10 Steps to become a Lean Enterprise

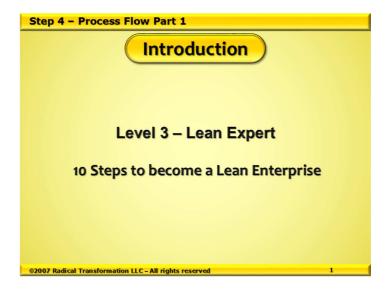
Lean Expert Training Course

Step 4
Improve Process Flow
Part 1

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Please note that some of the screens in the online course have been omitted from this workbook. This is to protect any proprietary information that may be included in the pictures.



Welcome.

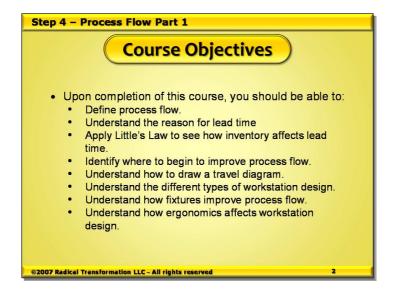
We would like to welcome you back to our next module in this online training course.

This training module is called "Step 4 – Improve Process Flow Part 1."

This module is a continuation of our Lean Expert online course series called "10 steps to become a Lean Enterprise."

This program has been specifically designed to demonstrate our step by step methodology that will allow any organization to become a Lean Enterprise.

Let's continue your lean journey!



Course Objectives

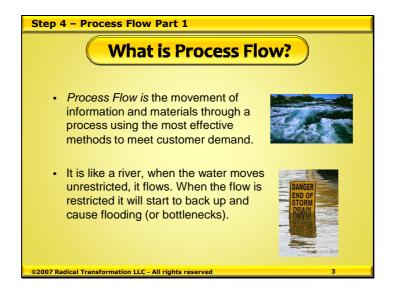
Here are the course objectives for Step 4 – Improve Process Flow Part 1.

We specially designed this course to give the information you need to get a full understanding of each step required to become a Lean Enterprise.

Upon completion of this course, you should be able to:

- Define process flow.
- Understand the reason for lead-time
- Apply Little's Law to see how inventory affects lead-time.
- Identify where to begin to improve process flow.
- Understand how to draw a travel diagram.
- Understand the different types of workstation design.
- Understand how fixtures improve process flow.
- Understand how ergonomics affects workstation design.

Now we are going to work through each course objective.



What is Process Flow?

We will start this training module by asking a few key questions.

- What is process flow?
- How does process flow affect a business?
- Why is process flow one of the ten critical steps towards becoming a Lean Enterprise?

Answering these questions will give an organization a better understanding of the importance of process flow when they are implementing Lean principles.

<u>Process Flow</u> in a manufacturing or an office environment is the movement of information and materials through a series of activities. This movement must be achieved using the most effective methods to meet the customer demand.

If a process is flowing it is easier to move items through an entire system. It is like a river.

When the water moves unrestricted it flows freely. However, when the flow of the water is restricted, it will start to back up and cause flooding (or bottlenecks).

The only way to improve process flow is to identify where the restrictions or constraints are happening and remove them.

Another good analogy for this is a drain blockage in a shower. The water level rises and eventually overflows onto the floor because it cannot flow down the drain. Therefore, you have to turn off the water and call a plumber.

The plumber arrives, assesses the situation, and tries to establish where the blockage is located and how to deal with it.

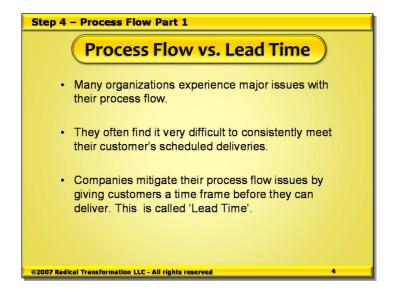
He will choose the best tool for the job from one of many in his toolbox.

He will then proceed to isolate and remove the blockage to allow the water to flow freely down the drain.

There are two extremely important points in this analogy:

- 1. The plumber was experienced at his job. So he had a good idea where to look and how to find the blockage.
- **2.** He knew through experience the best tool to use to remove the blockage.

The only job left is to clean up the mess and put the place back to how it was before the problem.



Process Flow vs. Lead Time

Many organizations experience major issues with their process flow. It can be a problem in an office or on the shop floor.

Organizations often find it difficult to meet their customer's delivery schedule on a consistent basis.

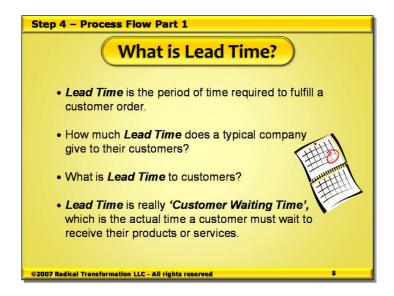
There is nothing worse than failing to deliver an order to a customer on the date it was originally promised.

What do most companies usually do to overcome this problem?

Companies mitigate their process flow issues by giving their customers a set period of time before they can fulfill a delivery.

This period is known as 'Lead Time'.

We will take a more detailed look at lead-time and discover what it is on the next screen.



What is Lead Time?

<u>Lead Time</u> is the period of time required to fulfill a customer order.

It is a time period to allow a business to receive an order, purchase the materials, manufacture the item, and deliver it to the customer.

How much *Lead Time* does a typical company give to their customers?

Most companies give a lead-time of 3, 4, or 5 weeks. It is dependent upon two things:

- 1. How long their material replenishment cycle is from their suppliers.
- 2. How efficient their production system is in meeting the demand of the customer.

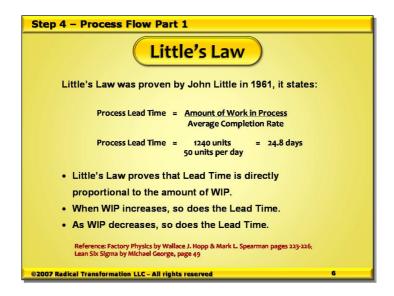
What is **Lead Time** to a customer?

Lead Time is really '**Customer Waiting Time**', which is the actual time a customer must wait to receive their products or services.

In today's business climate, most customers do not like to wait.

If they have implemented lean principles they cannot wait because their "Just In Time (JIT)" production system will stop without deliveries being on time, every time.

In the next screen we will look at one of the main causes of process delays that will increase the amount of lead-time.



Little's Law

There is a correlation between inventory and lead-time.

Excessive inventory is one of the main causes of long lead-times.

Excessive inventory is also one of the eight wastes.

The root cause is overproduction, which is making more than the next operation needs.

Can this statement be proven?

There is a formula called "Little's Law" that can be used to prove the link between inventory and lead-time. Here is the formula:

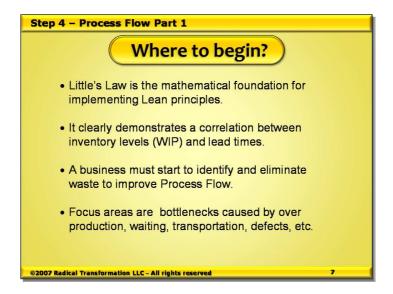
Process lead time = <u>Amount of Work in Process (WIP)</u> Average Completion Rate (ACR)

Little's Law clearly demonstrates that lead-time is directly proportional to the amount of work in process (WIP) and inversely proportional to the average completion rate.

In simple terms this means:

- If you reduce WIP while producing at the same completion rate, you will reduce lead-time.
- If you increase the completion rate while maintaining the same level of WIP, you will reduce lead-time.

The only way for an improvement team to prove this formula is to start slowly lowering the inventory levels to see what happens to the lead-time.



Where to Begin?

Little's Law is the mathematical foundation for implementing Lean principles.

It clearly demonstrates and validates a correlation between increasing levels of inventory (WIP) and longer lead times.

A business must start to address their process flow issues by looking for ways to reduce their inventory levels.

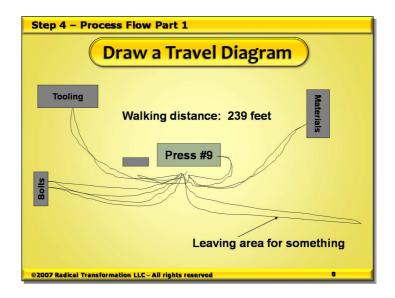
However, they cannot just go ahead and reduce their inventory levels by 50% in the hope that everyone will still be able to meet the customer demand.

A business must identify and eliminate the waste that is restricting their process flow.

Some of the causes are bottlenecks, which occur because of over production, waiting, transportation, defects, etc.

If there is a buildup of parts or work in process (WIP) in front of an operation, it is an indication of a constraint or bottleneck.

It is important to identify the reason for the bottleneck and then try to find ways to eliminate it.



Draw a Travel Diagram

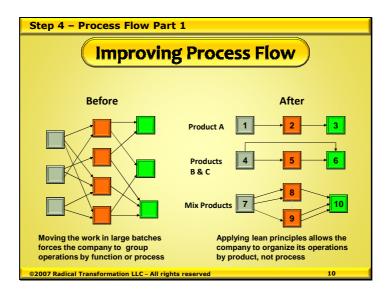
Identify the process flow and draw a travel diagram (also known as a spaghetti diagram) of the facility or work area to show what is happening.

- How many people work in the area?
- How do the materials move in and out of the area?
- How much inventory is there at each operation in the work area?

A travel diagram should identify the following:

- Each of the work processes,
- The flow of production through the work area. How far does the product travel?
- The movement of the workers in the work area. How far do they travel?
- The staging locations for equipment and materials. Where are the bottlenecks?
- Transportation of materials in and out of the work area. How far does it travel?
- The distanced traveled by the workers outside the area to obtain parts, equipment, or information.

The purpose of the travel diagram is to document the work area layout and flow patterns. This will help to determine where the inventory is building up and the reasons why.



Improving Process Flow

Many organizations find it very difficult to improve process flow because they are using functional layouts. Skill sets and processes are used in a functional layout to group people and equipment together.

You can see this represented in the "Before" graphic on the screen. The product or service will pass through a variety of different paths dependent upon process availability. This is a nightmare for the production-scheduling department.

The goal is to improve process flow by using a different layout configuration. It is important to try to organize the workflow by product or service.

The purpose for doing this is because if a product or service is being generated consistently, for example 8 hours per day 365 days a year, it is necessary to produce it in the most effective and efficient manner. Therefore, it would be necessary to create a dedicated single model flow line or cell for this type of product or service. You can see this represented in the **Product A** graphic on the screen.

If a company were producing a couple of similar products or services over a period of days or weeks, it would need to create a flexible model flow line or cell. You can see this represented in the **Products B & C** graphic on the screen.

If a company were producing multiple products or services on an irregular basis or ones that do not fit into any of the previous groupings, it would need to create a mixed model flow line or cell. You can see this represented in the **Mixed Products** graphic.

The production process for **Product A** is the most efficient layout because it has dedicated resources focused on producing only one product line.

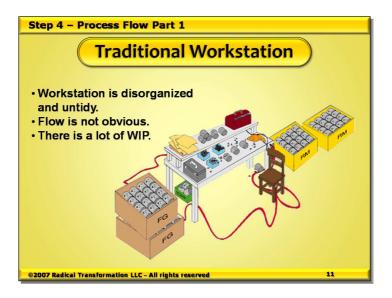
The production process for **Products B & C** is not as efficient as the **Product A** layout. This process would have downtime due to changeovers. It would have to reduce changeover times to lower the inventory levels and improve the process flow.

The production process for the **Mixed Products** layout is the least efficient of the three. It will have multiple changeovers and short runs of each product. However, the effectiveness of this layout is a trade off with the efficiencies of the other layout designs. The **Mixed Products** layout isolates the bulk of non-value added activities into one work area or cell. This brings it to the full attention of the improvement team, who can work towards identifying and reducing the waste.

The purpose for designing and implementing different types of layouts is to improve process flow and increase the value for the customer.

The "Before" example in this screen forced everything to go through a self-inflicted bottleneck that was created because of the use of a functional layout.

The "After" example in this screen separates the products and services into smaller groups and organizes the necessary resources to support them in the most productive manner. Remember, it is impossible to get everything to flow perfectly. It is a tradeoff between cost and the effectiveness to deliver the products and services to the customer on time, every time.



Traditional Workstation

In this screen you can see an example of a traditional workstation. It is not organized and is untidy because of the inventory at both ends of the workstation.

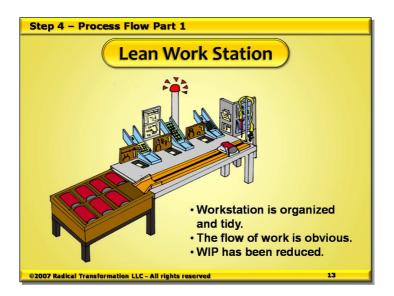
The batch quantities of the work in process (WIP) identified as raw materials (RM) and finished goods (FG) is a clear sign that there is limited process flow.

The workload is in batches when delivered to the workstation. The items move one unit at a time until all the parts in the batch are completed.

This production method is called "batch and queue". The parts will sit in a queue with other parts and wait until it is their turn to go through the production activity.

Once they are finished units they will wait until the entire batch of parts is completed. At this point, the finished items are ready to be moved onto the next operation.

One of the disadvantages of a traditional workstation is the worker is unable to start working on any other items until the current batch of parts has been completed and moved aside.



Lean Work Station

In this screen there is an example of a lean workstation. The workstation looks much more organized and capable of allowing the work to flow through the process. Work in process (WIP) is moving into the workstation and returned into the same container. This looks and works much better than the traditional workstation.

An optimum workstation design should include the following:

- Standardized operations for repeatability and consistency.
- Appropriate sizing for the types of products to be manufactured.
- Easy parts layout so everything is organized in a logical manner.
- Tool standardization so the workers are using the same tooling between different workstations.
- Tool placement so the workers know where the tooling is located.
- Visual controls to differentiate between abnormal and normal situations.
- Reduce the range of operator motions to maintain consistent methodology.
- Quality at source because it does not move a defective part to the next operation.
- Standard replenishment process to allow the worker to focus on production and eliminate any non-value added activities such as having to find and obtain their own materials.



Assembly Workstation

In this screen is an example of a visual assembly workstation.

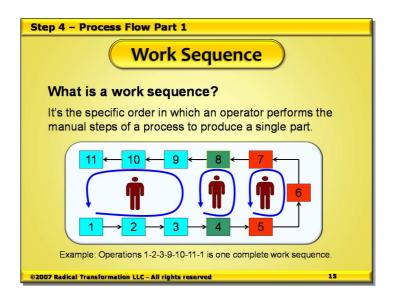
Workers need minimal training to understand where and how the parts, materials, and equipment are located and organized.

This type of workstation is useful for a low volume and high product mix. It would not be effective to use a cellular design for this volume or mix of products.

The workstation should be the right size to support the type of workload.

The best designs are those that give the workers a 180 or 360 degree access around the product.

This type of assembly workstation is flexible and is used to set up several different types of products.



Work Sequence

Take a look at the graphic in this screen with the following question in mind.

What is a work sequence?

A work sequence is the specific order in which an operator performs the manual steps of a process to produce a single part.

In this screen, there is an example of a work cell with several operations that flow in sequential order, i.e. 1, 2, 3, 4, etc.

The work sequence for each of the workers in this work cell does not follow the material and operation sequence.

Here is the sequence for each of the three workers:

- The first worker is responsible for operations 1, 2, 3, 9, 10 and 11.
- The second worker is responsible for operations 4 and 8.
- The third worker is responsible for operations 5, 6 and 7.

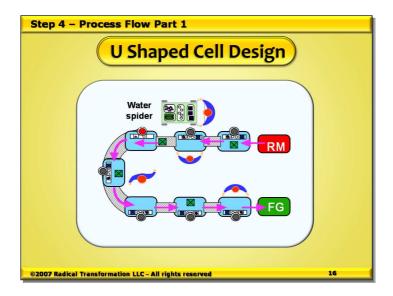
Each of these three workers has their own work sequence to follow to produce a single part.

In the Toyota Production System (TPS), this type of work sequence is known as "chaku-chaku" which translates into "one worker, several tasks".

Even though one worker has more operations to look after than the others do, the workload between all three workers is balanced.

This ensures that none of them will become overwhelmed and start to fall behind.

If a worker does fall behind it would create waste in the form of excessive buildup of inventory, which is a bottleneck or constraint.



U Shaped Cell Design

The U shaped cell is useful for a high volume and low product mix.

This particular cell design has minimal movement which allows the workers to multitask (or chaku-chaku). The cell has a small footprint and does not take up much floor space.

The U shaped cell design is easy to move and adjust in size.

The number of workers can be increased or reduced to accommodate fluctuating customer demand.

If takt time increases, this means a reduction in customer demand. The cell will need fewer workers and the number of tasks will increase for each person.

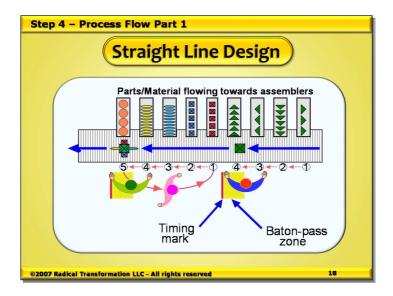
If takt time reduces, this means an increase in customer demand. The cell will need more workers and the number of tasks will decrease for each person.

A U shaped cell creates a better environment for workers to improve their communication.

The product quality improves because the workers are closer together.

They are able to give immediate feedback to the other workers about defects.

A U shaped cellular design is ideal for products that are easy to handle such as smaller size assemblies.



Straight Line Design

A straight-line design is useful for large products that are not so easy to maneuver.

Sometimes this is a moving line with a motorized conveyor or rollers. It is a good design for handoffs to the next worker.

In the example on the screen, you can see the timing mark on the floor. This is the point where a worker will hand off the assembly to the next worker.

The positioning of the timing marks would be determined using takt time.

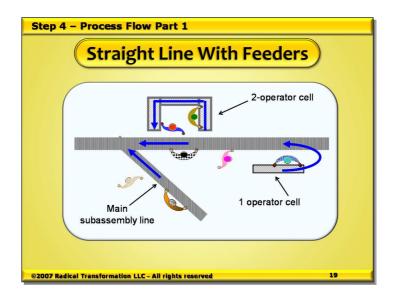
This type of line is easy to re-supply with parts and materials. The part replenishment in the example on the screen occurs on the opposite side of the line.

A worker picks the part from the inclined delivery system. If a worker encounters difficulties during the assembly process, they can follow the product down the line. However, this should be more the exception than the rule.

The disadvantages of this design are that it is static and difficult to modify without major work.

It can become a monument or an island and lacks the flexibility to process many different types of products.

Workers often have to walk long distances around the end of the line to get to the other side.



Straight Line Design with Feeder Lines

This is the same basic work cell design that was shown on the previous screen.

The only difference is this design has feeder lines converging with the main production line.

These feeder lines are useful to deliver subassemblies to the main line. In the example on the screen, there are three different configurations for the feeder cells.

It is common to see different types of feeder cell designs throughout a facility.

The 2-operator example in the screen is a commonly used feeder cell design. It has many practical uses.

It is often used (alongside a line as depicted in the graphic) to remove defective products off the main line. The workers in the cell will repair and test the items. They will return the repaired units onto the main line.

This process is effective because the workers do not need to stop the main line if there are one or two defects. However, the repair cell would have a maximum limit for the number of defective parts removed from the man line.

When the maximum limit has been reached, the workers will stop the main line. This is a clear indication that there is a major quality problem. The next thing is to find the root cause of the defect and eliminate it.



Fixtures

Fixtures are devices that serve a number of uses. A fixture can help to orient and secure an assembly.

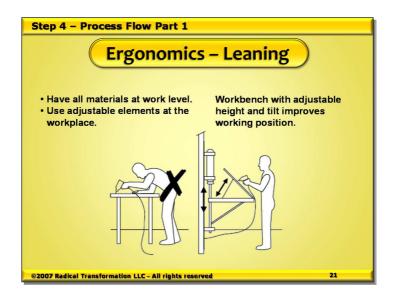
Fixture designs can be static or they can rotate to allow a production worker to turn the unit to access different locations.

Fixtures allow a production worker to have both of their hands free. This can help to improve the alignment and location of parts into an assembly.

The production worker does not need to hold or support the weight of an assembly when using a fixture. Fixtures can help to improve the work process and reduce cycle times.

Fixtures can also help to improve:

- Safety items are secured and unable to tip over or fall.
- Ergonomics they eliminate twisting, bending, or stretching.
- Quality A worker has both hands free, which allows them to take more care when aligning and locating parts into a main assembly. This will reduce many rework issues caused by handling damage.



Ergonomics - Leaning

In this screen you see a picture of a person leaning over their workbench.

The worker has to do this because of the poor design of the workstation.

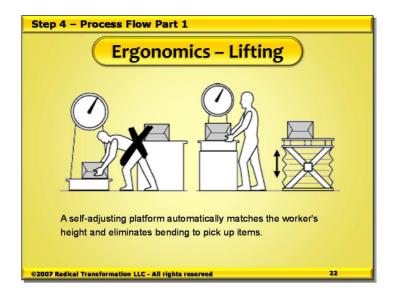
It is important to design a workstation that does not force a worker to stoop or lean over to do their work.

A well designed workstation would have all the materials available at a reasonable working level.

It would use adjustable elements at the workplace.

The best method is to design a workbench with an adjustable height and tilt to improve the working position.

The picture on the right of the screen demonstrates this concept.



Ergonomics – Lifting

On the left of this screen you see a picture of a person bending over to pick up an item from low down near to the floor.

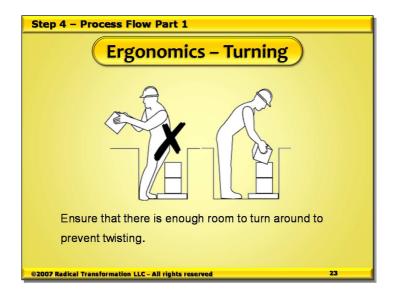
This action is putting undue pressure on the person's lower back, which could cause injury.

The worker has no choice because of the poor design of the work area.

It would be easier on the worker to use a self-adjusting platform that automatically matches the worker's height and eliminates bending to pick up items.

The picture on the right of the screen demonstrates this concept.

The worker can grasp the item and move it over to the scales easily.



Ergonomics – Turning

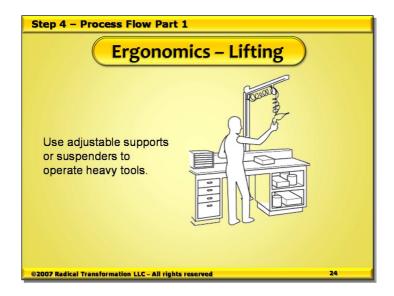
In this screen you see a picture of a person picking up an item and twisting to place the item aside.

The reason for this is because the worker does not have enough room to move both feet.

This is causing the worker to twist from the knees and waist to position the item to the side or behind them.

The work area design should allow enough room so a person can take a couple of steps to turn their entire body.

This will help to prevent them from having to twist at the waist or the knees.



Ergonomics – Lifting

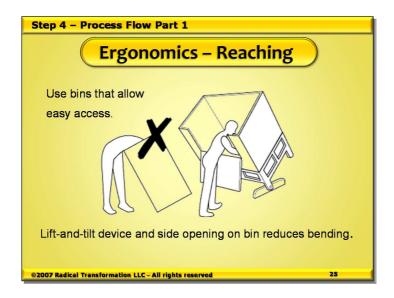
In this screen you see a picture of a person using an adjustable lift to pick up an item and move it.

It is important to make sure the person does not have to lift any items that are too heavy for one or more people.

It is also important to remember that using additional people instead of using a lifting device can affect productivity.

While the workers are involved in the activities of moving an item, they are not doing their own work.

This is another example of waste in the workplace.



Ergonomics – Reaching

On the left of this screen you see a picture of a person trying to work inside of a bin.

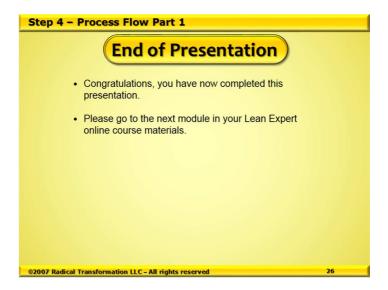
The only way they can reach into the bin is to tip it slightly and balance the weight.

This creates a dangerous working environment for the worker if the bin tips over onto them.

Try to use bins that allow the worker to gain easy access.

On the right of the screen, is a picture of a bin with a lift-and-tilt device and side openings.

This will reduce the need for workers having to bend or balance the weight.



End of Presentation.

Congratulations, you have now completed this presentation.

Please go to the next training module in your Lean Expert online course materials.

Reference Materials

- 1. One-Piece Flow: Cell Design for Transforming the Production Process.
 - By: Kenichi Sekine. Published by Productivity Press 2005.
- 2. Lean Assembly: The Nuts and Bolts of Making Assembly Operations Flow.
 - By Michel Baudin. Published by Productivity Press 2002.
- 3. Identifying Waste On The Shopfloor.
 - By Productivity Press Development Team. Published by Productivity Press 2003.
- 4. Making Materials Flow: A Lean Material-Handling Guide for Operation, Production-Control, and Engineering Professional.
 - By Rick Harris, Chris Harris and Earl Wilson. Published by LEI 2001.

Documents List

There are no documents required for this training module.