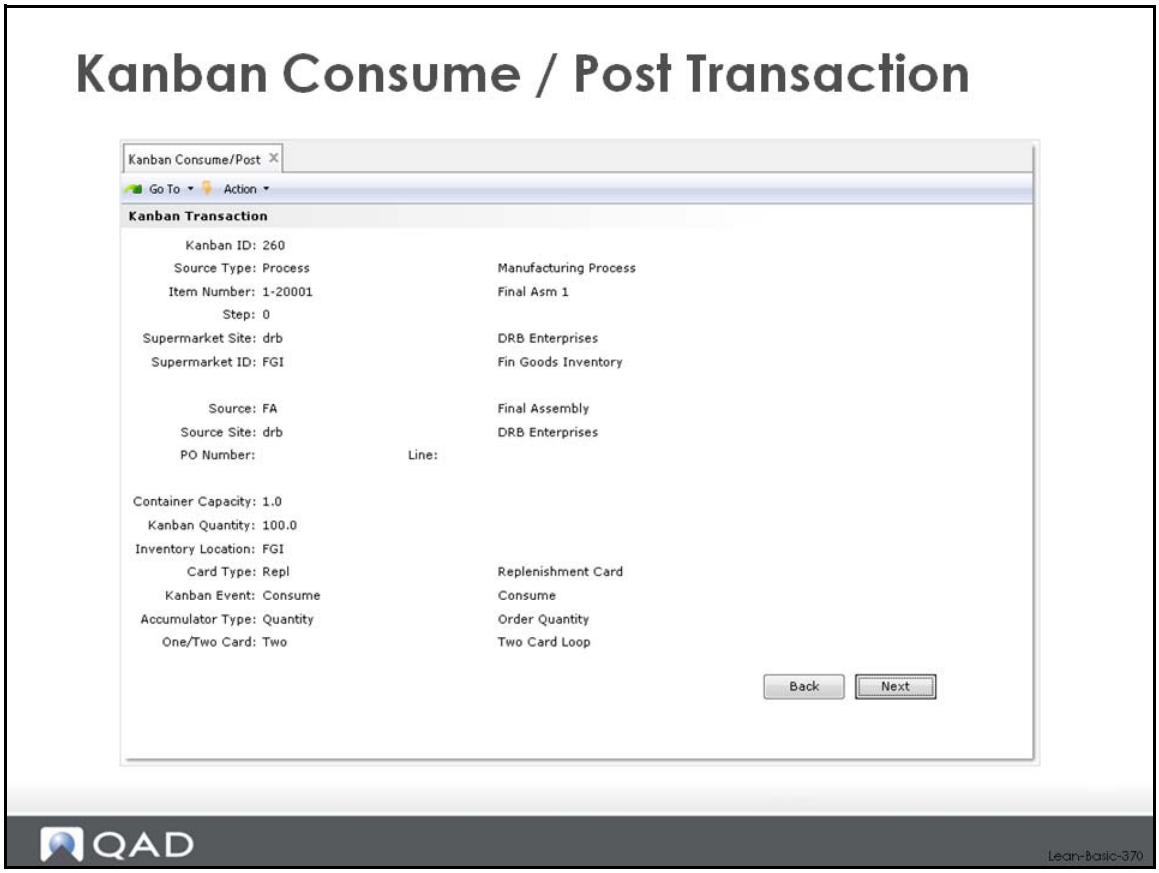

The Consume/Post Kanban transaction is shown in the displays above. As with all the kanban transactions in the system, you need only to enter the kanban card ID, a unique identifier for the card, and hit enter. No additional data would be required to process the kanban card, and in this case, record the kanban card as empty, if the control file parameter “Controlled kanban entry” is set to None, and the parameter “Effective date entry” is unchecked. The system does present an initial screen prompting for a “POU reference” (the point of use for the material being consumed) but this can be left blank – just hit enter to continue to the screen shown below. If you enter a point of use reference when you launch the transaction, then the same POU will apply to all transactions processed in the session.

In the transaction display, you are being prompted for the Kanban ID, which is the unique card number that you want to process. Either type the card number into the Kanban ID field, or use a wedge, light pen or some other kind of bar code scanning device to enter the proper ID. The “Transaction Log” data in the lower frame of the screen shows recently processed kanban transactions.

Depending on how the control file and loop values are set, the system may prompt for additional data, or display status data on the effect of the transaction. For example, if the “controlled kanban entry” parameter is set to either “Warning” or “Error”, then you will be prompted for additional card identification fields including the item number, source, destination supermarket, etc. If the parameter “Effective date entry” is set, then you must enter the actual date of the transaction. This would typically be used only when the system has been down for some time and getting the transactions into history with the correct transaction date is important.

In this situation you might toggle the “Effective data entry” setting back and forth to first enter the transactions that were unprocessed from when the system was down, and then reset the system back to normal processing using the automatically assigned system date.

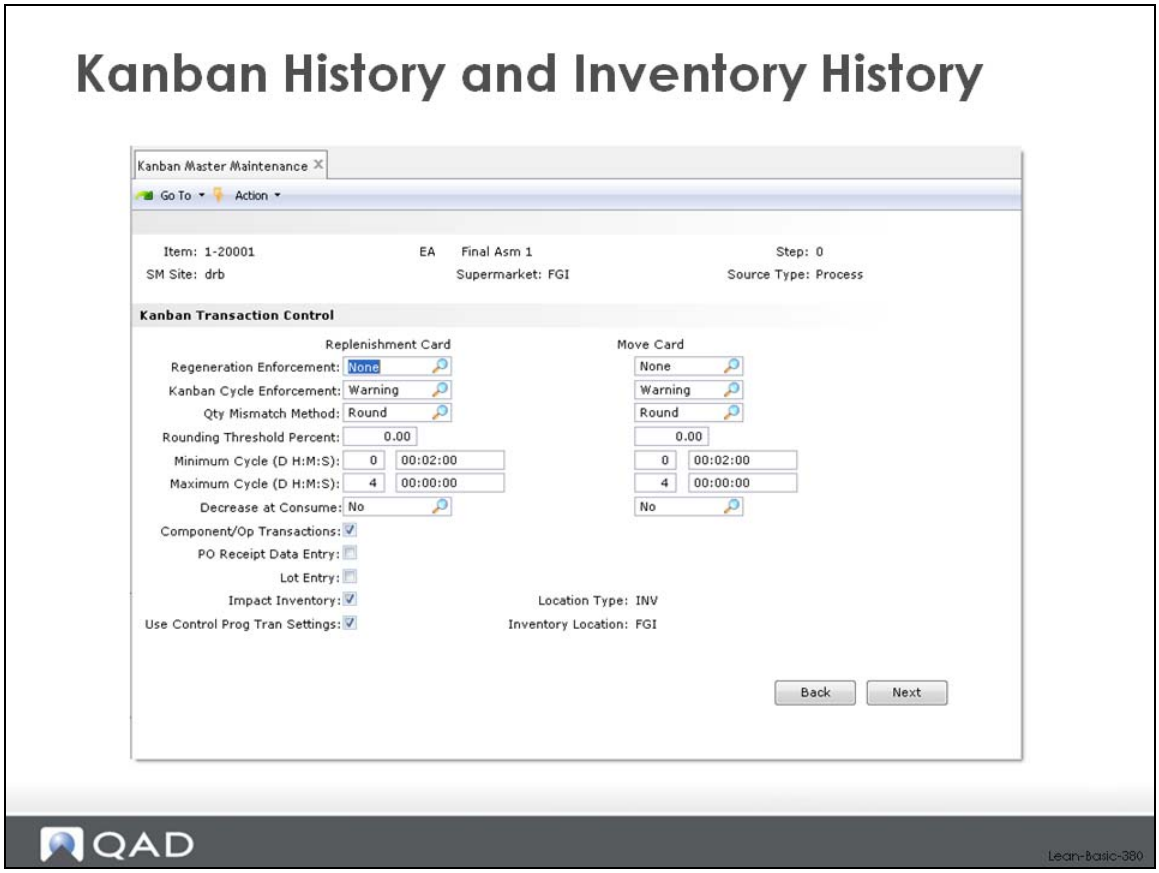
## Kanban Consume / Post Transaction




An audit or status display is shown when the control file setting for “Trans delay in seconds” is greater than zero. You should be aware that when the status screen is presented, it will remain on display for only the specified time – if the display is a bar code display or uses the older character user interface.If you are using the .NetUI then you must clear the screen by clicking on “Next”. Here is an example of the status display.

The rest of the kanban transactions (Kanban Authorize, Kanban Acknowledge, Kanban Ship, Kanban Fill) look similar to the consume/post transaction, with a single prompt for the Kanban ID and the log of transactions processed recently. Additional related displays are controlled by the user’s control file and loop settings.

## Kanban History and Inventory History




All kanban transactions are stored in a special kanban history file, kb_hist, in the system. Any inventory transactions that were generated from kanban activity will be stored in the normal system tr_hist file. Inventory transaction generation is controlled by the control file and loop settings in the system, Component/Op Transactions and Impact Inventory. These controls are located in the Kanban Transaction Control frame of the Kanban Master Maintenance transaction (above).

The Component/Op Transactions setting determines whether the system should backflush material and labor when the kanban fill transaction is reported against a replenishment loop. The Impact Inventory setting determines whether a receipt transaction for the item sourced in a replenishment loop should be generated.

Normally the inventory transactions that will be generated by the system will be among the following:

*P O Receipt.* This is the inventory transaction generated by a kanban fill against a supplier loop, if Impact Inventory = yes (checked).

*W O Receipt (Unplanned).* This is the inventory transaction generated by a kanban fill against a manufacturing loop, if the loop covers the final operation or operations of the item's routing and if Impact Inventory = yes (checked).

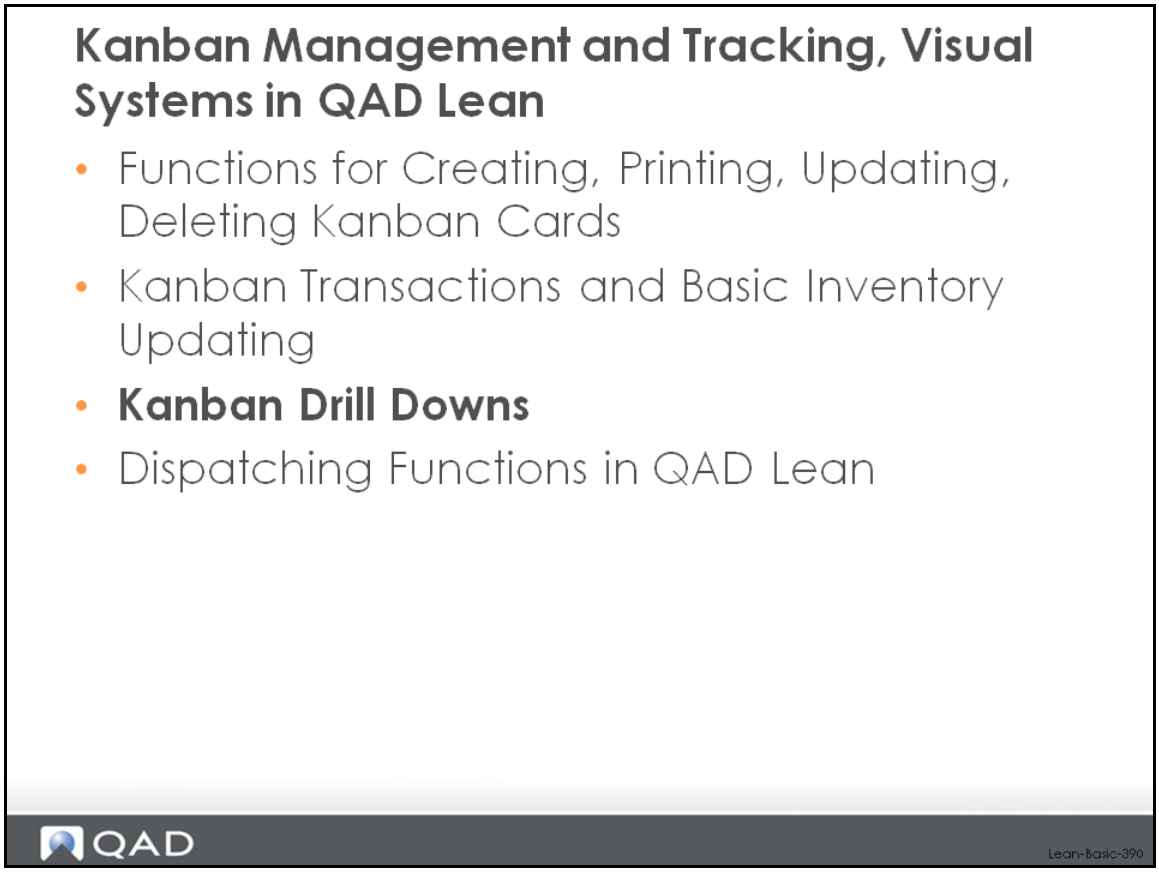
*Transfer Receipt.* This is the inventory transaction generated by a kanban fill against an inventory loop, if Impact Inventory = yes (checked).

*Unplanned Issue.* This transaction will be generated against the item in a loop if the destination supermarket is a WIP supermarket, if Impact Inventory = yes (checked). (For example, if the fill transaction for a supplier loop is to a WIP supermarket, the system will generate the P O Receipt above to receive the part into stock and immediately generate an Unplanned Issue to move the part out of stock and into WIP.)

*Backflush Issue.* A backflush issue transaction will be generated for each of the component items associated with the loop, backflushed on the kanban fill transaction, if Component/Op Transactions = yes (checked).

*Transfer Issue.* This is the inventory transaction generated against the item in the source supermarket in an inventory loop. It is the equivalent of the backflush of component items in the bill of material, if Component/Op Transactions = yes (checked).

## Kanban Drill Downs

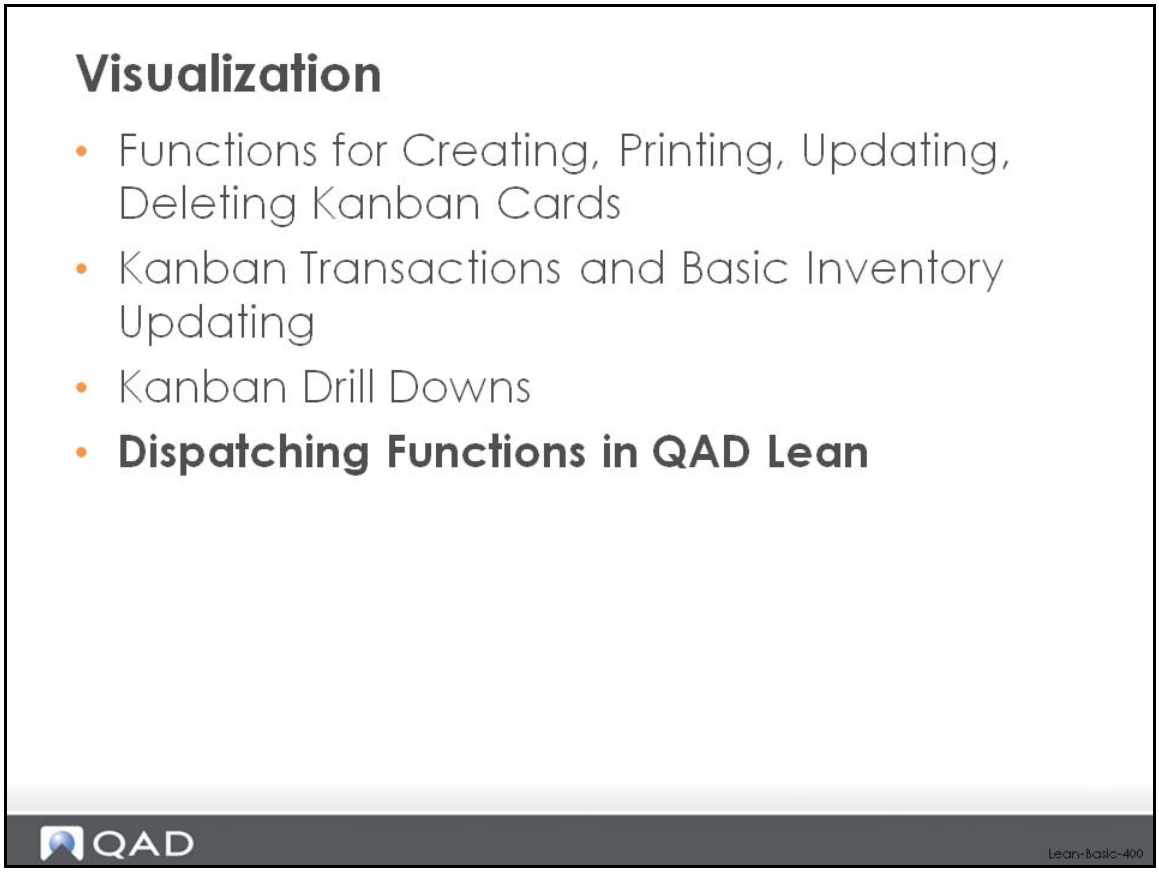



You can “drill down” to the kanban and inventory transaction histories associated with kanban transactions using either the Item/Loop/Card Transaction View or Item/Loop Transactions View functions that are on the Kanban Transactions menu of the system. The Item/Loop/Card Transaction view drills down from the part number to the specific loop to the specific card to retrieve the transaction histories. The Item/Loop Transaction view drills down from the part number to the loop and then the transaction histories.

### Check Your Loop Parameters

If you are getting unexpected results or the transactions are not behaving as you expected, check the Kanban Control Parameters and the Kanban Loop Parameters. These dictate basic transaction behavior, including whether inventory updates are performed as part of the kanban reporting, whether and which of the kanban transactions must be reported in the logical Fill-Consume sequence, how frequently a card can be reported against, etc.

# Visualization




### Dispatching and Visualization Functions in QAD Lean

The essence of kanban systems is visual control – and assuming that the visualizations will be done electronically and not via a traditional visual control board, the mechanisms for doing this in QAD Lean are:

- Kanban Dispatch List
- Kanban Visualization (part of Supply Visualization)

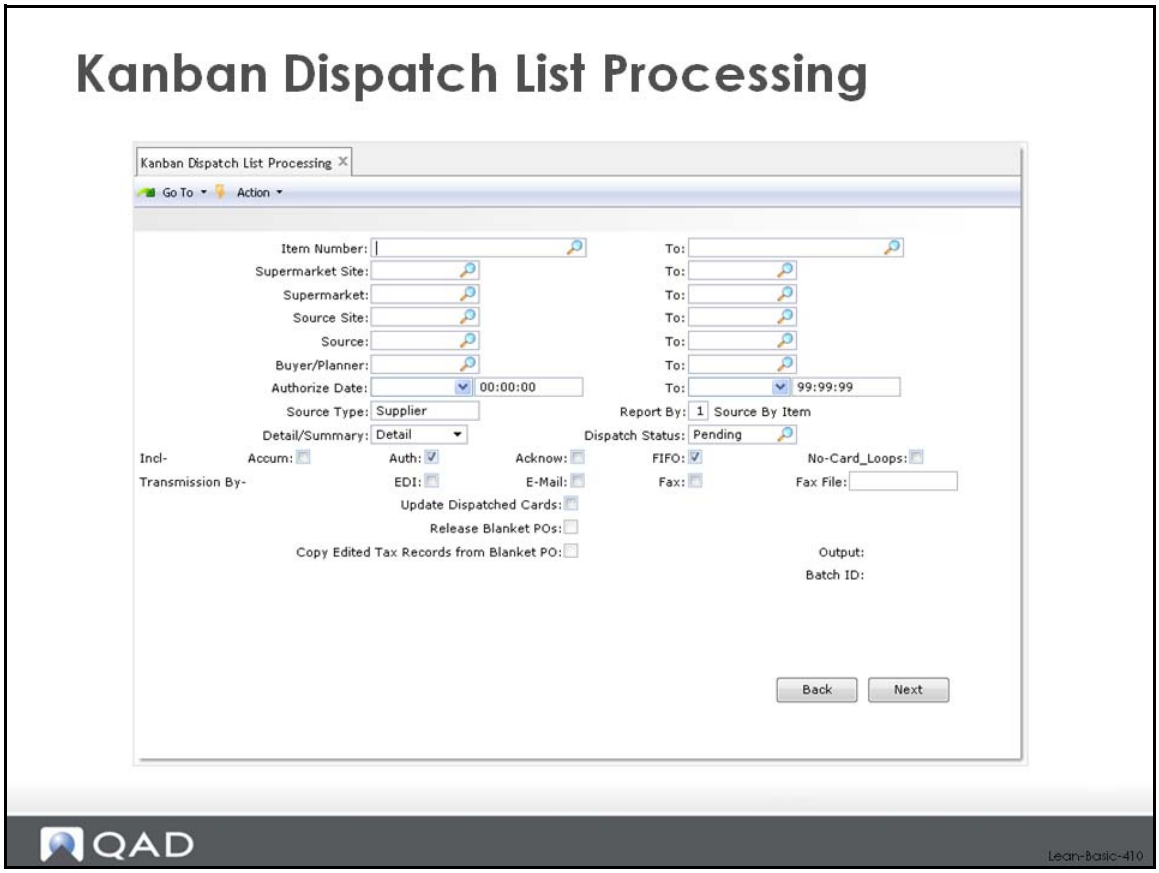
These electronic versions of the traditional mechanisms can be especially helpful when there isn't a close proximity between the person who needs the information and the source of the information. For example, a supplier in a distant city may need to see kanban authorizations and the status of the kanban loop and yet he is a thousand miles away. Or the vice president in charge of manufacturing may be interested in the status and performance of a particular machining center but isn't in the shop at the time. Or someone in customer service may need to know when a particular job is scheduled in the assembly cell in order to provide feedback to the customer. Information about each of these situations is provided by the visualizations in QAD EA.

### Kanban Dispatch List

The Kanban Dispatch List shows all the work authorized in the pull system. It provides the same function as a "visual kanban control board".

This capability in the system provides a way to signal suppliers when new kanbans have been authorized, as well as to show them all the outstanding replenishment signals. In an internal production process, it shows the work that needs to be done, in the order in which it was authorized (or in some other specified sequence), for the authorized lot sizes.

## Kanban Dispatch List Processing




The Kanban Dispatch List is initiated by selecting “Kanban Dispatch List Processing” in the Kanban Dispatch Menu. The user will be presented with the following selection screen above.

*Selection Criteria and Restrictions.* These selection criteria work in the normal way and along the lines of other selection screens in QAD Enterprise Applications. The user can specify a range of items, supermarket sites and supermarkets, source sites and sources (process, supermarket, supplier), a range of kanban planners, as well as a range of dates. The user can restrict the selection to a specific type of source (supplier, internal process, supermarket) and specify the sort sequence (“Report By”), indicate whether the dispatch report should show each individual kanban card (“Detail/Summary = Detail”) or a single summary line for all authorized cards at the same time for a part (“Detail/Summary = Summary”), as well as whether kanban cards that have already been communicated via the dispatch list should be displayed again (Dispatch Status = Pending means show only newly authorized cards, = Dispatch means show only the cards that have already been communicated, = All means all cards).

For a dispatch list being produced for an internal manufacturing process, the normal “report by” sort sequence option is 3 – sort by date and time of authorization.

*Types of Kanban Cards Displayed.* Normally the dispatch list would show the authorized kanban cards for the specified source or sources. However, the user can specify that the report should show cards that have other statuses as well. Simply check the appropriate status box or boxes (*Accum, Auth, Acknow, FIFO*) to specify which type or types of kanban cards will be displayed.

Checking the “Auth and FIFO” boxes produces a dispatch list of all authorized work for the source.

The “Accum” box causes the system to show cards that are currently empty and accumulating to the lot size or the fixed ordering interval. If you were to select only cards in this status you would generate the equivalent of the visual “load assembly board”, which shows empty cards that have not yet been authorized.

Check the “Acknow” box to include cards that have already been communicated to the source and which the source has acknowledged will be filled. Sometimes, especially for internal process sources, companies using the software use the “acknowledged” status to indicate the cards that have been authorized and are now set up and/or running.

*Communications Mechanism.* Checkboxes allow the user to specify how the dispatch data should be communicated to the source of supply:

- EDI
- Email
- Fax

These transmission methods are in addition to the printed report which could be mailed to the supplier. Notice that to use the options for EDI, email and fax, you will need additional setup in the system.

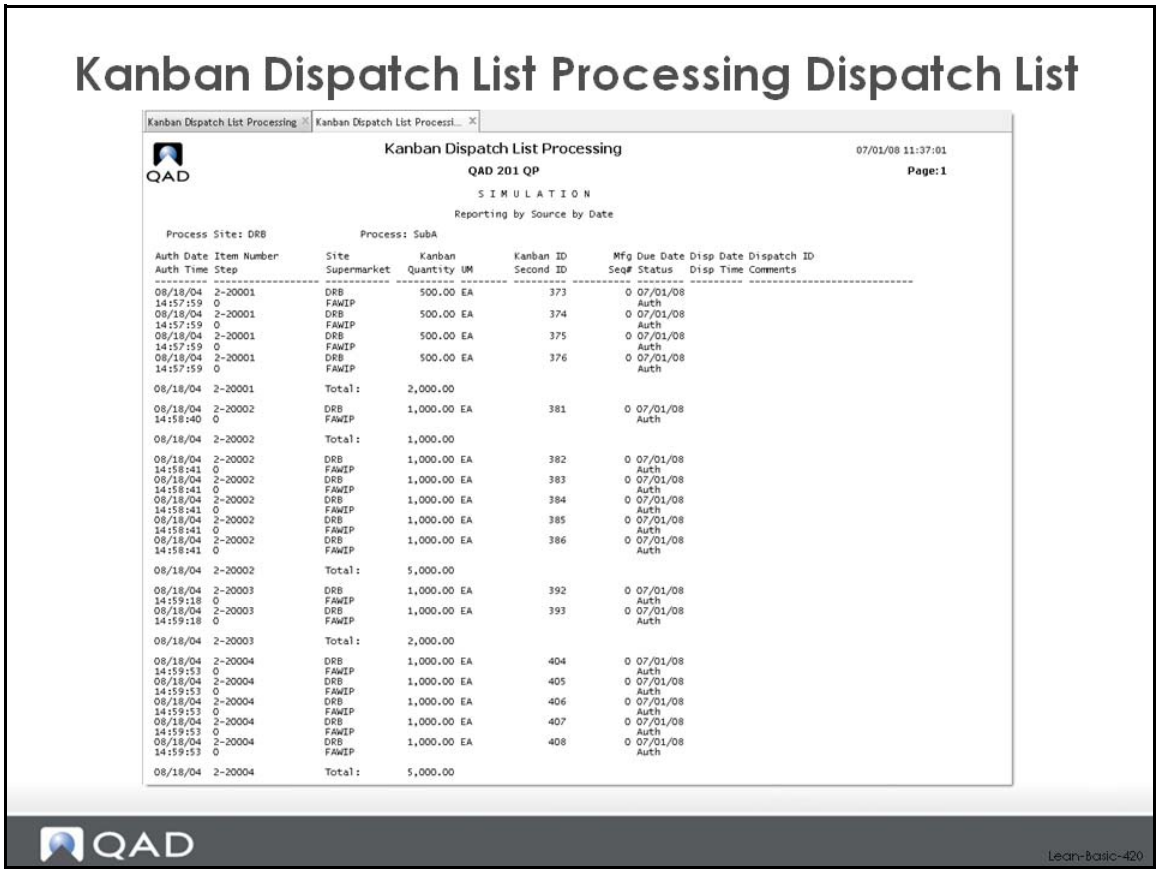
*Processing and Updating Options.* Several updating options are shown at the bottom of the display:

Update Dispatched Cards – by selecting this option, the system will mark each of the cards selected in this run of the dispatch list as “dispatched”. In subsequent runs of the dispatch list, with Dispatch Status = Pending, these cards will not be re-reported. This is the option of use if you only wish to communicate newly authorized cards.

Release Blanket POs – this option causes the system to generate purchase order releases against blanket POs when cards in loops with blanket orders have been authorized.

Copy Edited Tax Records from Blanket PO: refer to the system documentation for detail on this accounting related functionality.\

## Example




A typical dispatch list, run in detail mode, and sorted by authorized date/time within source is shown above.

In this display, you can see for each source:

- Authorized date and time for each card.
- Item number and step associated with each card.
- Destination site and supermarket.
- Kanban quantity and unit of measure.
- Kanban ID (unique card number) and Secondary ID (user field).
- Mfg Seq (fixed product wheel sequence).
- Due date and time.
- Dispatch date and time (when the card was communicated to the supplier).
- Dispatch ID (system identifier for each group of cards communicated to a supplier).

Normally, work would be done in a strict FIFO sequence. The jobs authorized first would be produced first. However, in situations where there is a fixed product sequence, or at least some sequencing consideration that affects the setup time between items, the “Mfg_Seq” information shows the relationship between different items. Where it is possible to run in the product wheel sequence and still meet the due dates, then a team leader in an area might choose to do the work in something other than the strict FIFO sequence.

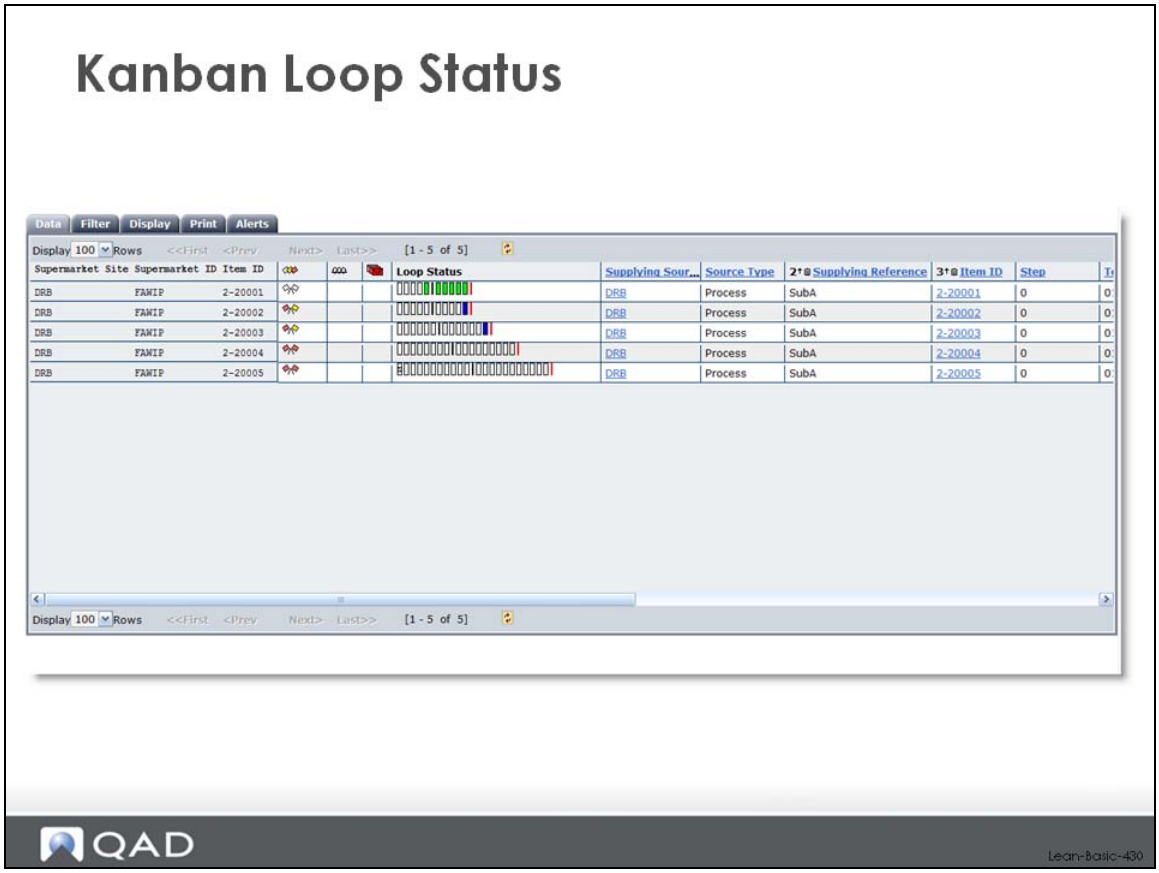
### Kanban Visualization

The module of QAD Enterprise Applications provides extensive functionality for communicating with suppliers and for managing customer/supplier relationships. An important part of Supply Visualization is the Kanban Visualization function that shows the status of kanban cards and kanban loops and provides a way to offer “visual control boards” over long distances. However, it is also possible to use the Kanban Visualization functions to support these visual control boards for internal manufacturing processes as well. The Kanban Visualization displays can be used as a graphical alternative to the Dispatch Report, or they can be used in conjunction with it.

The Kanban Visualization function provides:

- Kanban loop status displays
- Kanban control board (dispatching) displays
- Kanban transaction recording

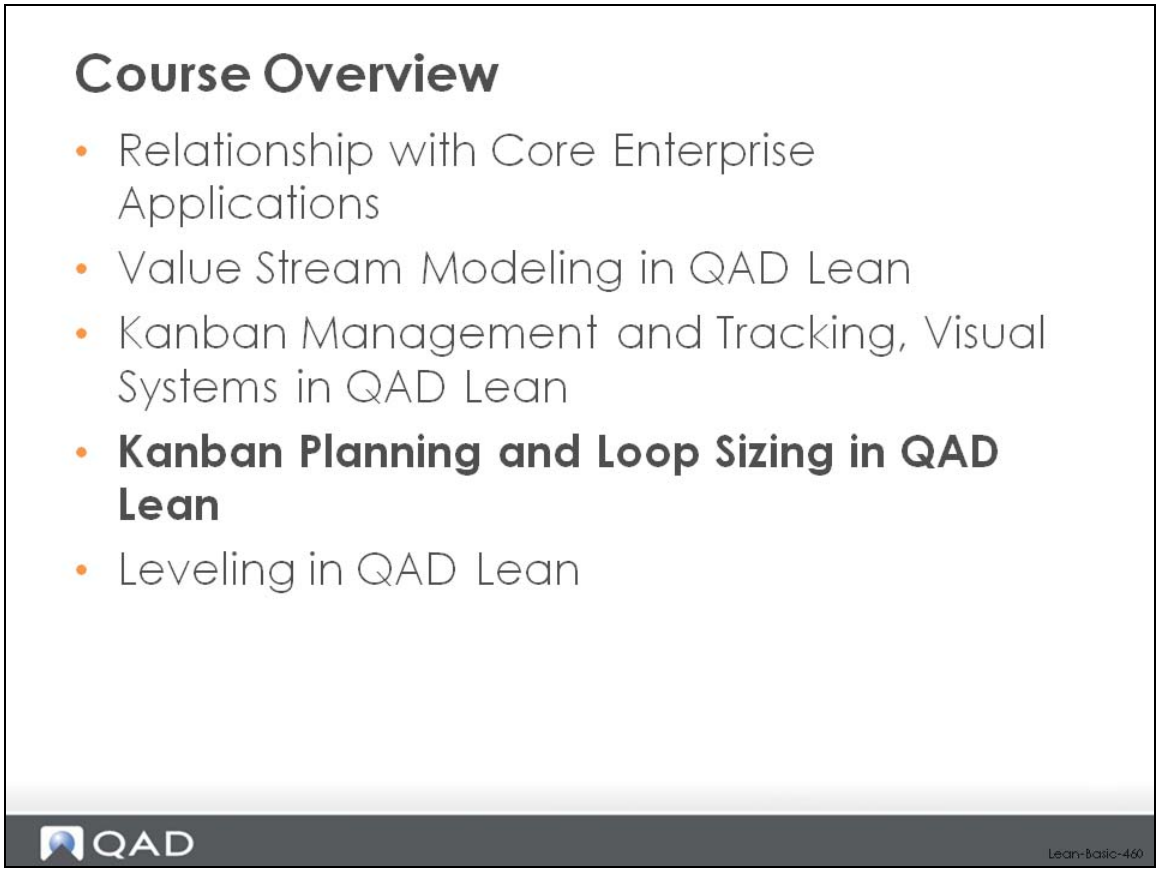
## Kanban Loop Status



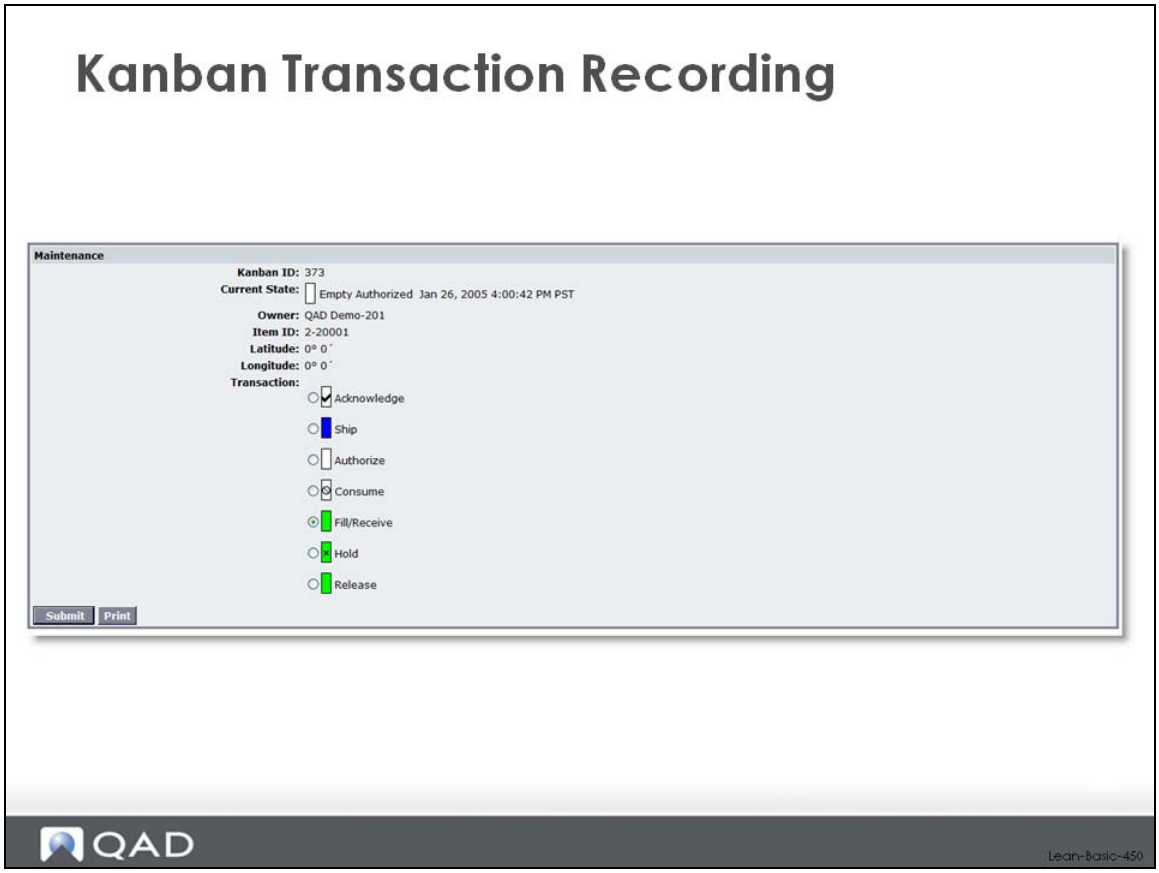
## Kanban Control Board

| Kanban ID | Card State | 1 Kanban ... | Item ID | Kanban Qty | Nex... | Supplying S... | Source Type | Supplying R... | Supermarke... | Number of C... | 2 Authori... |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 373 | [] | 373 | 2-20001 | 500.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 374 | [] | 374 | 2-20001 | 500.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 375 | [] | 375 | 2-20001 | 500.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 376 | [] | 376 | 2-20001 | 500.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 378 | [] | 378 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 379 | [] | 379 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 380 | [] | 380 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 381 | [] | 381 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 382 | [] | 382 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 383 | [] | 383 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 384 | [] | 384 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 385 | [] | 385 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 386 | [] | 386 | 2-20002 | 1000.0 | | DRB | Process | SubA | FAWIP | 10 | 2004-08-18 ... |
| 388 | [] | 388 | 2-20003 | 1000.0 | | DRB | Process | SubA | FAWIP | 13 | 2004-08-18 ... |
| 389 | [] | 389 | 2-20003 | 1000.0 | | DRB | Process | SubA | FAWIP | 13 | 2004-08-18 ... |
| 390 | [] | 390 | 2-20003 | 1000.0 | | DRB | Process | SubA | FAWIP | 13 | 2004-08-18 ... |

## Kanban Planning and Loop Sizing in QAD Lean



## Kanban Transaction Recording




In this part of the class, we'll look at the basic functions for setting up the pull system, sizing kanban loops, and creating the appropriate number of kanban cards. Specific functions we'll look at include:

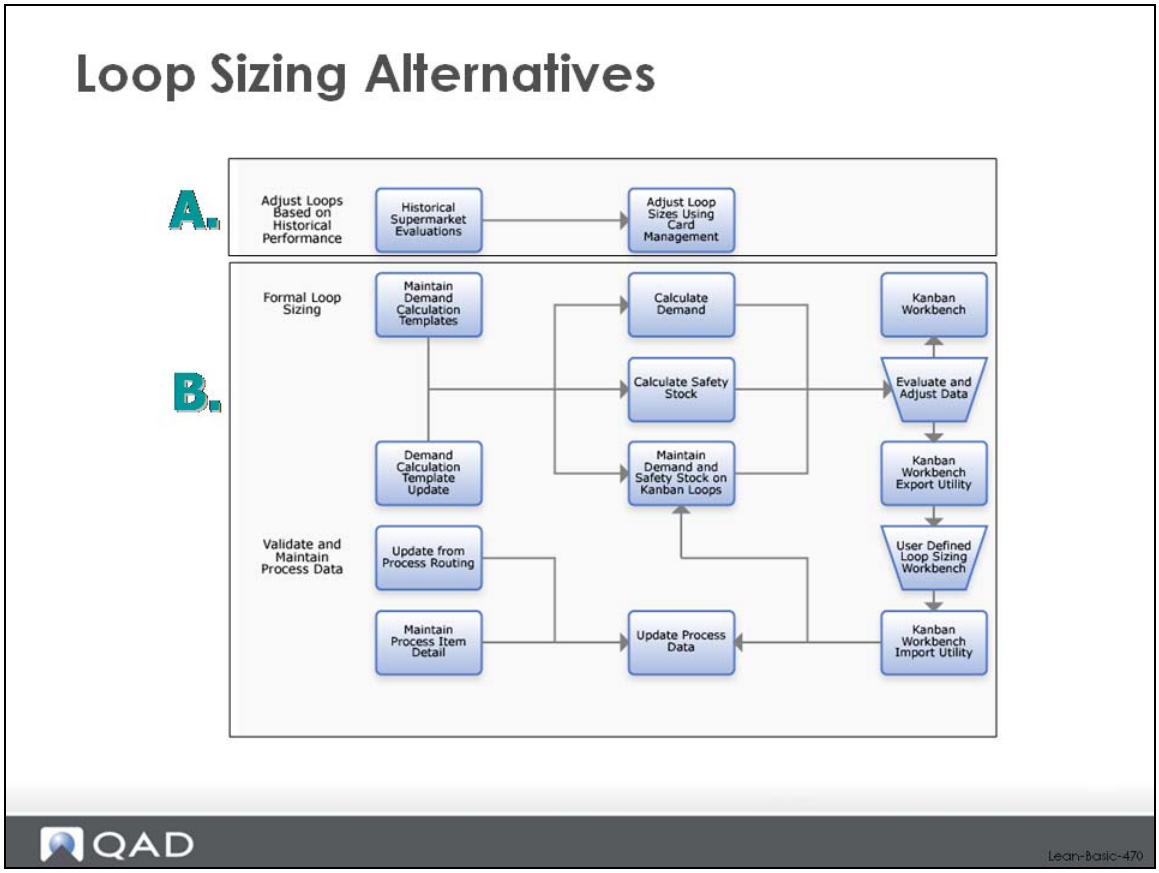
- Average Daily Demand Calculations
- Safety Stock Calculations
- Kanban Workbench

There are two competing schools of thought regarding kanban loop sizing.

The "empirical" (or experimental or observational) method relies on adjusting the inventory buffer or loop size based on its observed performance over time. If the item is experiencing too many stockouts then perhaps the amount of inventory in the loop should be increased. If the inventory for the item never dips below a certain value (for example it never goes below the level of the safety stock), then maybe the level of inventory should be decreased. This observational method is described in "Kanban: Just in Time at Toyota". Bill Sandras explains a similar observational method in his book "Just-in-Time: Making It Happen" which he describes as "one less at a time".

The "theoretical" method is based on a simple mathematical model of inventory behavior based on statistical inventory management principles. The amount of inventory in a loop should be based on the demand during the replenishment time, safety stock, and the order quantity. In this method, when average demand increases or decreases, when replenishment time changes, when the amount of demand variability is greater or smaller, and as the order quantity is adjusted because of process and standards changes, the loop size should be altered.

## Loop Sizing Alternatives




Both methods are supported in QAD Lean and are pictured above.

Which is better? Should you use the empirical or the theoretical method of loop sizing?

The truth is that there is no "best" method. What works for you – or even how you combine the two methods to work together – may be different from what works for other companies. Suffice it to say that if you are just getting started, you'll probably want to size your loops initially based on the theoretical method that models your demand and production process. For many companies, getting an appropriate lot size – neither so small that they run out of capacity because of excessive numbers of set ups nor so large that lead times are extended and excess inventory generated – is a key issue that can't be dealt with easily. The "theoretical" loop sizing method takes the element of emotion and argument out of the process. Once loop sizes are set and the process has been stabilized and made routine, then it may be appropriate to phase in some element of the empirical approach.

In this section of the class, we will look at the "theoretical" method of loop sizing, returning to the empirical method in a later section.

### Assumptions of the Pull System

One of the fundamental assumptions of a pull system is this: "relatively constant and uniform demand". The core idea of pull – replace what was used – depends on having relatively stable and steady demand. While it is possible to buffer demand variability somewhat through the selective

use of safety stock, something we'll discuss in this chapter, the basic logic of the system is to plan based on an average demand level. As demand changes over time, the average demand needs to be recalculated and this may happen as frequently or as infrequently as required. It is certainly possible to recalculate average demand, and the associated kanban loop sizes, on a daily basis although it is probably more common to do it weekly or monthly.

*Average Daily Demand Calculations.* The calculation of average demand in QAD Lean can be done in several different ways:

- Using a kind of "gross requirements calculation", sometimes called a summarized explosion or quick deck explosion, which looks at future forecasts, customer orders, and distribution demands, and explodes them through the bill of material without considering on hand inventories or quantities on order. As you might guess, if you have past due customer orders, they will still be included in the average demand calculation. Past due forecasts will also be used, back to the limit defined by the MRP forecast consumption parameter. The horizon used for the calculation is specified via a parameter, and can vary by part or group of parts.
- Using the average usage based on inventory issue transactions from the transaction history file. The horizon used for the calculation is specified via a parameter, and can vary by part or group of parts.
- A blend of the two. The horizons used for the calculation are specified via a future days and a past days parameter, and can vary by part or group of parts.

For each kanban loop you need to decide – "should the demand be based on historical demands or future projections?" Maybe historical usage reflects demand more accurately than future forecasts and customer orders. Or perhaps future demands are a reasonable reflection of what's likely to happen, but only over a very short horizon.

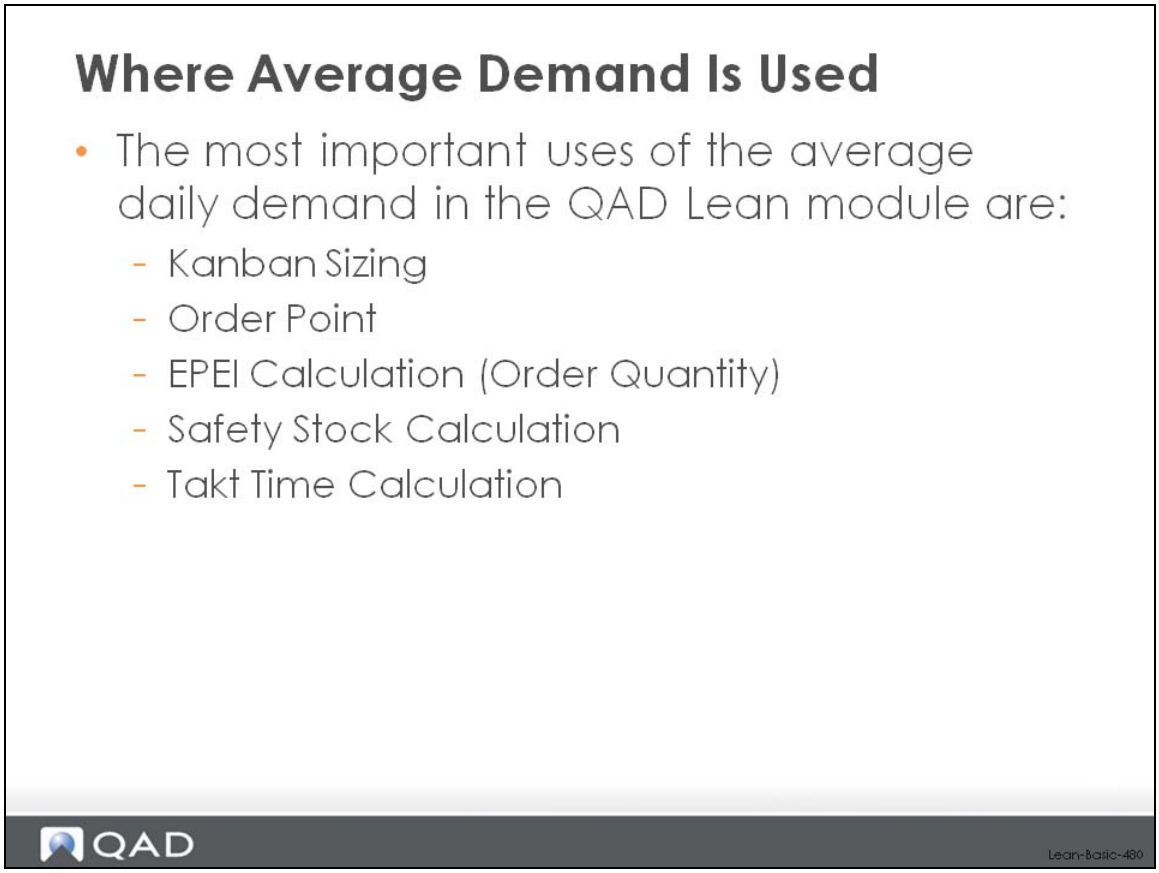
In these cases you may want to use the historical usage as the basis for the average daily demand.

Or it could be that you only want to look at future demand, because history is irrelevant for these parts that you're producing. This would be especially true for a new part, for a part that experiences significant seasonality, or is part of a significant new product introduction/ramp up or a significant product phase out/ramp down.

Or you may want to use a little bit of both: some history to reflect actual usage and some future demands to pick up trends in the forecasts and actual customer orders. In QAD Lean, you specify both the historical and future horizons for the demand calculation, and this can be different from one part to the next.

And regardless of what you decide, the average demand on any given kanban loop must reflect the average demand for the part AND the percentage of demand that is filled from that specific loop. For example, final assembly may move material to a shipping supermarket and it may also move the same part to another supermarket that is part of a company distribution network. Historical demand (the transfers of inventory from the specific supermarkets) will reflect the exact usage of the part. But demand in the future is calculated for the part and then "prorated" based on what percent of the total typically goes to the specific supermarket.

## Where Average Demand Is Used




In a case where 50% of the demand goes to one supermarket and 50% goes to the other, the appropriate percentage would be loaded to the kanban loop record (the demand percent in the loop) and this data would be used in calculating average daily demand.

So why is average daily demand calculation so important to these lean functions? Why not simply set the average daily demand manually for each kanban loop?

QAD Lean will allow you to manually set average daily demand on each kanban loop. Simply use the Kanban Master Maintenance function in the system. However, as with any data that is set and maintained manually, there is usually a significant effort required to develop and maintain the data. In some cases that means that the data will not be updated as frequently as it should, and in other cases that means that it will not be as accurate as it needs to be.

For kanban sizing, the average daily demand drives both the order point and the order quantity calculations.

1. The basic order point calculation (order point = demand during replenishment lead time plus safety stock) uses the average daily demand directly in determining demand during replenishment lead time, and indirectly in cases where safety stock has been calculated from demand variability. A comprehensive order point calculation also uses the average daily

demand in its calculation of FIFO stock (demand during the FIFO lead time) and in its calculation of demand during a fixed ordering interval in a variable quantity/fixed kanban system.

2 For manufactured parts the average demand will also contribute to the order quantity calculation. This is because the average daily demand is a key input to the EPE Interval calculation, and the EPE Interval is the most important factor in setting the order quantity. The lot size or order quantity must be large enough to cover the demand during the production interval (EPE I).

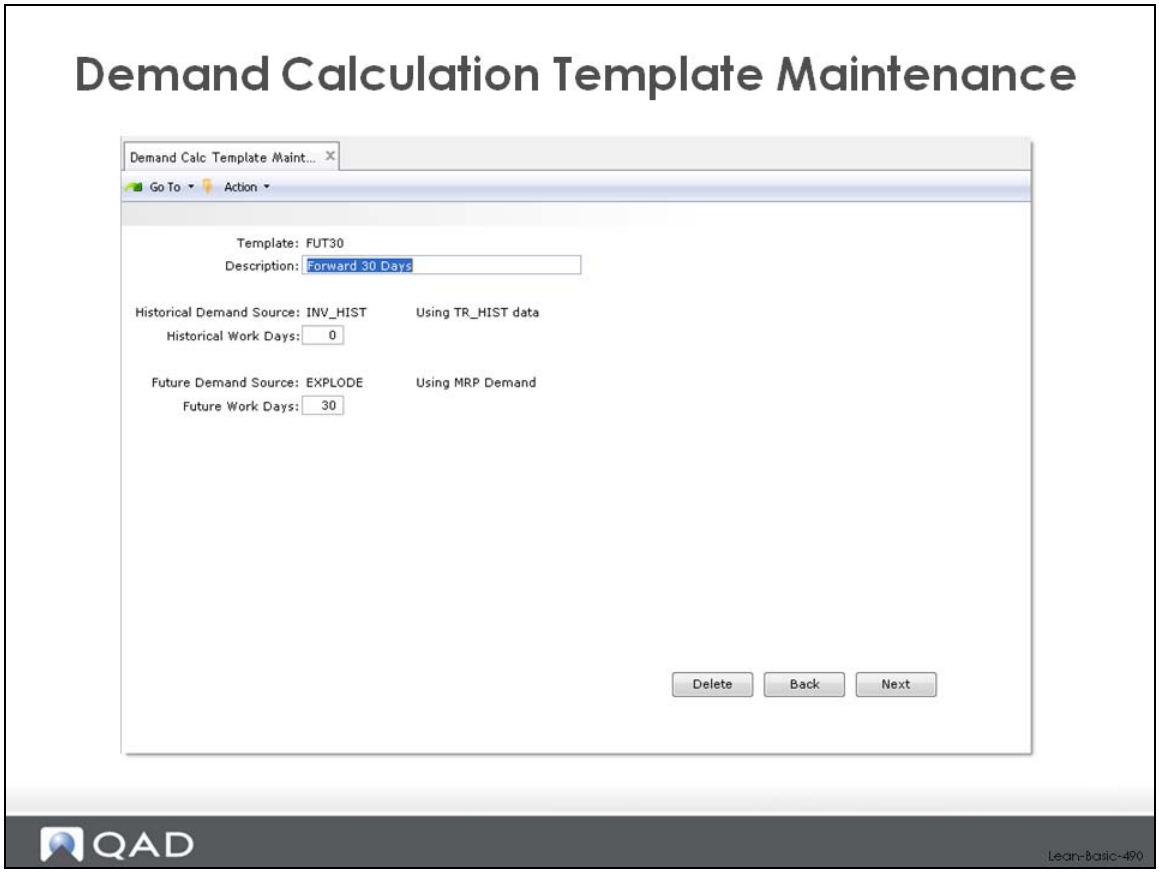
Average daily demand is a key input to the “statistical” calculations of safety stock in the system, because both of the calculations involve a measurement of demand variability based on average demand. The so-called *simple* method for calculating safety stock computes the average demand variability over time, and then, based on a user specified service level, determines how much safety stock is required. In the *peak* method, the safety stock is set to the difference between the largest observed peak demand and the average demand.

Finally, the average daily demand is an input to the takt time calculation in the system. Takt time for a process is the normal working time per day divided by the total average daily demand for all the parts produced in the process. This is the drumbeat of production that must be met to synchronize with customer needs.

### Demand “Templates” Determine the Method, Horizon, and Loops

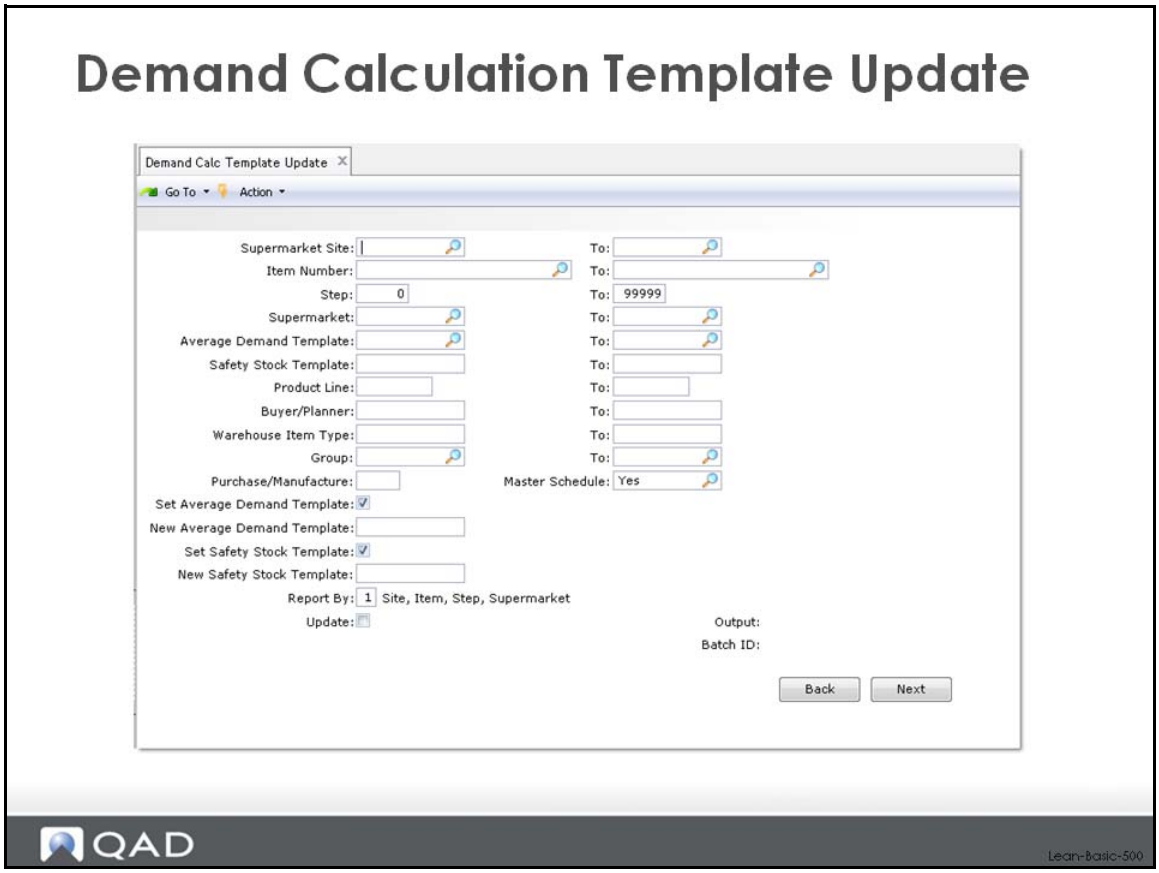
The “average demand” functionality in QAD Lean is built around the idea of “demand templates” that specify the calculation method and the horizon parameter and that can be assigned or reassigned to different kanban loops. For example, one user might set up a demand template called FUT30 that specifies the gross requirements calculation over a 30 day forward horizon, and assign this template to all of his parts. Another user might set up a template called PAST20 that specifies using historical usage over 20 past days, and assign this template to most or all of his parts.

## Demand Calculation Template Maintenance




An example of the demand template for Fut30 is shown above.

## Demand Calculation Template Update




Once templates have been set up, they can be assigned to individual items through Kanban Master Maintenance, or a group of items can be “mass updated” using the Demand Calculation Template Update. The Demand Calculation Template Update function is shown.

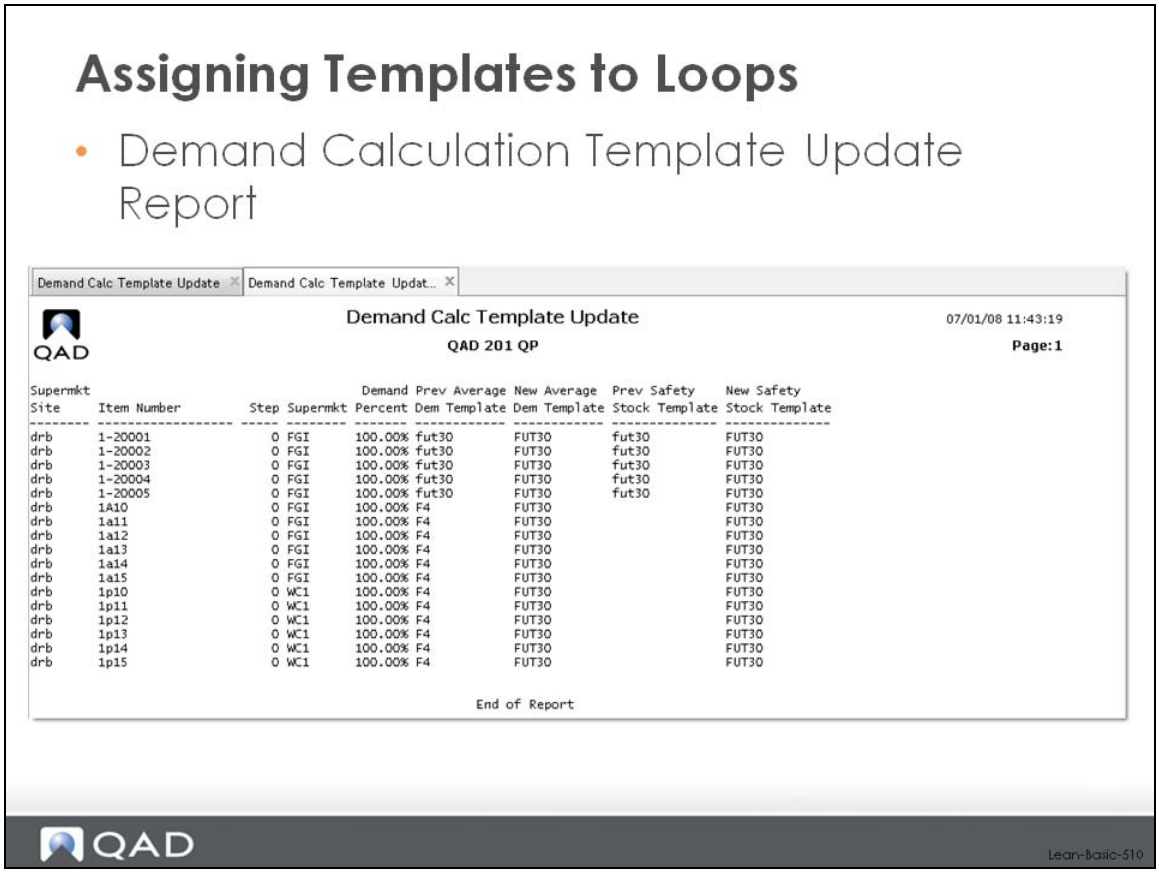
The selection criteria in this display work in the normal way and along the lines of other selection screens in QAD Enterprise Applications.

The user can select kanban loops based on:

- A supermarket site or range of sites for the destination supermarket
- An item number or range of item numbers
- A step or range of steps
- A destination supermarket or range of supermarkets
- The parts that have been assigned an existing demand template or range of templates.
- The parts that have been assigned an existing demand template or range of templates for the safety stock calculations.
- A product line or range of product lines.
- A buyer/planner or range of buyer planners.
- A warehouse item type or range of types.
- A group or range of groups.
- A particular category (purchased or manufactured) of part.

- The master schedule code.

## Assigning Templates to Loops

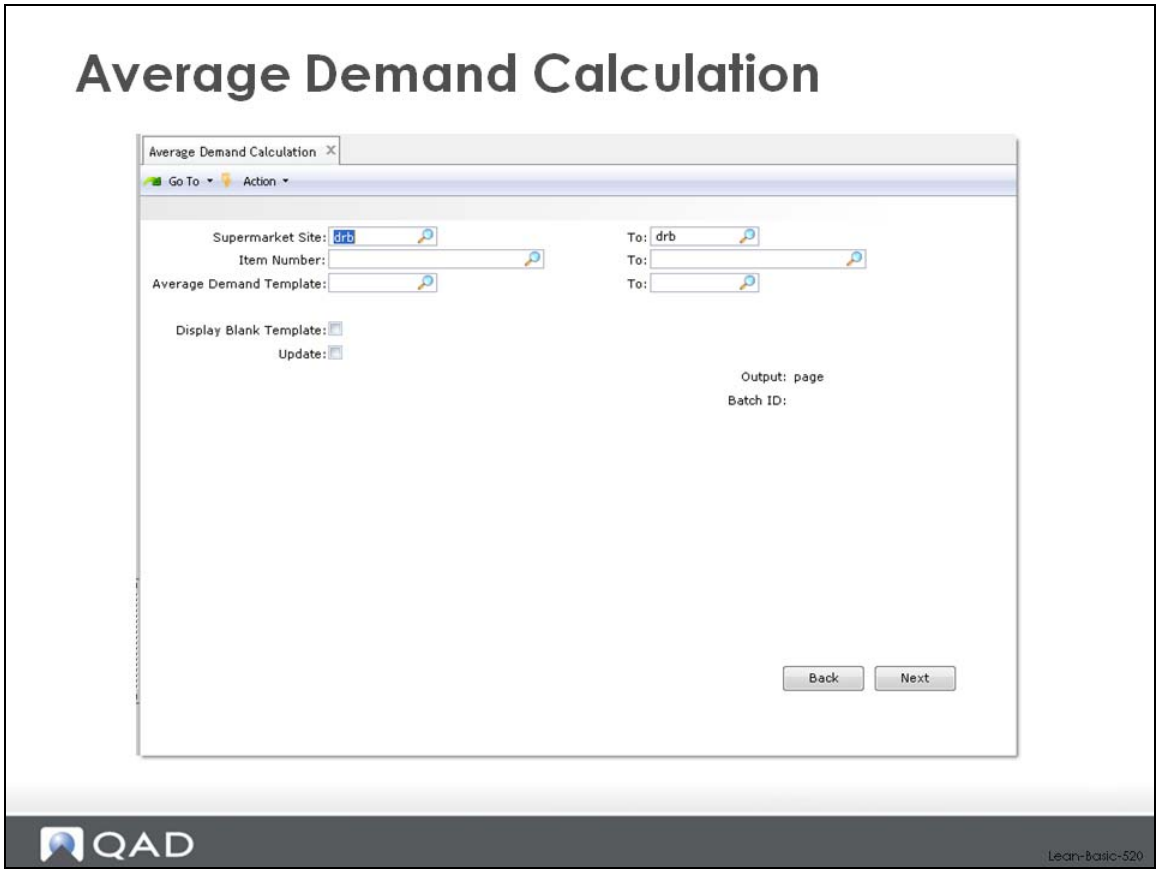



| Supermkt Site | Item Number | Step | Supermkt | Demand Percent | Prev Average Dem Template | New Average Dem Template | Prev Safety Stock Template | New Safety Stock Template |
|---|---|---|---|---|---|---|---|---|
| drb | 1-20001 | 0 | FGI | 100.00% | fut30 | FUT30 | fut30 | FUT30 |
| drb | 1-20002 | 0 | FGI | 100.00% | fut30 | FUT30 | fut30 | FUT30 |
| drb | 1-20003 | 0 | FGI | 100.00% | fut30 | FUT30 | fut30 | FUT30 |
| drb | 1-20004 | 0 | FGI | 100.00% | fut30 | FUT30 | fut30 | FUT30 |
| drb | 1-20005 | 0 | FGI | 100.00% | fut30 | FUT30 | fut30 | FUT30 |
| drb | 1A10 | 0 | FGI | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1a11 | 0 | FGI | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1a12 | 0 | FGI | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1a13 | 0 | FGI | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1a14 | 0 | FGI | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1a15 | 0 | FGI | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1p10 | 0 | WC1 | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1p11 | 0 | WC1 | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1p12 | 0 | WC1 | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1p13 | 0 | WC1 | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1p14 | 0 | WC1 | 100.00% | F4 | FUT30 | | FUT30 |
| drb | 1p15 | 0 | WC1 | 100.00% | F4 | FUT30 | | FUT30 |

Additional functionality exists to assign templates for safety stock and average demand calculations based on the selection. Check the “Set Average Demand Template” and/or the “Set Safety Stock Template” boxes and specify the appropriate demand or safety stock template to be used in the calculations for the set of selected parts. If you check the “Update” box, then the system will actually update the loop records for the selected parts. Otherwise the Demand Calc Template Update will operate like a simulation and no updating will be done.

The system produces this audit report (regardless of whether the update was done or not)

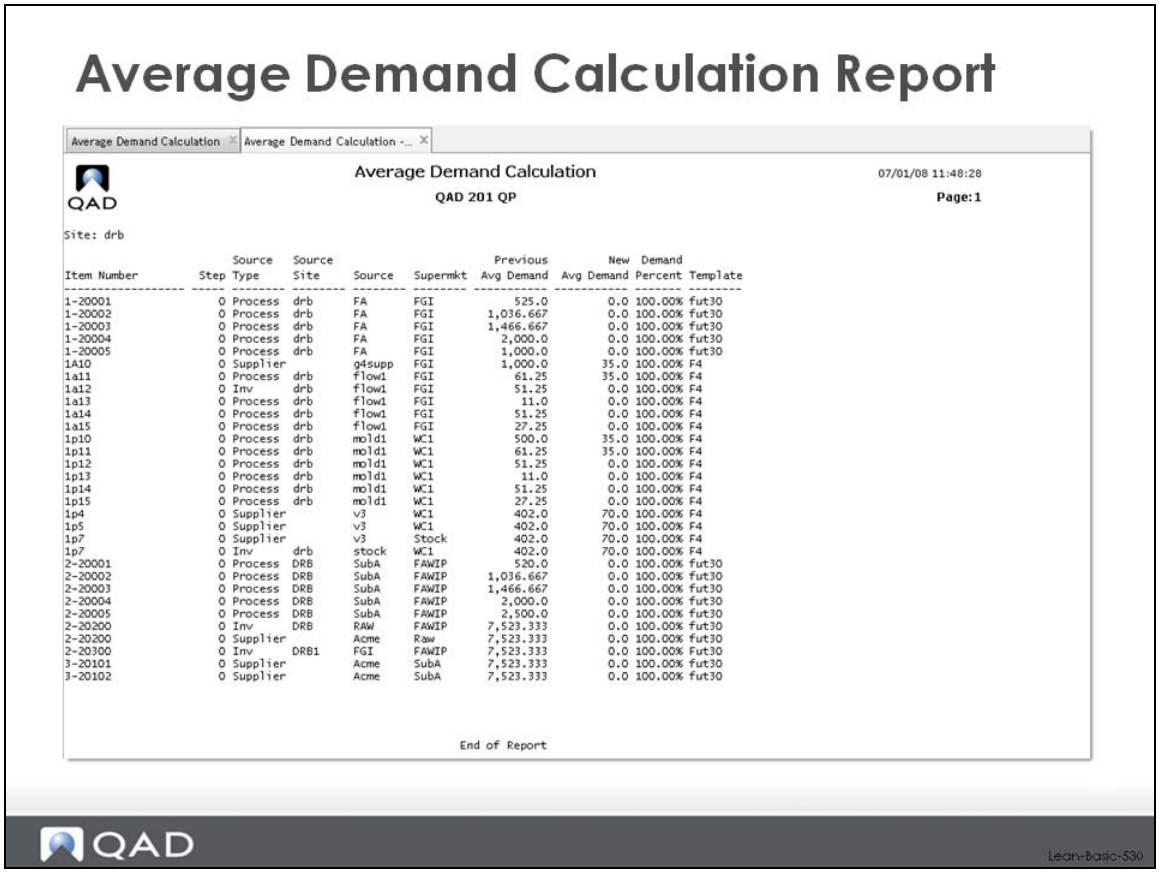
## Running the Average Demand Calculation




After templates have been assigned to individual items, it is possible to calculate average demand:

Here the user can specify a supermarket site or range of sites, an item number or range, or a template or range of templates. The “Update” checkbox controls whether the system updates the database or simply prints an “audit report” showing what would have happened:

## Average Demand Calculation Report




| Item Number | Step | Source Type | Source Site | Source | Supermkt | Previous Avg Demand | New Avg Demand | Demand Percent | Template |
|---|---|---|---|---|---|---|---|---|---|
| 1-20001 | 0 | Process | drb | FA | FGI | 525.0 | 0.0 | 100.00% | fut30 |
| 1-20002 | 0 | Process | drb | FA | FGI | 1,036.667 | 0.0 | 100.00% | fut30 |
| 1-20003 | 0 | Process | drb | FA | FGI | 1,466.667 | 0.0 | 100.00% | fut30 |
| 1-20004 | 0 | Process | drb | FA | FGI | 2,000.0 | 0.0 | 100.00% | fut30 |
| 1-20005 | 0 | Process | drb | FA | FGI | 1,000.0 | 0.0 | 100.00% | fut30 |
| 1A10 | 0 | Supplier | | g4supp | FGI | 1,000.0 | 35.0 | 100.00% | F4 |
| 1a11 | 0 | Process | drb | flow1 | FGI | 61.25 | 35.0 | 100.00% | F4 |
| 1a12 | 0 | Inv | drb | flow1 | FGI | 51.25 | 0.0 | 100.00% | F4 |
| 1a13 | 0 | Process | drb | flow1 | FGI | 11.0 | 0.0 | 100.00% | F4 |
| 1a14 | 0 | Process | drb | flow1 | FGI | 51.25 | 0.0 | 100.00% | F4 |
| 1a15 | 0 | Process | drb | flow1 | FGI | 27.25 | 0.0 | 100.00% | F4 |
| 1p10 | 0 | Process | drb | mold1 | WC1 | 500.0 | 35.0 | 100.00% | F4 |
| 1p11 | 0 | Process | drb | mold1 | WC1 | 61.25 | 35.0 | 100.00% | F4 |
| 1p12 | 0 | Process | drb | mold1 | WC1 | 51.25 | 0.0 | 100.00% | F4 |
| 1p13 | 0 | Process | drb | mold1 | WC1 | 11.0 | 0.0 | 100.00% | F4 |
| 1p14 | 0 | Process | drb | mold1 | WC1 | 51.25 | 0.0 | 100.00% | F4 |
| 1p15 | 0 | Process | drb | mold1 | WC1 | 27.25 | 0.0 | 100.00% | F4 |
| 1p4 | 0 | Supplier | | v3 | WC1 | 402.0 | 70.0 | 100.00% | F4 |
| 1p5 | 0 | Supplier | | v3 | WC1 | 402.0 | 70.0 | 100.00% | F4 |
| 1p7 | 0 | Supplier | | v3 | Stock | 402.0 | 70.0 | 100.00% | F4 |
| 1p7 | 0 | Inv | drb | stock | WC1 | 402.0 | 70.0 | 100.00% | F4 |
| 2-20001 | 0 | Process | DRB | SubA | FAWIP | 520.0 | 0.0 | 100.00% | fut30 |
| 2-20002 | 0 | Process | DRB | SubA | FAWIP | 1,036.667 | 0.0 | 100.00% | fut30 |
| 2-20003 | 0 | Process | DRB | SubA | FAWIP | 1,466.667 | 0.0 | 100.00% | fut30 |
| 2-20004 | 0 | Process | DRB | SubA | FAWIP | 2,000.0 | 0.0 | 100.00% | fut30 |
| 2-20005 | 0 | Process | DRB | SubA | FAWIP | 2,500.0 | 0.0 | 100.00% | fut30 |
| 2-20200 | 0 | Inv | DRB | RAW | FAWIP | 7,523.333 | 0.0 | 100.00% | fut30 |
| 2-20200 | 0 | Supplier | | Acme | Raw | 7,523.333 | 0.0 | 100.00% | fut30 |
| 2-20300 | 0 | Inv | DRB1 | FGI | FAWIP | 7,523.333 | 0.0 | 100.00% | fut30 |
| 3-20101 | 0 | Supplier | | Acme | SubA | 7,523.333 | 0.0 | 100.00% | fut30 |
| 3-20102 | 0 | Supplier | | Acme | SubA | 7,523.333 | 0.0 | 100.00% | fut30 |

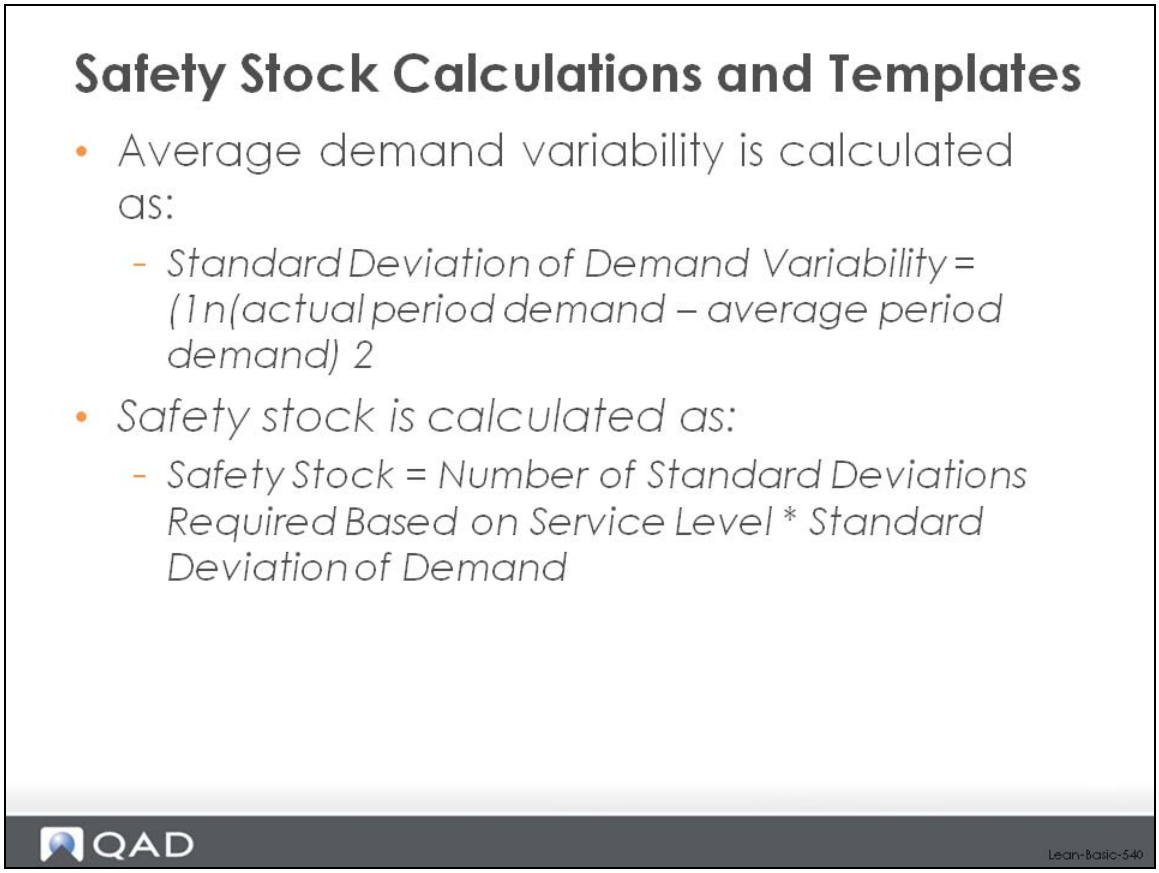
The Update control in the average demand calculation allows you:

Assess the magnitude of a demand change before changing the system and resizing kanban loops.

Do “what if” analysis and look at different calculations of demand before committing to a specific number.

Review the data and look for obvious errors or problems before kicking off a whole series of downstream processes.

## Safety Stock Calculations and Templates

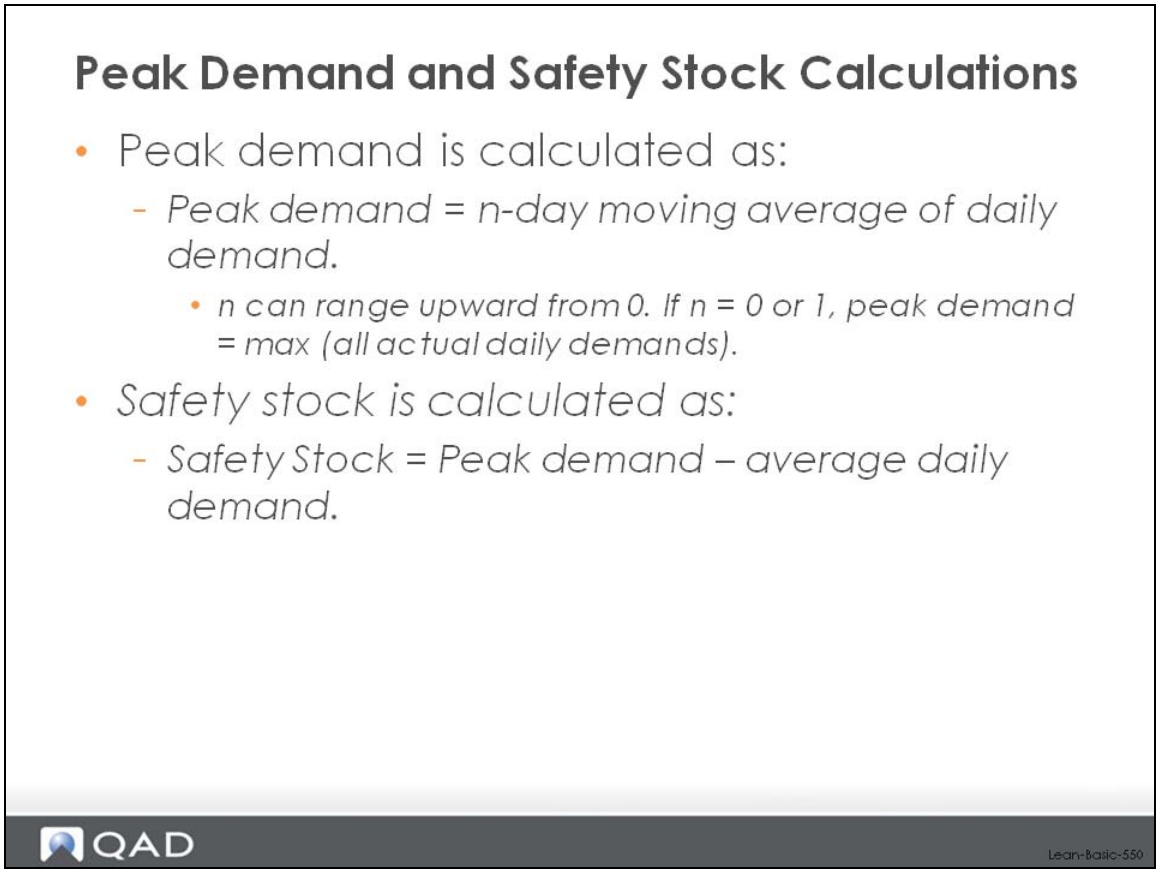



The same basic functionality for assigning templates to individual items or groups of items, and for running the average demand calculations for a range of parts also applies to the safety stock calculations in the system.

It's worth noting that, at the present time, only items with independent demand (forecasts or customer order) are included in the safety stock calculation. If you want safety stock on items with only dependent demand, you must set it manually.

The way the safety calculation works is based on parameters associated with the loop (safety stock method – either statistical, "peak" or average, desired service level), etc. In the simple safety stock method, the system does a traditional statistical safety stock calculation based on variability and specified service level. (See image above)

## Peak Demand and Safety Stock Calculations




The idea here is that you are trying to set safety stock based on some customer service level you've decided on, and are basically saying “given this amount of demand variability how much safety stock would I need to carry to get X% customer service?”

Of course, as you probably know, there’s no amount of inventory that can guarantee 100% customer service. But what about 98%? Or 95%? You can set your desired service level to whatever value you feel is appropriate, and the QAD Lean module will calculate the amount of safety stock needed to support that, assuming only that you have a “normal”, statistically unbiased statement of demand.

In the peak safety stock method, the system does a slightly different kind of calculation and one that is less sensitive to whether your forecast is biased. The peak calculation determines the difference between “peak demand” and average demand. See image above.

The rational for calculating an “average peak” based on an n-day moving average is that even though the peak demand appears on a specific day, often there is an allowable response time for dealing with that demand. For example, many companies use their replenishment lead time as an approximation of the typical or allowable response time. By doing this, the magnitude of the pure peak demand is reduced and less safety stock is required to meet it.

Say for instance, you want to look at average demand over the past two months compared to the maximum peak demand by week. In this instance you might have average daily demand of 50 but a maximum average peak of 75. Therefore you would need to carry 25 units in inventory as a safety stock to make sure you cover typical variations in demand.

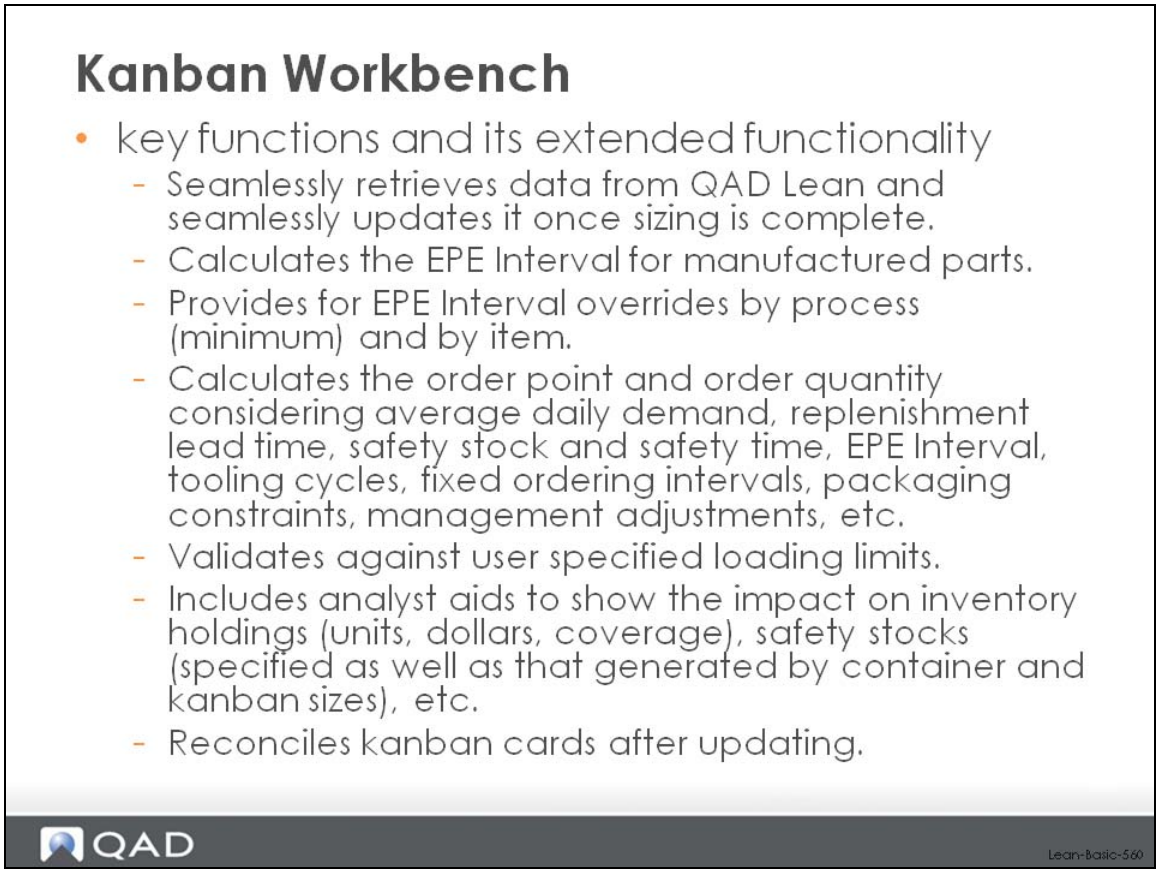
*Kanban Workbench.* The Kanban Workbench in QAD Lean is a comprehensive function for determining the size of kanban loops based on demand, lead time, safety stock, cycle and setup time, fixed and variable ordering intervals, and other logistics constraints. It is an interactive tool that can be run in simulation mode, and then saved back to the main database. This way you can simulate changes to the loop sizing factors, see the impact, adjust, etc. until you are happy with the results and choose to save and update.

Often the earlier adopters of pull systems struggled with loop sizing. How do we ensure that we have enough inventory in the loop to maintain some semblance of flow? How small can our lot sizes be before we start running out of capacity from too many setups? What about purchased parts on fixed ordering intervals? How should we size those loops? What's the inventory investment we're making if we commit to some set of loop sizes? How many times will we really setup each week? How much safety stock is being generated by our choices of container or kanban quantities? What kind of load do we generate on our processes? All these questions, and more, are ones that need answers.

To get answers, users of kanban have frequently built sizing "workbenches" using MS Excel, and have often gotten good results from this approach. But sometimes, because Excel is such a well known tool, and so easily modifiable, different kanban planners in the same company will often have different workbenches with different logic for sizing their processes and associated loops. Add to that the problem of getting data out of the manufacturing database and back in after being run through the Excel workbench and you can see some of the problems that these users faced.

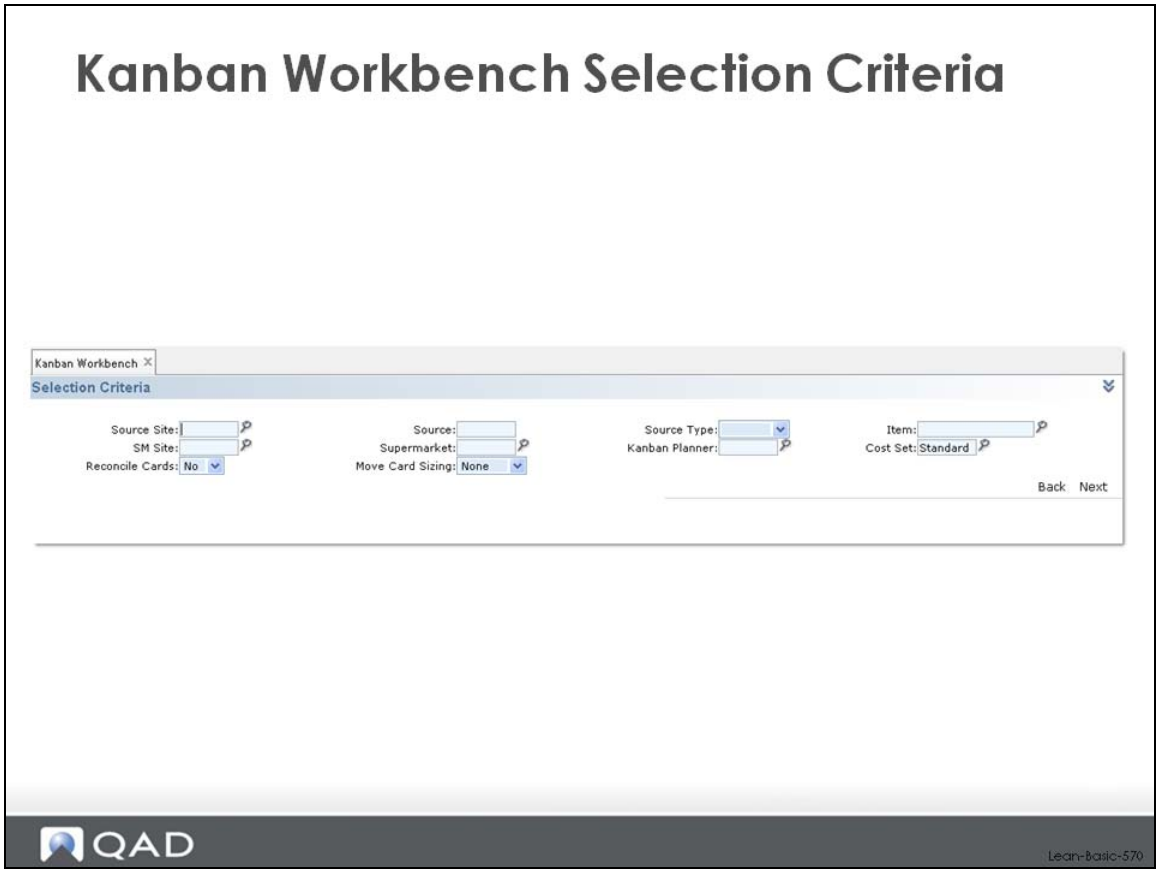
The Kanban Workbench in QAD Lean was specifically designed as a general purpose, standardized function that included the normal logic for kanban loop sizing and was connected directly to the QAD Lean database. The idea was to move the loop designers out of spreadsheet design and data entry into usage. This way the kanban planners can spend more time focusing on "what's the best size for my kanban loop" rather than on "does my spreadsheet have the correct logic" and "did I get the data in correctly".

## Kanban Workbench



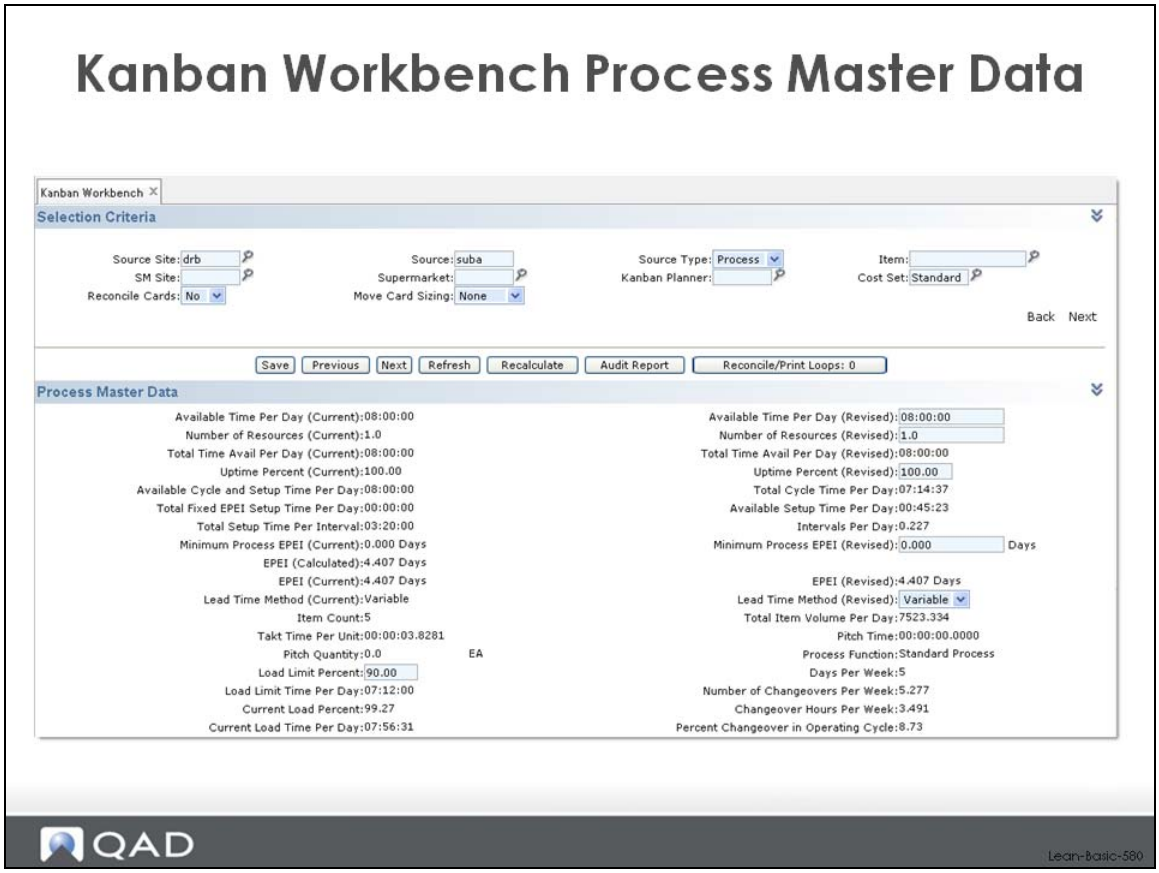

Retrieves data from QAD Lean as input to user developed Excel workbenches, and subsequently updates the QAD Lean database after user sizing calculations are saved.

## Selection for Sizing




A user can select loops associated with a particular source (process, supermarket, supplier), loops whose destination is a particular destination supermarket, loops associated with a particular planner, loops for a particular item or part, or an individual loop. This is done using the selection criteria screen shown above.

## Kanban Workbench Process Master Data




After selection, the system will return a multi-frame workbench that includes:

- Process Master (summary) Data, including the calculated EPE Interval (source = process only)
- Process Detail Data, including cycle and setup time, yield factor (source = process only)
- Sizing Data
- Analyst Data

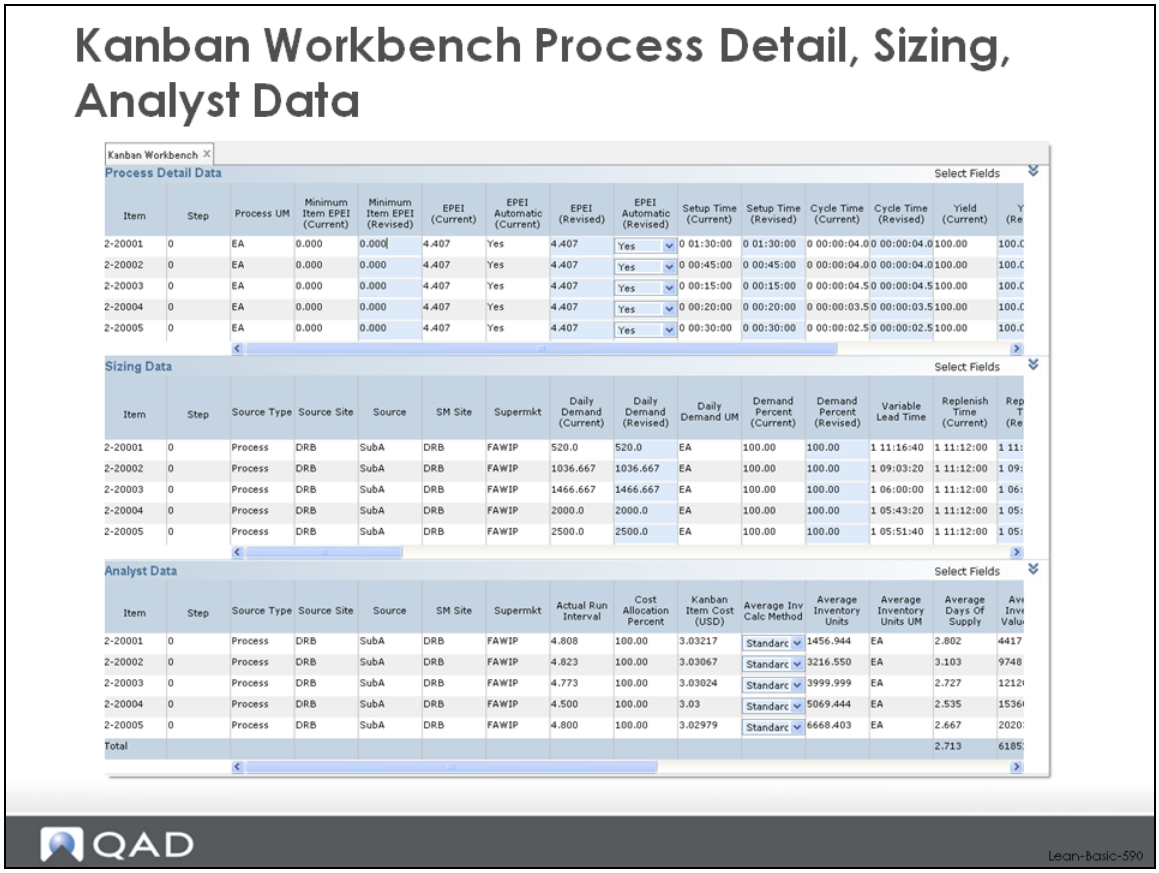
The Kanban Workbench Process Master Data frame, shown above, displays the key process data (time in a normal day, number of resources, uptime, etc.) as well as the essential calculations for the source process. These include the EPE Interval, takt time, current load time per day versus load limit, number of changeovers in one week, changeover hours per week, changeover expressed as a percentage of time in the EPE Interval.

Arguably the most important calculation, at least from the perspective of kanban loop sizing, is the EPE Interval calculation. The Process Master Data displays the elements of this calculation (available time in a day, cycle time per day, fixed setup time per day because of item EPEI overrides, net time available for setup per day, and total setup time for all other parts). These are used in the calculation to get the smallest possible production interval. This can be overridden by the user in cases where it makes sense to run to a larger interval. The override can be specified in the Minimum Process EPEI.

Data in the blue boxes can be changed so that you can simulate the effects of changes to the process. This is where you can add or reduce the time in a normal day, increase or decrease the number of machine resources, increase or decrease the uptime in the process, override the EPE Interval by specifying a “minimum process EPEI”, and control whether you want replenishment lead times calculated automatically or not.

Notice the control buttons located between the selection criteria and the process master data. These allow you to save data back to the live database, refresh the data in the workbench from the live database, produce an audit report of changes you’ve made, and reconcile your kanban cards based on the new loop sizing. The *next* and *previous* buttons will move you through the detailed loop data twenty records at a time. If you change any of data values in the workbench and then *save* the results back to the database, your changes will be stored and become the permanent values used in subsequent sizing and other calculations. If you refresh without saving, then the system will discard your changes and return the original (last saved) data from the database to the workbench.

## Kanban Workbench Process Detail, Sizing, Analyst Data




The Process Detail Data frame, shown above, provides process detail data like item EPEI overrides, setup and cycle times, yield factors, and adjusted daily demand considering the process yield.

You can maintain the key Process Detail Data fields here in the workbench. Available for updating are:

- Minimum Item EPEI
- Setup Time
- Cycle Time
- Yield Factor

You can use these fields for initial data loads or for making minor adjustments, or for simulating the results of kaizen events that you may have underway or in planning.

Many companies use the workbench as a kind of “mass maintenance” function in the system. Instead of loading setup time, cycle time, and yield factors using the Process Item Detail maintenance screens, they update the data here. For example, you can move up and down columns of data, tab from one field to another, key data directly or copy and paste, etc. as a way to quickly update these data fields. The data will be used by the workbench immediately, and when you hit the “save” button you can save it back to the database.

The Sizing Data frame (also shown) shows the balance of the basic data needed for loop sizing, as well as the details of the loop sizing calculation.

For each loop, the key details include:

- Average daily demand (assumes you've updated this before running the workbench, either manually or using the average daily demand calculation in the system).
- Demand percent
- Lead time elements (replenishment time, internal and external FIFO time)
- Replenishment lead time
- Calculated demand during lead time
- Safety stock
- Safety time
- Variability factor
- Calculated order point
- EPE Interval
- Calculated order quantity
- Units per kanban
- Final order point
- Final order quantity
- Maximum inventory (order point plus order quantity)
- Number of order point cards
- Number of order quantity cards
- Total cards
- Current card total
- Change in number of cards from sizing

The basic idea of the kanban sizing logic in the system is to determine how frequently you can set up (the EPE Interval) each item, how much inventory is needed in the loop as a way to cover the interval between setups as well as the lead time between replenishments, what the effect of packaging might be, etc. It's one thing to say that the order quantity is ten, but if the packaging quantity is 25, then the kanban loop will need to be sized for that consideration (or the package size needs to change). An even with safety stock, you also have to have enough inventory in the loop to cover your order quantity, the time that it takes you to produce your order quantity, the time it takes to go through the FIFO lane, and any transit times or wait times. A fixed ordering interval arrangement with your supplier adds another consideration.If you communicate your needs to the supplier every hour, the loop requires substantially less inventory that if you communicate weekly.

You can maintain the key Sizing Data fields here in the workbench.

Available for updating are:

- Average daily demand (assumes you've updated this before running the workbench, either manually or using the average daily demand calculation in the system).
- Demand percent
- Replenishment time
- Internal FIFO time
- External FIFO time

- Safety stock
- Safety time
- Variability factor
- Packs per kanban
- Card reporting control
- Fractional kanban control
- Order quantity multiple (in cards)
- Card reconciliation control
- Run out option

You can use these fields for initial data loads or for making minor adjustments, or for simulating the results of kaizen events that you may have underway or in planning. Many companies use the workbench as a kind of “mass maintenance” function in the system. Instead of maintaining these fields individually using Kanban Master Maintenance, or in the case of the demand and safety stock through the batch processes, they update the data here. For example, you can move up and down columns of data, tab from one field to another, key data directly or copy and paste, etc. as a way to quickly update these data fields. The data will be used by the workbench immediately, and when you hit the “save” button you can save it back to the database.

The workbench provides a summarized analysis for benefit of the kanban planner/loop designer. This analysis is shown in the “Analyst Data” frame of the workbench.

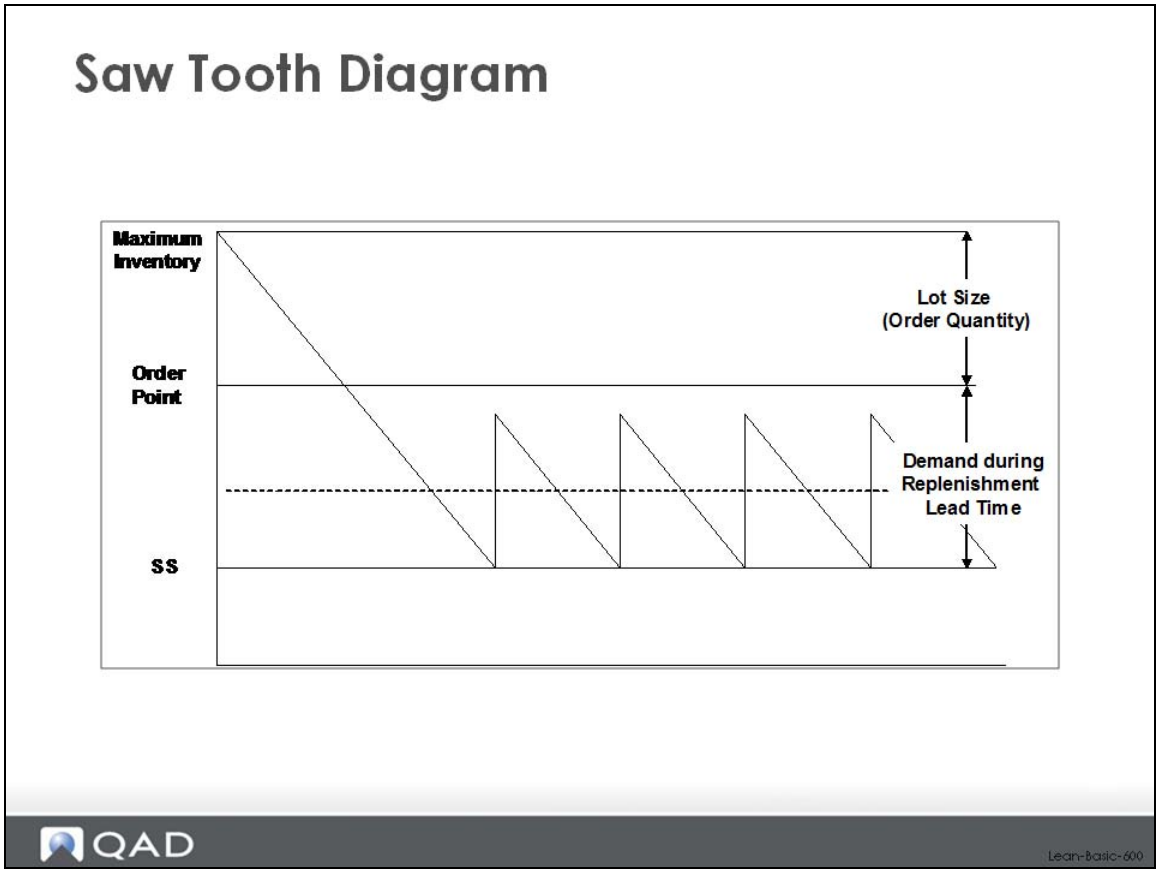
The Analyst Data frame helps the kanban planner understand the impact of his or her decisions on things like inventory investment, safety stock levels, actual production intervals, and loading. By simulating different conditions the kanban planner can choose the “optimal” loop sizes.

Shown for each loop, and in many cases as an overall total:

- Actual run interval
- Average inventory
- Average coverage
- Average inventory investment
- Safety stock and safety time
- Container generated safety stock
- Total safety stock investment
- Safety factor based on safety stocks and loading
- Loading statistics

This data allows for more precise control and management of inventory and your manufacturing assets. For example, safety stock, while providing an important function in the system, is “sitting inventory” and often represents money that can be better spent elsewhere. By calculating the real amount of safety stock that you are carrying, you're managing your investment and your inventory dollars, and perhaps improve overall inventory flows at the same time.

## Saw Tooth Diagram




In this frame you can maintain the Average Inventory Calculation control which determines how the average loop inventory is calculated in the system. The standard calculation ("Standard") models a typical "saw tooth diagram" like the one shown in the diagram above. (Note that the diagram below is showing the behavior of the supermarket inventory only – it does not model total inventory behavior like the Average Inventory Calculation. However the basic concept remains the same: inventory oscillates back and forth in kind of a sawtooth way.) The alternative calculation ("MFG1") is a more complicated calculation that attempts to model inventory behavior accounting for the fact that all the material is not received into the supermarket all at the same time. If you change the control, the new value will be used by the workbench immediately, and when you hit the "save" button you can save it back to the database.

The example above for process SubA illustrates how a kanban planner might use the kanban workbench to evaluate process changes that might benefit the company. An astute kanban planner probably would look at the EPE Interval for SubA (4.4 days), and without looking at anything else, conclude that there was a big opportunity in the cell. By looking at the analyst data for the cell, he or she might get a sense of the financial opportunity – a substantial inventory savings from the current level of $61,000.

But the question is – what is the best way to reduce the EPEI and achieve a savings?

- The "bucks and bodies" solution is one alternative. Add overtime or additional resources (machines or people) and the EPE Interval will be smaller but there will be a cost in labor or equipment.

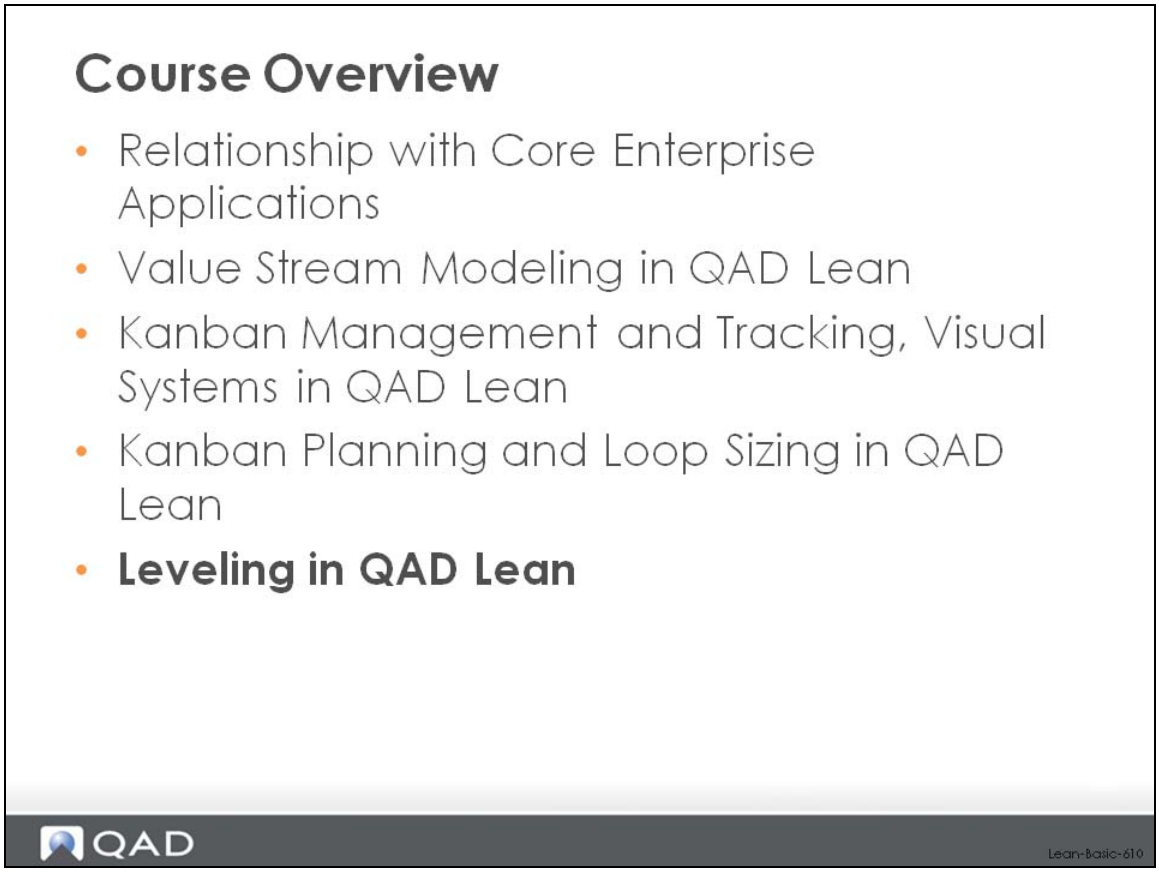
- “Speeding up” the process – improving the cycle time – is another alternative but probably has minimal effect.
- Reducing setup on one or more of the items being produced will often improve the interval, especially when the setups are large.
- Running one or more of the items at a different frequency (overriding the EPE I selectively by item) will change the interval and may result in overall lower inventory depending on how it is done.

The workbench is a tremendous help in managing the number of loops that you need to design and maintain. However, many times users have already invested a lot of time and effort into building their own Excel spreadsheets to provide these same functions. Here there may be similar, comfortable tools but no easy way to get the data from the core ERP system into the spreadsheet, or back out when the sizing is over.

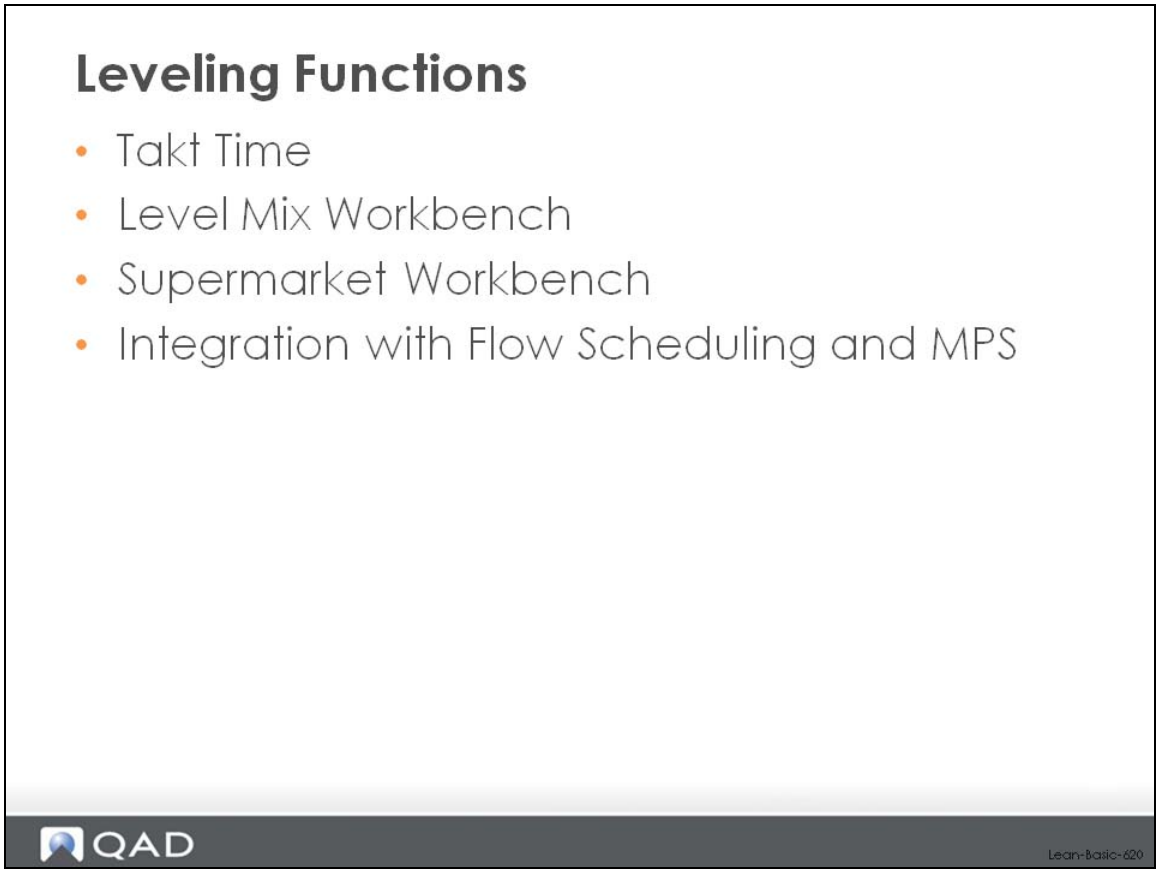
QAD Lean provides functions to help with this problem. Specifically, the system provides an export program that you can export the data and load that into your Excel spreadsheets, and an import program to get the data out of the Excel spreadsheet and import it back into QAD Enterprise Applications. To use these functions, all that is required is that you modify your spreadsheets to:

- Read the imported data from a specifically formatted comma delimited format.
- Write data that is coming back to QAD Lean to a specifically formatted comma delimited format.

## Leveling in QAD Lean



## Leveling Functions




In this part of the class, we'll look at the basic functions for leveling volume and mix in the system, and for using the leveled schedule to drive other processes and projections. Specific functions we'll look at include:

- Takt Time
- Level Mix Workbench
- Supermarket Workbench
- Integration with Flow Scheduling and MPS

We'll first return to a subject – takt time – that we discussed earlier in the class and spend a little more time considering why it's so important to planning and execution processes.

### Takt Time: Drumbeat

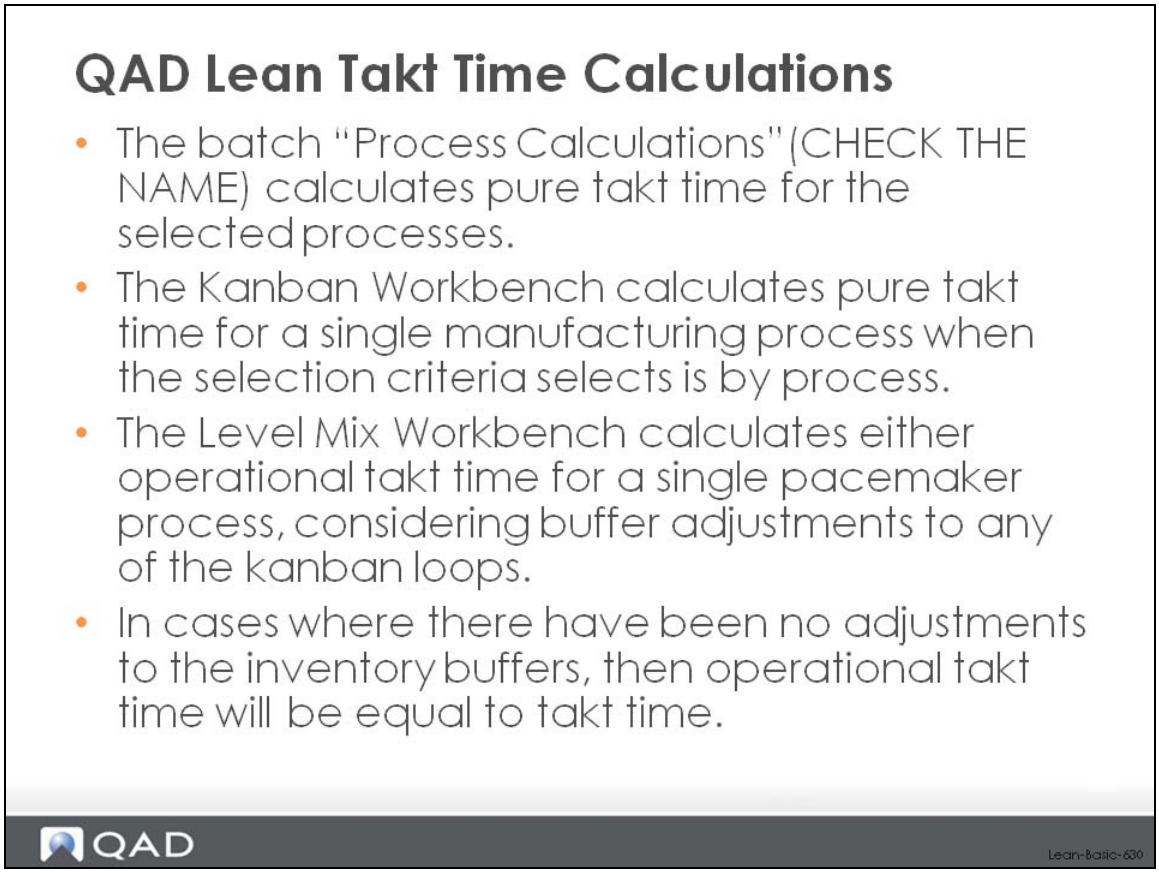
Takt time represents the rate of output from your supply chain if you are fully synchronized with your customers: one visor every 30 seconds, a completed fork lift truck every 20 minutes, one aircraft every 5 days 4 hours and 12 minutes, etc. Operational takt time represents the rate of output from the supply chain taking into consideration customer demand, adjustments to inventory buffers, and any temporary work time adjustments.

Ideally, takt time should equal operational takt time. However there will be times when they will not be equal – when the inventory buffer is being increased to compensate for increased levels of demand variability for example, the operational takt time will be smaller (more units need to be

produced in the same period of time). Or if the inventory buffer is being reduced, because of increased flexibility in the factory, the operational takt time will be larger than the takt time (fewer units need to be produced in the period of time). Or if the takt time cannot be met based on normal working time and the current cell design, temporarily increasing the available time through temporary overtime or a Saturday ship will reduce the operational takt time.

Both calculations are very important. In the long run, the least costly way to operate is to meet customer demand without increasing inventory levels and without running overtime or with additional shifts. However, it may not be possible in the short term to meet the takt time given the design of the cell and the number of operators available. Or there may be a need to increase output levels because demand variability is increasing and more inventory is needed. Running at pure takt time is the ultimate objective, but in the short term it may be necessary to run at a different rate.

## QAD Lean Takt Time Calculations




Do we need takt time for all processes?

Knowing the takt time for pacemaker processes is essential. Takt time for the pacemaker sets the drumbeat for all upstream processes (where the pull system is operating) and downstream for the FIFO processes through which the product must flow to get to the customer.

"Running to takt" is also essential for establishing level demand for the upstream materials. If you have leveled the schedule and then are producing at takt, then you should be withdrawing materials at a leveled rate as well – which will send an image of the drumbeat to the upstream processes in the form of pull signals, as well as flowing product to the downstream FIFO processes at the same rate.

### Leveling and the QAD Lean Level Mix Workbench

The Level Mix Workbench in QAD Lean provides a comprehensive tool for leveling both the volume and mix of products produced in each pacemaker. Leveling is done considering operational takt time (takt time), the EPE Interval for the process, time scheduled per day, and time scheduled per shift. The leveling calculation has the overall objective of allowing you to create a constant production drumbeat at the pacemaker process, and with important functions for:

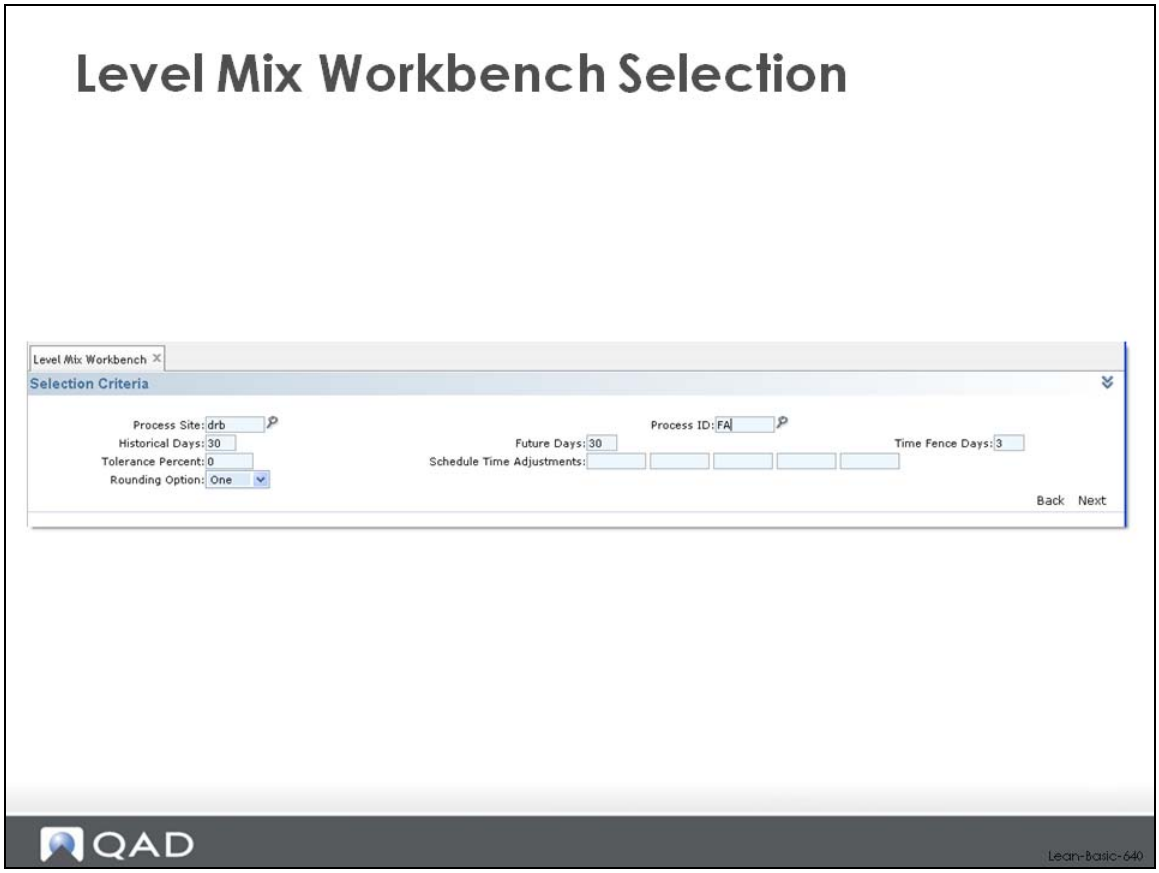
- Variable calendar, user-controlled horizon and time fence
- Automatic level schedule calculation
- Integrated with flow schedules

- User specified buffer adjustments to reflect agreed changes in inventory levels, in both volume and mix
- User override of schedule
- Product wheel sequencing
- Simulation processing to evaluate potential schedules before updating the system

Depending on your industry and the relationship you have with your customers, you may use the Level Mix Workbench to create a leveled plan (master schedule) to drive supplier schedules but use a conventional heijunka box for executing against real customer orders. Or the Level Mix Workbench might operate both for planning and execution: the leveled plan into the future would drive supplier schedules as well as dictate the execution schedules for the pacemaker process. How you operate is your own choice, and in some respects will be determined by the size of your customer order backlog. If you have a very short backlog (a few hours to a few days, where you are typically shipping from finished goods stock), then you'll probably use the output of the Level Mix Workbench for planning only. However, if you are like Toyota, where the backlog of firm orders stretches several months into the future, you may use the output of the Level Mix Workbench for both planning and execution.

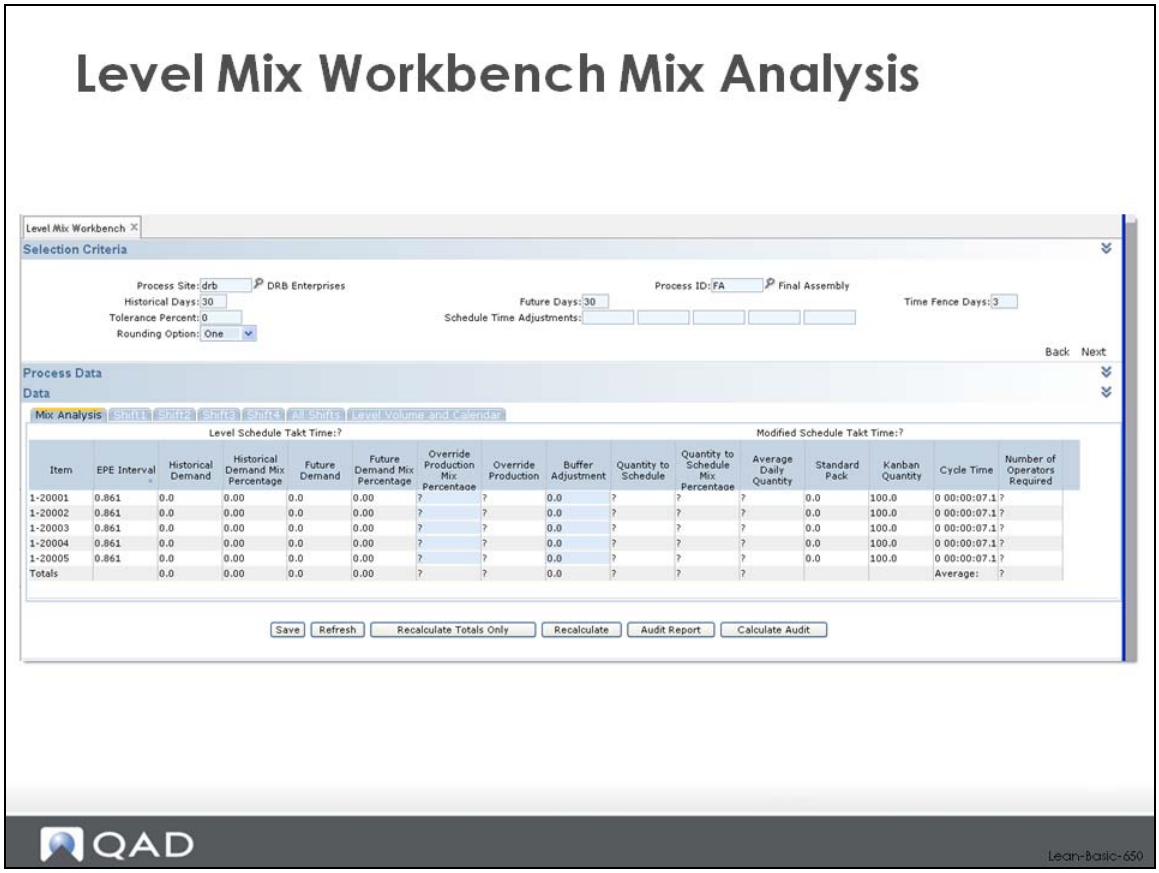
Leveling is a key component of managing demand variability. Even in a situation with erratic, non-linear customer demand, through the use of a finished goods supermarket and level scheduling, the demand fluctuation passed into the supply chain can be reduced substantially. Work can be done at relatively constant pace, and scheduled so that you're producing each item more frequently and carrying less inventory overall.

## Selection for Sizing




A user can select all the kanban loops associated with a particular process source using the selection criteria screen shown above.

## Major Tabs and Frames

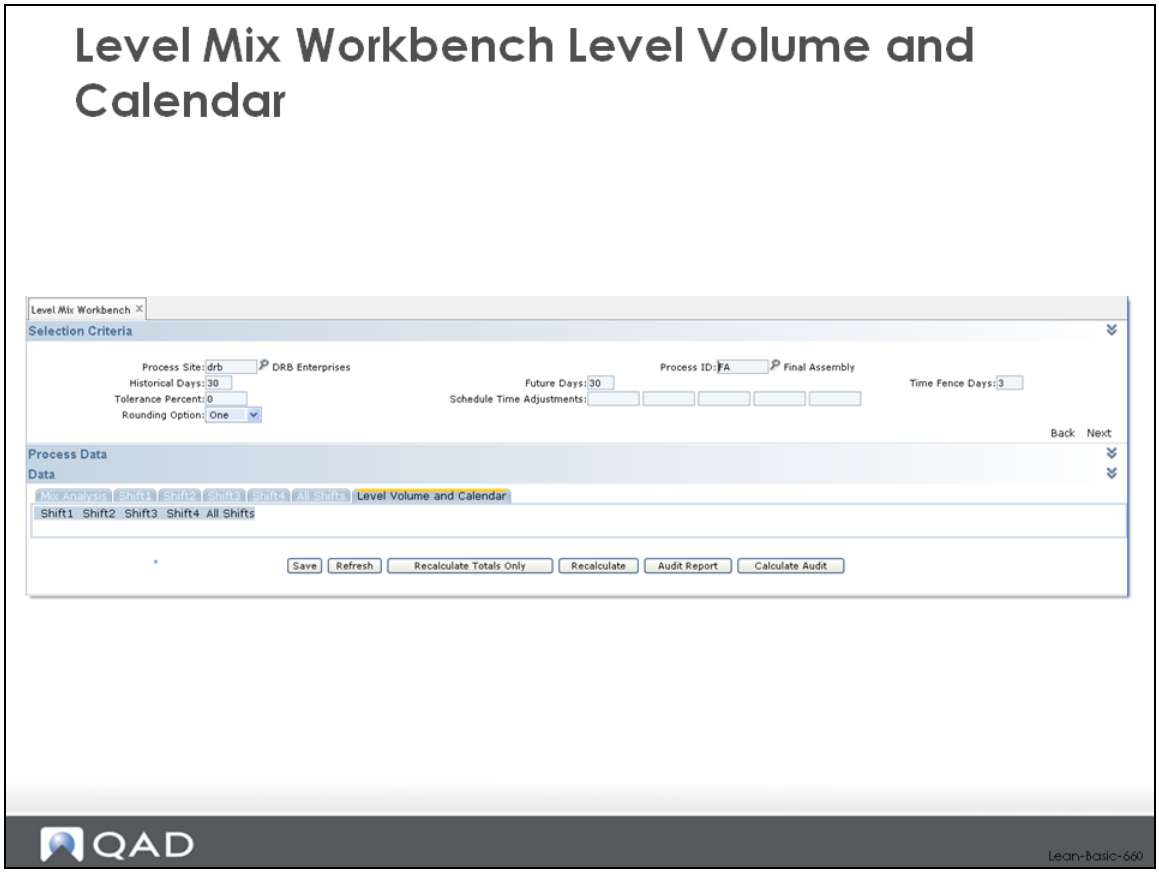



After selection, the system will return a multi-tabbed workbench that includes:

- Process Master Data including the details of the EPE Interval calculation.
- Mix Analysis (historical and future mix, buffer adjustment)
- Schedule by Shift (Shift 1 – Shift 4, Overall)
- Level Volume and Calendar Data

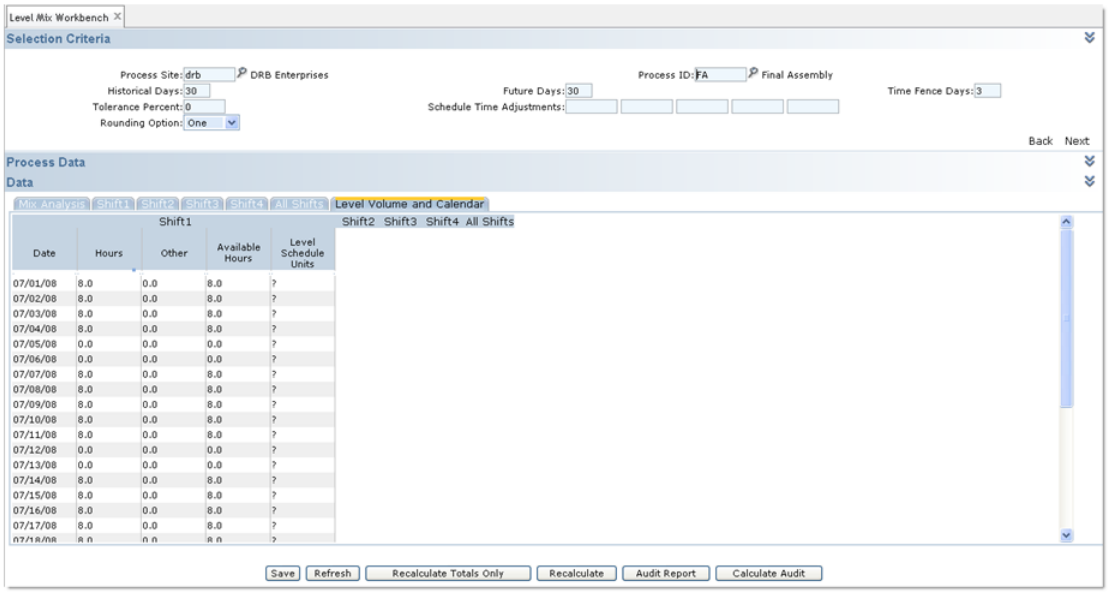
The Mix Analysis Frame, shown immediately above, displays the historical and future demands against each loop, as well as an analysis of how much each item contributed to the total historical demand and how much each item will contribute to future sales. These percentages are input to the leveling calculation unless the user specifically overrides them (Override Production Mix Percentage) or adjusts the inventory buffer (Buffer Adjustment) for one or more of the items. After making any adjustments, the quantity that will be scheduled for each part, including the average daily quantity (Average Daily Quantity) and operational takt time (Modified Schedule Takt Time) is shown.

## Level Mix Workbench Level Volume and Calendar



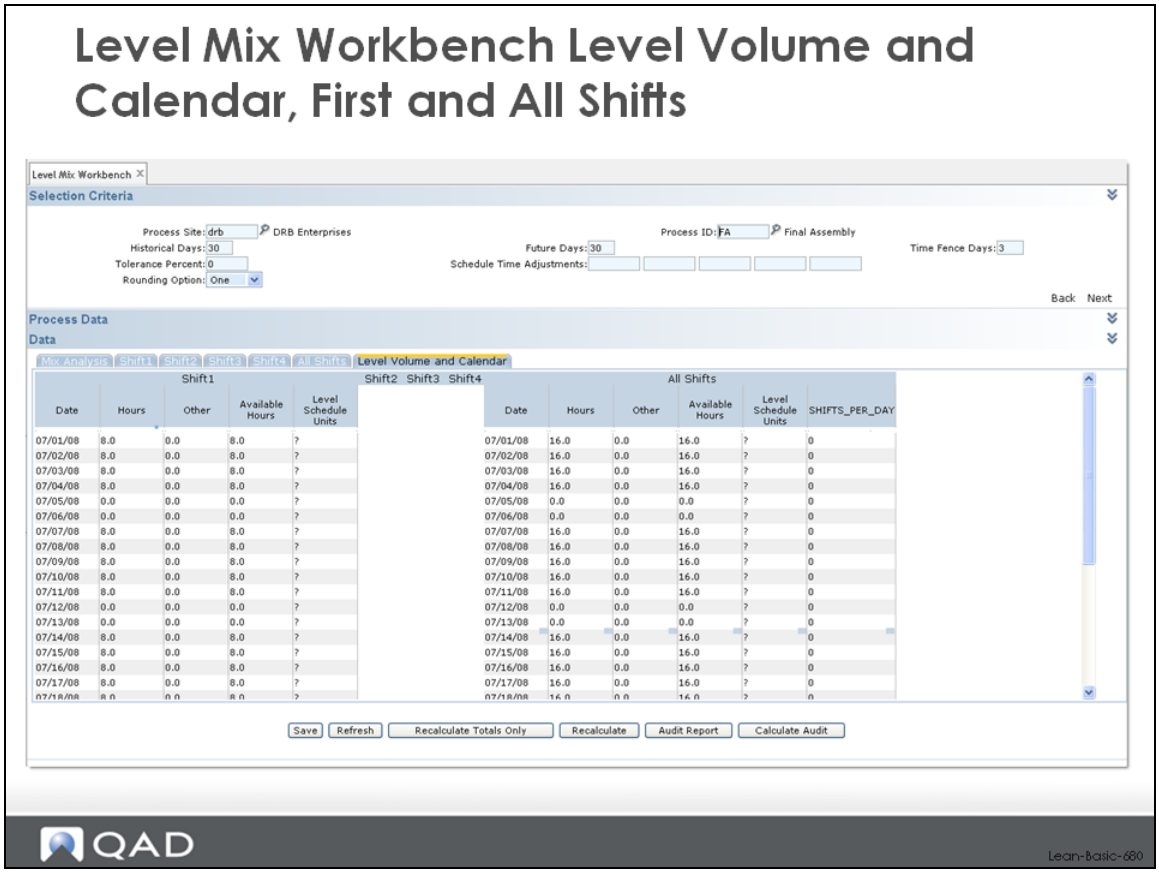

View the overall volume that is being scheduled by day using the “Level Volume and Calendar” tab shown above. Once you have selected this tab, the system presents five subtabs – one for each shift and one overall volume by day display. If you select one of the shift tabs (Shift 1, Shift 2, Shift 3, Shift 4), the system presents a display that allows calendar maintenance including scheduling overtime, adjusting for meetings or projects, shutdowns, etc.

# Level Mix Workbench Level Volumeand Calendar



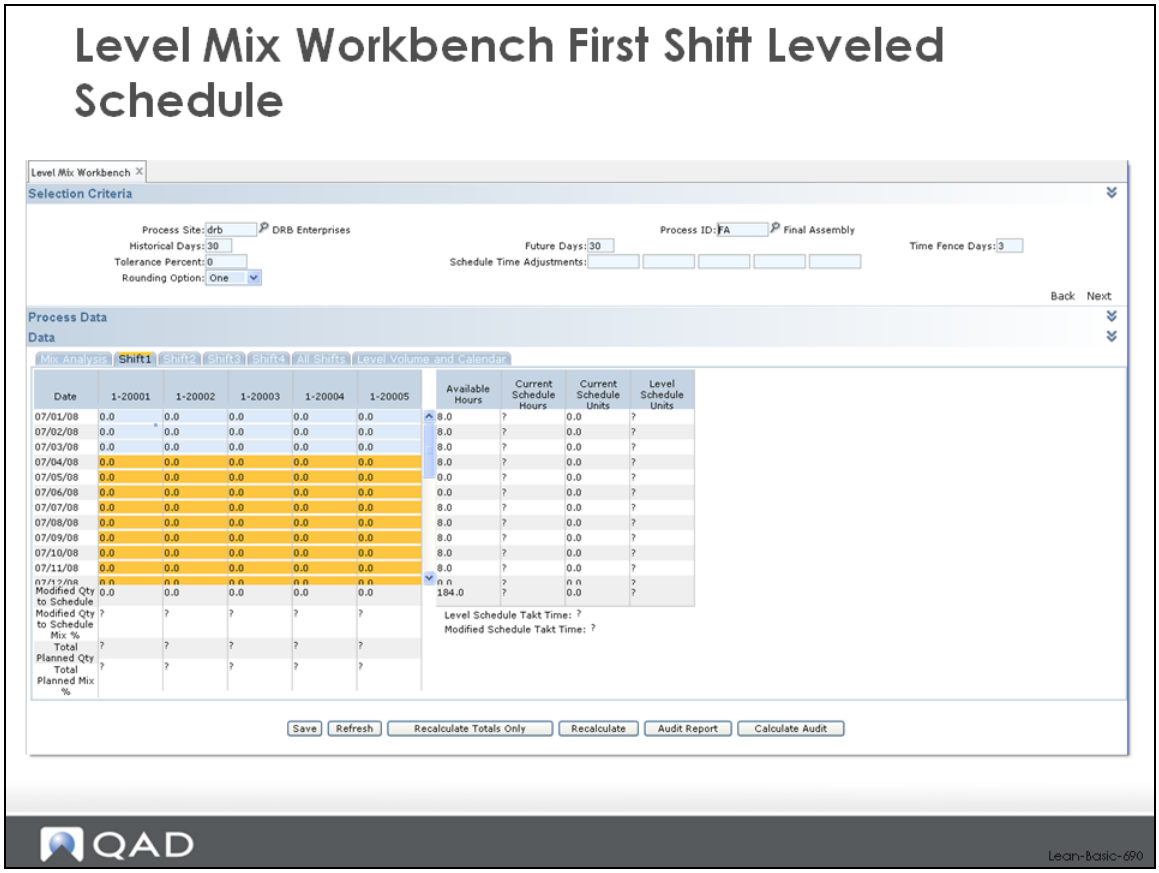

The Level Mix Workbench is integrated with your shop calendar, and provides a convenient way to maintain and adjust daily time for each of five major categories. For example, you can change overtime, meetings, downtime, training hours, etc., in fact any major categories that you decide and have set up, in the workbench itself. When you save your data, the calendar will be updated accordingly. An example of the maintenance display for Shift 1 is shown below. In this display, “overtime” has been setup as a specific category in the calendar and it can be maintained directly in the workbench.

## Level Mix Workbench Level Volume and Calendar, First and All Shifts




By clicking on one or more of the other subtabs you can open additional shifts or the overall volume and these will be shown side by side with the Shift 1 data. An example is shown above.

## Level Mix Workbench First Shift Leveled Schedule




Once you are happy with the calendar and want to generate (or adjust) the level schedule for each part, click on one of the major tabs labeled “Shift 1”, “Shift 2”, … “All Shifts”. An example of one of the frames is shown above.

Initially the scheduling frames in the Level Mix Workbench will show only the already scheduled work for the process. Hit the “Recalculate” button, however, and the system will calculate a leveled schedule for each of the items. Only those periods that are beyond the “Time Fence Days” will be scheduled.

Each date from the current date through the end of the selected horizon is shown on the left. In the header row above these dates you can see the individual items that have been scheduled. In each cell, you can see the quantity scheduled, and to the right is the summary (hours and quantity) by date and at the bottom, the quantity scheduled for each item against the target schedule.

You can override the schedule by maintaining it directly. The cells in the display above that are shaded yellow are open to change. After changing the schedule, click on “Recalculate Totals Only” and the system will update totals by part and by date.

This allows you to do the necessary fine-tuning and tweaking. And once you’ve done that, you can push that information back down, into flow schedules that will drive supplier schedules.

*Scheduling Logic in the Level Mix Workbench.* The level scheduling logic in the system has several parts:

- Scheduling at takt time.

- Quantity scheduled based on EPE Interval.
- Sequencing of work based on “product wheel” considerations or the number of operators required to meet takt time.

Product wheel sequencing handles situation where there’s a fixed processing sequence for products. For example, color or flavor based sequencing is a type of “product wheel”. In chemical plants producing polyester film, the product wheel might be based on product type (polymer), film width, film thickness.

When the number of operators in the cell varies based on the work content, it doesn’t typically make sense to float operators in and out too frequently. Consequently, an alternative might be to base the sequencing on the number of operators with all the five operator jobs first and then the ones that require four, and then three, and then two, and then one. Alternatively, you can sequence it the other way around, where you want the fewest number of operators first and the higher number of operators last. If you have a well-cross-trained workforce, you might set up two different processes with the opposite rules for sequencing – one with ascending operators and the other with descending operators. This way, one process will free up operators just as the other needs them.

The workbench is a tremendous help in leveling both mix and volume. However, many times users have already invested a lot of time and effort into building their own Excel spreadsheets to provide these same functions. Here there may be similar, comfortable tools but no easy way to get the data from the core ERP system into the spreadsheet, or back out when the leveling is over.

QAD Lean provides functions to help with this problem. Specifically, the system provides an export program that you can export the data and load that into your Excel spreadsheets, and an import program to get the data out of the Excel spreadsheet and import it back into QAD Enterprise Applications.To use these functions, all that is required is that you modify your spreadsheets to:

- Read the imported data from a specifically formatted comma delimited format.
- Write data that is coming back to QAD Lean to a specifically formatted comma delimited format.

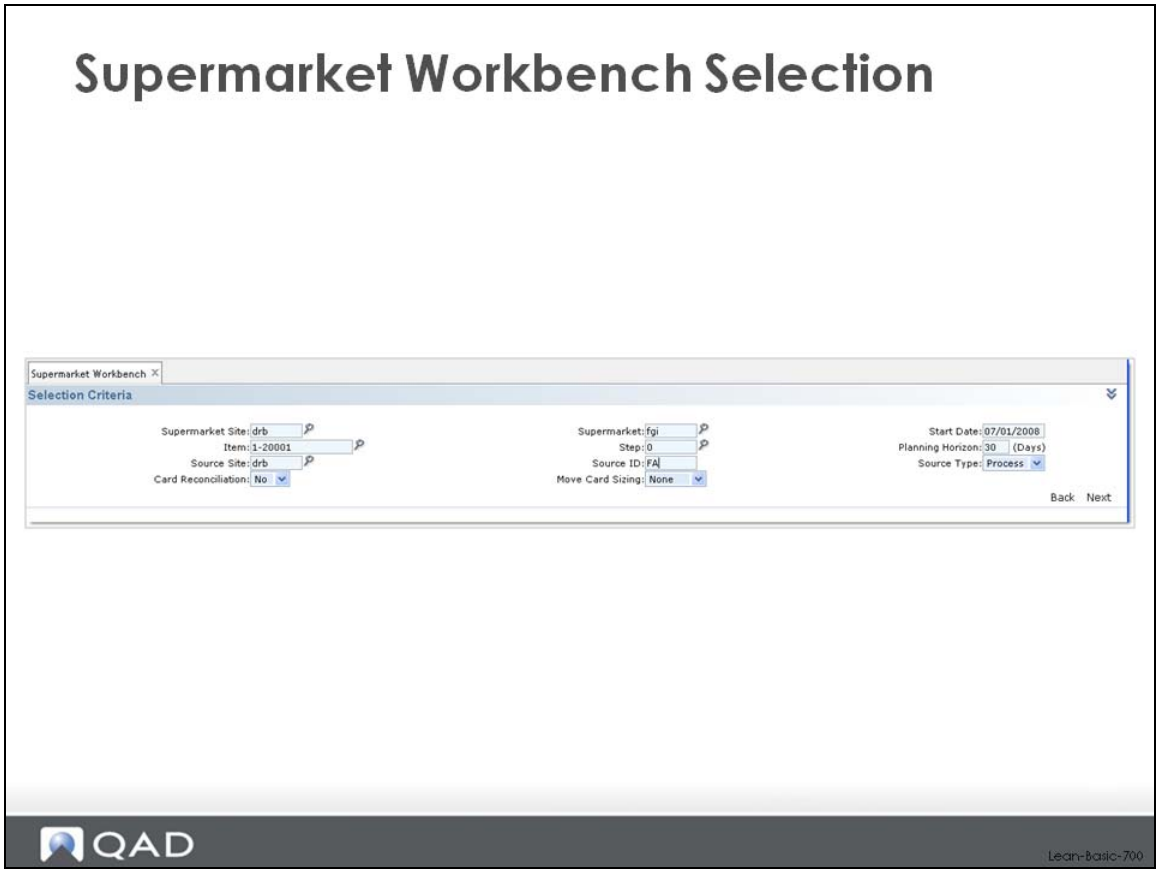
### Supermarket Workbench

The “Supermarket Workbench” provides a picture of inventory performance into the future. In effect, it allows you to evaluate the amount of inventory that you're carrying at the supermarket compared to the future demand and your planned level schedule for material coming into that supermarket. If future demand is level, the leveled production schedule will be able to cover it with minimal inventory. However, if the future demand for an item is “spiky” – perhaps because of the nature of your customers and markets, or perhaps because you create the condition through promotions or other marketing initiatives – you’ll need to verify that the amount of inventory is sufficient to absorb peak demand without backorders. Having a perfectly leveled schedule and minimum variability in manufacturing is a fine objective, but if it ends up causing missed deliveries, backorders, and upset customers then it’s hard to put a positive spin on it.

Leveling is just one part of effective master scheduling. The other part is supply/demand balancing. To give the best customer service, supply and demand must be in balance. To achieve maximum profitability with minimum disruption in manufacturing, the schedule must be level – at least in terms of volume, and ideally in terms of mix of product to be produced. The Level Mix

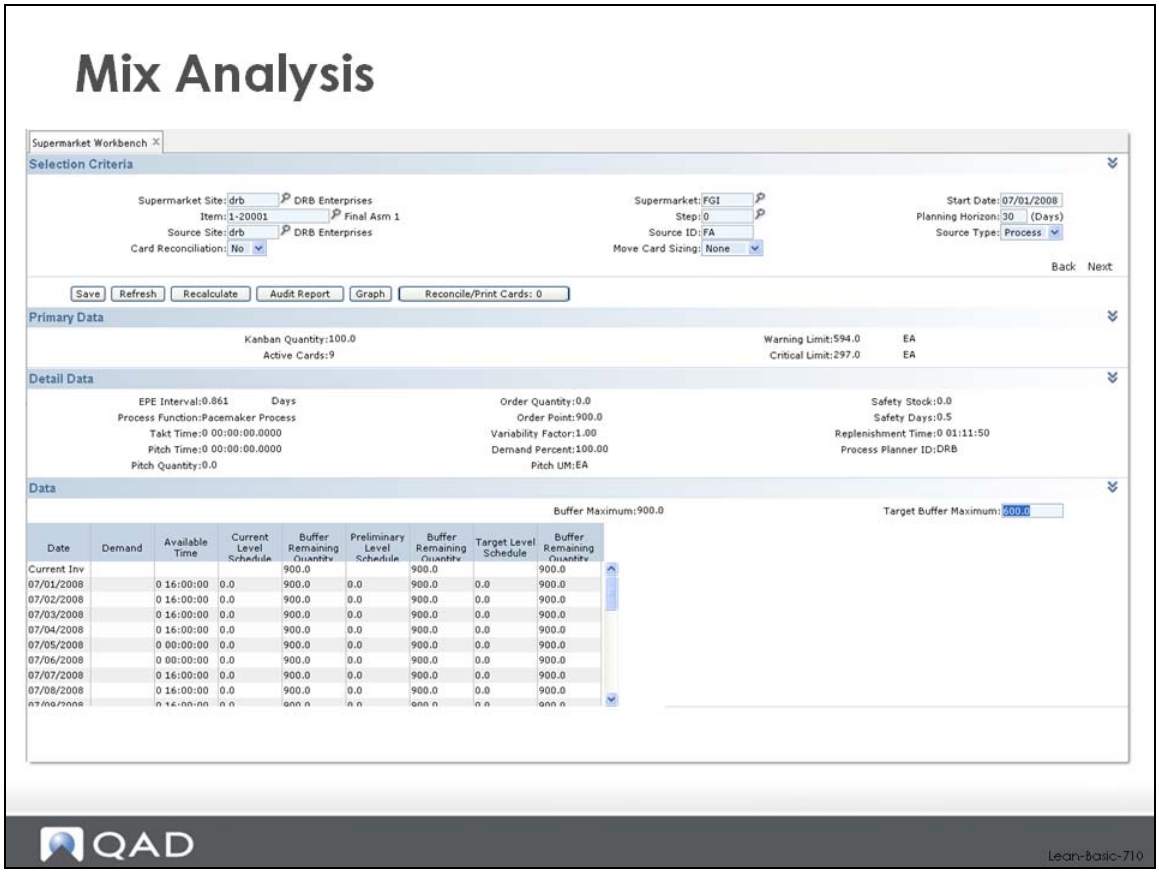
Workbench provides a mechanism to ensure that the schedule has been leveled and meets demand over the leveling horizon. The Supermarket Workbench is one tool in the system to help verify that supply meets demand by date.

## Supermarket Workbench Selection




A user can select a specific item associated with a particular process source and supermarket destination using the selection criteria screen shown above.

## Major Tabs and Frames




After selection, the system will return a multi-frame workbench that includes:

- Primary Data – key loop data for the item being evaluated
- Detail Data – process master data including the takt, pitch and EPE Interval data and additional loop data including order point and order quantity, safety stock and safety time, replenishment time
- Data – time phased data showing demand, several variants of the level schedule, and the inventory projection associated with each one

In the Data frame, the Supermarket Workbench shows three different variants of the leveled schedule and associated inventory:

- Current Level Schedule – this is the last stored level schedule.
- Preliminary Level Schedule – this is the calculated level schedule, calculated by the Supermarket Workbench using logic similar, but not identical, to the logic in the Level Mix Workbench.
- Target Level Schedule – this is also a calculated level schedule, using a buffer adjustment supplied from the field labeled “Target Buffer Maximum”. However, the logic associated with this version of the level schedule applies the buffer adjustment immediately, rather than phasing it over time which might be what you would expect.

By toggling back and forth between the Level Mix Workbench and the Supermarket Workbench you can verify that your leveled schedule by item keeps supply and demand in balance. Once you are happy that this is the case, you can save the level schedule generated by the Level Mix Workbench. If you've set up the appropriate data in the Flow Schedule software that is part of QAD Lean, this leveled schedule by item will be saved back to the database and subsequently be used for projecting supplier requirements.

Alternatively a user of the system could use the normal MPS displays (MPS Summary, MPS Detail) to evaluate the supply demand balance situation for each of his or her items. To do this, Save the leveled schedule back to the Flow Schedule database and then call up each item, one after another, in the appropriate MPS inquiry.

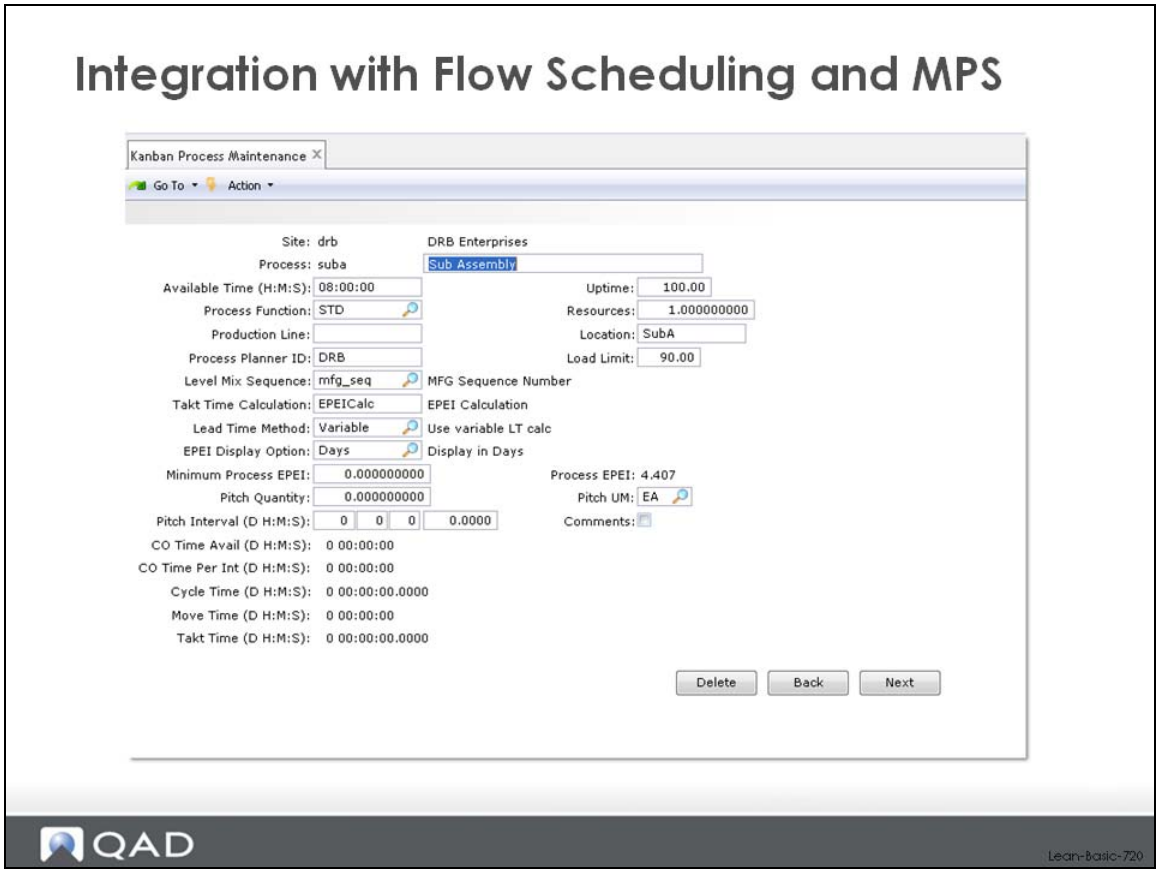
### User Workbenches

The workbench is a tremendous help in evaluating the level schedule. However, many times users have already invested a lot of time and effort into building their own Excel spreadsheets to provide these same functions. Here there may be similar, comfortable tools but no easy way to get the data from the core ERP system into the spreadsheet, or back out when the review is over.

QAD Lean provides functions to help with this problem. Specifically, the system provides an export program that you can export the data and load that into your Excel spreadsheets, and an import program to get the data out of the Excel spreadsheet and import it back into QAD Enterprise Applications. To use these functions, all that is required is that you modify your spreadsheets to:

- Read the imported data from a specifically formatted comma delimited format.
- Write data that is coming back to QAD Lean to a specifically formatted comma delimited format.

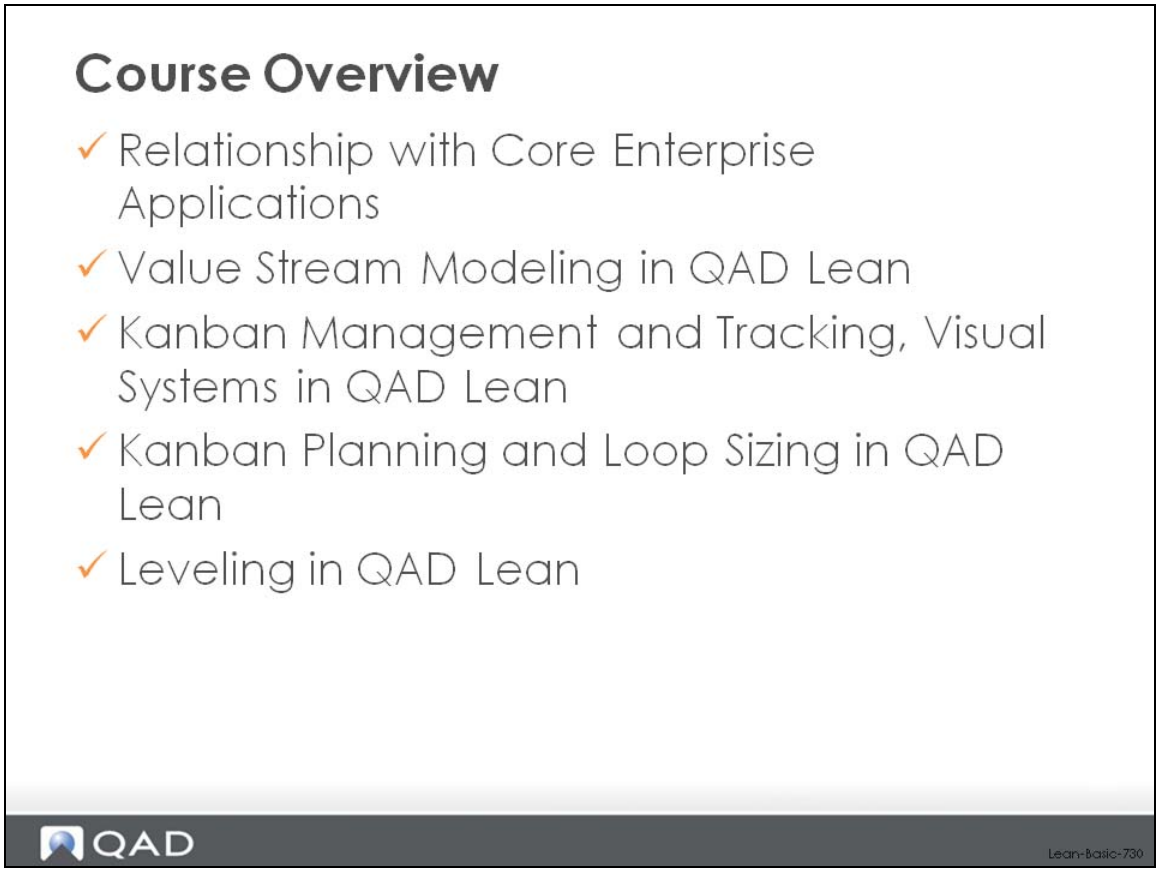
## Integration with Flow Scheduling and MPS




The Level Schedule generated by the Level Mix Workbench can be saved as the master production schedule to drive supplier projections in QAD EA. This would be especially desirable in situations where different products require different components or materials.To set up the system to allow the level schedule to update the Flow Schedule, you must set up a “production line” in the flow scheduling system, and then reference that production line in the kanban process master to which it corresponds.For example, in the screenshot above, you would enter the appropriate production line in the Flow module in the “Production Line” cell. You can give the production line the same name as the kanban process, or you can name it something completely different.

Refer to the system documentation for information on setting up the production line in the Flow module itself.

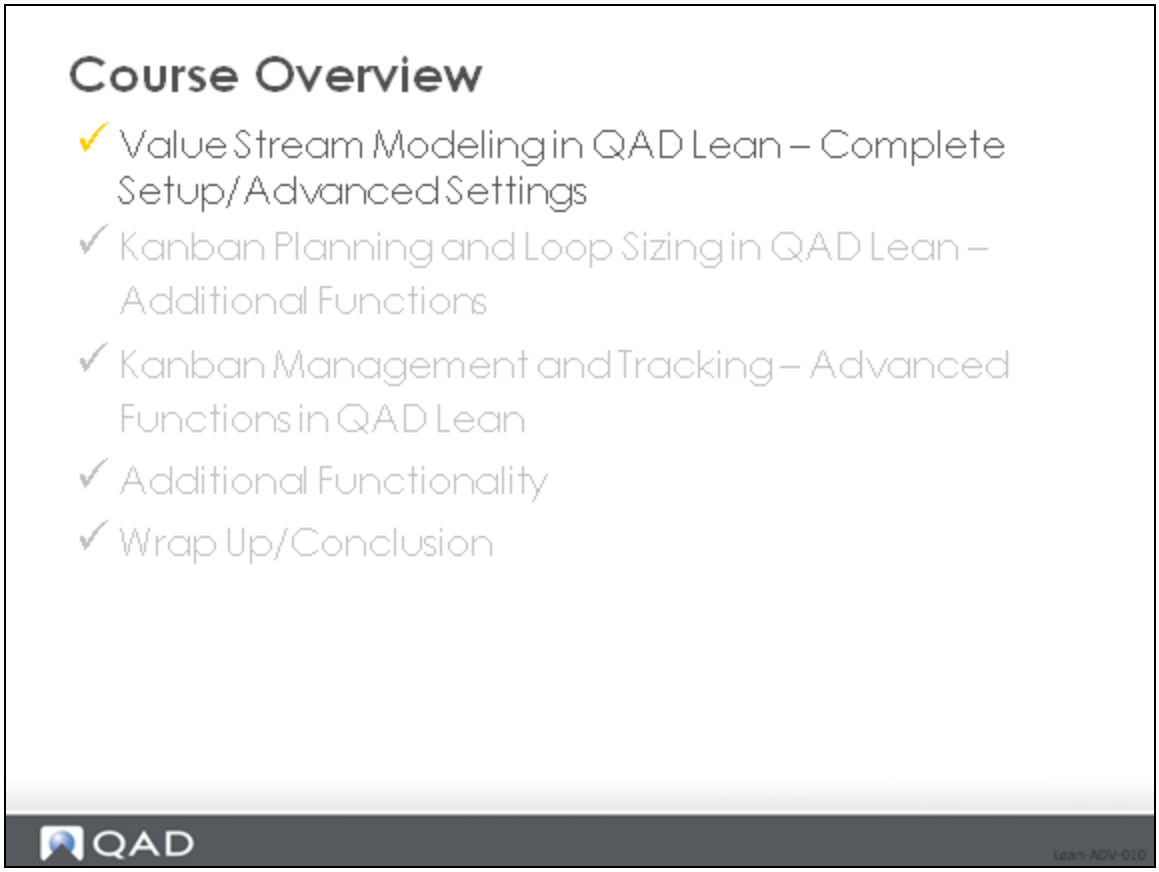
## Course Overview



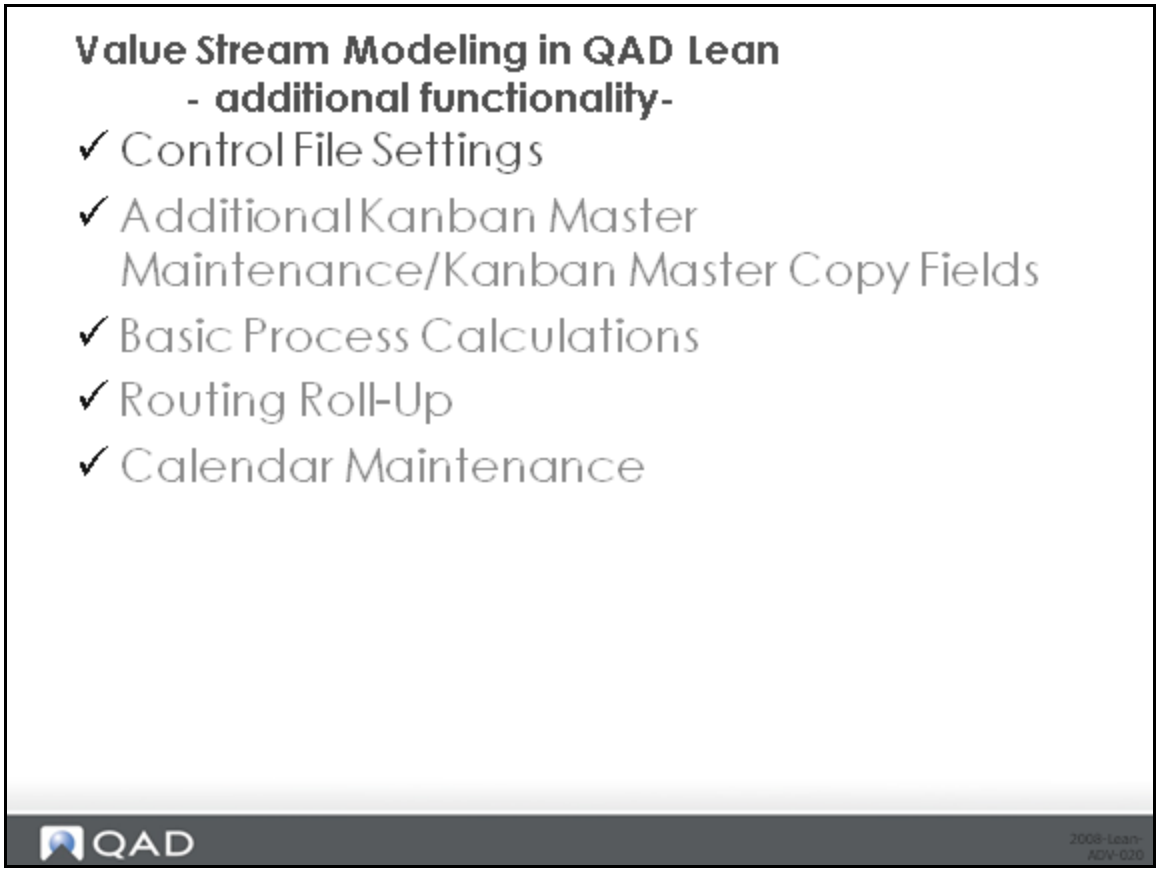
Chapter 3

# Advanced Functions of QAD Lean

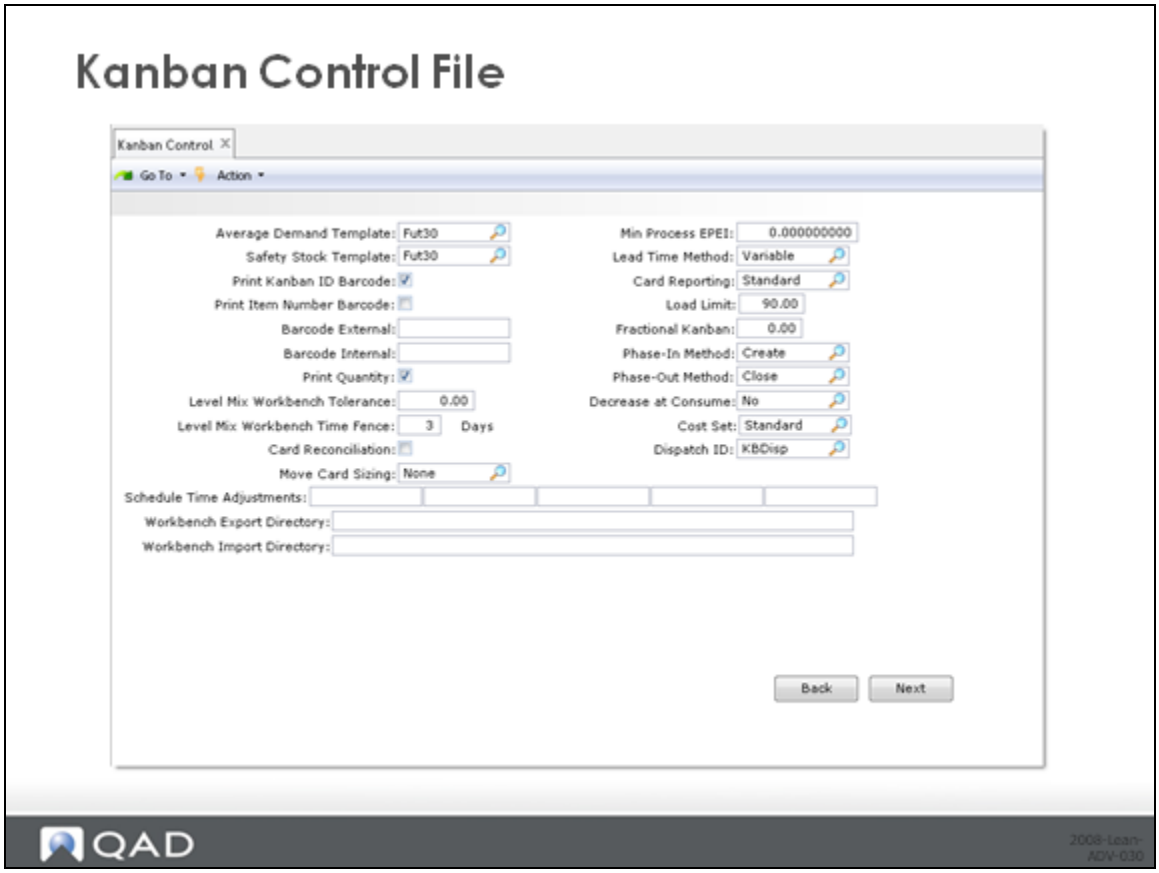
## Course Overview



## Value Stream Modeling in QAD Lean



## Additional Control File Settings




As we saw earlier, the Kanban Control File function of the system establishes the basic default data and default behavior of the QAD Lean module. Three distinct frames of data cover basic kanban controls, transaction controls, and kanban event (status change) controls, as shown above.

The additional controls in the Kanban Control record (not covered earlier in this class) include:

- Print the item number, in the form of a barcode, on the kanban card (Print Item Number Barcode checkbox). Use this if you want to scan each card twice, once for the card number and the second time as a verification of the item number.
- Internal and external barcode format references (Barcode External, Barcode Internal) – use these to indicate which of the many barcode formats should be used.
- Move card sizing logic to be used (Move Card Sizing, none = no move card sizing, MaxBuff = adjust the number of cards to match the size of the new “maximum inventory” for the part after sizing, ReplCrd – adjust the number of move cards to equal the new number of replenishment cards for the same part).
- Calendar categories that normally will be the defaults for the Level Mix Workbench calendar adjustment categories (Schedule Time Adjustments) – you must setup categories with these names in your calendar in advance of running the workbench, but then you can change the time by individual day for any of the five categories you’ve created.
- Input and output directories for the import and export files for workbenches. If you plan to use your own workbenches (Kanban Workbench, Level Mix Workbench, Supermarket Workbench) you will be creating import and export files so you can use data from the QAD

Lean database, and then bring updated data back to it. The “output” directory indicates where you want the system to create the export file. The “input” directory indicates where the system should look for the import file.

Recall that in the earlier discussion of these control file settings, we set the Phase In and Phase Out methods to “create” and “close” respectively. Here is some additional information you might want to consider when setting these two controls:

- Phase-in Method.
  - Phase in Method = Create will create new cards for the loop for the required quantity. Even if there are existing cards that have been retired (deactivated), new cards will be created.
  - Phase in Method = Activate will find any cards that have been retired and try to reactivate them. Only cards that are an exact match – same part number and loop, same kanban quantity, same BOM and Routing Code, same source and destination, same purchase order number (if purchased part), etc. – will be reactivated. If there aren’t enough cards to reactivate, the system will create new cards.
- Phase-out Method.
  - Phase-out Method = Close) will find cards that should be taken out of the loop. This is done as part of the “reconciliation” process in the system. In the case of cards that are empty and not authorized, it will immediately deactivate the card. It will look for additional cards in the following sequence: full cards, shipped cards, acknowledged cards, and finally empty-authorized, and change the “active code” to “close”. This allows these cards to continue to circulate until the point where they have been emptied. When a closed card has been emptied (processed by the Consume transaction, the system will change it to deactivated. Once the card has been deactivated, it cannot be transacted against using the normal Consume, Authorize, Acknowledge, Ship, and Fill transactions.
  - Phase-out Method = Deactivate will find cards that should be taken out of the loop and change the card to “deactive” (inactive). This is done as part of the “reconciliation” process in the system. It will look for cards in the following sequence: empty cards, full cards, shipped cards, acknowledged cards, and finally empty-authorized. Notice that when this option is used, the system may actually deactivate cards that are in circulation in manufacturing or with the supplier. Once the card has been deactivated, it cannot be transacted against using the normal Consume, Authorize, Acknowledge, Ship, and Fill transactions, so you should use this alternative with care.

Here’s some additional information about the “Decrease at Consume” option. As you should remember, the basic logic of the system is to take cards out of a loop at the point that the card is emptied (transacted against with the Consume transaction). However, while this is the basic logic, there is one additional piece of information that you should know:

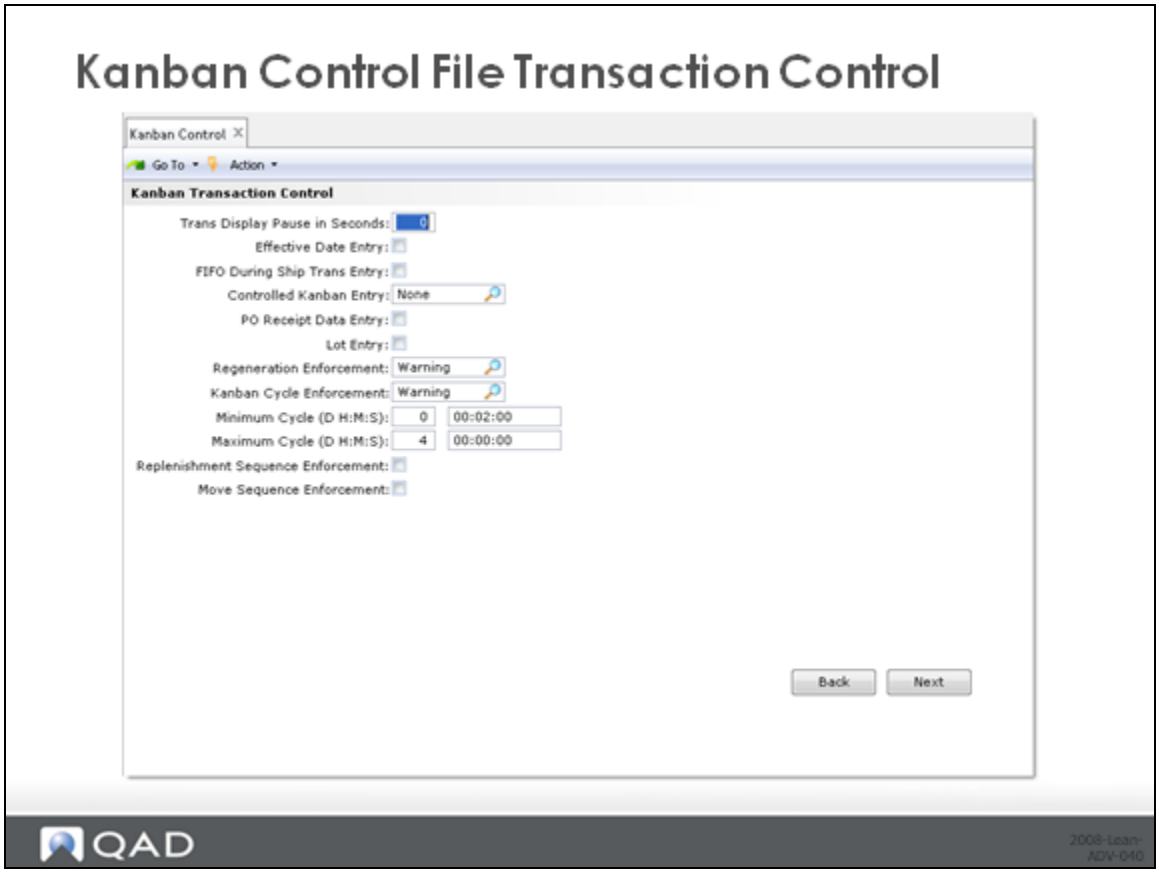
- The system will still try to find cards that can safely be retired without additional processing. These cards would be ones in empty status.

Depending on how much control you want over the process that retires cards, the best choices for automatic reconciliation are probably either Decrease at Consume = yes, or Decrease at Consume = no and Phase-out Method = Close.

Finally, you should note that nearly all the Control File Settings default into the appropriate record when the record is created. In most cases, the “appropriate” record is the loop (Kanban Master) record although in some cases it is the Process Master.

If you change Control File Settings, the new values will apply to records created after the change. If you want the new settings to apply to the older, existing Kanban Master or Process Master records then you must change the values in the records themselves.

## Kanban Control File Transaction Control




The additional controls in the second frame of the Kanban Control record (not covered earlier in this class) include:

*Effective Date Entry.* You may be familiar with a similar option in the core QAD EA functionality. When this option is set to no (unchecked), the system automatically assigns the transaction date based on the system date (today's date). However, what this means is that if the computer has been down for an extended period of time – perhaps just a few hours at night but spanning two different days – the date of the transaction may be incorrect. Since kanban transactions may generate inventory receipts and issues generated by backflushing, this may mean that the financial postings are in the wrong fiscal period. To make sure that this doesn't happen, you can toggle the Effective Data Entry value to "yes" after the computer system comes back on-line. As long as the value in this control remains set to yes, the system will require the transaction date to be input as part of the transaction itself.

*Controlled Kanban Entry.* This is a kind of "belt and suspenders" option in QAD Lean. Normally you would set this control to "none" in which case the system would require only the entry of the Kanban Card ID in the kanban transactions. The Kanban Card ID is after all a unique identifier so that the system can determine the item number, supermarket destination, etc. from the card itself.

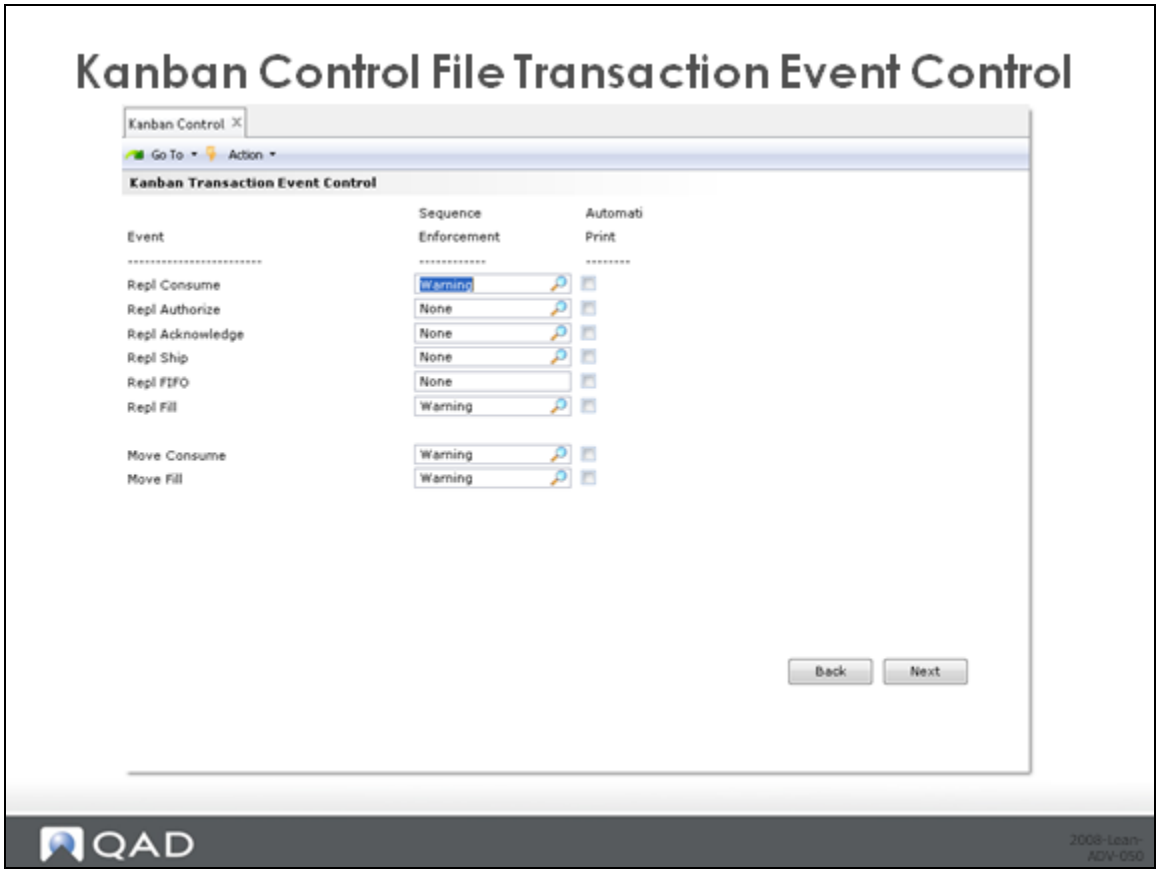
*PO Receipt Data Entry.* Check this option if you want various purchase order receipt data (receiver slip id …) to be recorded as part of the kanban fill transaction for purchased parts.

*Lot Entry.* This option provides a kind of “poor man’s lot control”. Check it if you want lot information recorded as part of the kanban fill transaction. This lot information will be carried into the kanban history file with the other information for the transaction.

*Maximum Cycle (D H:M:S).* The “maximum cycle” time defines the maximum frequency between transactions against a kanban card. For example, if you feel that each kanban card should be transacted against at least every four days, set the maximum cycle to 4 00:00:00. The maximum cycle for each kanban loop is used as part of the process for identifying potentially missing cards.

*Move Sequence Enforcement.* Check move sequence enforcement if you want the system to ensure that a move card is not processed out of sequence.

## Kanban Transaction Event Control



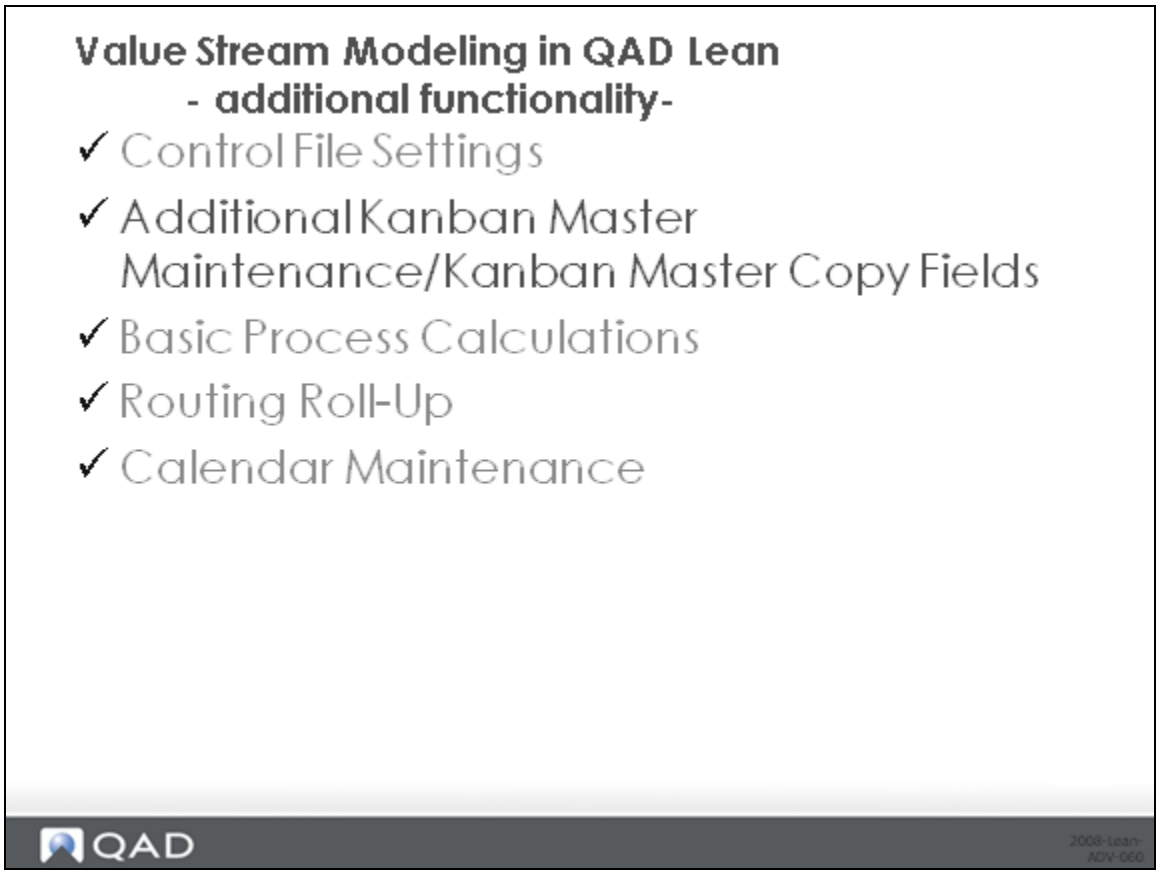

As we saw earlier, the settings in the Kanban Transaction Event Control Frame reflect decisions about which of the transactions (consume, authorize, acknowledge, ship/fill and fill) will enforced for replenishment loops. The same thing is true of kanban transactions associated with the move loops out of a supermarket and to a point of use. You have the choice of no enforcement (None), warn on error (Warning) or reject completely (Error) for both the consume (Move Consume) and fill (Move Fill) transactions.

In the display above, the move and fill transactions for each move loop using the control file settings will be enforced with a warning.

As before, the auto print boxes allow the user to specify the point in the move loop where the cards are to be reprinted.

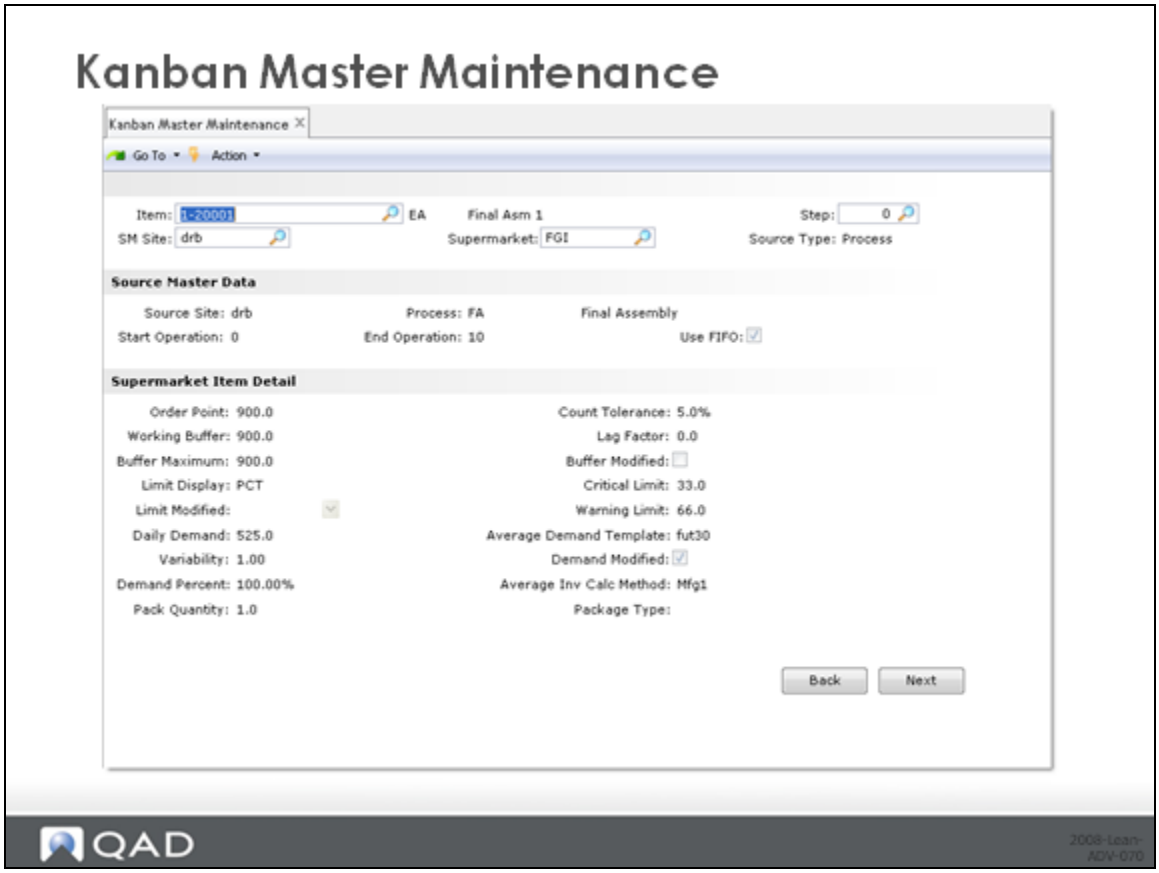
Please note that the Transaction Event Control Settings work somewhat differently than the other control file settings. Other Control File Settings related to kanban loops default into the loop record when it is created. In the case of the Transaction Event Control Settings though, each loop has a checkbox “Use Control Prog Tran Settings” which when used, indicates that the control file settings themselves should be used for validating the kanban transactions. If the checkbox is unchecked, then the user can set different enforcement values for the loop being maintained.

## Additional Kanban Master Maintenance / Kanban Master Copy Fields




The Kanban Master Maintenance screens are shown on the next pages.

## Kanban Master Maintenance




Here are the fields that you can maintain in the first Supermarket Item Detail frame of each kanban loop:

*Order Point.* Typically calculated and updated by the Kanban Workbench, the order point is the demand during the replenishment lead time plus safety stock, rounded to a multiple of the kanban quantity.

*Working Buffer.* The current amount of inventory in the kanban loop, based on the actual number of non-joker kanban cards and the kanban quantity. For example, a loop with 6 kanban cards and with a kanban quantity of 100, the working buffer is 600.

*Buffer Maximum.* Typically calculated and updated by the Kanban Workbench, the authorized maximum amount of inventory in the kanban loop: buffer maximum = order point plus order quantity.

*Limit Display.* This controls how the critical and warning limits used in the historical buffer evaluation are interpreted. PCT = percent. QTY = quantity.

*Limit Modified.* The system displays the last date when the value of Critical Limit or Warning Limit was modified. A blank indicates that the fields are still set to their initial values.

*Daily Demand.* Average daily demand, typically calculated and updated in the Average Demand Calculation. If you want to update this value, you can also do it using the Kanban Workbench.

*Variability.* A kind of "management adjustment" to the order point calculation in the system. The sum of the demand during the replenishment lead time and the total safety stock is multiplied by the variability factor to generate the preliminary order point. Variability = 1.00 means no variability. Variability = 1.05 inflates the order point by 5% (in effect +5% variability) while variability =.95 reduces the order point by 5%. If you want to update this value, you can also do it using the Kanban Workbench.

*Demand Percent.* Indicates what percentage of total demand for the part is satisfied by this loop. If you want to update this value, you can also do it using the Kanban Workbench.

*Pack Quantity.* Number of units in one standard packaging unit. Pack quantity x number of packs per kanban = kanban quantity. You can leave pack quantity equal to one, in which case "number of packs per kanban" is really the number of units per kanban.

*Count Tolerance.* Specify the allowable percentage of variation between the kanban inventory or WIP quantity (depending on the location type specified in Supermarket Maintenance), calculated as the number of full kanbans times the kanban quantity, and the MFG/PRO inventory balance, adjusted by the quantity represented by Lag Factor. The default is 5%.

*Location Type.* Supermarket location type (WIP, INV)

*Inventory Location.* Supermarket location number.

*Buffer Modified.* The system indicates whether the initial buffer size has been updated.

*Critical Limit.* Specify the percentage of the Buffer Maximum value or the quantity the system should use in determining whether the supermarket buffer size is too small. When you run Historical Buffer Evaluation or Supermarket Workbench, the system analyzes the actual performance of the buffer size as it relates to this value.Each time inventory drops below the critical limit the system records the stockout exposure. Stockout exposure is the difference between the critical limit and the actual inventory (based on full kanbans). The cumulative stockout exposure during the period being analyzed and may cause the system to recommend increasing the buffer maximum.

*Warning Limit.* Specify the percentage of the Buffer Maximum value or the quantity the system should use in determining whether the supermarket buffer size is too large. When you run Historical Buffer Evaluation or Supermarket Workbench, the system analyzes the actual performance of the buffer size as it relates to this value. If the actual inventory (based on full kanban cards) is never less than the warning limit, then you probably have too much inventory and would be justified in cutting it.

*Average Demand Template.* The template used to calculate average daily demand.

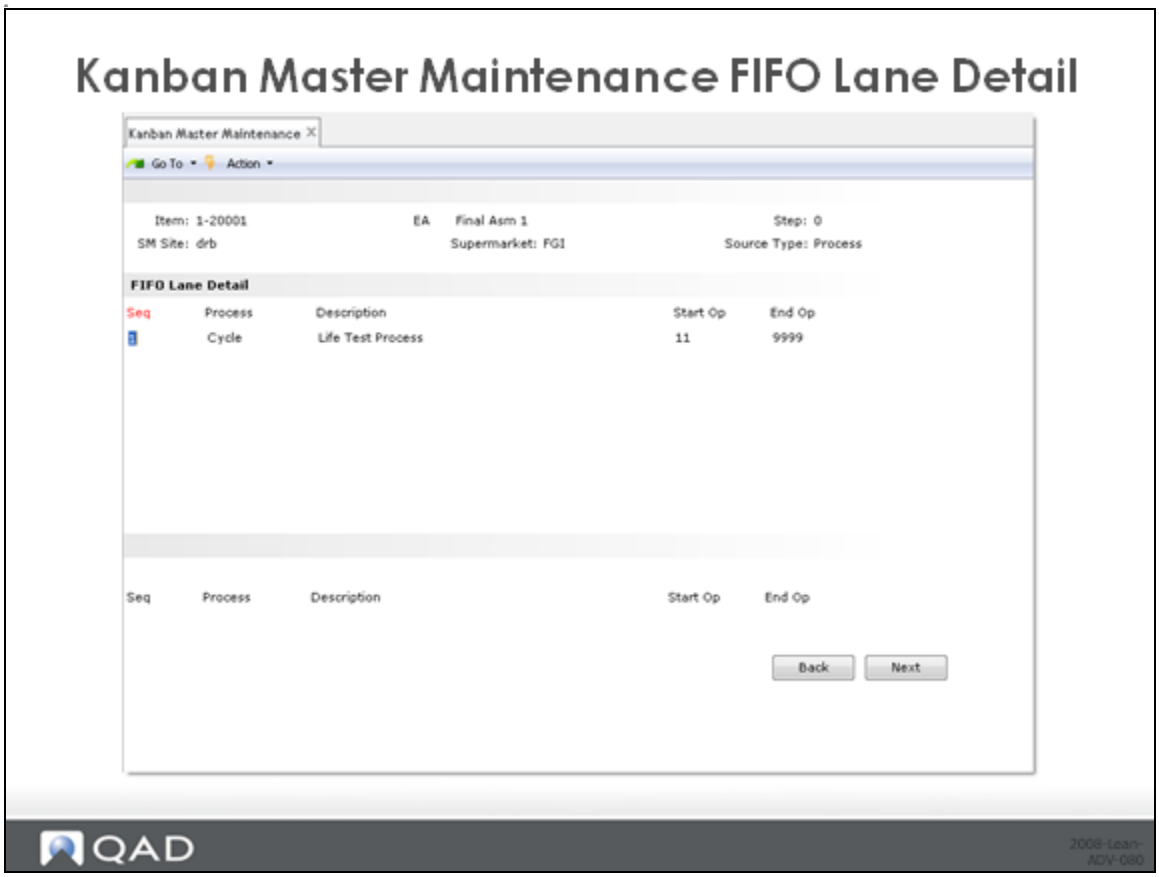
*Demand Modified.* Indicates whether the average daily demand has been changed manually.

*Average Inventory Calculation Method.* This control determines how the average loop inventory is calculated in the system. The standard calculation ("Standard") models a typical "saw tooth diagram" like the one shown in the diagram earlier in the class. The alternative calculation ("MFG1") is a more complicated calculation that attempts to model inventory behavior accounting for the fact that all the material is not received into the supermarket all at the same time. If you want to update this value, you can also do it using the Kanban Workbench.

*Package Type.* Specify the type of packaging that holds the quantity shown in Pack Quantity. For example, this could be box, pallet, or case.

*Lag Factor.* Specify the number of kanbans that are expected to be in process at any particular time where the component has not been backflushed. The default is 0 (zero). When you run Inventory Validation Report for this loop, the system accounts for the kanban quantity currently in process by multiplying the Lag Factor value by the kanban quantity, then subtracting the result from the MFG/PRO quantity on hand. It then compares the result with the kanban inventory level and determines if the difference is out of tolerance based on the specified percentage. You can specify a lag factor when a kanban item is a component that is backflushed when the parent item is received sometime later than when the kanban is reported as consumed.

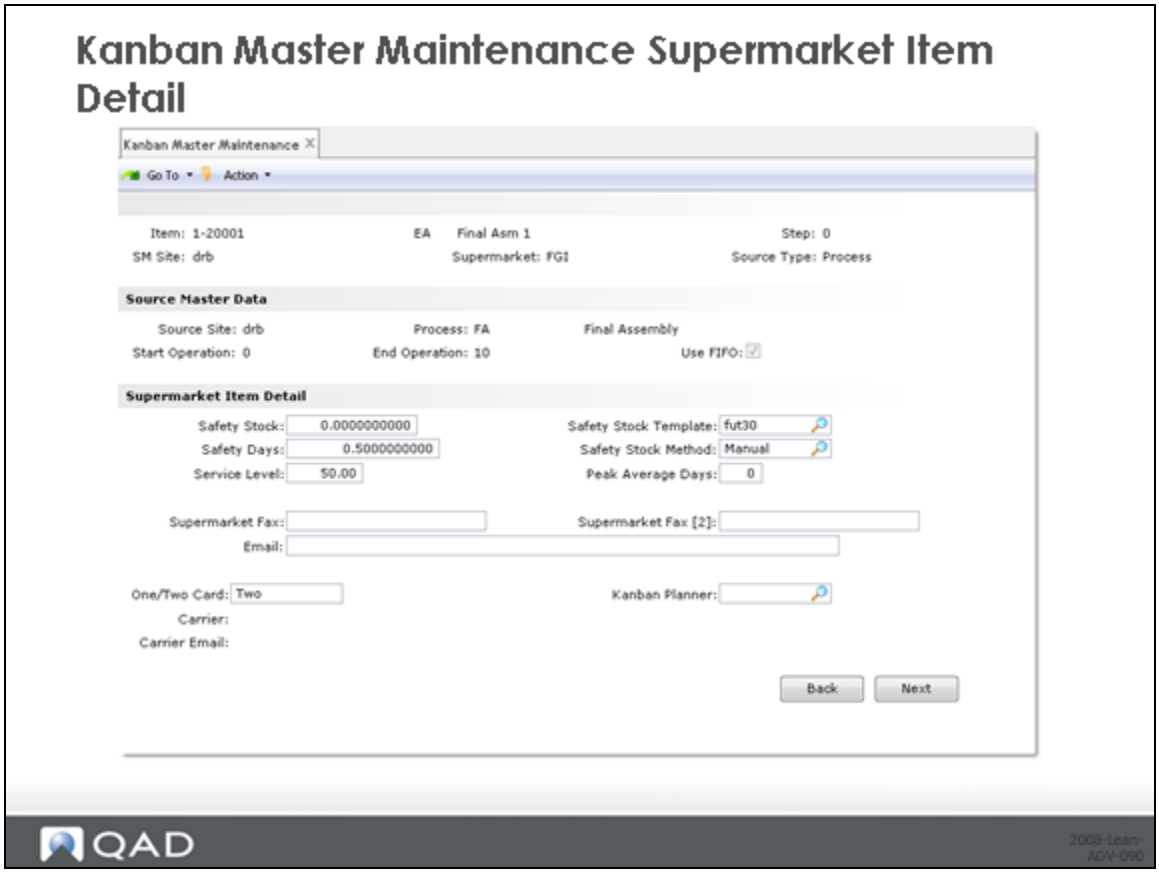
## Kanban Master Maintenance FIFO Lane Detail




The FIFO Lane Detail maintenance frame was explained earlier in the class. However it is worth noting the relationship between data here and the FIFO time (internal and external) defined in one of the subsequent frames. QAD Lean does not attempt to break down the FIFO lead time into the individual lead time elements associated with each FIFO process. Instead, you define the FIFO Lane (here) and then the total amount of time in the FIFO Lane for internal FIFO processes and the total amount of time in the FIFO lane for external processes.

It is even possible to define the FIFO Lane without FIFO time, or vice versa. Someone wanting to provide for the additional time required in a FIFO lane, but who didn't want the burden of defining the lane and subsequently tracking work through it can ship this display and simply add internal or external FIFO time.

## Kanban Master Maintenance Supermarket Item Detail




Here are the fields that you can maintain in the second Supermarket Item Detail frame for each kanban loop:

*Safety Stock.* Quantity to buffer demand or supply variability. If you want to update this value, you can also do it using the Kanban Workbench.

*Safety Stock Template.* Template used by the safety stock calculation program to specify which demands are used in the calculation.

*Safety Days.* Number of days of safety stock used to buffer demand variability. Safety days are converted to additional safety stock by multiplying by the average daily demand. If you want to update this value, you can also do it using the Kanban Workbench.

*Safety Stock Method.* Specifies how safety stock should be calculated.

- Manual = safety stock is specified manually.
- Simple = calculate safety stock based on demand variability and specified service level. Demand variability is computed as the standard deviation. The number of standard deviations of demand is determined by the service level. Safety stock = number of standard deviations based on service level x standard deviation quantity.
- Peak = calculate safety stock based on difference between average maximum demand and average daily demand. Average maximum demand is based on a moving average (peak average days).

*Service Level.* Desired service level for the Simple statistical safety stock calculation.

*Peak Average Days.* The number of days used in the moving average calculation of average maximum demand.

*Supermarket Fax.* Fax number for the destination supermarket.

*Supermarket Fax [2].* Second fax number for the destination supermarket.

*Email.* E-mail address for the destination supermarket.

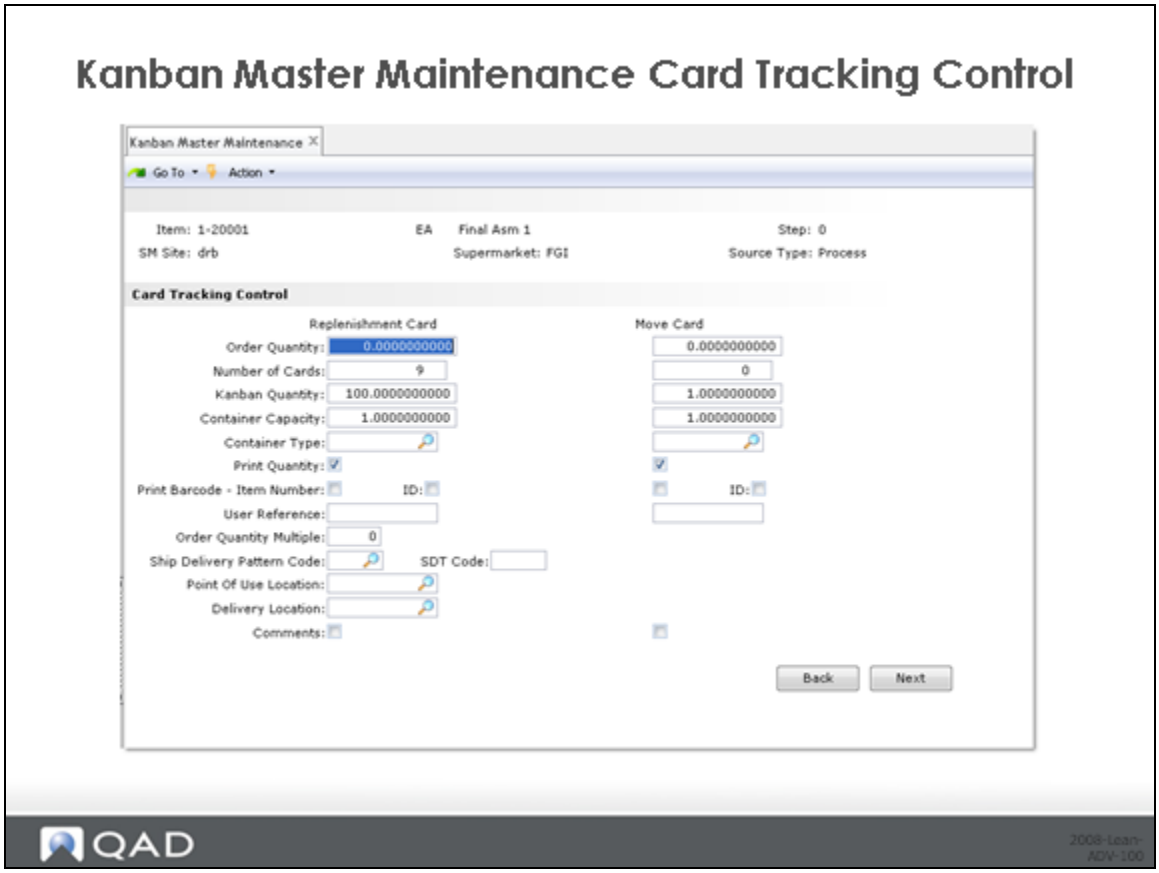
*One/Two Card.* One card or two card loop? One card loops are loops where a single set of cards handle both movement and replenishment. Two card loops are loops where two sets of cards – replenishment cards and move cards – are used. Move cards handle withdrawal from the supermarket and delivery to the point of use. Replenishment cards handle replenishment of the supermarket.

*Kanban Planner.* Person responsible for administration of the loop.

*Carrier.* Record the company handling transportation for the item.

*Carrier Email.* E-mail address for the carrier.

## Kanban Master Maintenance Card Tracking Control




Use the two Card Tracking Control frames to specify detailed information about the cards used in a kanban loop.

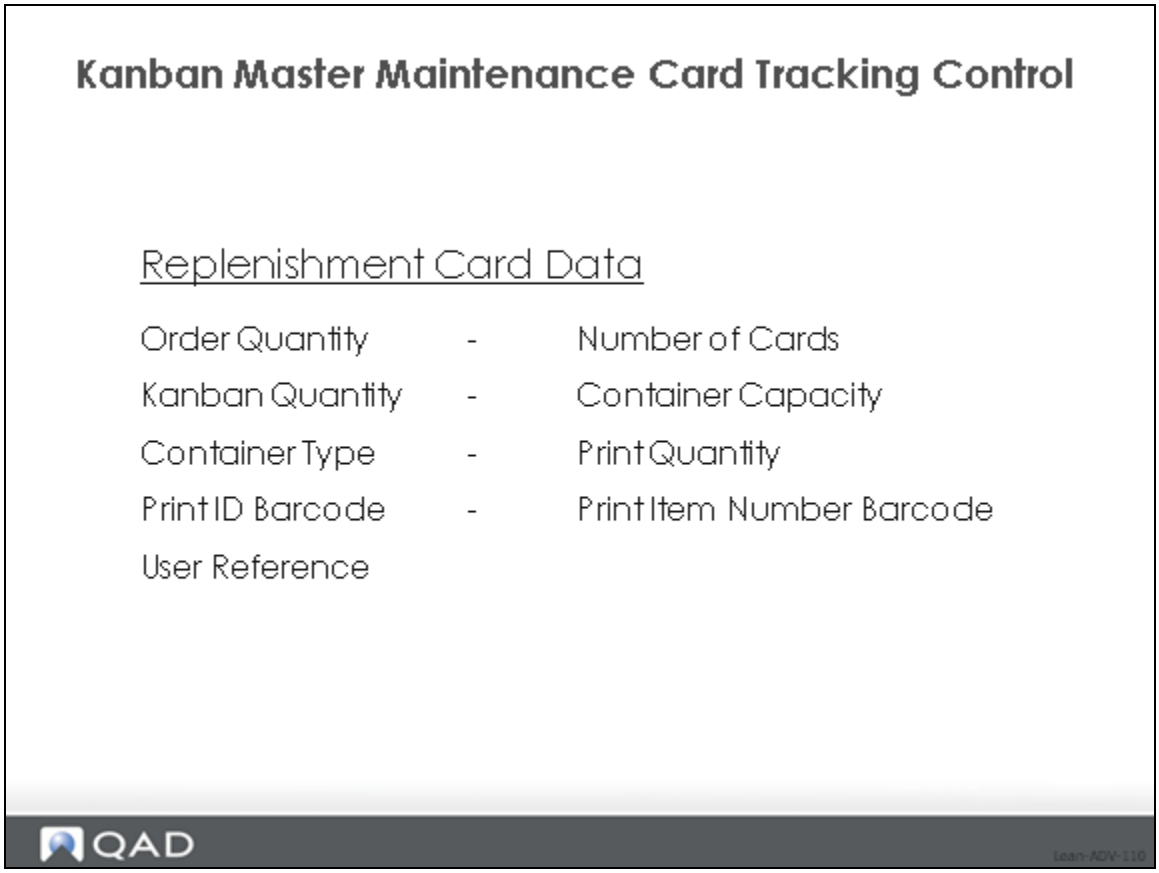
The first frame lets you enter sizing and control information for the kanban cards. (When you use Kanban Workbench, you can have the system update much of this data based on kanban sizing calculations.)

If you do not choose to use Kanban Workbench to size cards, you can enter the size and number of cards in this frame. Depending on the data you enter, the system may display warning messages recommending changes to some values.

After you finish setting up and sizing the loop, you can create and print the cards using Kanban Card Create.

If you are setting up a two-card loop, two sets of fields display so you can enter different data for the replenishment card and the move card, as shown in Figure above.

## Replenishment Card Data




*Order Quantity.* Enter the number of units the supplying source will replenish when the inventory level at the supermarket reaches the order point. This can be represented by a single card or by an accumulated quantity from multiple cards. (The Kanban Workbench can determine whether multiple cards have to be accumulated or you can use the next frame to specify whether multiple cards are accumulated based only on the quantity or on a combination of the quantity and interval-based factors. This quantity should be a multiple of the value specified in Kanban Quantity.

*Number of Cards.* Enter the number of cards to be included in this kanban loop. The system may update this field when the supermarket maximum buffer size is modified in the Kanban Workbench.

*Kanban Quantity.* Enter the number of items per kanban. It should be a multiple of the value specified in Pack Quantity.

*Container Capacity.* This field identifies a physical constraint placed on the container or item, which could be any of the following:

- Maximum quantity held by a carton or container
- Standard supplier package size
- Production constraint such as size of an oven tray
- For unwieldy or heavy items, the maximum amount that can be handled
- The system displays a warning message if you set this field to 0 (zero).

*Container Type.* Enter the type of container for this kanban item. This field defaults from Kanban Item Master Maintenance. If you enter a value, it must be defined in Container Type Maintenance (17.22.5).

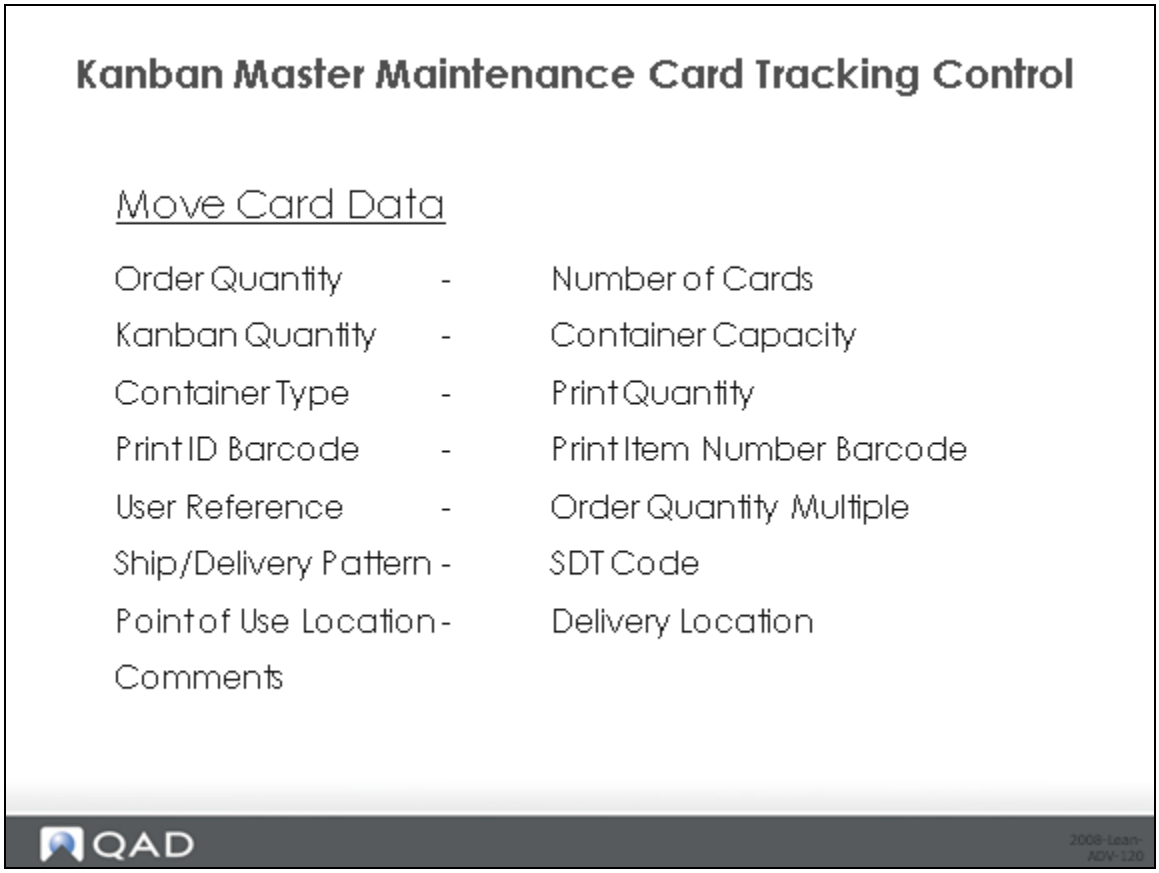
*Print Quantity.* Enter Yes to print the kanban quantity on each kanban card.This value defaults from Kanban Control.

*Print ID Barcode.* Enter Yes to print a kanban ID barcode on each kanban card. This value defaults from Kanban Control.

*Print Item Number Barcode.* Enter Yes to print an item barcode on each kanban card. This value defaults from Kanban Control.

*User Reference.* Optionally enter an alphanumeric reference (up to eight characters) to this kanban loop. This value displays on various reports and inquiries.

## Move Card Data




*Order Quantity.* Enter the number of units the supermarket will transfer to the point of use when the point of use needs additional inventory.

*Number of Cards.* Enter the number of cards to be included in this kanban loop.

*Kanban Quantity.* Enter the number of items per kanban. It should be a multiple of the value specified in Pack Quantity.

*Container Capacity.* This field identifies a physical constraint placed on the container or item, which could be any of the following:

- Maximum quantity held by a carton or container
- Standard supplier package size
- Production constraint such as size of an oven tray
- For unwieldy or heavy items, the maximum amount that can be handled
- The system displays a warning message if you set this field to 0 (zero).

*Container Type.* Enter the type of container for this kanban item.

*Print Quantity.* Enter Yes to print the kanban quantity on each kanban card. This value defaults from Kanban Control.

*Print ID Barcode.* Enter Yes to print a kanban ID barcode on each kanban card. This value defaults from Kanban Control.

*Print Item Number Barcode.* Enter Yes to print an item barcode on each kanban card. This value defaults from Kanban Control.

*User Reference.* Optionally enter an alphanumeric reference (up to eight characters) to this kanban loop. This value displays on various reports and inquiries.

*Order Quantity Multiple.* Enter the number of kanbans that serves as the lowest common denominator for system loop-sizing calculations. If you do not want to enforce an order quantity multiple, leave the field set to the default 0 (zero). If you enter a value here, Kanban Workbench increases the order quantity until it is a multiple of this value. For example, if you enter 3, the system cannot size the loop at 2 or 5 cards. Instead, it rounds up the order quantity to the next multiple of 3, resulting in a number of cards that is also a multiple of 3: a loop size of 2 would become 3, a loop size of 5 would become 6, and so on. The system applies fractional kanban and card reporting method logic before adjusting the order quantity to meet the order quantity multiple requirement.

*Ship/Delivery Pattern.* Enter the one or two-character code that specifies the ship or delivery patterns for this kanban loop. Entries are validated against codes defined in Generalized Codes Maintenance - The ship/delivery pattern typically specifies the frequency when shipments or deliveries are accepted; for example, any day Monday through Friday, or Tuesday only.

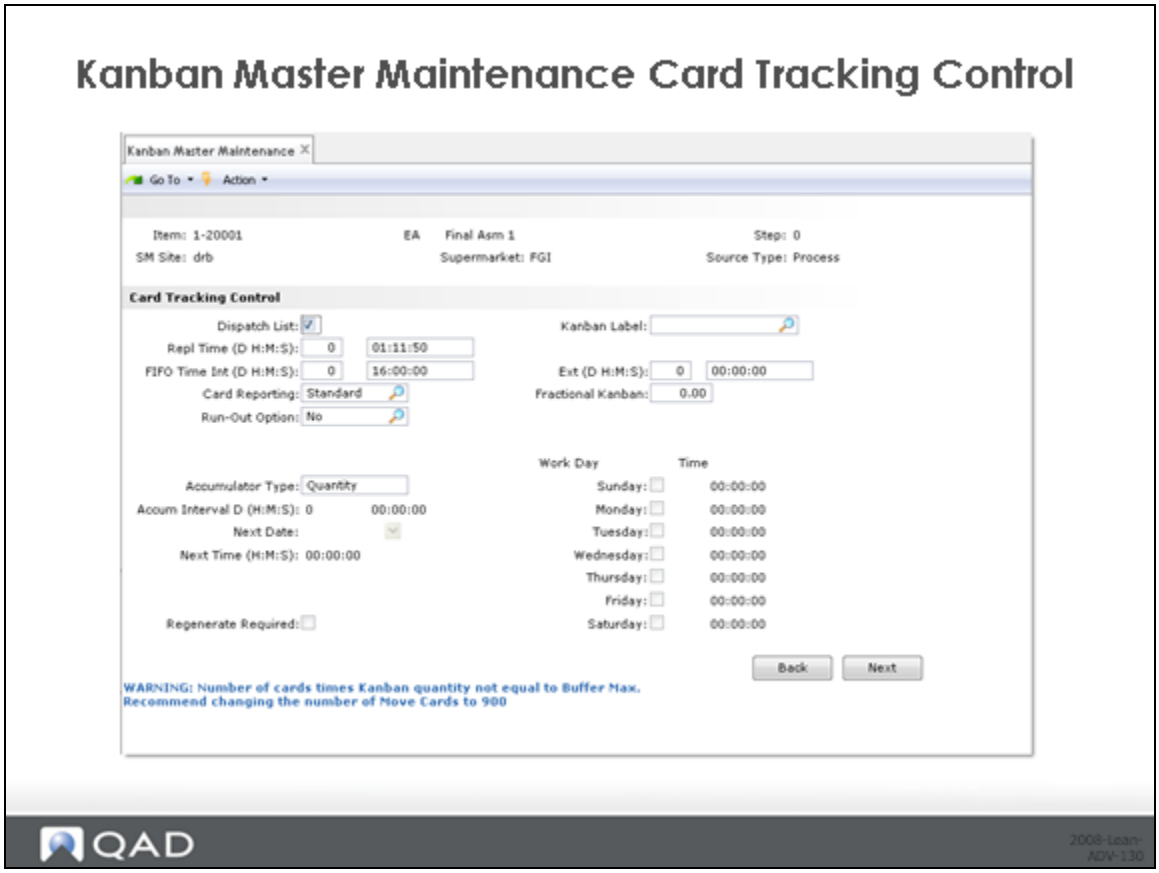
*SDT Code.* Enter a two-character shipping delivery time (SDT) code associated with this kanban loop. SDT codes typically relate to exact times for supplier deliveries. Daily item requirements can be split into hour and minute buckets based on these codes. However, this field is for reference only. It is not associated with SDT codes used elsewhere in QAD EA.

*Point of Use Location.* Enter a code representing the location where the kanban item supplied by this loop is used.

*Delivery Location.* Enter a code representing the location where the kanban item supplied by this loop is delivered.

*Comments.* Enter Yes to update or enter comments related to cards in this kanban loop; otherwise, enter No. When Comments is Yes, the transaction comments screen displays for you to enter or review comments regarding the cards.

## Kanban Master Maintenance Card Tracking Control




Here are the fields that you can maintain in the Card Tracking Control frame for each kanban loop:

*Dispatch List.* If you want this item included on the dispatch list for the source, check this box.

*Kanban Label.* This is an optional identifier for a kanban label definition associated with this loop. This value must be defined in Kanban Label Definition Maint (17.22.16.18).

*Repl Time (D H:M:S).* Enter the replenishment time required. Replenishment time is the time required by the source (primary process, supplier, supermarket) and is expressed as days/hours/minutes/seconds, but is not the same thing as replenishment lead time. Replenishment time is the amount of clock time required (that one day is 24 hours of time) but when converted to elapsed days based on the calendar may be significantly longer in terms of elapsed days. For example, the Replenishment Time might be set to 1 day (24 hours). If the primary process is currently working one eight hour shift per day, then the Replenishment Lead Time will be 3 days (it takes 3 eight hour days to equal the replenishment time of 24 hours). You can see the details of this calculation in the Kanban Workbench.

*FIFO Time Int (D H:M:S).* (FIFO Time Internal) - Enter the amount of time—in days, hours, minutes, and seconds—required for this item to complete the total number of internal FIFO processes defined for the kanban loop. If you have three internal FIFO processes in the FIFO lane for the loop, put the total time required across the three processes, including queue, move and transit as well as processing time.

This value is used in due date calculations and the calculations performed by Kanban Workbench. If you modify the internal FIFO time in that program and save your changes, the system updates this value.

*Ext (D H:M:S).* (FIFO Time External) - Enter the amount of time—in days, hours, minutes, and seconds—required for this item to complete the externally performed FIFO processes defined for the kanban loop.

The Process Item Operation Rollup will calculate total external FIFO time for any items that have operations with subcontract lead times (specified in Routing Maintenance), and enter that value here.

This value is used in due date calculations and the calculations performed by Kanban Workbench. If you modify the external FIFO time in that program and save your changes, the system updates this value.

This field applies only to loops that are supplied by a primary process that includes one or more FIFO processes with subcontract operations.

*Card Reporting.* The number of cards you need in a kanban loop may be different depending on whether you report a kanban card empty when the first piece is removed from the container or when the last piece is taken out. For example, if you report the card empty when the first piece comes out, the signal to replenish will be sent immediately even though there may be some inventory left in the container. This inventory effectively acts as a kind of invisible safety stock that is available during the replenishment period. If you report the card as empty when the last piece comes out, there isn't any such safety inventory and you will be running, in some sense, "closer to the vest" when it comes to inventory replenishment.

To get the same basic coverage when you have some kanbans reported empty on the first piece out and others reported empty on the last piece out, loops with "last piece reporting" should have one additional card.

To accommodate this in the system you can set the Card Reporting option to:

- Standard – create the number of cards indicated by the normal kanban loop sizing logic.
- Add – add one card to the loop after calculating the loop size in the normal logic.
- Remove – subtract one card from the loop after calculating the loop size in the normal logic.

This setting affects kanban sizing calculations performed using Kanban Workbench.

*Fractional Kanban.* The Fractional Kanban value (%) for the loop lets you control the point at which the system reduces the kanban loop size to a single card. When both the preliminary order point and the preliminary order quantity are greater than zero but less than this percentage of the kanban quantity, the system recognizes that the loop can be run with a single card without any risk of running out of material. Consequently, the system eliminates the order point card that would have otherwise been created.

One caveat in using the Fractional Kanban though: the fractional kanban logic to force the loop to a singe card only makes sense if you are reporting the card empty when the first piece is removed from the kanban (container). In this situation there will be enough material left in the container to cover the replenishment lead time.

That will not be true if you report the card empty when the last piece comes out of the container. In this situation, the material will all be gone and there will be nothing availble to cover requirements during the replenishment lead time.

*Run Out Option.* This is a reference only field, designed to indicate that when running this item, the operator should consider “running out” (using all of) the raw material rather than using the exact quantity required based on the kanbans. For example, it may be less expensive to simply use up the portion of a steel coil after producing what is required than it is to dismount it and store it for subsequent use.

*Accumulator Type.* Specify how the system accumulates empty replenishment cards for this kanban item. If cards are accumulated based on quantity, then they will be authorized for replenishment only when enough cards have been emptied to reach the order quantity. If you accumulate on time or schedule, then all the empty cards for an item will be authorized when you reach the appropriate point in time.

The accumulator type can be:

- Quantity: When the sum of empty replenishment cards reaches the total amount specified in the order quantity, the system authorizes them regardless of how much time has elapsed.
- Time: When you use this type, enter a time in Accum Interval field to indicate how frequently you want cards authorized (and communicated with the supplier). Each time the specified interval elapses, the system looks at all empty cards in the loop. If the total of the individual cards meets or exceeds the order quantity, all cards are automatically authorized. In most cases, unless there’s a minimum container size larger than the kanban quantity, the order quantity will be zero, so all empty cards will be authorized.
- Schedule: Access the fields on the right side of the frame to specify days and times when the system evaluates the number of empty cards. If the total of the individual cards meets or exceeds the order quantity, all cards are automatically authorized. As before, in most cases unless there’s a minimum container size larger than the kanban quantity, the order quantity will be zero, so all empty cards will be authorized.

*Accum Interval (D H:M:S).* Specify the amount of time between authorizations when Time is the accumulator type. For example, if you communicate kanban authorizations with your suppliers every four hours then set Accum Interval equal to 0 04:00:00.

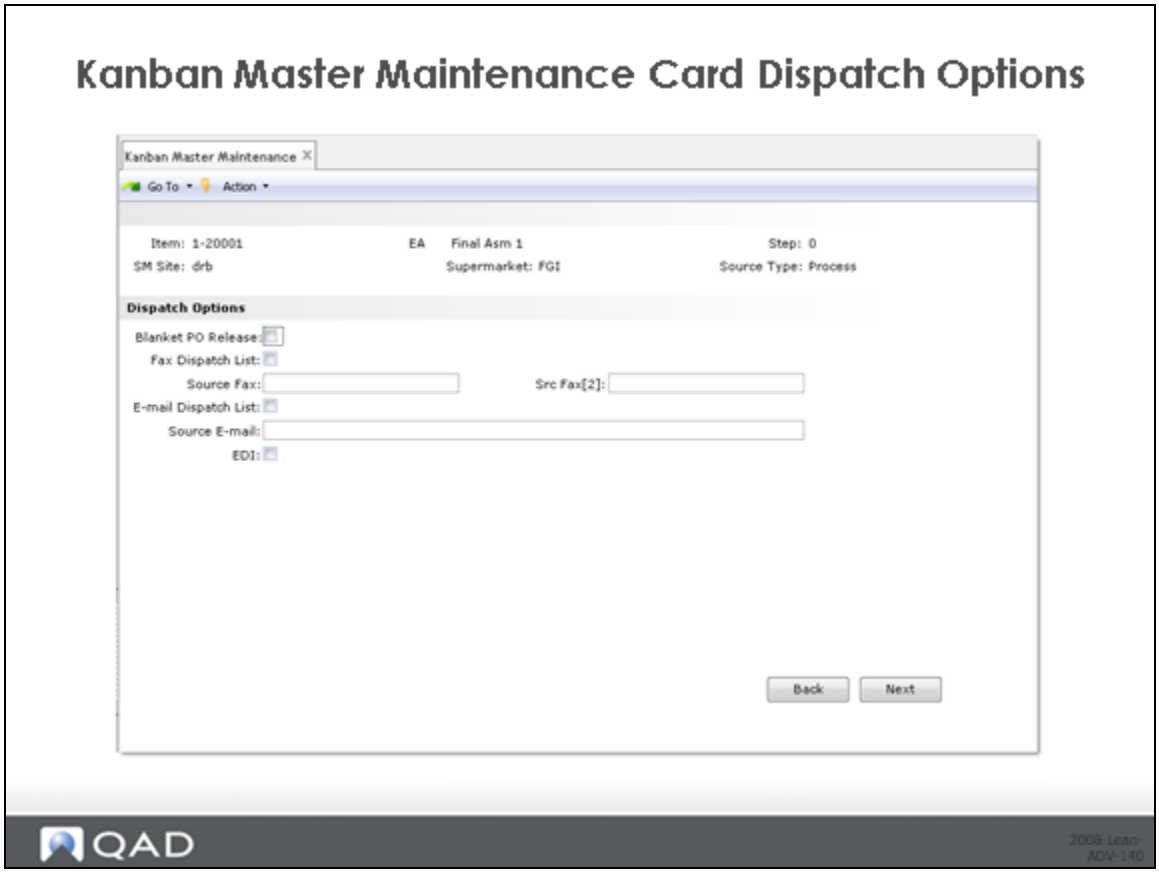
*Next Date.* Specify the next date for authorization for this item when Time is the accumulator type. Normally this value is maintained by the system based on the last actual authorization date and time and the accumulator interval, but when you are initially loading the system you should load a value here.

*Next Time (H:M:S).* Specify the next time for authorization for this item when Time is the accumulator type. Normally this value is maintained by the system based on the last actual authorization date and time and the accumulator interval, but when you are initially loading the system you should load a value here.

*Work Day and Time.* (Sunday – Saturday) for Schedule Accumulator – specify which days and times are authorization points, when Schedule is the accumulator type. Please notice that you cannot have multiple authorizations in a single day when the schedule accumulator is used.

*Regenerate Required.* This display-only field indicates whether key loop information has changed that might require you to regenerate and reprint kanban cards. Key loop information includes things like the kanban quantity, the supplier or the purchase order, the routing or BOM code, etc.

## Kanban Master Maintenance Card Despatch Options




Kanban items can be included on or excluded from the dispatch list based on settings found in this frame, and a user can control some basic dispatch processing using these settings. Here are the fields that you can maintain in the Dispatch Options frame for each kanban loop:

*Blanket PO Release. S*pecify whether dispatch list processing attempts to release a PO from a blanket order. When this is Yes and you enter a valid blanket PO number in the Purchase Order field in the Source Master Data frame, dispatch list processing uses that blanket order as the default. When the loop does not specify a blanket PO number, the system attempts to find an available blanket order matching the supplier and item.

*Fax Dispatch List.* Indicate whether to allow selection of this kanban when dispatch lists are processed in fax format. When set to No, this kanban is not included in dispatch list fax reports.

*Source Fax.* Enter the fax number for the supplying source. This number is used when dispatch lists are reported by source. When this field is blank, the system uses the fax number defined in the supplier or site address. When a dispatch list is sorted by supplying source and printed in fax format, this fax number, preceded by a # symbol, is printed on the first line of the report.

*E-mail Dispatch List.* Indicate whether to e-mail dispatch lists for this kanban. When set to No, this kanban is not e-mailed or included in dispatch list e-mail reports.

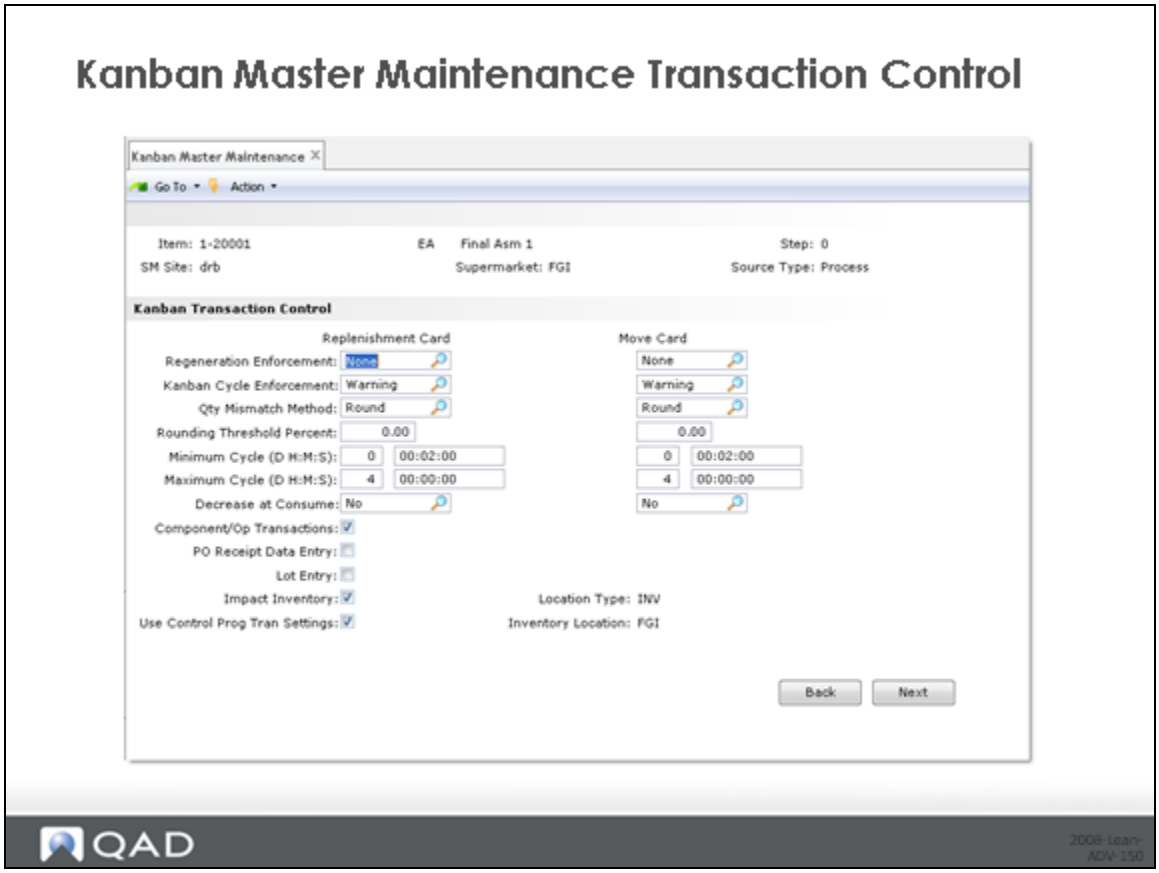
*Source E-mail.* Enter the e-mail address for the supplying source. This address is used when dispatch lists are reported by supplying source. When this field is blank for a loop supplied by an external supplier and you are using the PRO/PLUS Supplier Performance module, the e-mail address defined for the supplier is used. Otherwise, the system does not search further.

*EDI.* Enter Yes to generate dispatch lists for this loop in electronic data interchange format for export to the loop supplier using EDI ECommerce. The default is No.

When you select this option for a supplier kanban, the system verifies that an EDI ECommerce trading parameter called Send Kanban Dispatch exists for the supplier and has been set to Yes. This is a logical parameter in Trading Partner Parameter Maintenance (35.13.10). If this is not defined, a warning displays.

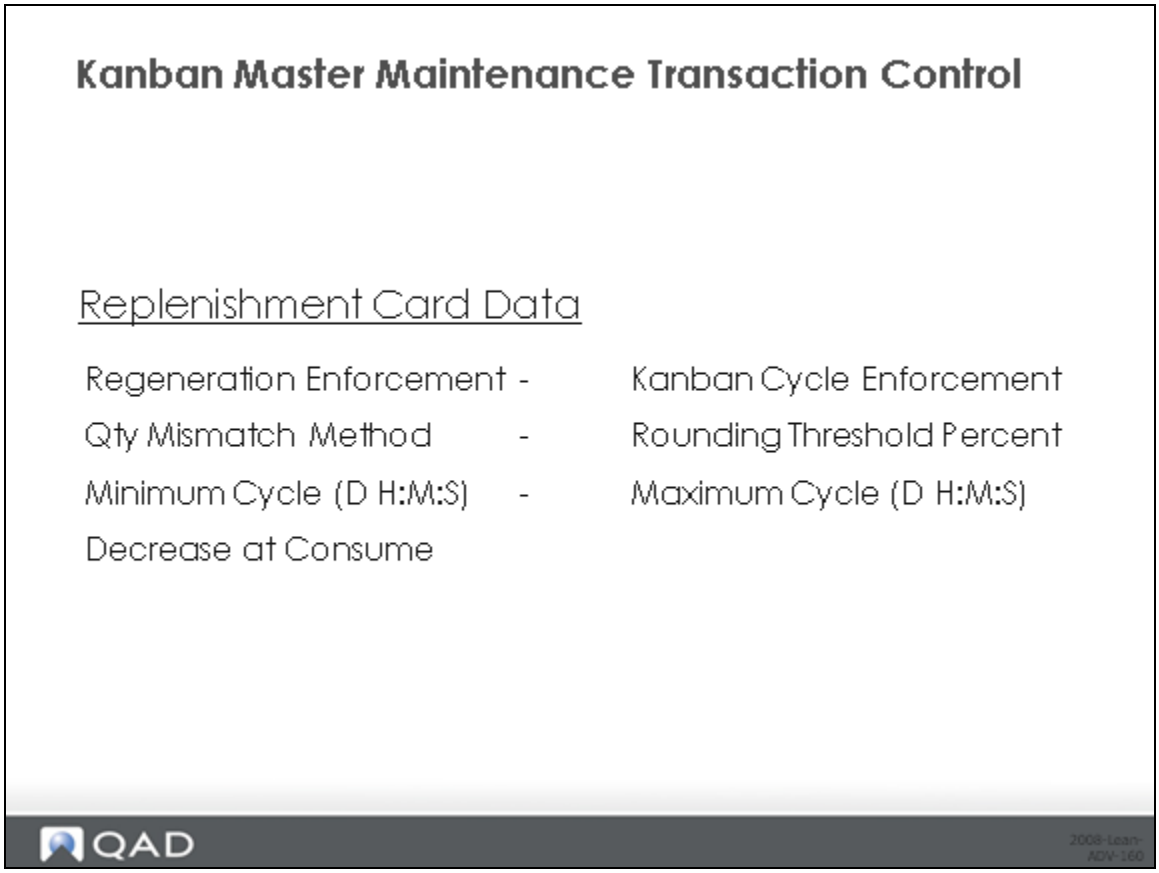
Here are the fields that you can maintain in the Kanban Transaction Control frame for each kanban loop:

## Kanban Master Maintenance Transaction Control




Here are the fields that you can maintain in the Kanban Transaction Control frame for each kanban loop:

## Replenishment Card Data




*Regeneration Enforcement.* Specify how cards are managed for this loop when they are recorded in one of the programs on the Kanban Transactions Menu and the system determines that cards should be regenerated. This occurs when certain card-detail values are no longer synchronized with loop values. For example, if the kanban quantity has changed since the cards were created then the data is no longer consistent (synchronized) and the cards should be regenerated.

This field defaults from Kanban Control.

Valid values are:

- None (the default)
- Warning
- Error

*Kanban Cycle Enforcement.* Indicate the level of *minimum kanban loop cycle enforcement*. This field defaults from Kanban Control. If the amount of time since the last update to a card is less than the “minimum cycle” then the system may produce a warning or error message based on this setting. For example reporting a card empty and then full within a few minutes may not make sense in your manufacturing environment. If this is the case, then it may make sense to set the minimum cycle to a few minutes and the cycle enforcement to produce a warning or error message.

Valid values are:

- None (the default) – don't check the minimum cycle.
- Warning – produce a warning message that the user can override.
- Error – produce an error message that the user cannot override.

*Qty Mismatch Method.* Use this field in combination with *Rounding Threshold* to control how the system manages partial kanban quantities for this loop during certain automated processing functions. These functions determine which cards are selected based on loop and quantity information rather than card ID. They are associated with the following programs:

- Kanban Consumption Import (17.22.19.20).
- EDI ECommerce Document Import (35.1) when used to import advance ship notices (ASNs).
- PO Shipper Receipt (5.13.20).

The system uses the logic defined here when the reported item quantity does not represent an exact number of kanbans. For example suppose an item reported through an import file from Kanban Consumption Import includes a quantity of 47, even though the kanban quantity is 20. In other words what is being reported is 2 cards with a remaining quantity of 7. The system uses Quantity Mismatch Method and Rounding Threshold to determine whether to round the number of cards selected up to 3 or down to 2, or to display an error message and not select any cards for update.

Valid values are:

- Round (the default). The system rounds the remaining quantity based on the value specified in Rounding Threshold and generates kanban history records without acknowledging that rounding took place.
- Warning. The system rounds the remaining quantity as specified in Rounding Threshold, creates kanban history records, and displays a warning message on the output report.
- Error. The system does not complete processing for the loop unless the quantity specified is an exact multiple of the kanban quantity. An error message displays on the output report.

In many respects, this control provides an automated way to avoid dealing with a fundamental problem – why is more or less than the kanban quantity being reported? In the case of the transactions reporting ASNs and PO Receipts, one quantity was ordered and another quantity delivered. You should really determine why this is and work with the supplier to resolve it – the pull system really only works well when there is predictable and consistent reporting of results.

*Rounding Threshold Percent.* Specify the percentage of kanban size the system uses to round off partial kanban quantities in determining the number of cards to select for automated processing.

This value is used in combination with Quantity Mismatch Method. It applies only when that field is set to Round or Warning. When it is Error, the system does not process loops unless the specified quantity is an exact multiple of the kanban quantity.

Leave Rounding Threshold set to the default 100.00 to always round partial quantities down. Change it to 0.00 to always round them up. Any other value represents the percent of the kanban quantity that must exist before the system rounds up to select an additional card. If the excess quantity is less than this percentage, the system rounds down.

For example, suppose the kanban quantity is 20, and Rounding Threshold is 25.00% for an item. This means that any remaining quantity of 5 or more will be rounded up. So a record imported using Kanban Consumption Import with a quantity of 47, or 2 cards with a remaining quantity of 7

will be rounded to 3 cards because 7 is greater than the threshold of 5. In the same scenario with Rounding Threshold set to 50.00%, the system would report only 2 cards, since the remaining quantity of 7 does not meet the threshold requirement of 10.

*Minimum Cycle (D H:M:S).* Enter the minimum kanban loop cycle time in days, hours, minutes, and seconds. Values default from Kanban Control.

Leave these fields blank if you do not want to enforce a minimum kanban loop cycle.

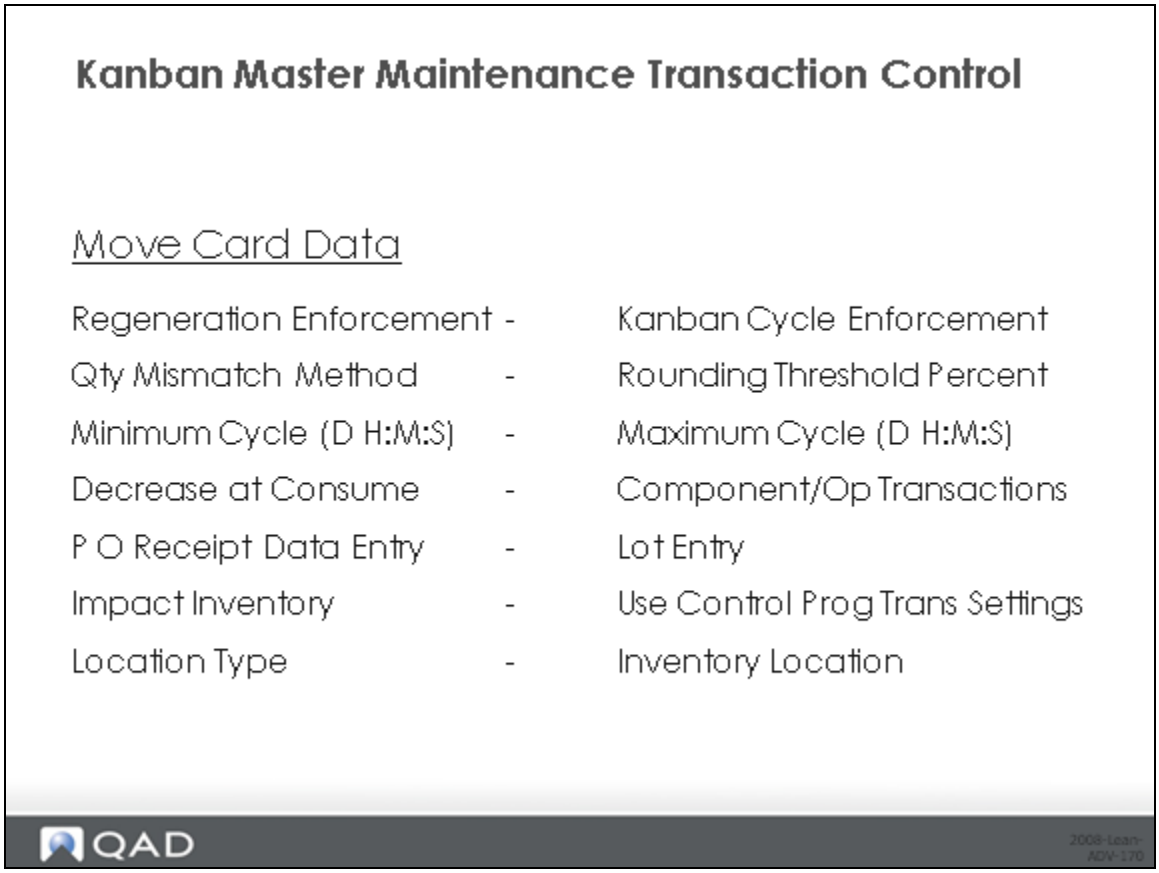
*Maximum Cycle (D H:M:S).* Enter the maximum kanban loop cycle time in days, hours, minutes, and seconds. Values default from Kanban Control.

Leave these fields blank if you do not want to enforce a maximum kanban cycle.

*Decrease at Consume.* Specify whether you want to have cards that are no longer needed removed from this loop the next time they are consumed, as well as whether the system prompts for confirmation before removing them. This value defaults from Kanban Control.

Card Reconciliation must be Yes in Kanban Control to activate the Decrease at Consume feature on the system level. When it is No, this field has no effect.

## Move Card Data




*Regeneration Enforcement (unlabeled).* Specify how cards are managed for this loop when they are recorded in one of the programs on the Kanban Transactions Menu and the system determines that cards should be regenerated. This occurs when certain card-detail values are no longer synchronized with loop values. For example, if the kanban quantity has changed since the cards were created then the data is no longer consistent (synchronized) and the cards should be regenerated.

This field defaults from Kanban Control.

Valid values are:

- None (the default)
- Warning
- Error

*Kanban Cycle Enforcement (unlabeled).* Indicate the level of minimum kanban loop cycle enforcement. This field defaults from Kanban Control. If the amount of time since the last update to a card is less than the “minimum cycle” then the system may produce a warning or error message based on this setting. For example reporting a card empty and then full within a few minutes may not make sense in your manufacturing environment. If this is the case, then it may make sense to set the minimum cycle to a few minutes and the cycle enforcement to produce a warning or error message.

Valid values are:

- None (the default) – don't check the minimum cycle.
- Warning – produce a warning message that the user can override.
- Error – produce an error message that the user cannot override.

*Qty Mismatch Method (unlabeled).* Use this field in combination with *Rounding Threshold* to control how the system manages partial kanban quantities for this loop during certain automated processing functions. These functions determine which cards are selected based on loop and quantity information rather than card ID. They are associated with the following programs:

- Kanban Consumption Import (17.22.19.20).
- EDI ECommerce Document Import (35.1) when used to import advance ship notices (ASNs).
- PO Shipper Receipt (5.13.20).

The system uses the logic defined here when the reported item quantity does not represent an exact number of kanbans. For example suppose an item reported through an import file from Kanban Consumption Import includes a quantity of 47, even though the kanban quantity is 20. In other words what is being reported is 2 cards with a remaining quantity of 7. The system uses Quantity Mismatch Method and Rounding Threshold to determine whether to round the number of cards selected up to 3 or down to 2, or to display an error message and not select any cards for update.

Valid values are:

- Round (the default). The system rounds the remaining quantity based on the value specified in Rounding Threshold and generates kanban history records without acknowledging that rounding took place.
- Warning. The system rounds the remaining quantity as specified in Rounding Threshold, creates kanban history records, and displays a warning message on the output report.
- Error. The system does not complete processing for the loop unless the quantity specified is an exact multiple of the kanban quantity. An error message displays on the output report.

In many respects, this control provides an automated way to avoid dealing with a fundamental problem – why is more or less than the kanban quantity being reported? In the case of the transactions reporting ASNs and PO Receipts, one quantity was ordered and another quantity delivered. You should really determine why this is and work with the supplier to resolve it – the pull system really only works well when there is predictable and consistent reporting of results.

*Rounding Threshold Percent (unlabeled).* Specify the percentage of kanban size the system uses to round off partial kanban quantities in determining the number of cards to select for automated processing.

This value is used in combination with Quantity Mismatch Method. It applies only when that field is set to Round or Warning. When it is Error, the system does not process loops unless the specified quantity is an exact multiple of the kanban quantity.

Leave Rounding Threshold set to the default 100.00 to always round partial quantities down. Change it to 0.00 to always round them up. Any other value represents the percent of the kanban quantity that must exist before the system rounds up to select an additional card. If the excess quantity is less than this percentage, the system rounds down.

For example, suppose the kanban quantity is 20, and Rounding Threshold is 25.00% for an item. This means that any remaining quantity of 5 or more will be rounded up. So a record imported using Kanban Consumption Import with a quantity of 47, or 2 cards with a remaining quantity of 7

will be rounded to 3 cards because 7 is greater than the threshold of 5. In the same scenario with Rounding Threshold set to 50.00%, the system would report only 2 cards, since the remaining quantity of 7 does not meet the threshold requirement of 10.

*Minimum Cycle (D H:M:S) (unlabeled).* Enter the minimum kanban loop cycle time in days, hours, minutes, and seconds. Values default from Kanban Control.

Leave these fields blank if you do not want to enforce a minimum kanban loop cycle.

*Maximum Cycle (D H:M:S) (unlabeled).* Enter the maximum kanban loop cycle time in days, hours, minutes, and seconds. Values default from Kanban Control.

Leave these fields blank if you do not want to enforce a maximum kanban cycle.

*Decrease at Consume (unlabeled).* Specify whether you want to have cards that are no longer needed removed from this loop the next time they are consumed, as well as whether the system prompts for confirmation before removing them. This value defaults from Kanban Control.

Card Reconciliation must be Yes in Kanban Control to activate the Decrease at Consume feature on the system level. When it is No, this field has no effect.

*Component/Op Transactions.* Controls whether the system will automatically generate the following types of transactions when this kanban-controlled item is received into the supermarket:

- Backflush components from the bill of material.
- Record labor based on routing information.
- For loops that include subcontract operations, create a purchase receipt.

This field defaults to Yes when the supplying source is a manufacturing process. Otherwise, it defaults to No and you cannot update it.

*P O Receipt Data Entry.* Specify whether the system should prompt for purchase order receiving information when a replenishment card from this loop is recorded in Kanban Fill/Receive. This value defaults from Kanban Control.

When the field is Yes, the system displays optional data-entry fields for a receiving note and packing slip number when the card is recorded.

*Lot Entry.* Specify whether the system prompts for a lot number and reference when a replenishment card from this loop is recorded in Kanban Fill/Receive. This value defaults from Kanban Control.

When the field is Yes, the system displays optional data-entry fields for a lot number and reference when the card is recorded.

*Impact Inventory.* Controls whether kanban fill transactions for this item will impact the item's inventory and the GL.

- Yes: The system automatically generates the appropriate inventory and GL transactions for the Fill kanban transaction. This is the default value for new kanban loops when the destination supermarket is an INV supermarket.
- No: Kanban transactions do not affect inventory balances or the GL. Only a kanban transaction record is created. This is the default value when the destination supermarket is a WIP supermarket.

You cannot set this field to Yes for an item that has one of the following characteristics:

- Family or configured item (Purchase/Manufacture is F or C in Item Master Maintenance or Item-Site Planning Maintenance for the supplying site)
- Phantom item (Phantom is Yes in Item Master Maintenance or Item-Site Planning Maintenance for the supplying site)
- Lot/serial-controlled item (Lot/Serial Control is not blank in Item Master Maintenance or Item Inventory Data Maintenance for the supplying site)
- Base process or co/by-product item (set up in Co/By-Product Maintenance or Process/Formula Maintenance).

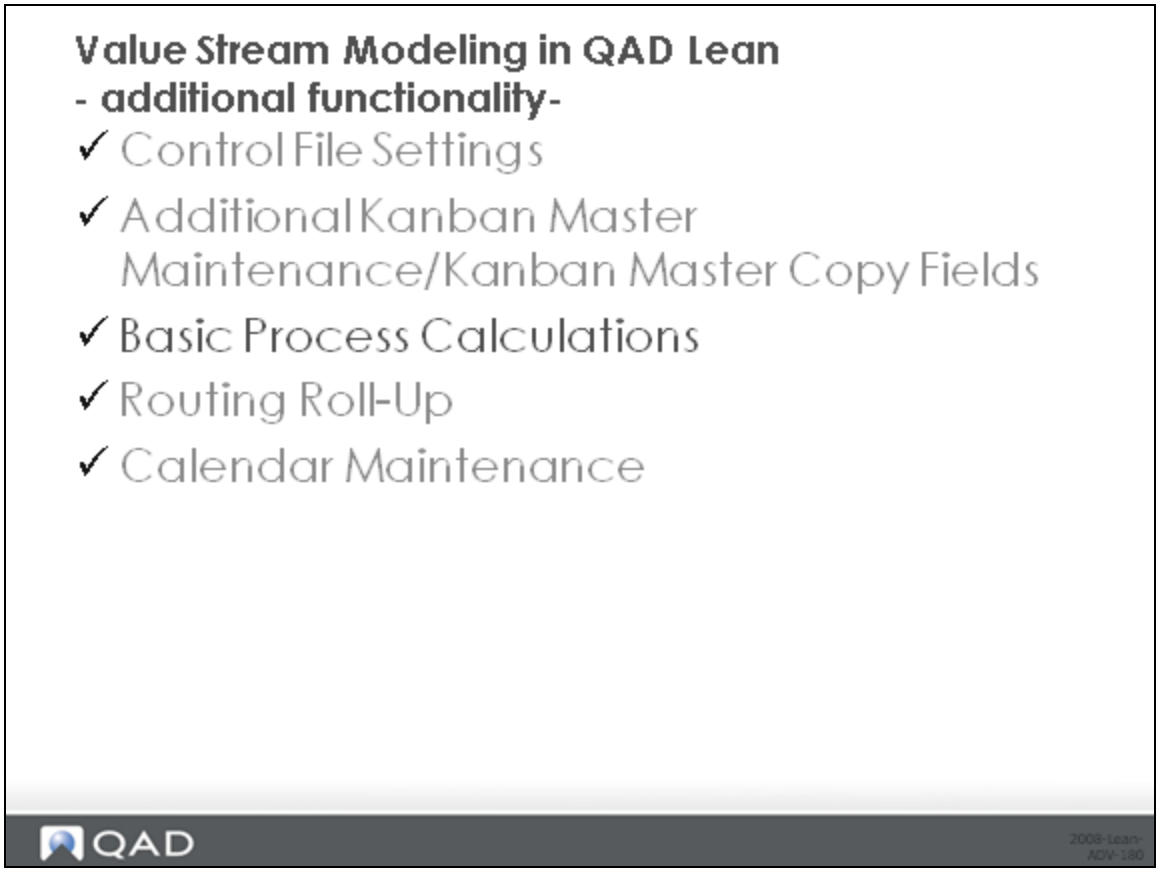
*Use Control Prog Trans Settings.* Specify whether sequence enforcement and automatic card print values for this loop are determined by Kanban Control or by Kanban Master (loop) Maintenance.

- No (the default): The system displays a new frame showing all the sequence enforcement and automatic print values that will apply only to this loop.
- Yes: This loop uses the values specified in Kanban Control. You cannot update them for this loop record.

*Location Type.* Indicate whether the inventory location for this loop is an inventory location or a WIP location.

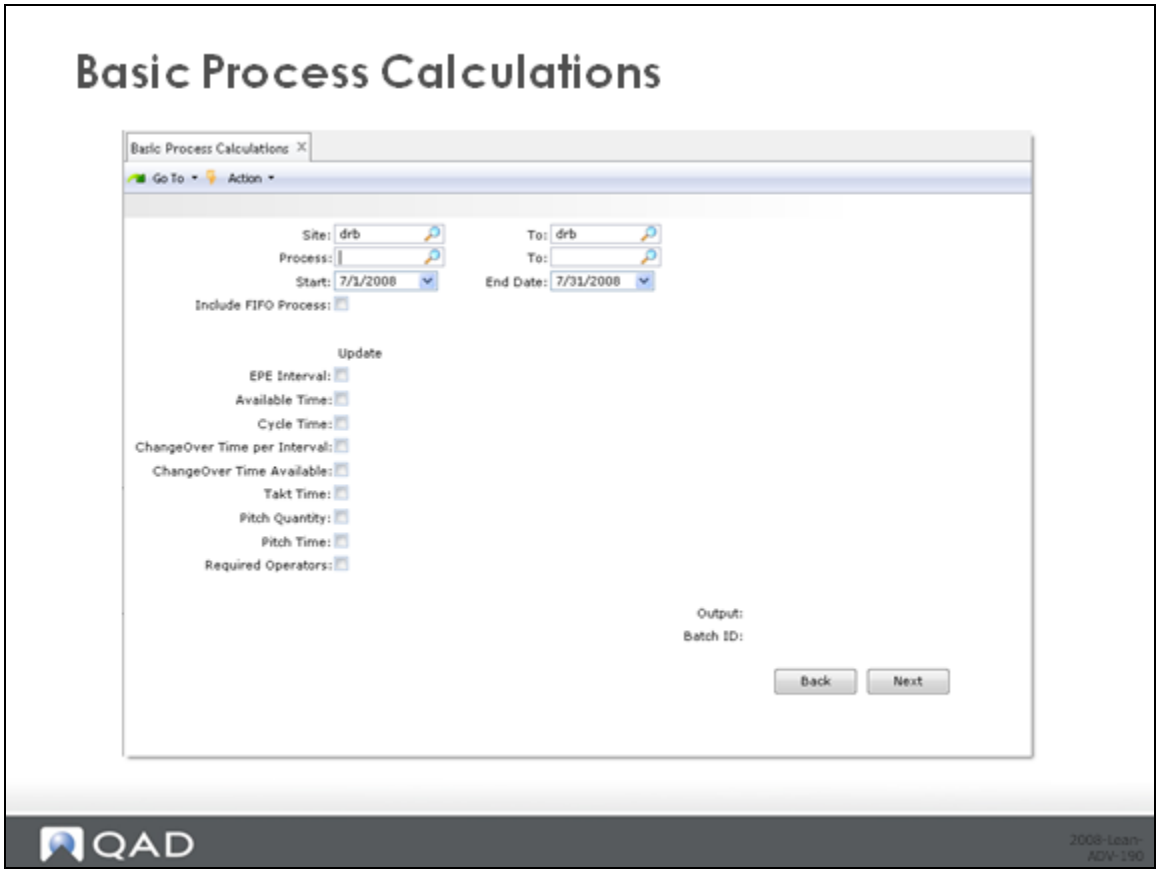
*Inventory Location.* What is the name of the inventory location associated with this loop? This value overrides the inventory location specified in the supermarket record.

## Basic Process Calculations




Basic Process Calculations provides a batch processing option for calculating and updating kanban-related parameters for specified ranges of sites and processes.

## Basic Process Calculations



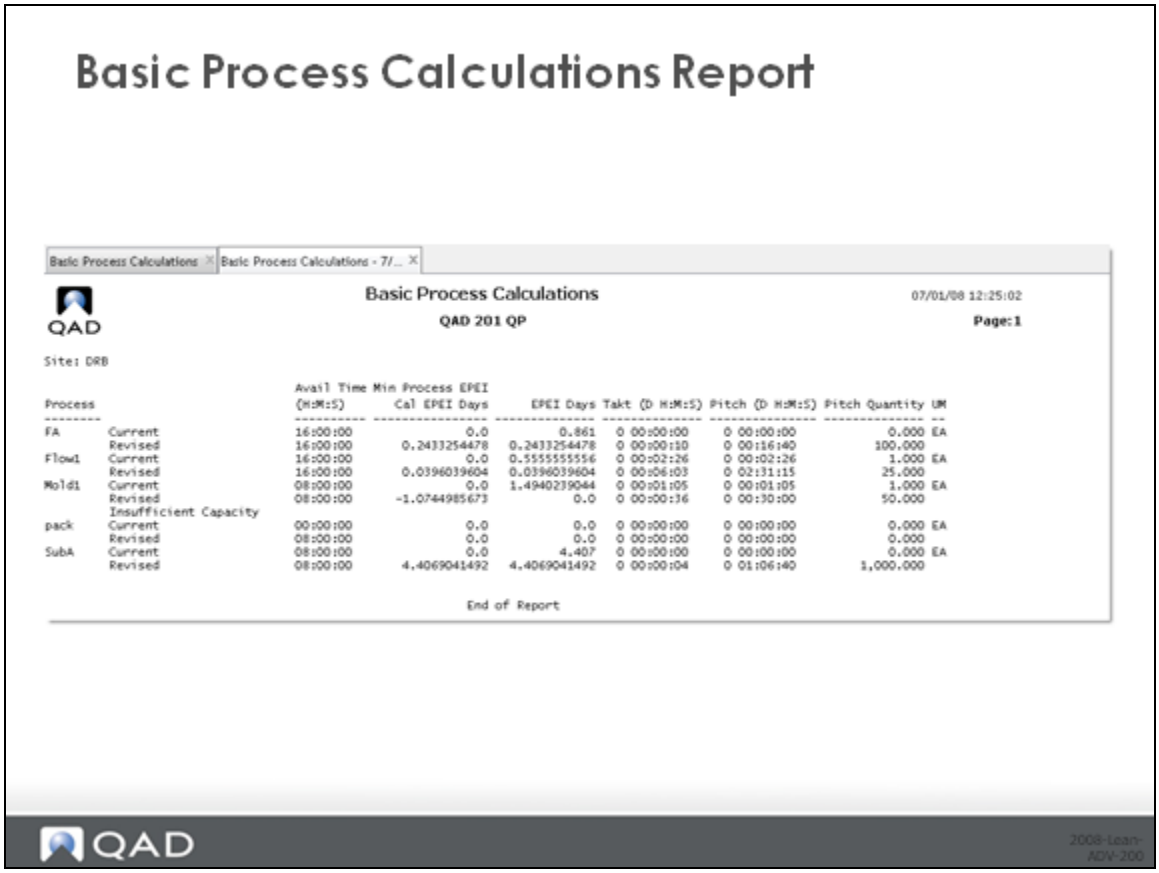

You can select processes based on a combination of site and process code, and specify whether the selection should include FIFO lane processes (those with Process Function set to FIFO in Kanban Process Maintenance). You can also set a date range for the system to use in determining how much time is available per day based on calendar records defined in Process Shift Maintenance.

Below are the calculations performed by the Basic Process Calculations function. Each calculation can be performed with or without an update to the data in the system. If you want the database updated, simply check the checkbox next the item number.

- EPE Interval (the every-part-every interval – EPEI). This is the time interval over which the process can produce every item associated with it.
- The time available in a normal (average) work day.
- The total cycle time per day across all items in each selected process.
- The total changeover time needed to produce each part in the interval.
- The total changeover time available each day based on normal working time less the total cycle time per day.
- Takt time. Takt time is the number of seconds the process has to produce each item to match the rate of customer demand.
- The number of items in the pitch. Pitch is a user-defined method of specifying the interval over which the performance of a process can be measured.
- The time required to produce the pitch quantity.

- The number of operators required to produce at takt time.

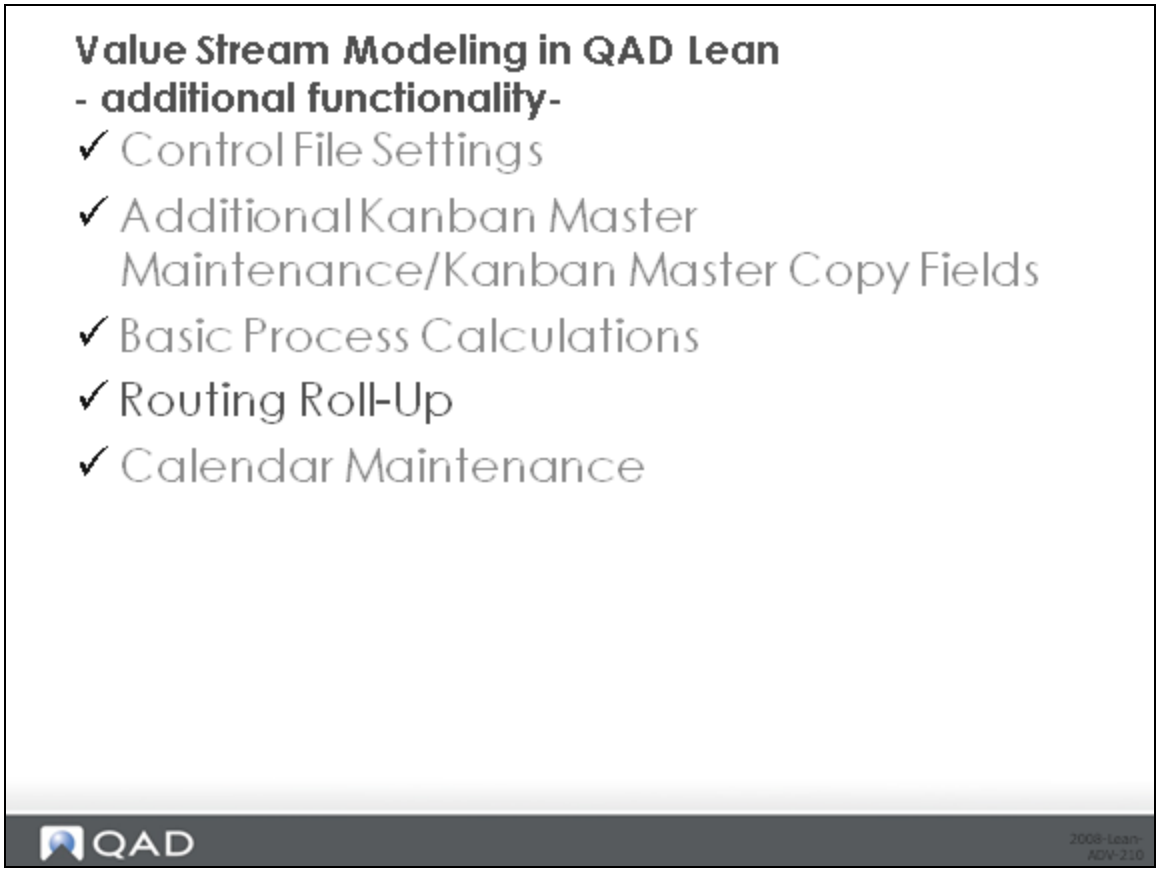
## Basic Process Calculations Report




| Process | | Avail Time Min Process (H:M:S) | Cal EPEI Days | EPEI Days | Takt (D H:M:S) | Pitch (D H:M:S) | Pitch Quantity | UM |
|---|---|---|---|---|---|---|---|---|
| FA | Current | 16:00:00 | 0.0 | 0.861 | 0 00:00:00 | 0 00:00:00 | 0.000 | EA |
| | Revised | 16:00:00 | 0.2433254478 | 0.2433254478 | 0 00:00:10 | 0 00:16:40 | 100.000 | |
| Flow1 | Current | 16:00:00 | 0.0 | 0.5555555556 | 0 00:02:26 | 0 00:02:26 | 1.000 | EA |
| | Revised | 16:00:00 | 0.0396039604 | 0.0396039604 | 0 00:06:03 | 0 02:31:15 | 25.000 | |
| Mold1 | Current | 08:00:00 | 0.0 | 1.4940239044 | 0 00:01:05 | 0 00:01:05 | 1.000 | EA |
| | Revised | 08:00:00 | -1.0744985673 | 0.0 | 0 00:00:36 | 0 00:30:00 | 50.000 | |
| | Insufficient Capacity | | | | | | | |
| pack | Current | 00:00:00 | 0.0 | 0.0 | 0 00:00:00 | 0 00:00:00 | 0.000 | EA |
| | Revised | 08:00:00 | 0.0 | 0.0 | 0 00:00:00 | 0 00:00:00 | 0.000 | |
| SubA | Current | 08:00:00 | 0.0 | 4.407 | 0 00:00:00 | 0 00:00:00 | 0.000 | EA |
| | Revised | 08:00:00 | 4.4069041492 | 4.4069041492 | 0 00:00:04 | 0 01:06:40 | 1,000.000 | |

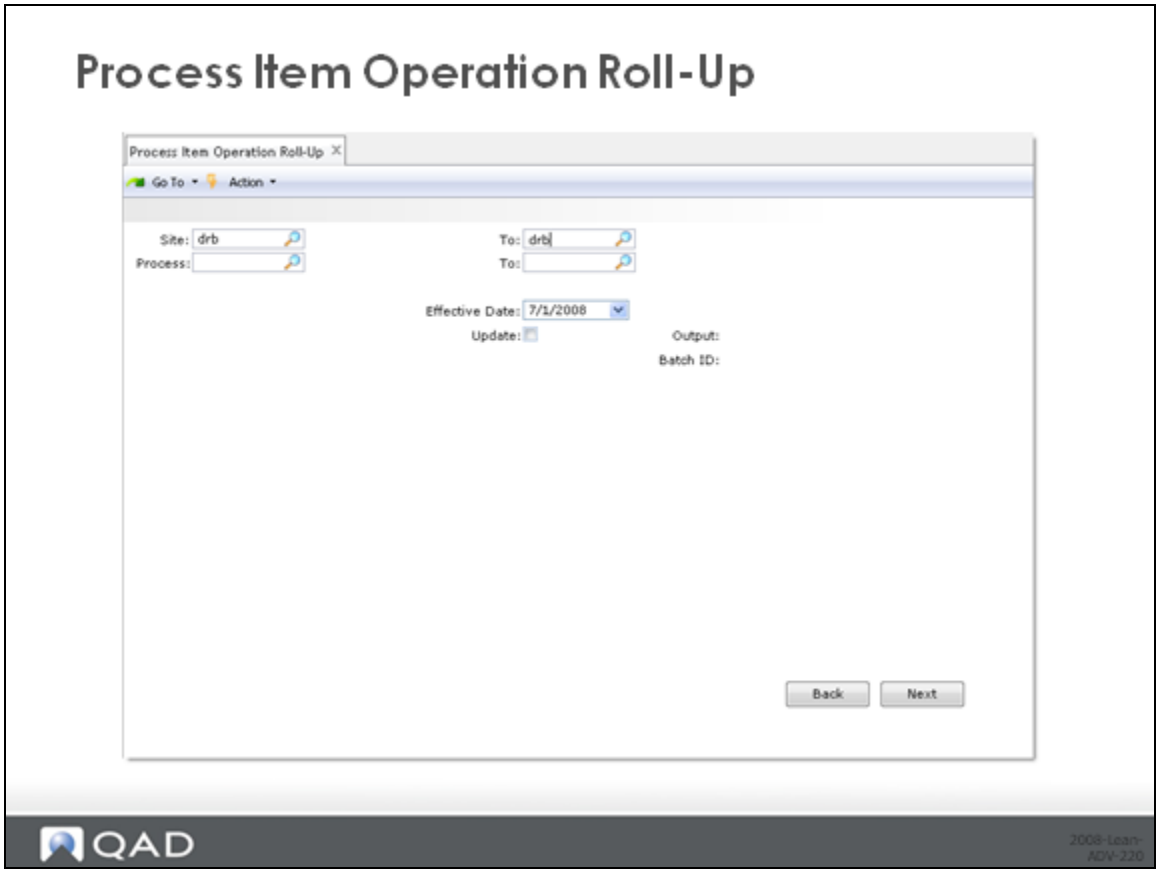
The system generates a report that shows the current and revised time available, EPEI, takt time, pitch, and pitch quantity, like the one displayed above.

## Process Item Operation Roll-Up (Routing Roll-Up)




The Process Item Operation Roll-up is a key function for users who have extensive routings that have reasonable run and setup standards and yield factors. The Roll-Up function will extract this data from the routing and transfer it to the Process Item Detail table for subsequent use by the kanban system for sizing.

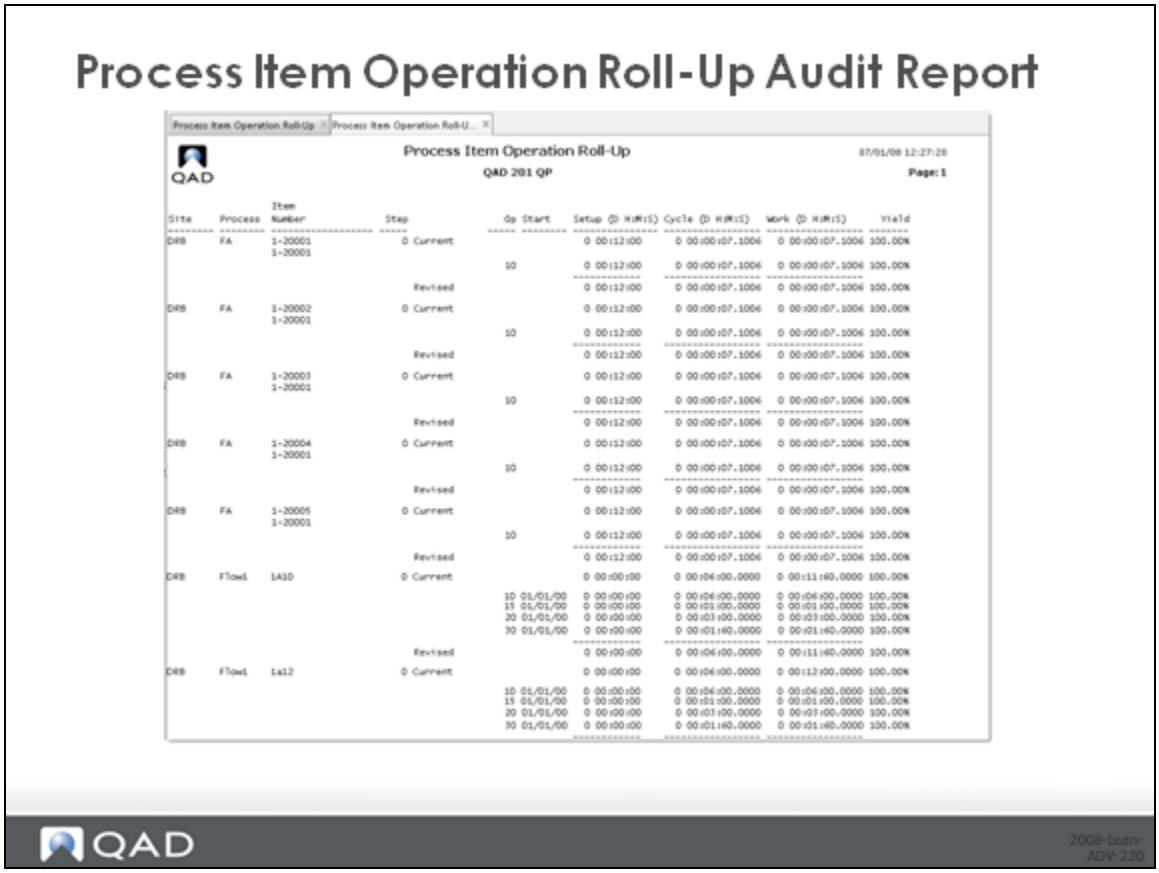
## Process Item Operation Roll-Up




The processing in this program attempts to determine the cycle, setup and work time as well as the accumulated yield for each process item in the selected process. The basic logic is:

- Cycle time – the system estimates the cycle time as the longest run time among the operations in the Start/End Op range for the process item.
- Setup time – the system estimates the setup time as the sum of the setup times for operations in the Start/End Op range).
- Work time – the system estimates the work time as the sum of the run times in the Start/End Op range.
- Yield – the system estimates the yield of a process item based on the yield per operation through all operations from the Start Op range through the balance of the routing. In effect the yield that is calculated is the cumulative yield through to the end of the loop.

## Process Item Operation Roll-Up Audit Report




| Site | Process | Item Number | Step | Op | Start | Setup (D HdMiS) | Cycle (D HdMiS) | Work (D HdMiS) | Yield |
|---|---|---|---|---|---|---|---|---|---|
| DRB | FA | 1-20001<br>1-20001 | 0 Current | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | | 10 | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | Revised | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| DRB | FA | 1-20002<br>1-20001 | 0 Current | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | | 10 | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | Revised | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| DRB | FA | 1-20003<br>1-20001 | 0 Current | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | | 10 | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | Revised | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| DRB | FA | 1-20004<br>1-20001 | 0 Current | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | | 10 | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | Revised | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| DRB | FA | 1-20005<br>1-20001 | 0 Current | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | | 10 | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| | | | Revised | | | 0 00:12:00 | 0 00:00:07.1006 | 0 00:00:07.1006 | 100.00% |
| DRB | Flow1 | 1A10 | 0 Current | | | 0 00:00:00 | 0 00:06:00.0000 | 0 00:11:60.0000 | 100.00% |
| | | | | 10 | 01/01/00 | 0 00:00:00 | 0 00:06:00.0000 | 0 00:06:00.0000 | 100.00% |
| | | | | 15 | 01/01/00 | 0 00:00:00 | 0 00:01:00.0000 | 0 00:01:00.0000 | 100.00% |
| | | | | 20 | 01/01/00 | 0 00:00:00 | 0 00:03:00.0000 | 0 00:03:00.0000 | 100.00% |
| | | | | 30 | 01/01/00 | 0 00:00:00 | 0 00:01:60.0000 | 0 00:01:60.0000 | 100.00% |
| | | | Revised | | | 0 00:00:00 | 0 00:06:00.0000 | 0 00:11:60.0000 | 100.00% |
| DRB | Flow1 | 1A12 | 0 Current | | | 0 00:00:00 | 0 00:06:00.0000 | 0 00:12:00.0000 | 100.00% |
| | | | | 10 | 01/01/00 | 0 00:00:00 | 0 00:06:00.0000 | 0 00:06:00.0000 | 100.00% |
| | | | | 15 | 01/01/00 | 0 00:00:00 | 0 00:01:00.0000 | 0 00:01:00.0000 | 100.00% |
| | | | | 20 | 01/01/00 | 0 00:00:00 | 0 00:03:00.0000 | 0 00:03:00.0000 | 100.00% |
| | | | | 30 | 01/01/00 | 0 00:00:00 | 0 00:01:60.0000 | 0 00:01:60.0000 | 100.00% |

An example of the audit report for the Process Item Operation Roll-Up is shown above. It displays the current and the revised values for setup time, cycle time, work time and yield.

## Process Shift Maintenance (Calendar Maintenance)

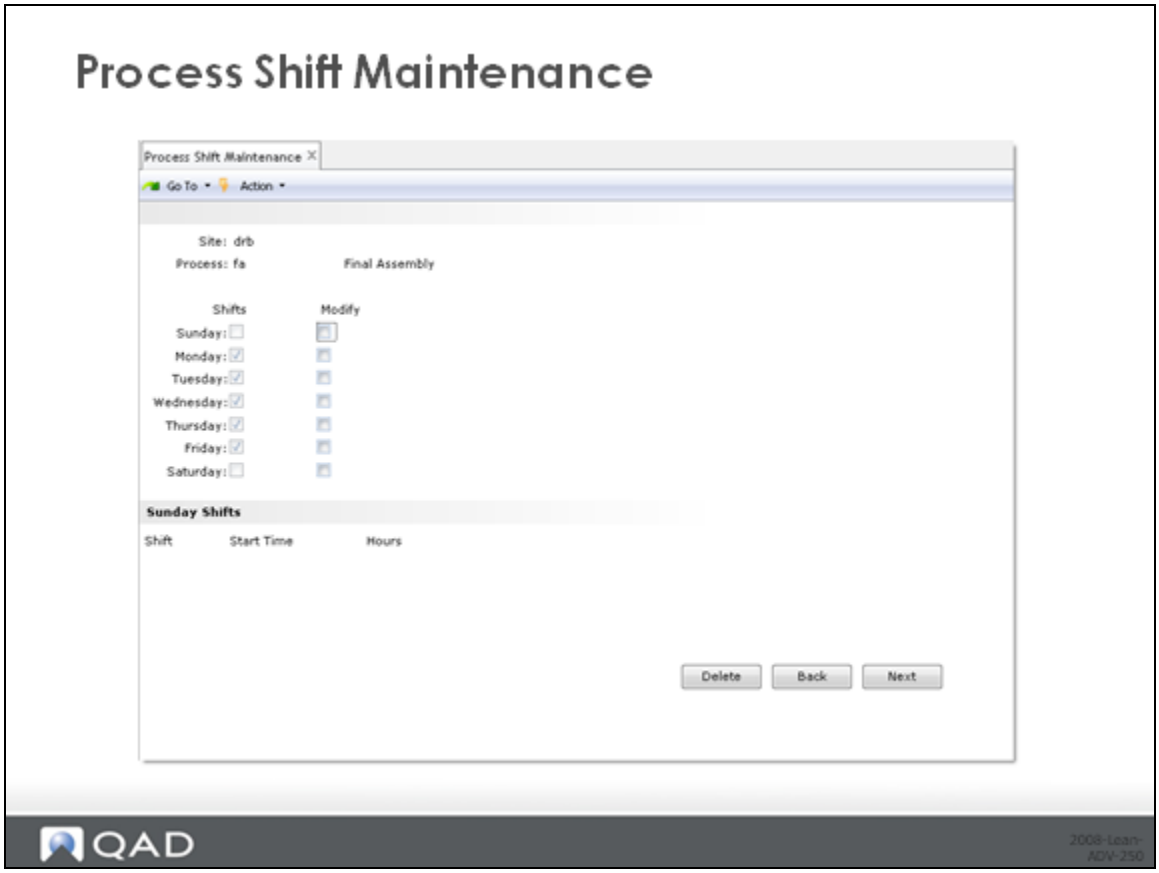
**Value Stream Modeling in QAD Lean**
**- additional functionality-**

- ✓ Control File Settings
- ✓ Additional Kanban Master Maintenance/Kanban Master Copy Fields
- ✓ Basic Process Calculations
- ✓ Routing Roll-Up
- ✓ Calendar Maintenance

QAD

2008-Lean-ADV-240

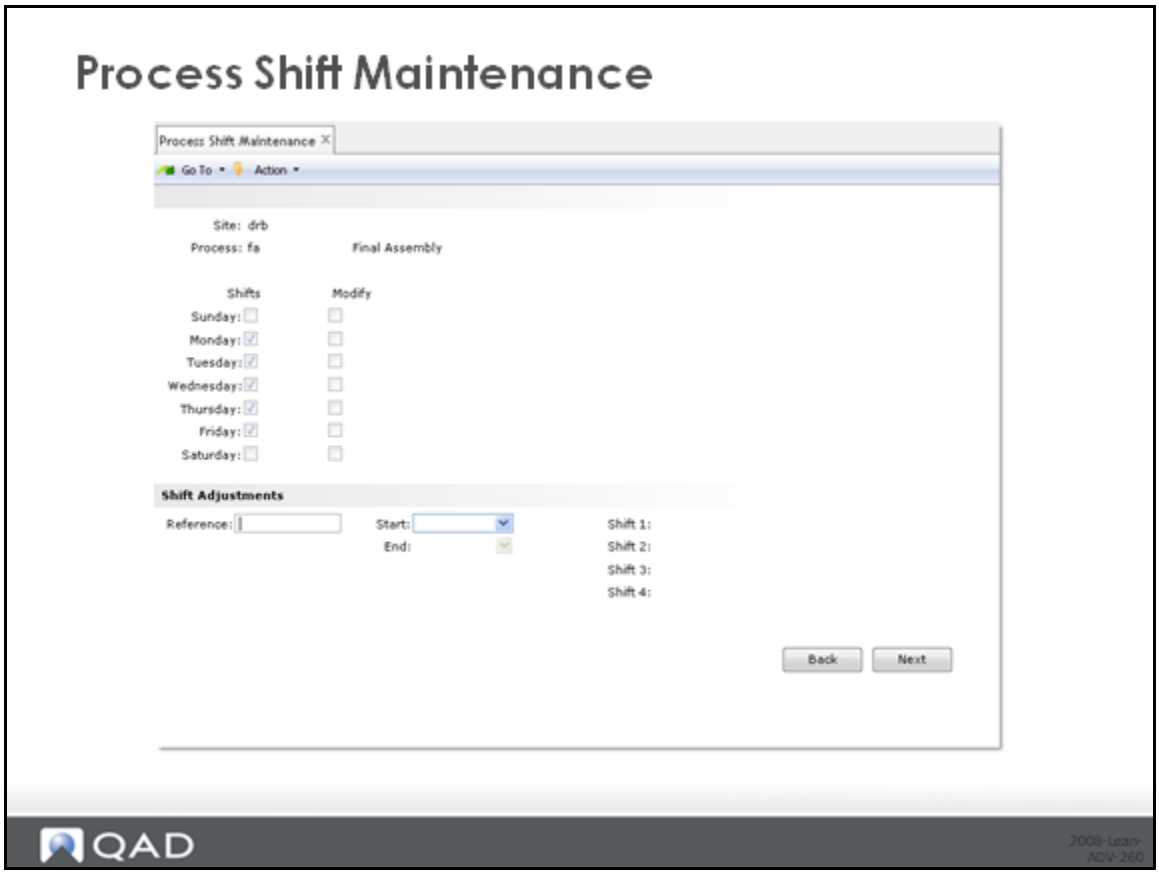
## Process Shift Maintenance




Use Process Shift Maintenance (17.22.13) to define the normal hours for each shift associated with a kanban process. You can also define any exceptions to that normal work pattern.

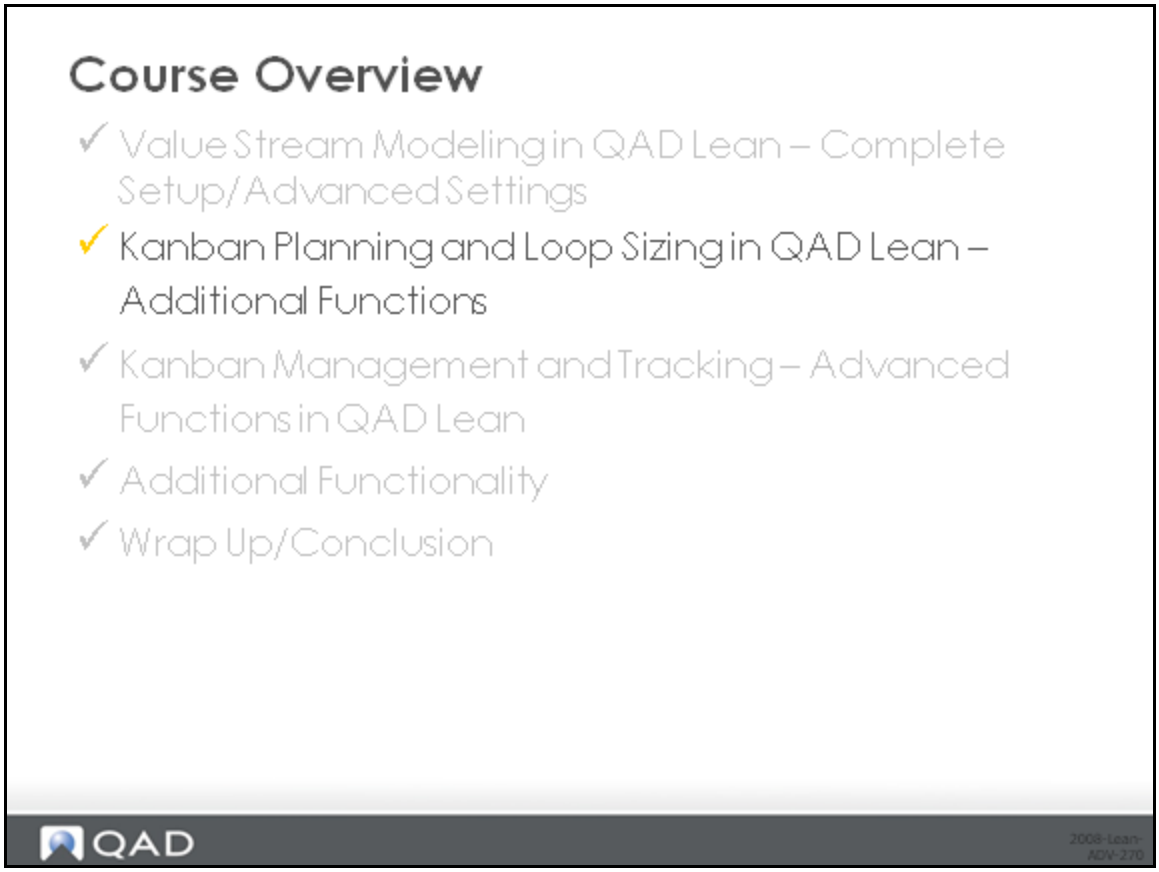
System calculations use process shift records to determine the amount of time available. For example, when you update process data using Basic Process Calculations (17.22.11), the system examines shift records during the specified period to calculate the available time for each work day.

Set up shifts for a site or for a process at a site. You can define up to four shifts for each day of the week. A working day should have at least one shift with some number of hours greater than zero.




The hours worked by a particular shift can change because of holidays, planned shutdowns, or periods with planned overtime. Manage exceptions by specifying adjustment hours to shifts by effective date. Note that when you run Preliminary Level Schedule Report (17.22.14 or 17.14.26 for the enhanced .NET UI version in Enterprise Edition) or Level Mix Workbench (17.22.23.3) for a process, you can specify the reference codes associated with these exceptions. The system adjusts available production time as appropriate and displays each code and the associated number of hours in an individual column.

# Kanban Planning and Loop Sizing - Additional Functions



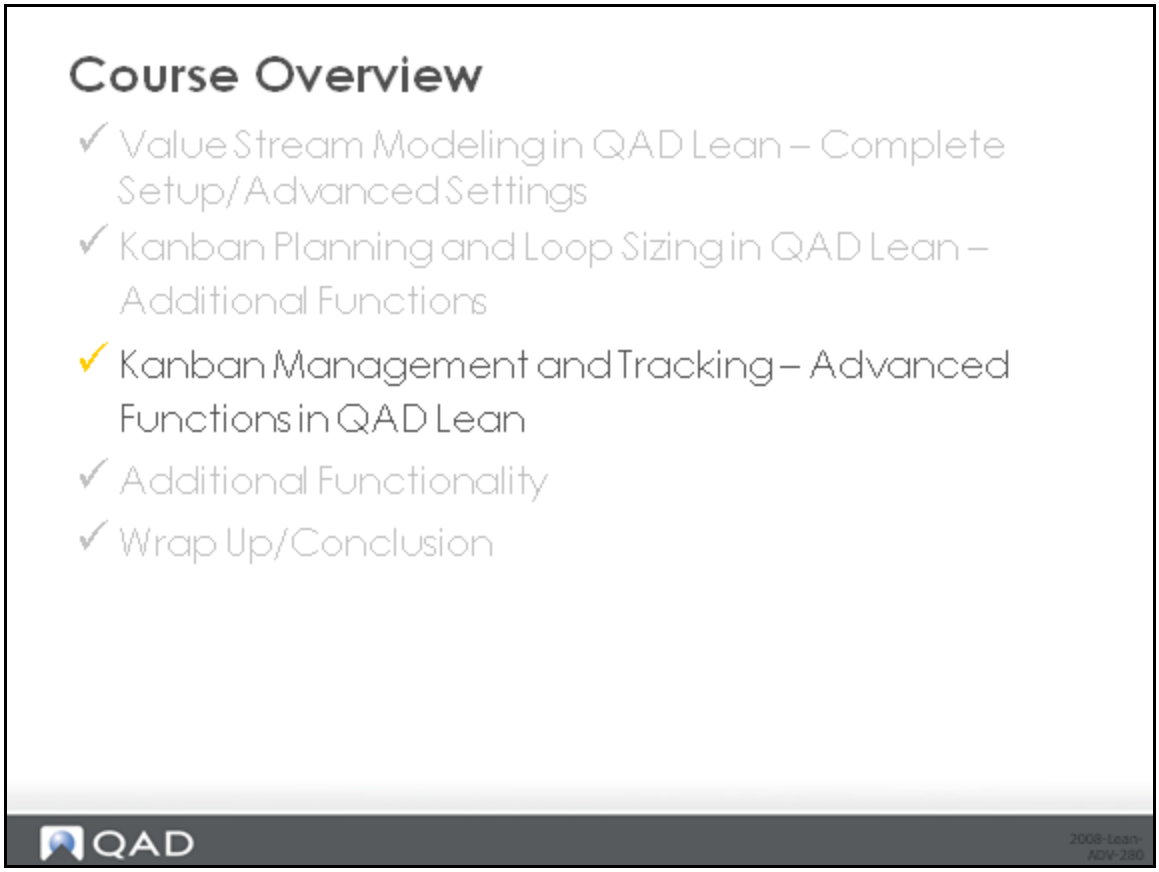

### Kanban Planning and Loop Sizing Using Browse Functions

Most of the data that is required for a kanban loop (often called the “plan for every part”) can be loaded from workbenches or using simplified maintenance driven by browse functionality. The browse functionality is particularly important in situations where the number of loops that may require maintenance is so large as to be impractical using the Kanban Workbench.

However, the basic browse functionality and simplified maintenance screens have not been merged into the software being delivered to customers today. When this functionality is available in the Demo Center, then this section of the class will be updated to reflect it.

Please check back later.

## Kanban Management and Tracking - Advanced



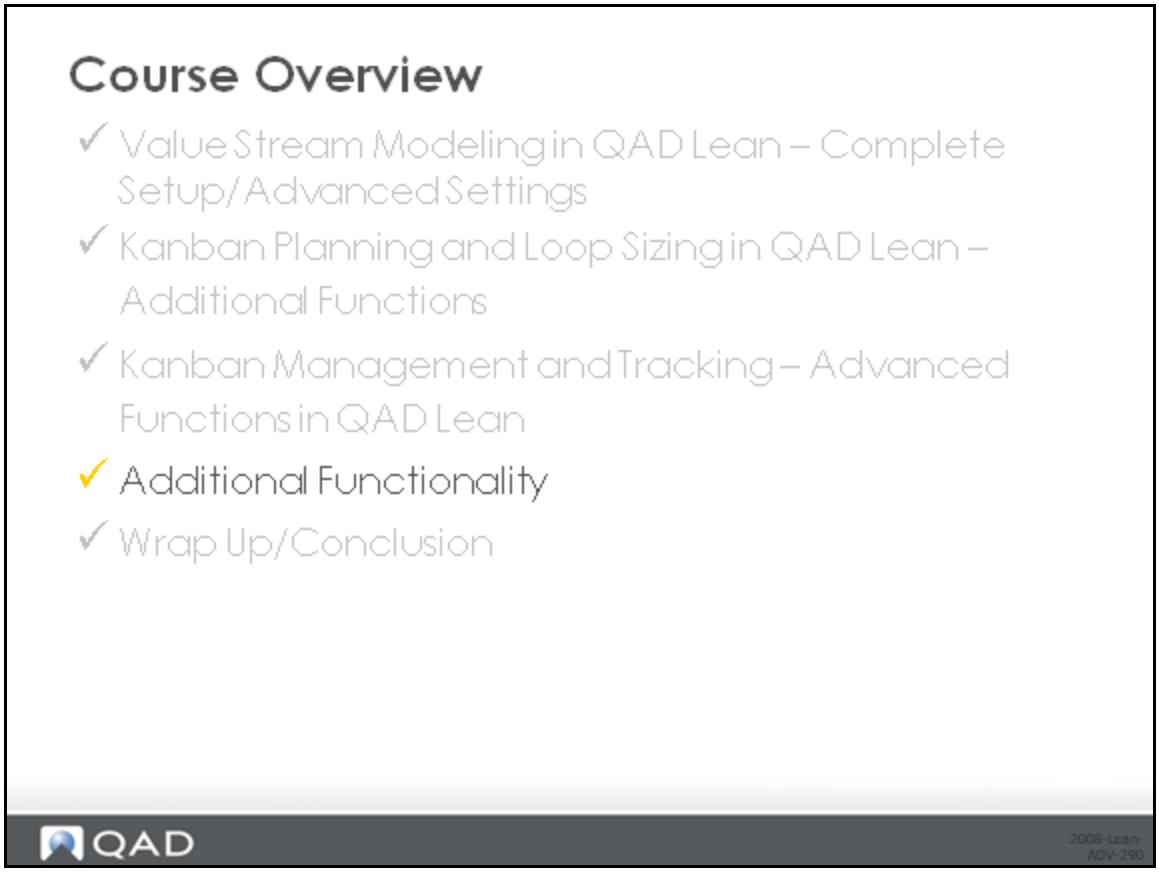

In this section of the class we'll look at:

- Kanban Transactions and Advanced Inventory Updating
  - Ship/Move – Scrap Reporting
  - Fill – Scrap Reporting, Inventory Receipt Override, Location Override

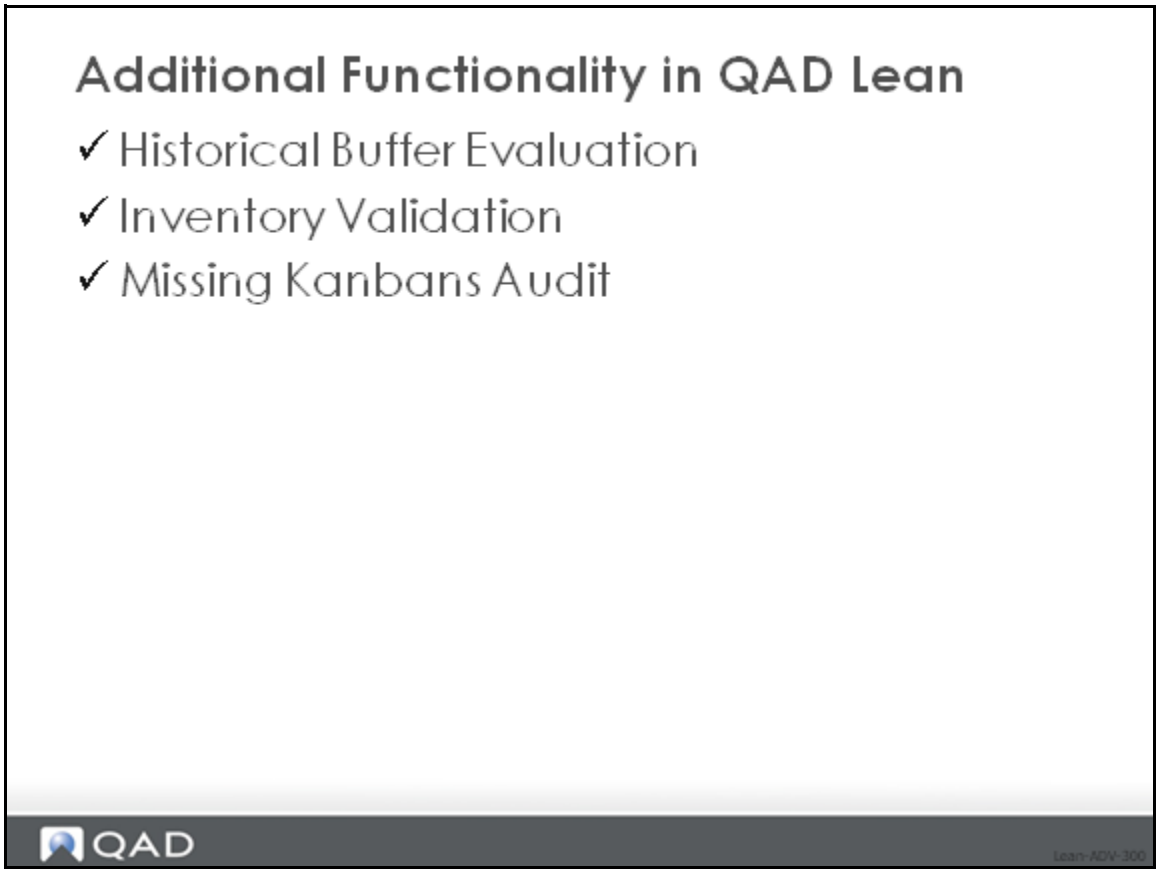
Kanban Transactions and Advanced Inventory Updating

These changes have not been merged into the software being delivered to customers today. When this functionality is available in the Demo Center, then this section of the class will be updated to reflect it.

# Additional Functionality



## Historical Buffer Evaluation




In this part of the class, we'll look at an alternative method for sizing kanban loops, and for adjusting the number of kanban cards circulating in the pull system. Specifically we'll look at a function called the Historical Buffer Evaluation.

As explained in an earlier section of the class, there are two competing schools of thought regarding kanban loop sizing.

### Empirical Method

The "empirical" (or experimental or observational) method relies on adjusting the inventory buffer or loop size based on its observed performance over time. If the item is experiencing too many stockouts then perhaps the amount of inventory in the loop should be increased. If the inventory for the item never dips below a certain value (for example it never goes below the level of the safety stock), then maybe the level of inventory should be decreased. This observational method is described in "Kanban: Just in Time at Toyota". Bill Sandras explains a similar observational method in his book "Just-in-Time: Making It Happen" which he describes as "one less at a time".

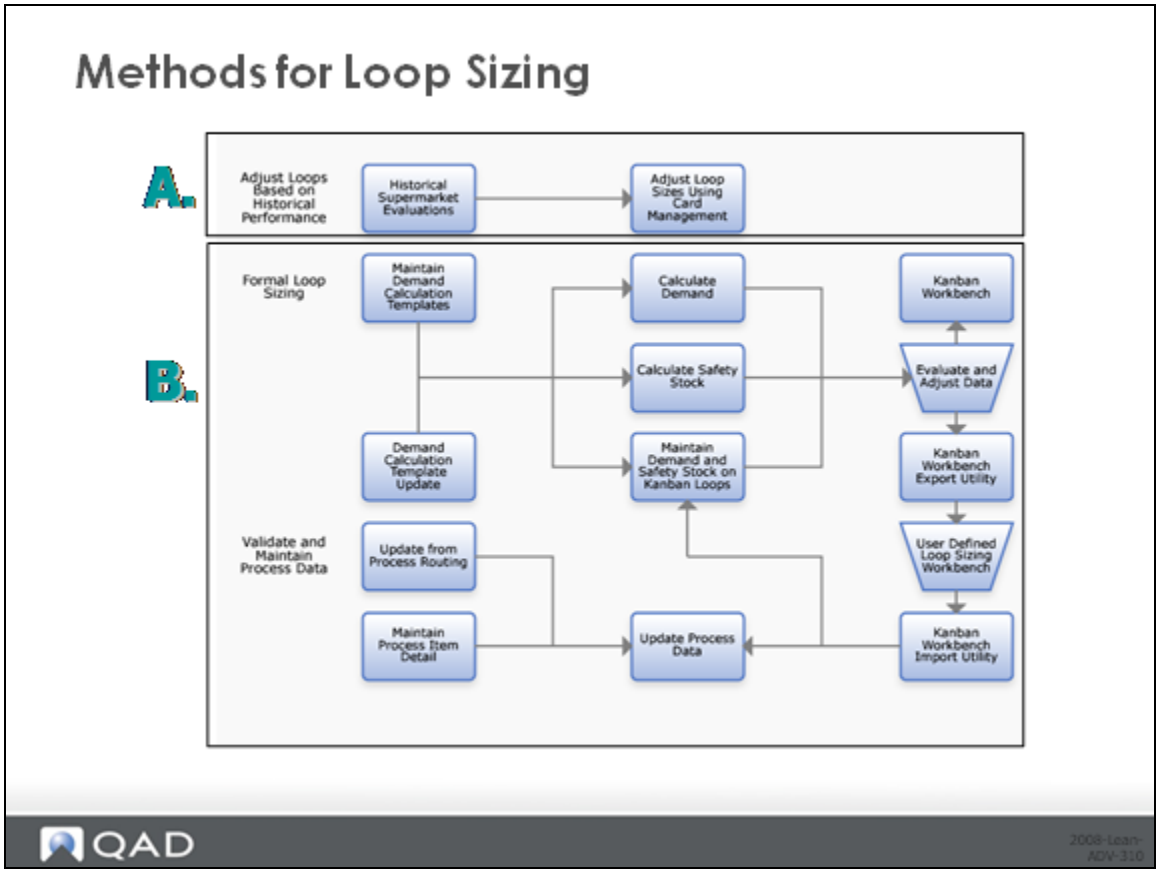
### Theoretical Method

The "theoretical" method is based on a simple mathematical model of inventory behavior based on statistical inventory management principles. The amount of inventory in a loop should be based on the demand during the replenishment time, safety stock, and the order quantity. In this method,

when average demand increases or decreases, when replenishment time changes, when the amount of demand variability is greater or smaller, and as the order quantity is adjusted because of process and standards changes, the loop size should be altered.

The next images show the two methods:

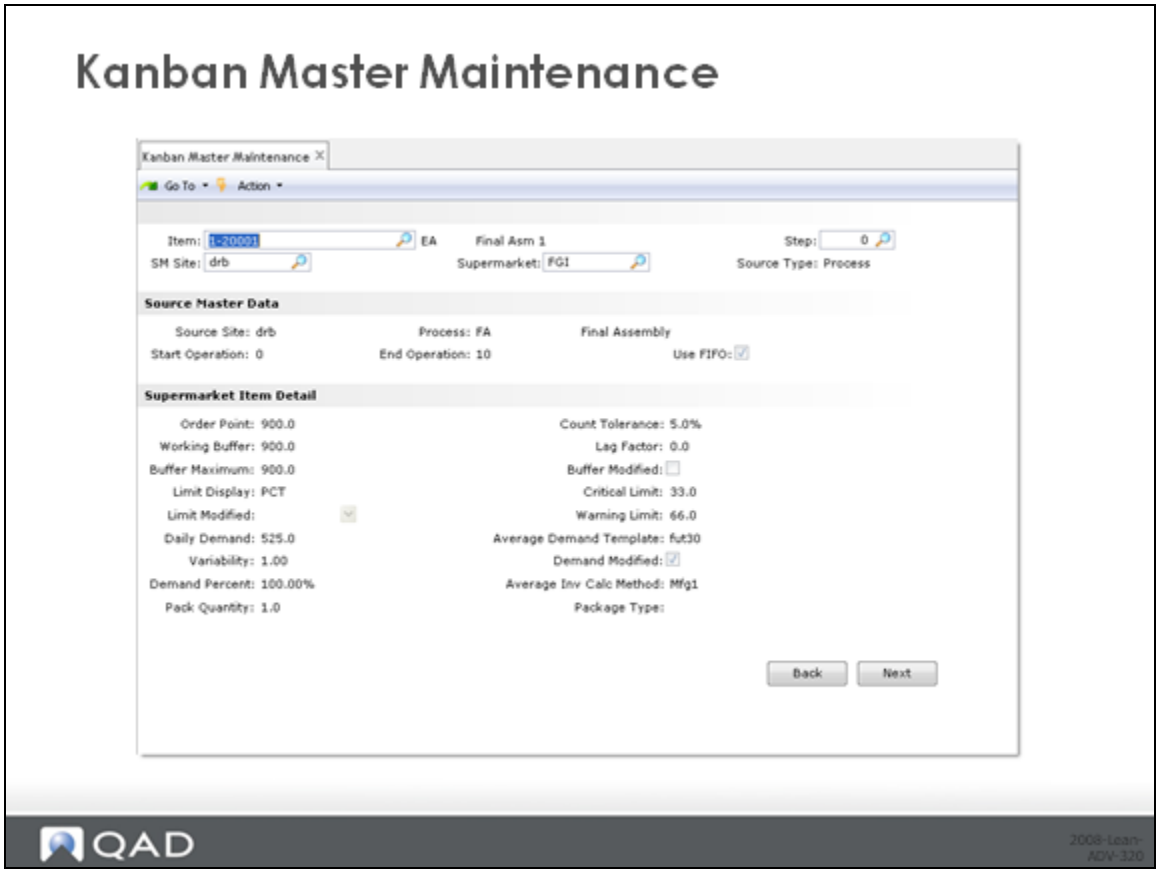
## Methods for Loop Sizing




The Historical Buffer Evaluation in QAD which is part of method A above provides an analysis of actual inventory performance over time so that you can determine whether the level of inventory is sufficient or in excess of what is needed and then increase or decrease the amount of inventory you are carrying in the loop.

The logic of the system is based on some “limits” that you set up in each kanban loop in the system. The “critical limit” defines the inventory level where you are risking a stockout on the item. This can be based on an inventory quantity or the percentage of the maximum buffer quantity. Similarly, the “warning limit” defines an excess inventory point – if the actual inventory never drops below this point then the buffer should be reduced. Again this limit can be defined as an inventory quantity or as the percentage of the maximum buffer quantity.

## Kanban Master Maintenance




The limit values are set up in the kanban loop using the Supermarket Item Detail frame of the Kanban Master Maintenance function of the system, an example of which is shown above:

As a starting point, many companies will set the critical and warning limits as a percentage of the maximum buffer quantity, often 33% and 66% respectively. Over time they may wish to change the limits to a specific quantity for each loop, perhaps the safety stock quantity and the order point quantity for the item for example.

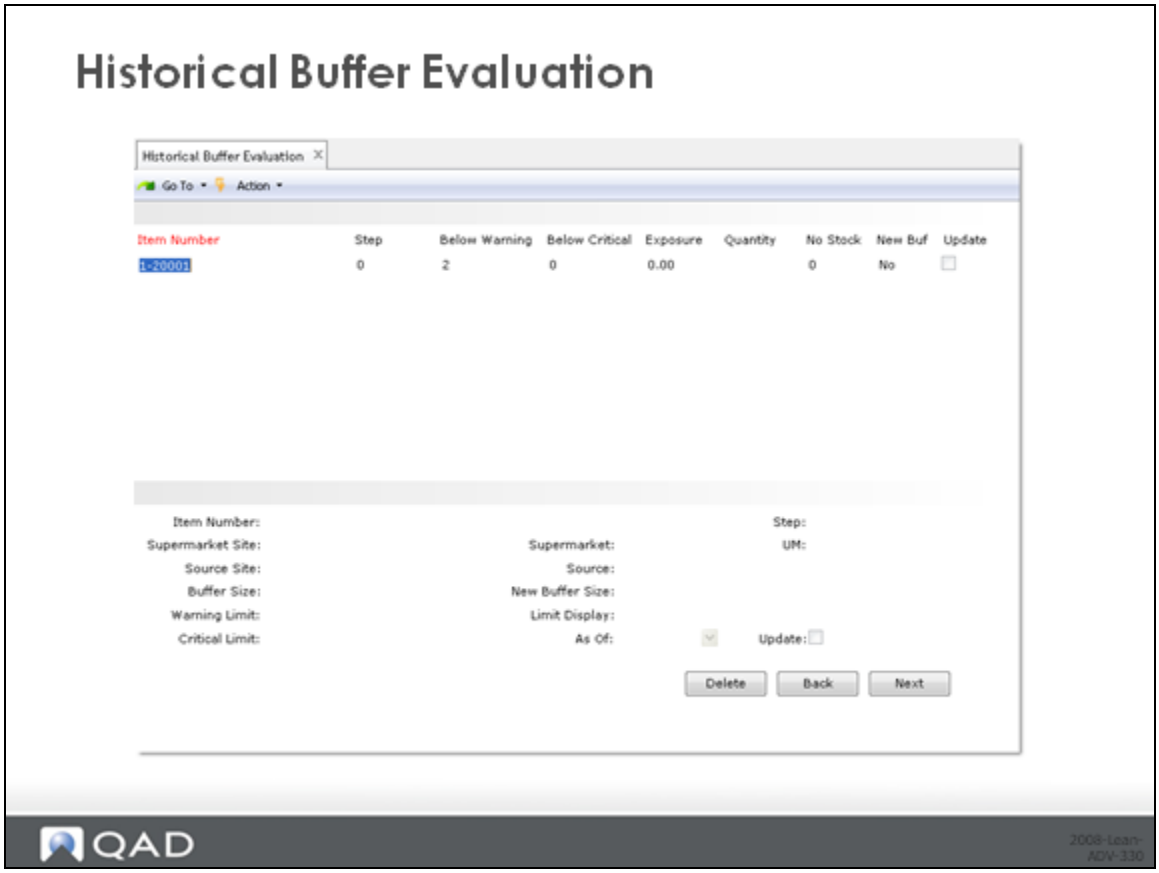
The logic in the system used to evaluate buffer performance, which is based on a comparison of actual inventory based on full kanbans and the limit values, is this:

1. Over the period specified, check the number of times that inventory has dropped below the warning limit. If the inventory has never dropped below the warning limit, then arguably the buffer maximum is set too high and should be reduced. For example, if you set the warning limit to equal the order point quantity and the inventory never actually reached the order point then you are probably carrying too much inventory. Or, maybe a more realistic situation – if you set the warning limit to equal the safety stock but you never actually dipped into the safety stock then you probably can safely reduce it.

2. Over the period specified, calculate the accumulated exposure to stockout and compare this accumulated value to the critical limit. The accumulated exposure to stockout is the sum over all the days in the period of the difference between the critical limit and the actual inventory, if the actual inventory is less than the critical limit. If the accumulated exposure to stockout is greater than the critical limit, even if you've never actually had a stockout, then the system

suggests that you may be carrying too little inventory and gives you an opportunity to increase the buffer maximum. As an example, if you set the critical limit to the safety stock quantity, and had exposures to stockout greater than the safety stock quantity then you might want to increase it. Or if you set the critical limit to be one kanban's worth of inventory then you would get a warning if you ever emptied all the kanbans in the loop. (Notice again that this doesn't mean that you stocked out, it just means that you had a greater exposure to a stockout.)

## Historical Buffer Evaluation




The Historical Buffer Evaluation display shows the detail of the analysis done against each item, and an exception indicator “New Buf” to show the loops that are candidates for updating based on the buffer analysis logic. Check “Update” and the system will provide access to the maintenance frame at the bottom of the display. Here you can change the maximum inventory buffer (“New Buffer Size) or the limits themselves (“Warning Limit”, “Critical Limit”).

There are several things you should recognize about the Historical Buffer Evaluation:

1. The logic of the analysis was based on a periodic evaluation at consistent fixed intervals of time. The system designers felt that 30 days was appropriate for the time between evaluations. However you can use a longer or shorter period if it suits you.

2. You may get odd results if you run the analysis, adjust the buffer size and them immediately rerun the analysis. This is because the new analysis will be done against the new buffer size, even though this buffer size was not actually being used in the loop during the period being analyzed. Consequently if you change the buffer size then you should wait for the appropriate amount of time (30 days or some other value of your choosing as described in point 1 above) before rerunning the analysis.

## Inventory validation

Often the accuracy of inventory, as represented by full kanban cards, is significantly higher than the accuracy of balance on hand. This is because kanban cards are typically updated immediately (a card is reported full when it is filled, empty when material is used out of the associated container) – and except for a very small amount of residual inventory from material left in a container even when it has been reported empty, for the most part a card is either full or it's empty. Getting a count is easy and typically aligned with the number of full kanban cards.

On the other hand, for the balance on hand, inventory updates may be delayed substantially from the actual usage of the parts – particularly anytime "backflushing" is used as the primary inventory updating method. This often means a substantial amount of time is required to track down and reconcile the computer balance with the physical quantity on hand.

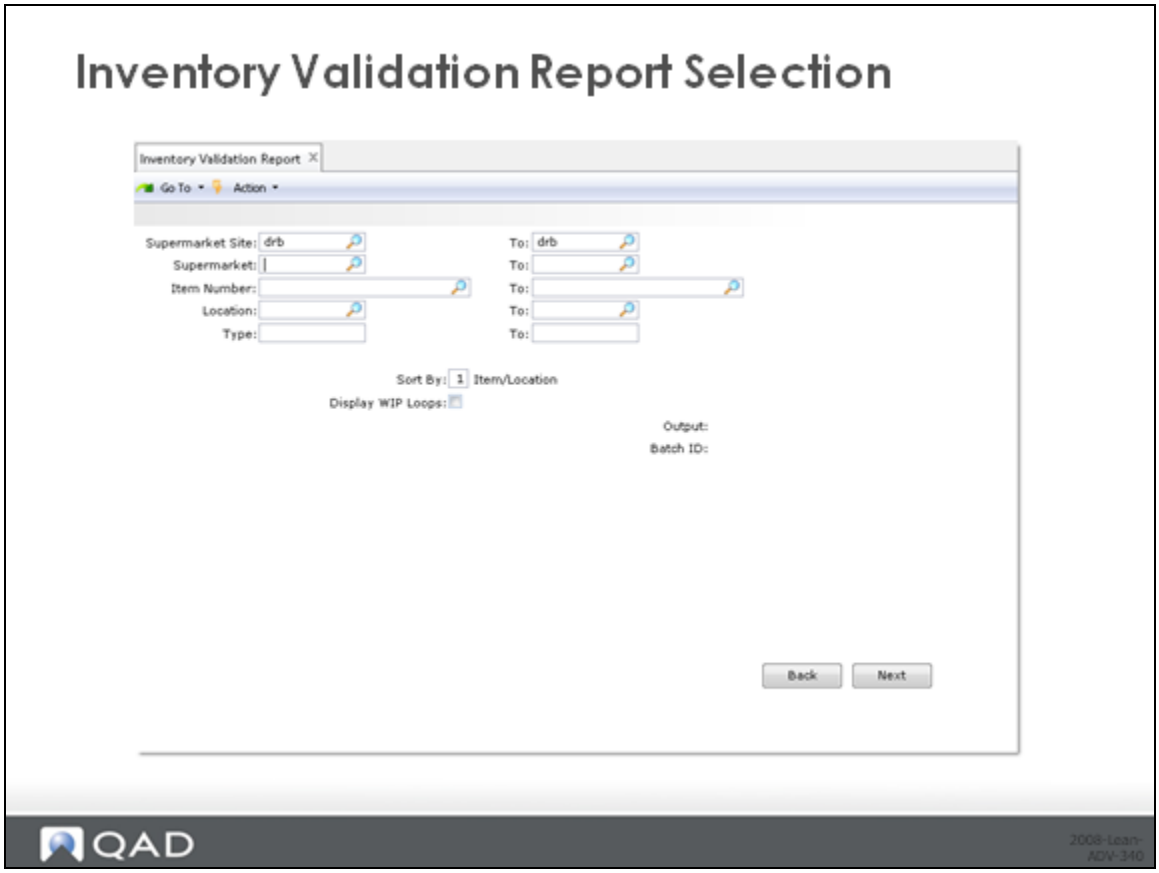
The inventory validation report shows differences between the inventory represented by full replenishment cards and the on-hand inventory balance of the supermarket location, flagging any differences greater than some user specified tolerances.

The report compares the two quantities and uses a tolerance percentage specified in Kanban Master Maintenance as well as a lag factor specified in Kanban Master Maintenance. The lag factor allows you to specify the number of kanbans that are typically in process for each loop and unreported. The tolerance factor is used to identify out-of-tolerance situations.

The system applies the lag factor to the on-hand balance before comparing the inventory levels. Inventories that differ by more than the specified tolerance are flagged.

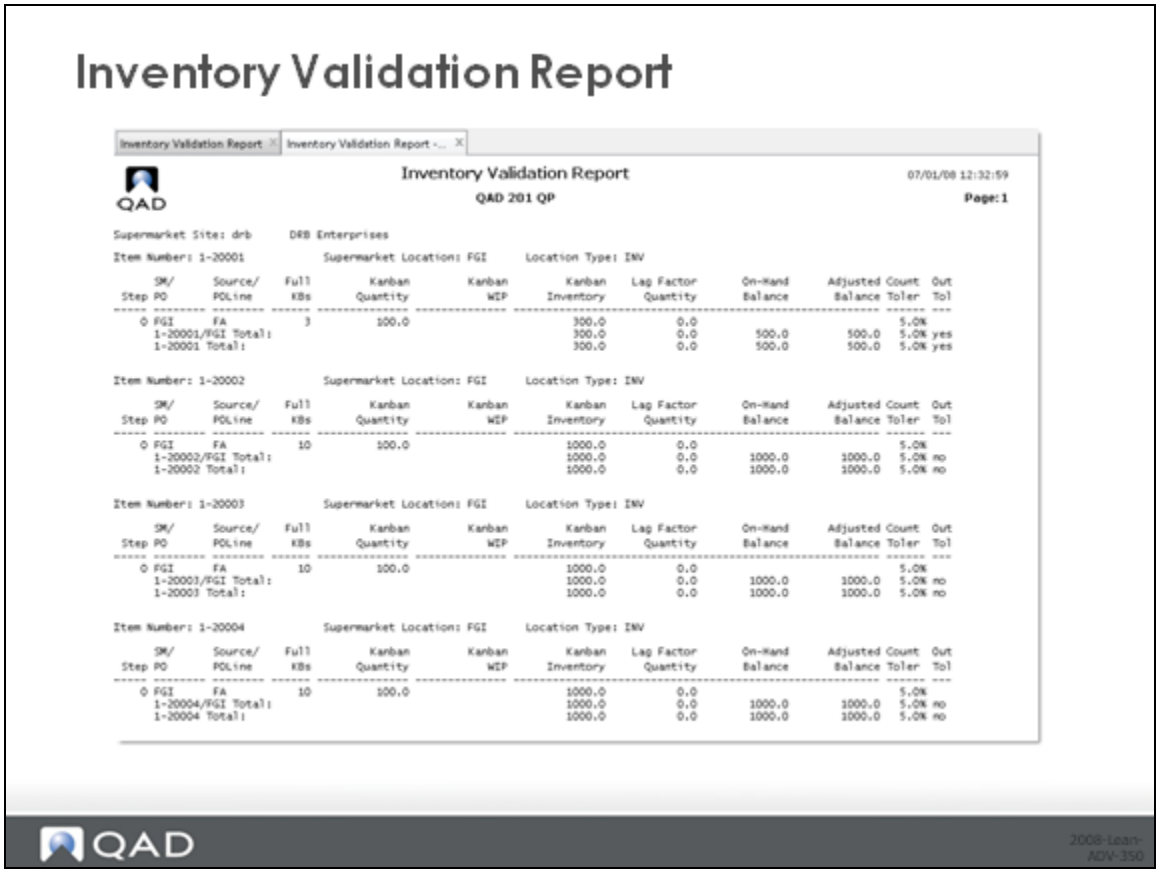
You can use this report to identify situations that might require an audit of card status or an inventory cycle count.

## Inventory Validation Report Selection




The user can specify a range of sites, supermarkets, items, locations, and types as a way to select the inventory that should be validated.

## Inventory Validation Report




An example of the inventory validation report is shown above.

You should notice that this method of validating inventory isn't foolproof and depends on your estimate of the number of kanbans in process. And what may not be immediately obvious, the lag factor needs to be based on the number of kanbans for parent items that are in process and not backflushed, not the number of kanbans circulating for the component in question.

For this reason, the Inventory Validation Report does have a purpose, but in practice it may be more difficult to work with than you might expect.

## Missing kanbans (lost cards)

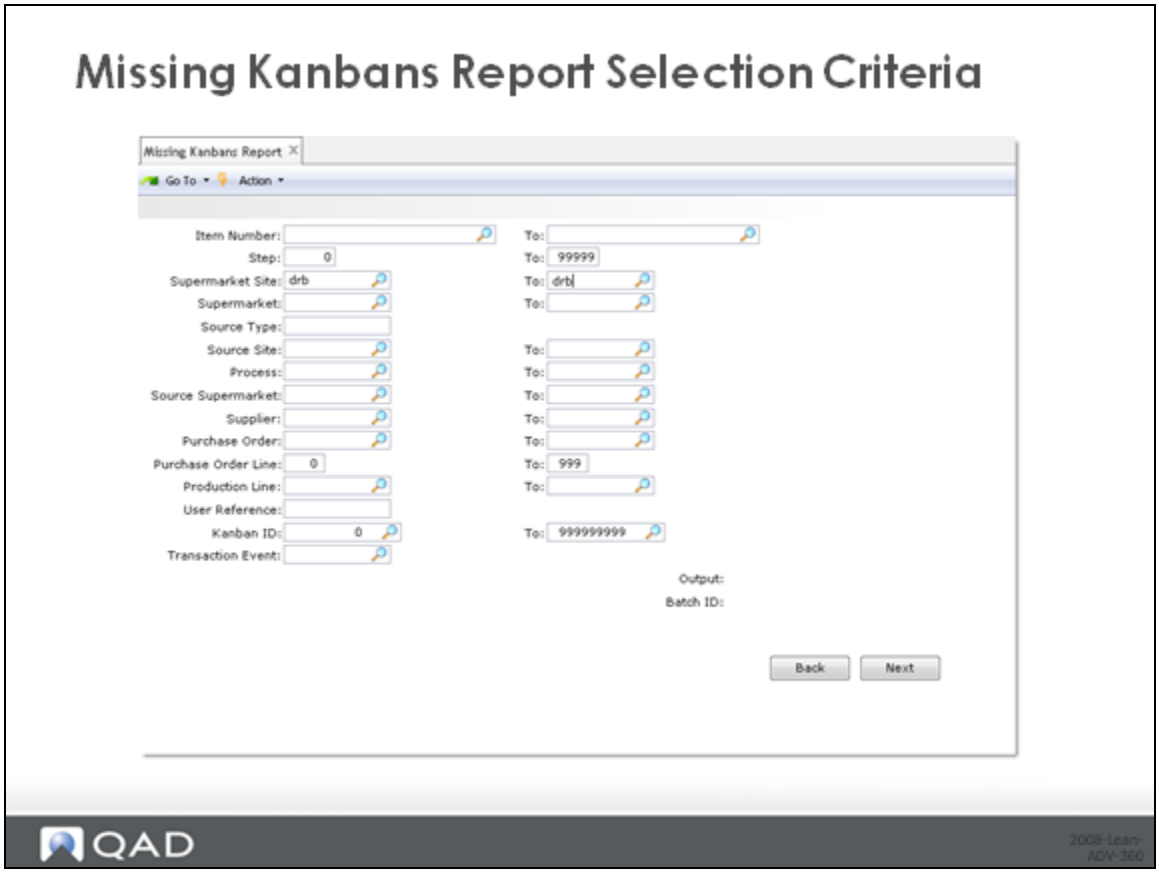
Kanbans are sized to print the exact number of cards that fulfill the demand for the kanban-controlled item. When a kanban card is lost or destroyed, the effect is to cripple the replenishment system, ultimately leading to shortages.

This report determines the time elapsed between the last time a transaction was entered for a specific kanban card and the current date and time. If the amount of elapsed time is greater than the maximum kanban cycle specified for that kanban, then more than likely one of two different things are going to be true:

- The card is missing.
- There is way too much inventory and the card is never being processed.

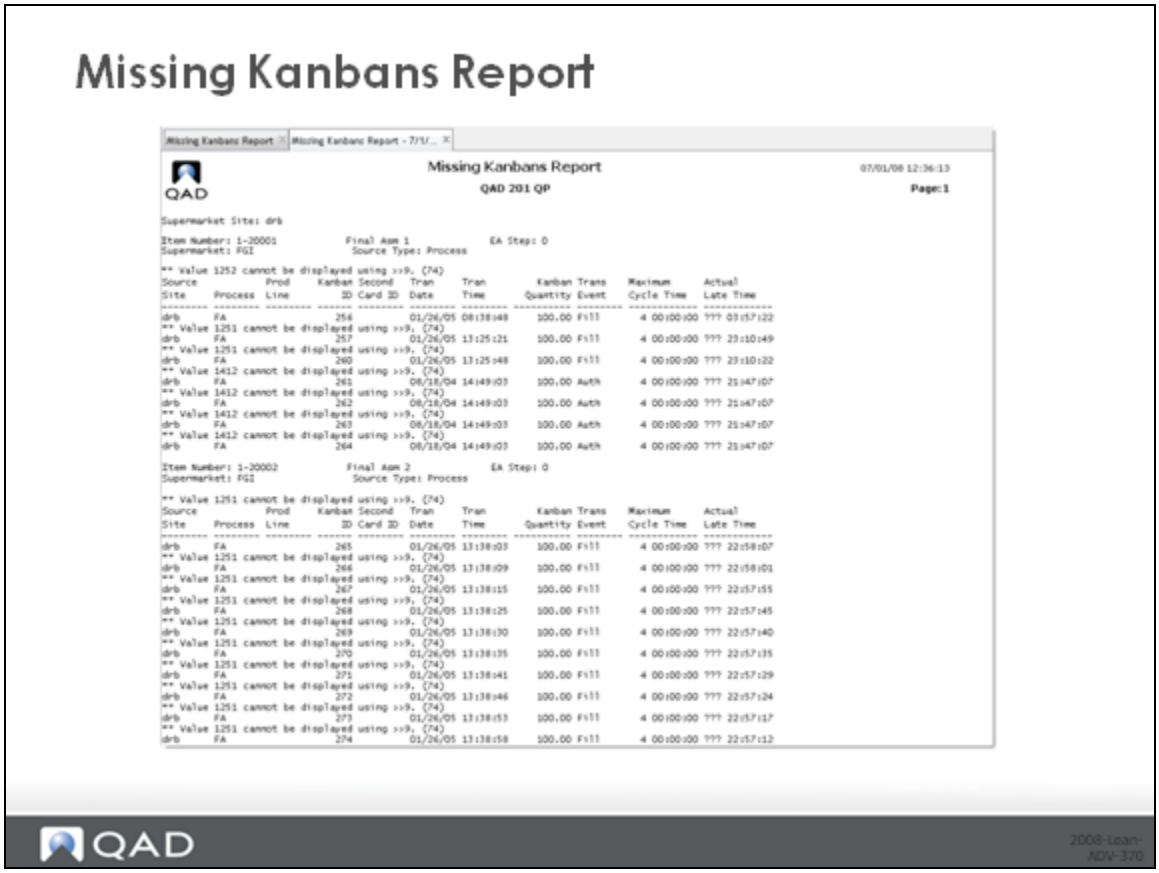
Without some way of flagging potentially missing cards, the users of the system would be forced to do a period wall to wall inventory.

## Missing Kanbans Report Selection Criteria




The user can specify a range of items and steps, sites, supermarkets, sources, etc. as a way to tailor the selection to those loops he or she is responsible for.

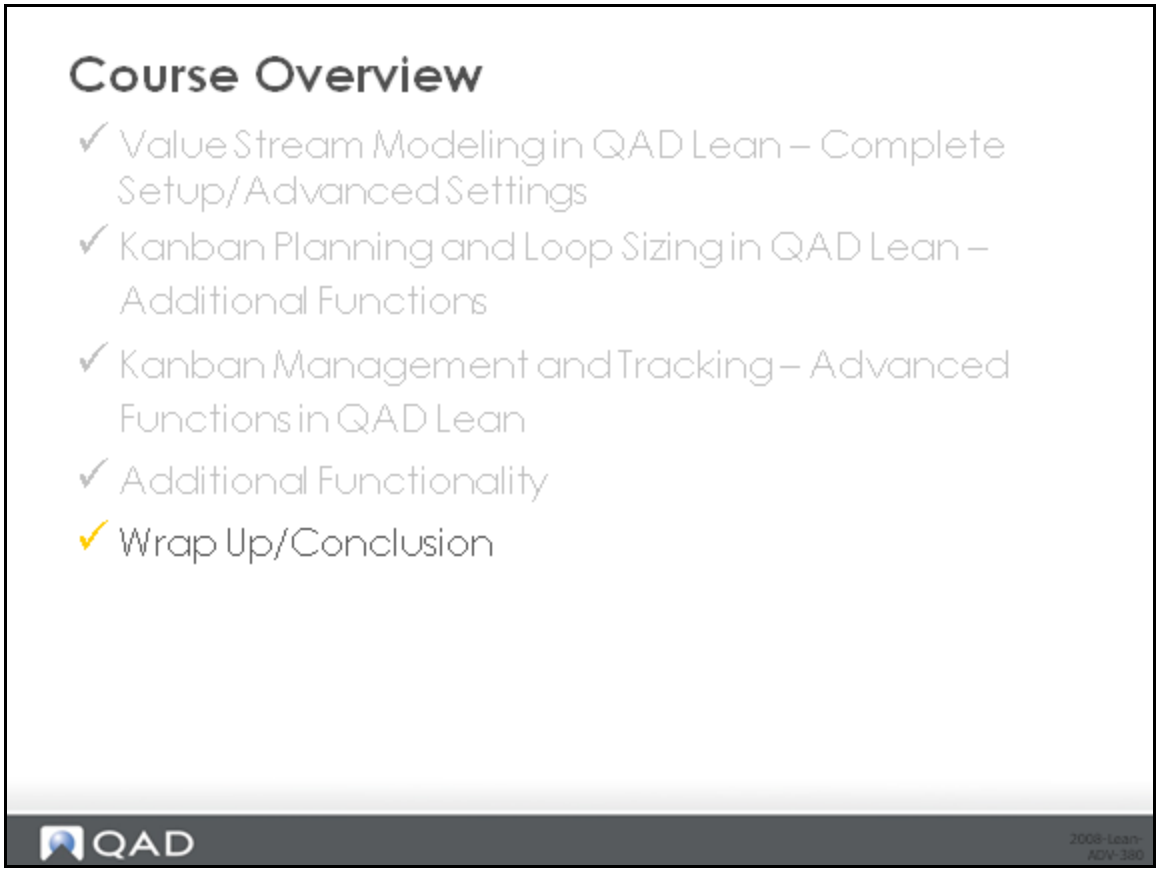
## Missing Kanbans Report




An example of the missing kanbans report is shown above.

The Missing Kanbans Report can be used as a kind of exception report to identify and locate kanban card problems without having to do a wall to wall audit.

## Wrap Up / Conclusion




That concludes this eLearning session on lean manufacturing concepts and the QAD Lean System. At this time you can:

- Review parts of the class that may not have been clear to you.
- Take the on-line comprehension exam that accompanies the session and thus complete the course.

Good luck on your personal lean journey!

Appendix A

# Reading Material on Lean Manufacturing

# Reading Material

***A Study of the Toyota Production System***. Shigeo Shingo.

***Creating Continuous Flow.*** Mike Rother and Rick Harris.

An Action Guide for Managers, Engineers, and Production Associates.

How to create real, not fake, flow through your processes. Excellent material in an easy-to-read, workbook-like format

***Creating Level Pull.*** Art Smalley.

***Creating Mixed Model Value Streams.*** Kevin J. Duggan

Practical Lean Techniques for Building to Demand.

Practical lean techniques for building to demand. Highly recommended.

***Kanban. Just-in-Time at Toyota.*** Japan Management Association

***Japanese Manufacturing Techniques.*** Richard J. Schonberger

***Just-in-Time. Making It Happen.*** William Sandras

***Lean Production Simplified.*** Pascal Dennis.

A Plain-Language Guide to the World's Most Powerful Production System.

An excellent introduction to Lean concepts.

***Lean Lexicon.*** Chet Marchwinski and John Shook.

A graphical glossary for Lean Thinkers.

***Lean Standard System.*** Christopher Gray

***Lean Thinking.*** Jim Womack and Dan Jones.

Banish Waste and Create Wealth in Your Corporation.

The best introductory book on the subject of Lean Manufacturing

***Learning to See.*** Mike Rother and John Shook.

Value-stream mapping to add value and eliminate waste. Excellent material in an easy-to-read, workbook-like format

***Let's Fix It! Overcome the Crisis in Manufacturing.*** Richard J. Schonberger.

Research-based principles of manufacturing management.

***Making Materials Flow.*** Rick Harris, Chris Harris, and Earl Wilson.

Designing material routes for lean production. Excellent material in an easy-to-read, workbook-like format.

***Seeing the Whole.*** Dan Jones and Jim Womack.

Value-stream mapping to add value and eliminate waste across an entire Lean Enterprise. Excellent material in an easy-to-read, workbook-like format.

***The New Manufacturing Challenge. Techniques for Continuous Improvement.*** Kiyoshi Suzaki.

***Today and Tomorrow.*** Henry Ford.

Lean manufacturing concepts from the real Father of Lean.

***Toyota Production System.*** Yasuhiro Monden.
The definitive study of TPS.

***Toyota Production System. Beyond Large-Scale Production.*** Taiichi Ohno.
The Toyota Production System from the "Father of TPS."

***Value Stream Management.*** Don Tapping, Tom Luyster and Tom Shuker.

***World Class Manufacturing.*** Richard J. Schonberger.

Appendix B

# Study Questions

## Study Questions

1 The objective of lean manufacturing is:

a Waste-free, optimized product flow across the value stream.

b Pulling to customer demand.

c Operator empowerment to stop the process when there is a problem.

d Enhanced market share.

2 Three different types of manufacturing in use today include:

a Craft production, mass production, lean production.

b Japanese manufacturing, American (North American) manufacturing, Third World manufacturing.

c Push, Pull, Attractive

d Demand driven, supply driven, design driven.

3 The key ideas that made mass production possible include:

a Interchangeable parts

b Pre-hardened metals

c Standard gauging and the moving assembly line

d Standardized/simplified work

e Waste elimination

f All of the above

g None of the above

4 Muda, mura, and muri are the Japanese words for:

a Defects, excess, and detachment.

b Waste, unevenness (variability) and strain.

c Sort, straighten, and simplify.

d Operator involvement, empowerment, recognition.

5 Waste in manufacturing, as identified by Taiichi Ohno, includes all of the following except:

a Defects in products

b Overproduction of items not needed

c Inventories awaiting further processing or consumption

d Unnecessary processing

e Training meetings

f Unnecessary movement of people

g Unnecessary transport of material

h Waiting (on equipment or upstream processing)

i Design of products that do not meet users needs

6 The effect of reducing waste, unevenness and strain is typically to:

a Gain market share by responding faster.

b Improve the bottom line as evidenced by traditional accounting systems.

c Allow product to flow better, and as a by-product reduced inventory, shorter lead time, improved quality, reduced space requirements, improved customer service.

d Increase employee morale and as a by-product improve the quality of work life in the company.

7 Pull Replenishment is a fundamental concept in lean manufacturing that is based on one core idea:

a The use of inventory should be anticipated and scheduled for replenishment in advance of its use. In this way the overall objective of “zero inventory” can be achieved.

b Inventory should only be replenished when it has been used.

c Inventory is unnecessary and should be eliminated immediately at any cost.

d Inventory should be eliminated and additional labor added so as to have the flexibility to respond to changes in customer needs.

8 Flow is different from pull in that:

a In a flow environment material moves across the value stream through pipes or on assembly lines, while in a pull environment material is transported from work center to work center using fork lifts, tuggers, or some other form of conveyance.

b A flow environment typically is make-to-order manufacturing, whereas pull is make-to-stock.

c In a flow environment material moves without interruption from raw material to customer) while in a pull environment there are typically inventories between processes where continuous flow is not possible. For pull, material is moved from process to process to process based on the needs of the customer.

d Flow manufacturing is synonymous with “push” and is exactly the opposite of pull.

9 Is forecasting unnecessary in a flow or pull environment?

a Yes, every important company activity is driven by customer orders.

b No, many longer term business management processes still need forecasts of demand.

c Unnecessary in flow, but necessary to support pull.

d Necessary in flow, but unnecessary to support pull.

10 “EPE Interval” is another way to describe:

a The takt time, considering package quantities.

b The kanban quantity for an item.

c The smallest possible lot size possible for parts going through a particular process.

d The 5S process in lean manufacturing.

11 “Just-in-time” scheduling encompasses concepts like:

a Takt Time

b EPEI

c Leveling (Heijunka)

d Pull Systems

e All the above

f None of the above

12 “Jidoka” or automation with a human face encompasses concepts like:

a Setup Reduction

b Pokayoke (Mistake Proofing)

c 5S

d Cell Design and Operator Balancing

e Quality improvement (6 sigma)

f Standard Work

g All the above

h None of the above

13 The three prerequisites to lean production include:

a Leveling, standard work, kaizen.

b Six sigma, 5S, poka-yoke.

c Japanese management, flow manufacturing, value stream mapping.

d Value stream mapping, waste elimination, reduced inventory.

14 Which of the following is not part of “poka-yoke”?

a Enforce correct operations by eliminating choices that lead to incorrect actions.

b Signal or stop a process if an error is made or a defect created.

c Prevent machine and product damage.

d Eliminate inventory so that problems in the process are exposed and can be eliminated.

**15** Leveling is typically done at the:

- **a** Bottleneck process
- **b** Pacemaker process
- **c** Starting process
- **d** Process adding the greatest amount of value to the product.

**16** Which of the following is not a major use of value stream mapping:

- **a** It provides a big picture of material flows, without which the tendency is to work on improving individual processes (milling, drilling, hardening, etc.) rather than on improving the overall value stream.
- **b** It allows the manufacturing, materials and supply chain organizations to be structured around value streams rather than individual processes or functions.
- **c** It provides a common view for operations and accounting and becomes the basis for discussing real improvements.
- **d** It provides a detailed schedule for suppliers and internal manufacturing processes.
- **e** It makes the impact of decisions apparent in a quantitative way – in the Lead Time Ladder – rather than as spongy, “feel good” notions about what might happen.
- **f** It connects information flows and material flows.
- **g** It can become the basis for an implementation plan or series of implementation plans.

**17** Pitch is:

- **a** The same as the EPE Interval.
- **b** The time interval in a variable quantity/fixed interval kanban system.
- **c** An expression of takt time considering packaging quantities.
- **d** The Japanese word for takt time.

**18** Which of the following is not one of the pull rules:

- **a** Downstream processes may withdraw only the required quantity from the supplying upstream source.
- **b** A process may produce (replenish) only the quantity withdrawn by the downstream process – in other words, stop producing when the kanbans are full.
- **c** Never send defects on to the next process.
- **d** In the pacemaker process, keep the equipment running and producing parts even if there are no open kanbans.
- **e** Minimize the number of kanbans for each item.
- **f** Fine tune the number of kanbans as fluctuations in demand occur.

19 Which of the following is not currently a primary function of QAD Lean:

a Value stream modeling (kanban controlled items, supermarkets, processes, kanban loops, control file defaults, process specific calendars, average demand calculations, safety stock calculations).

b Transactions and tracking (kanban card creation, management and printing; kanban status tracking (consume to fill cycle), kanban “dispatch” list, transaction history).

c Loop sizing.

d Leveling.

e Operator balancing and cell design.

20 The three areas covered by the Kanban Control Record include:

a Values for takt time, EPE Interval, pitch quantity.

b Standard, pacemaker and FIFO controls.

c Supermarkets, processes and loop names.

d Basic default values for new records, transaction controls, sequence enforcement controls.

21 Two types of inventory that can be stored in a supermarket. The codes associated with this inventory are:

a Inv and WIP

b FIFO and On Hand

c RIP and OH

d RAW and FG

22 Kanban Process Maintenance has two basic parts:

a Process data maintenance and Process Item Detail maintenance.

b Process data maintenance and Kanban Master Maintenance.

c Process data maintenance and Basic Process Calculations.

d Basic Process Calculations and Process Item Operation Rollup.

23 The Kanban Process Item Detail screen provides a way to maintain:

a The basic bill of material for a kanban item.

b The “dance steps” for each operator in the cell when producing a specific item.

c Basic data that is routing related (starting and ending operations, yield, run time, setup time, etc.).

d The history of kanban transactions against an item.

24 If you have “retired” a kanban card by deactivating it, and would like to return it to an active status, you can use any of the following functions except for:

a Kanban Card Maintenance

b Kanban Multi-Card Maintenance

c Kanban Fill

d Kanban Card Activate

e Kanban Card Management

25 The Kanban Dispatch List includes all of the following data except:

a Authorized date and time

b Due date and time

c Sequence number for major/minor setup (mfg_seq)

d Current days of supply

26 The Kanban Dispatch List can be run in either detail or summary mode. This affects:

a The way information is passed to Supply Visualization (Kanban Visualization).

b The way data is updated in the Supplier Schedule in the system.

c Whether the report lists each card that needs to be replenished, or just a summary total for the item.

d Whether the user does a kanban fill for each kanban card, or one summary receipt transaction that fills all the different cards.

27 The “simple” method of calculating safety stock is based on:

a The MAPE and a measurement of forecast bias.

b The MAD and the desired service level.

c The standard deviation of the demand and the desired service level.

d The difference between maximum demand and average demand.

28 One of the most important calculations in the Level Mix Workbench, and the basis for the leveling calculations, is:

a Takt time (operational takt time)

b Total setup hours for all parts

c Cycle time per kanban

d Load percent

29 Users have two basic alternatives to the Supermarket Workbench in the system:

a Save the leveled schedule and display the supply demand consequences in the MPS display(s) or use a user developed workbench.

b Look at the Kanban Workbench from QAD Lean and the component availability check from QAD EA.

c Use operator balance charts and cell design tools in QAD Lean.

d Run the Basic Process Calculations and the Process Item Rollup

30 The Inventory Validation Report in the system:

a Tries to flag items that have potential inventory errors by comparing full kanbans with book inventory.

b Tries to show the value of inventory controlled by kanban.

c Tries to evaluate the level of inventory for each kanban item by looking at the supply demand balance over time.

d Tries to evaluate the level of inventory for each kanban item by looking at historical inventory performance.

## Answers to Study Questions

1 *A*

2 A

3 F

4 B

5 E

6 C

7 B

8 C

9 B

10 C

11 E

12 G

13 A

14 D

15 B

16 D

17 C

18 D

19 E

20 D

21 A

22 A

23 C

24 C

25 D

26 C

27 C

28 A

29 A

30 A