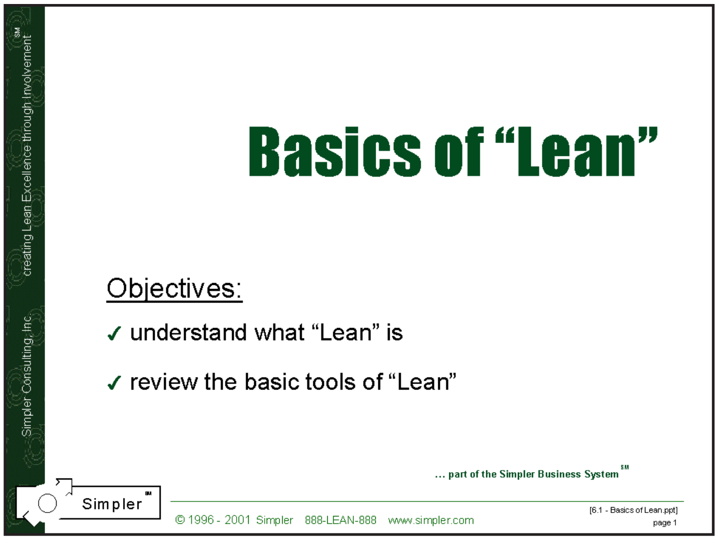
Simpler™

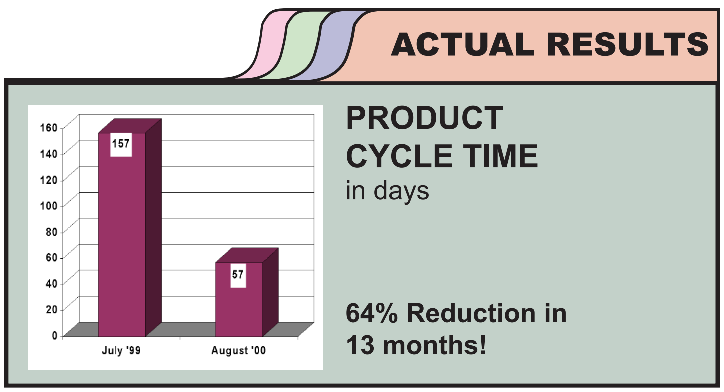
BASICS OF LEAN

Creating
Lean
Excellence
Through
Involvement℠

Simpler Consulting, Inc.

Simpler Business System Version 6.1





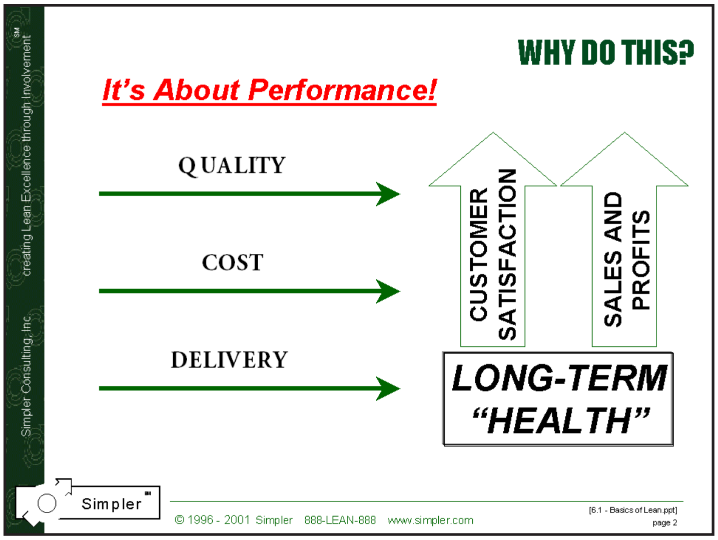
The objectives of this training module are two fold:

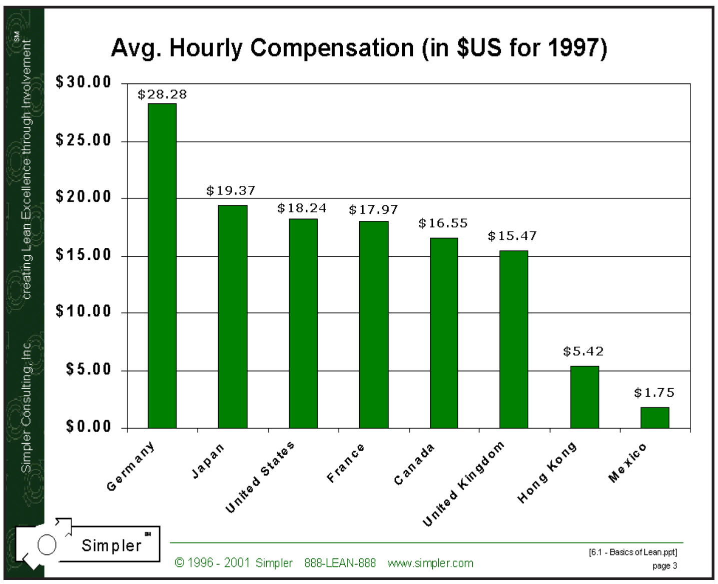
A. Begin the "lean" journey by helping you understand what lean is, and

B. Introduce you to the basic tools of lean.

After a proper introduction to the Basics of Lean, you should be able to begin seeing non-value adding steps, or "waste", in your environment.

You will also be introduced to some basic tools to help you see the waste that exists in every process or operation, no matter how simple or complex.





Source: U.S. Dept. of Labor, Bureau of Labor Statistics, April 2000

Avg. annual productivity increase in the US from 1977 to 1998: **3.9%**

Realized Gains For A Lean Conversion

	From Batch
Productivity	+ 271%
Inventory Turns	+ 400%
Defects	- 80%
On-Time Delivery	from 0% to 100% in 2 1/2 years

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Why Do This?

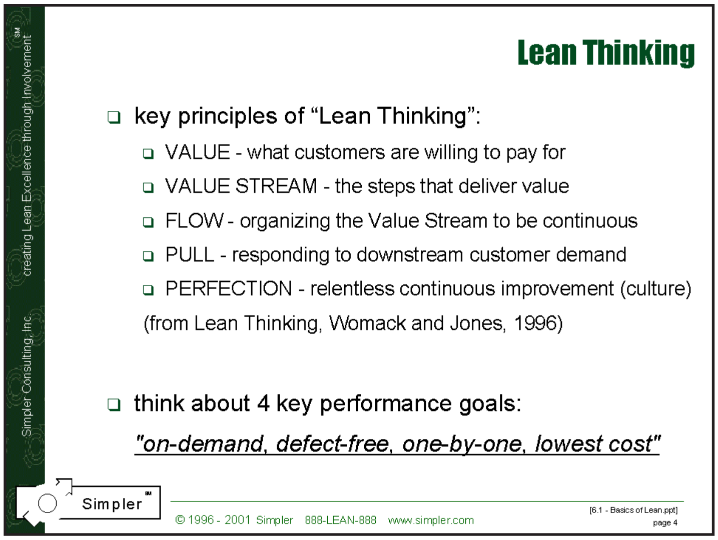
This training module will introduce you to the concept of "Lean Manufacturing" and help you better understand the key principles and tools involved in creating a Lean Conversion.

The reason for converting to a Lean manufacturing process is to improve the performance of your company. The long-term health of your company is dependent on meeting the needs of your customers... every time, all the time.

In determining how to have the most impact on customer satisfaction, there are three performance measures that are critical to your customers: Quality, Cost (Price), and Delivery. A dramatic improvement in these three measures WILL result in increased customer satisfaction, sales, and profits and will ensure long-term health for your company.

The graph on the left illustrates another reason companies will be converting to Lean. The development of Mexico and Far-Eastern countries as alternative locations to domestic plants offers a significant labor cost reduction. In order to keep operations domestic, companies will be forced to overcome the labor cost discrepancy with significant productivity increases.

As shown, the average annual productivity increase in the US from 1977 to 1998 was 3.9%. Companies who convert to Lean typically see annual productivity increases of 15-20%, or more.



In 1996 Jim Womack and Dan Jones wrote an important book called "Lean Thinking". This book has helped raise awareness of the power, principles and tools involved in implementing "Lean" (see also www.lean.org). Lean Thinking creates performance.

Buy & Read the book!

* These are basic principles that are very difficult to argue with.

* Simpler teaches and uses tools that help people apply these principles in their businesses.

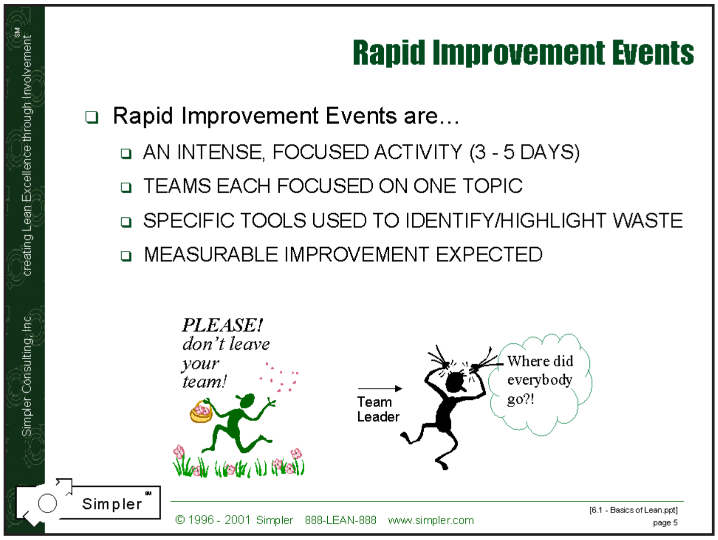
VALUE: Exactly what are customers willing to pay for? This challenges us to think differently about all deliverables - products, services and outputs of administrative processes. Who is the end-customer? What are they buying? (e.g. a customer wants "orderly organized storage" and buys a shelf, some bins and some labels)

VALUE STREAM: ...is "everything that goes into" creating and delivering the "Value" to the end-customer. These are the steps that deliver the Value. The Value Stream involves all the businesses that together provide this value. (e.g.. the shelf, bin and label companies)

FLOW: ...is a principle that helps us think differently about Value Streams. In most Value Streams, customers' needs are served very slowly in large batches with long delays. Flow challenges us to reorganize the Value Stream to be continuous… "one by one, non-stop".

PULL: ...focuses us on how the Value Stream responds to customer needs. Most Value Streams "push" products and services downstream. Parts arrive in batches whether needed or not. Pull challenges us to only respond "on demand" to our downstream customers.

PERFECTION: As we create Flow ("one by one") and Pull ("on demand") in the Value Stream, we are challenged to be relentless about improvement. Perfection challenges us to also create compelling quality ("defect free") while also reducing cost ("lowest cost").



What is a Rapid Improvement Event?

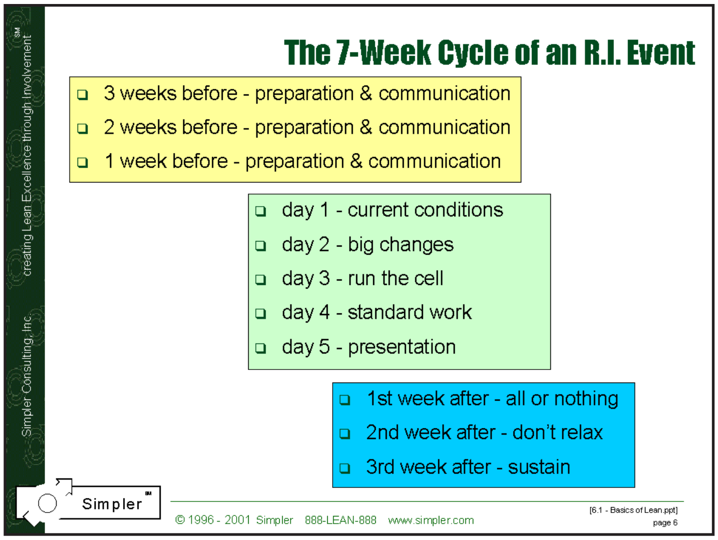
- a team activity (6-9 people)
- a 7 week cycle (including prep and follow-up)
- 3-5 days of full-time team activities
- focused on a specific topic
- clear measurements and targets
- agreed-upon approach
  (based on Lean principles)
- accountable for impact by the end of the Event

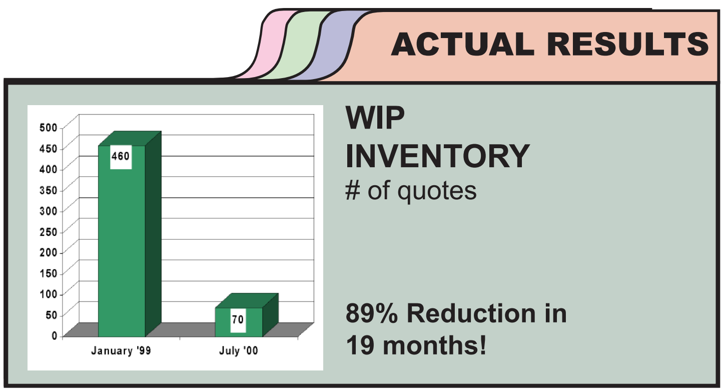
* Event topics should come from Value Stream Analysis

A Rapid Improvement (RI) Event is a simple, powerful tool for improvement.

The reason it works is simple - a focused group of people follow a proven structure and apply proven tools. The reason it works is that the people who "do the work" understand it best. When waste is clear to everyone and an approach makes sense for eliminating the waste, momentum is built. As teams overcome obstacles and implement quickly, the results follow.

Value Stream Analysis is a process of reviewing and developing vision and plans for improving a Value Stream. Event topics should be an output of this analysis. This approach to choosing Event topics assures a coordinated implementation. This is the key to long-term financial, customer and member benefits.





3 WEEKS BEFORE - Department sponsor choose measurements, targets, action, deliverables and team leader/co-leader

2 WEEKS BEFORE - prepare actual facts and data, communicate to area and select team

1 WEEK BEFORE - define boundaries, communicate again, review readiness, train

DAY 1 - study current conditions (it's not "Day 2" until this is done)

DAY 2 - implement big changes (don't leave until you've made 1 good item)

DAY 3 - run the cell after big changes (overdo the support, debug and improve)

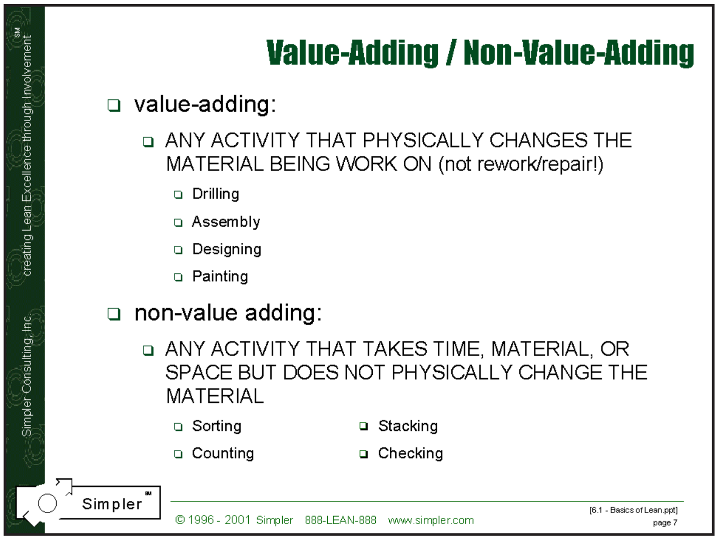
DAY 4 - establish the new Standard Work (put absolute focus on Standard WIP, Standard Work, good 6-S and working the Production Control Board)

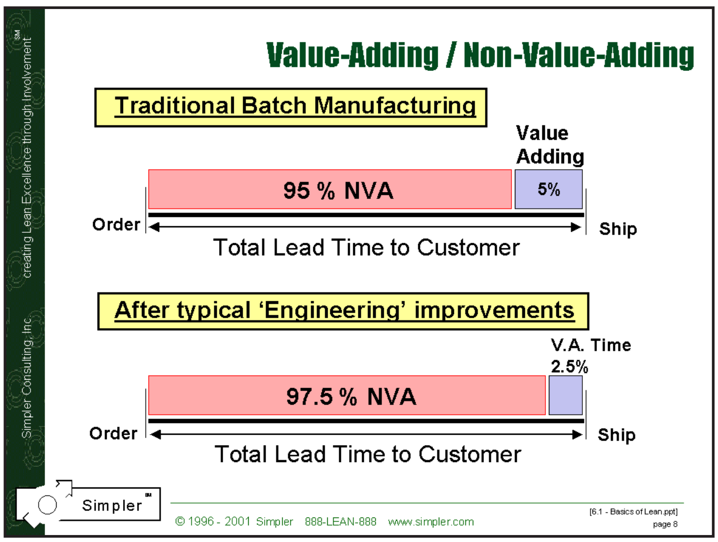
DAY 5 - presentation to top management (consider first presenting to cell members)

1 WEEK AFTER - "all or nothing" (put relentless focus on Standard WIP, Standard Work, good 6-S and working the Production Control Board - see and fix problems)

2 WEEKS AFTER - "don't relax" (put persistent focus on Standard WIP, Standard Work, good 6-S and working the Production Control Board - see and fix problems)

3 WEEKS AFTER - "sustain" (sustain the focus on Standard WIP, Standard Work, good 6-S and working the Production Control Board - see and fix problems). Publish final results.





In a batch environment, the Value-Adding time will be less than 5% of the total customer lead time, and is often less than 1%. Using a traditional 'Engineering' approach of "making parts faster", the end result is usually a faster machine or quicker way to add value, such as a better methodology. Engineers are not trained to identify and eliminate waste. This approach will often have no effect on the lead time to the customer; it generally results in only a smaller value-added/non-value-added ratio. Not until we attack the 'waste' that exists in that 95% of the time will we begin to see dramatic reductions in customer lead times.

The principles of "Value-Adding" and "Non-Value Adding" are fundamental to Lean Thinking. They challenge us to look at Value Streams with new "eyes".

When we say "Value-Adding" in a manufacturing context, we mean some activity done by a person or a machine that actually changes the value of materials from the customer's point of view. Usually this means the material physically changes somehow. When we say "Value-Adding" in a service or administrative Value Stream, we mean some activity done by a person or machine that actually contributes to satisfying the need of a customer. When we say "Non-Value Adding" we are referring to everything else which is "waste" that can be eliminated with creativity and effort.

EXAMPLE PRODUCT OR SERVICE:

____

END CUSTOMER:

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"VALUE" THE END-CUSTOMER IS BUYING:

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VALUE ADDING STEPS:

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NON-VALUE ADDING STEPS:

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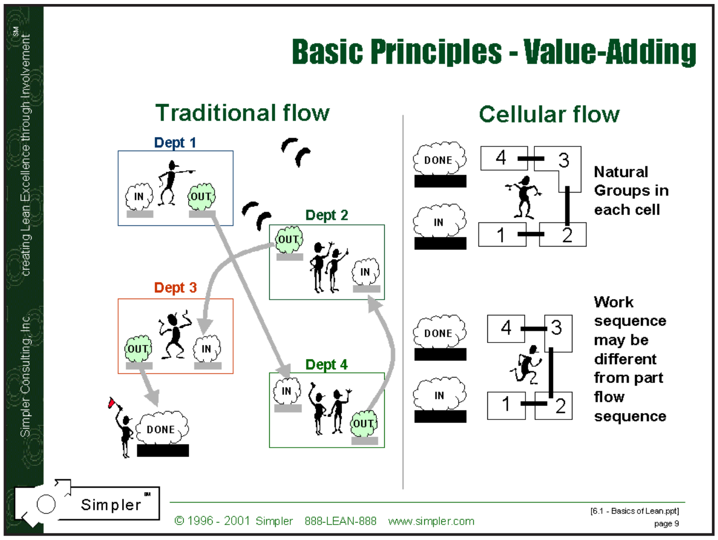
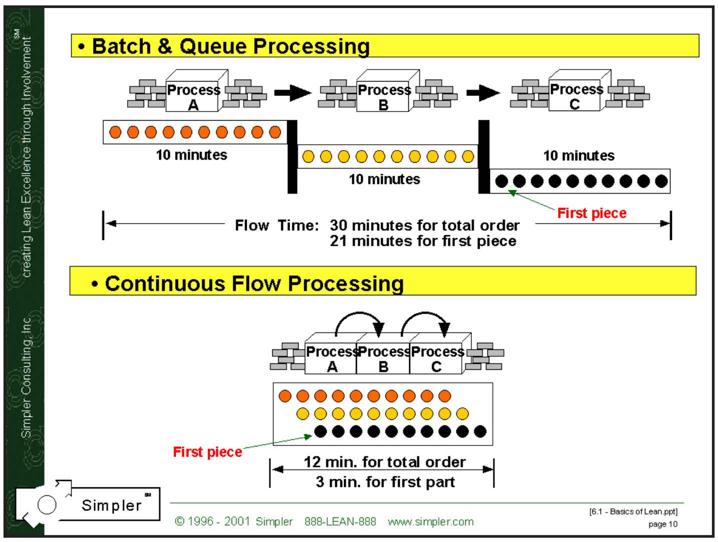
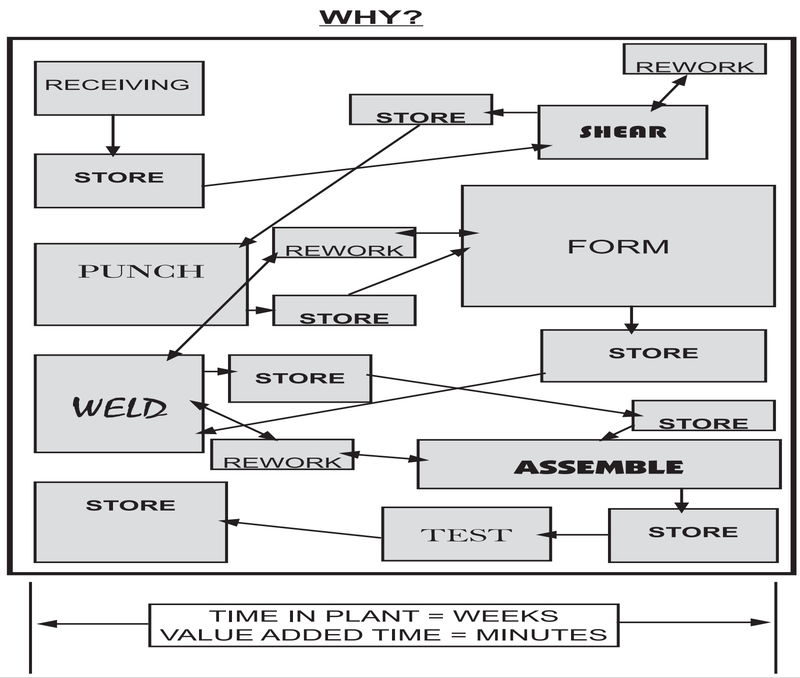




In a traditional departmental layout, the flow of material or items is interrupted by transporting, storing, and handling activities, all of which add no value in the eyes of the customer.

By organizing the value-adding steps in close proximity to one another, and producing items in 1-piece flow, you will begin to see a dramatic reduction in flow time. Flow time is the time it takes the part to go from raw material to shipping.

As the slide to the left illustrates, "flow time" in a batch environment is significantly longer than in a 1-piece flow cell.



OBJECTIVE:

Eliminate Waste, not just identify it.
Don’t automate waste!

“WASTE” isn’t a judgement. Many people have worked hard for years performing their jobs very well. Often, as we begin to “see” the difference between Value-Adding and Non-Value adding, we also begin to see how much waste there really is.

In most Value Streams, 80% of the steps done by people and machines are wasteful - moving, piling, unpiling, fixing, walking, copying, documenting, CYA-ing, meeting, loading, unloading, travelling, discussing… do these things add value?

As we learn to see waste, we need to work on not being judgemental about it. It is what it is… and it wasn’t created intentionally.

Calling something “waste” isn’t a criticism. If it’s non-value-adding, then it’s waste. Ask this question if in doubt:

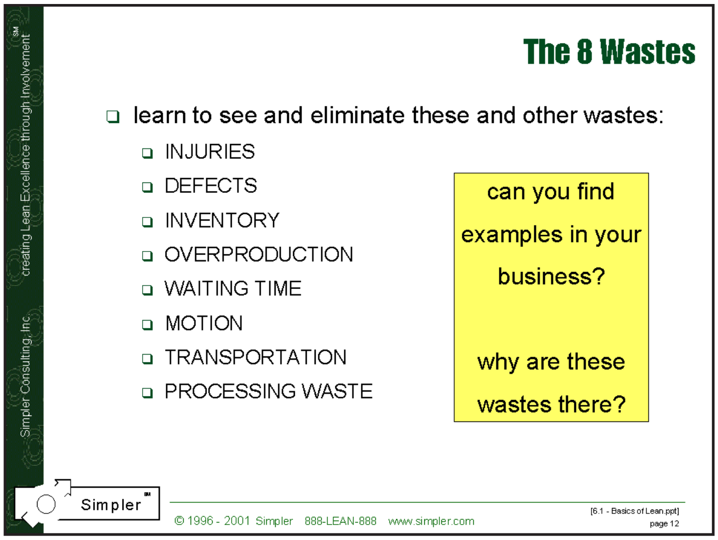
IF THIS STEP WENT AWAY, WOULD THE CUSTOMER KNOW OR CARE?

In order for this not to adversely impact morale, it’s important for us to be think about our words and work together to improve the business. We’d like to suggest three ground rules:

1: IF IT’S NON-VALUE ADDING, CALL IT WASTE.

2: STEPS ARE WASTEFUL, PEOPLE ARE VALUABLE.

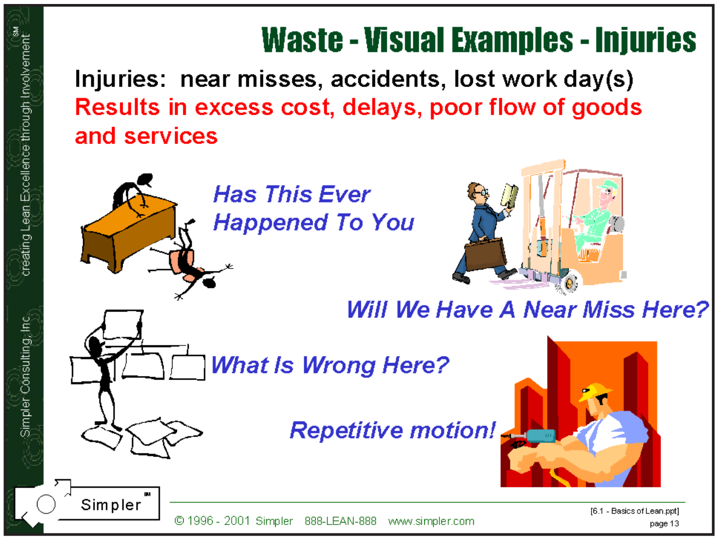
3: IT IS WHAT IT IS. THIS IS OUR BASE LINE NOW, LET’S IMPROVE IT.

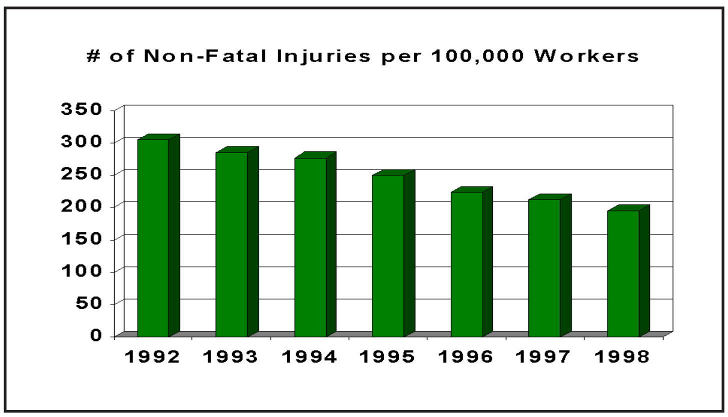


Find examples of these wastes in your business.

Why are they there?

	IN MANUFACTURING	IN SERVICE / ADMIN.
INJURIES - people must not get hurt	injuries, near-misses, things difficult to do	injuries, near-misses, things difficult to do
DEFECTS - zero defects is possible and can be created	rework areas, extra steps, inspectors	inconvenience, angry customers, redo's, wrong information
INVENTORY - items stopped or stored in the Value Stream	racks, off-site storage, $ of raw, wip, finished	partly done services, customers waiting, orders not entered, quotes in process
OVERPRODUCTION - items created before they're needed	piles or batches, things arriving before needed	excess capacity, batch service to only a few, global e-mails
WAITING TIME - people waiting for processes	people standing, trying to look busy, wandering	service providers waiting for work to do
MOTION - non-value-adding motion of hands, arms, legs	reaching, moving shoulders or elbows, walking	duplication, walking, body motion (see mfg.)
TRANSPORTATION - movement of items from A to B	forklifts, pallets, racks, conveyors, trucks, carts	moving of partly done work or of customers, go to fax machine
PROCESSING - big monuments, scrap, yield, NVA machine steps	oversized machines, scrap bins, energy use	NVA steps done to the item or the customer



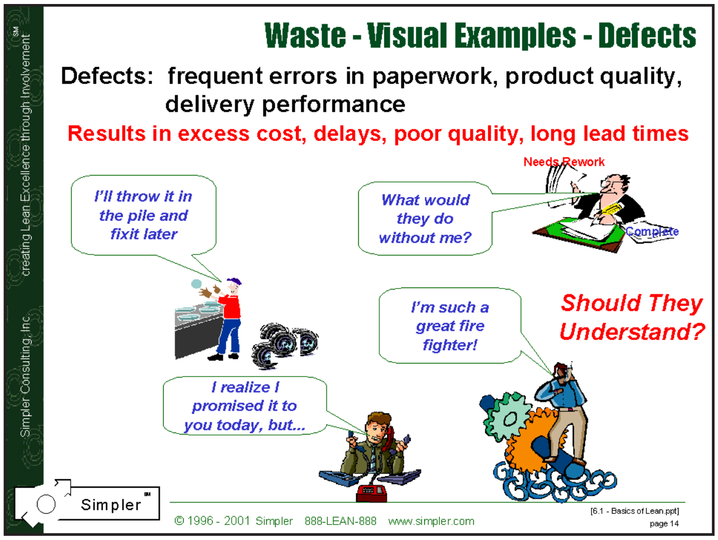


Source: Bureau of Labor Statistics

Injuries are an obvious waste. Lost time due to injuries sustained from an accident or poor ergonomics can cost the company a significant amount of money and lost productivity.

Injuries have obvious direct costs - worker's compensation premiums, time off from work and possible reduction in quality of life. But there are also significant secondary costs as a result of injuries: Cost of training a replacement, lost productivity, lower worker morale, and missed deliveries to customers.

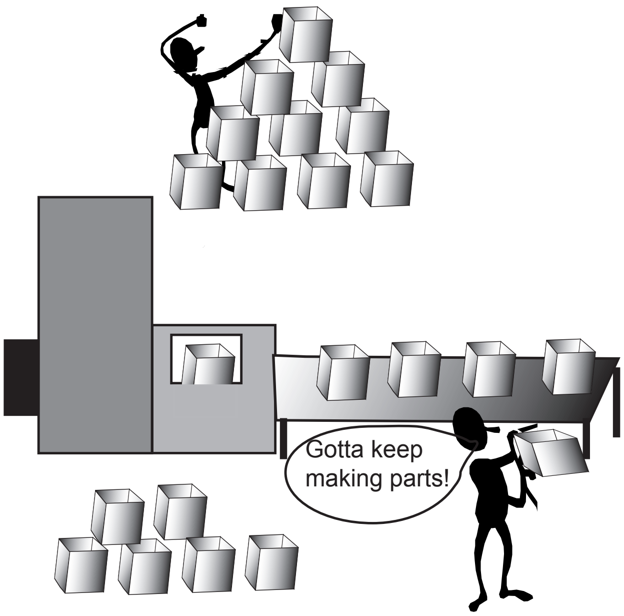
Recent laws in California, and federally, focus attention on the need to create a more ergonomically friendly workplace. Poor workplace ergonomics are the cause of thousands of injuries and lost work days each year, costing U.S. businesses billions of dollars.

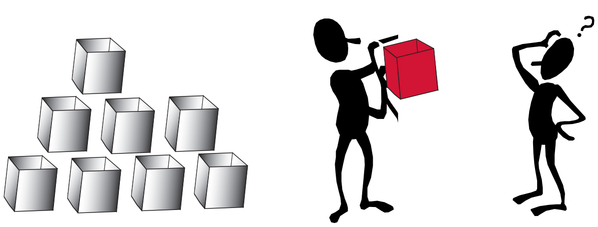


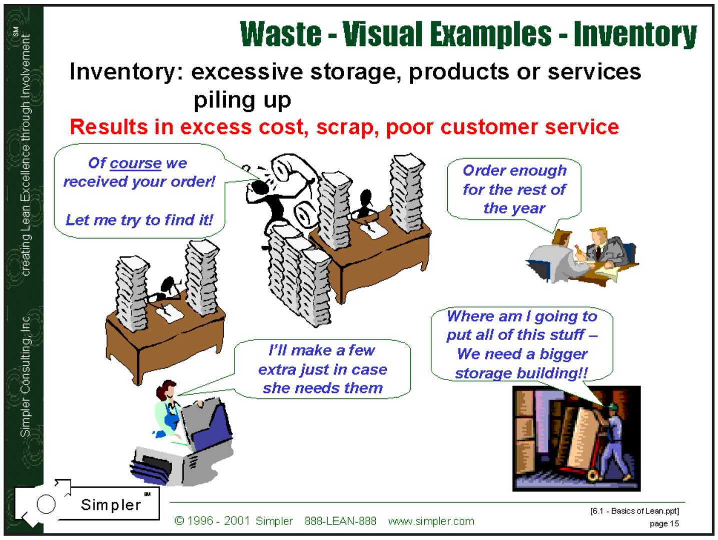
Defects are another obvious waste. Scrap material plus the cost to replace it, productivity lost while creating the defect, time required to sort the "pile" of questionable products, and the investment in a "Quality" department to "check" the work of others are all examples of waste.

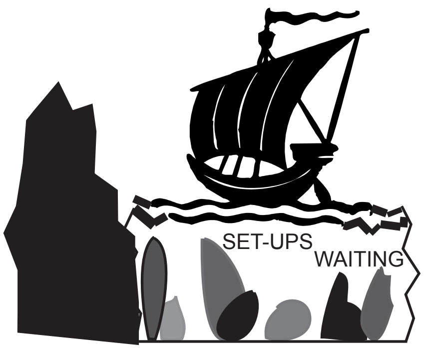
Another characteristic of a batch production environment is the inability of the system to detect defects in a timely manner. In a batch environment, defects are usually not found until they are moved to the next operation. If the defect occurred early in the previous operation, there will be a significant amount of scrap or rework to be done on the items.

When automation is applied in a batch environment, this problem is expanded. When high speed, automated equipment begins to make defective parts, it does so very quickly. Unless there are devices placed on the machine to detect bad parts, the machine will require a full-time operator to monitor the output, defeating the purpose of the automation.









By lowering the water level (inventory) we begin to expose the problems lying beneath... long set-ups, poor communication, operators waiting on machines, poor layout, etc..

A example of inventory waste. Here we see finished and work-in-process inventories that consume a lot of floor space. What do you think is involved in retrieving something on the top rack behind one of these piles of inventory?

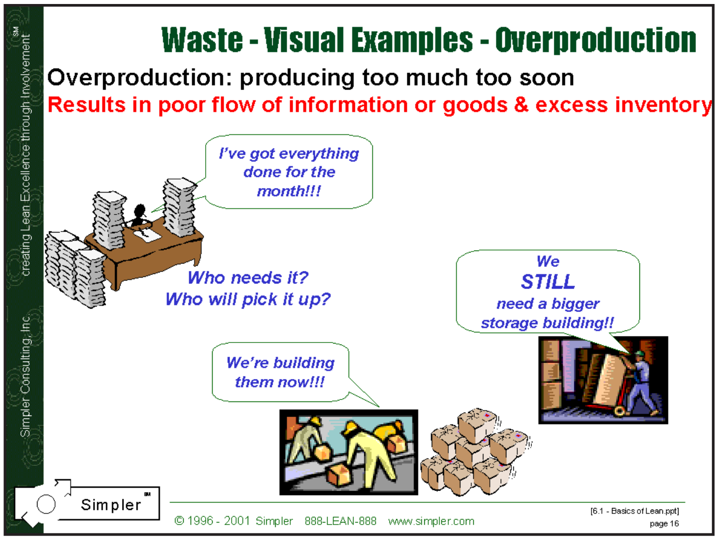
Inventory... the most **evil** of all wastes. Finished parts, semi-finished parts, raw materials, and supplies that are kept in inventory add no value in the eyes of the customer. Inventories do consume a tremendous amount of resources, hide problems, inhibit productivity and add costs to the operations.

Inventories require people to stock and retrieve the parts, move other inventory to get to the one you want, complete the transfer paperwork and count parts for inventory checks. Inventory takes up space; space that is often the point of much contention in companies.

Inventories hide problems. Supervisors will make the decision to run a week or a month of parts because of a set-up problem or because the machine will breakdown sometime in the next week. Inefficient processes will run ahead because they can not meet customer demand. Schedules generated by an MRP re-order point will require the process to make parts for an order that might be 2 months out. Lower inventory levels exposes problems in the system, and forces us to deal with them.

Inventories deplete cash from the business. Materials are bought and paid for, workers are paid and taxes and insurance are paid while the materials sit in the plant. And once the material is sold, it will often take at least 30 days to see the cash from the customer. The total lag from initial cash outlay to receipt of payment from the customer can run 90-120 days, or more.

In manufacturing, absolutely nothing gets better with time!

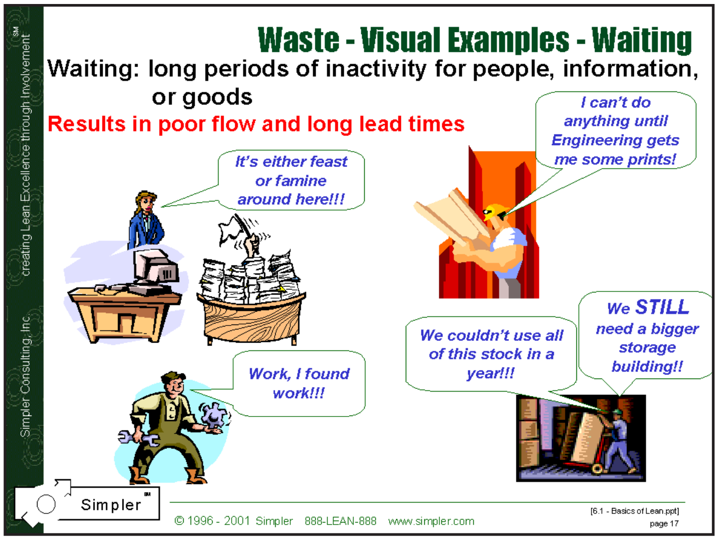


Most manufacturing companies hold the view that faster is better. If we can make 30 pieces/hour, then 50 pieces/hour must be better. Engineers are traditionally trained to look at the value-adding operations in a business and find ways to make them faster.

Overproduction is the result of this and years of conditioning supervisors to have enough product on hand "just in case". This mentality arises from problems such as machine breakdowns, absenteeism, quality problems, long set-up times, and production imbalance between departments. When a company runs in traditional batch mode with "departmental" supervisors and no direct connection between departments, the end result is a bunch of different operations running at their own pace. It doesn't take a supervisor getting burned too many times without parts to begin the process of "working ahead, just in case". Wouldn't you?

Additionally, companies who use machine utilization as a primary measure of efficiency will create an environment that encourages overproduction. When companies purchase expensive machines they often require the supervisor to "keep it running parts" in order to spread the fixed costs of the machine across more parts. The effect of this and all the other problems mentioned above is overproduction and inventory... the most evil of all wastes.

A example of overproduction. These parts consumed precious machine time to produce and are now taking up precious floor space to store.

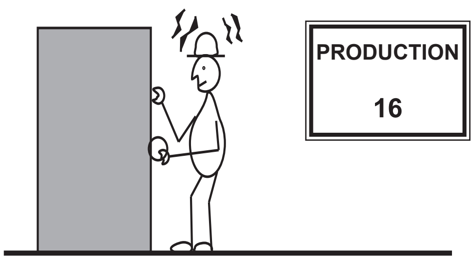


Waiting is an obvious waste that occurs far too often in most companies and, unlike many of the other wastes, is usually easy to identify. The waste of waiting can occur as a result of line imbalances, machine breakdowns, waiting for parts, poor scheduling, and poor communication, to name a few. Waiting also occurs when an operator is assigned to watch a machine during its automatic cycle time.

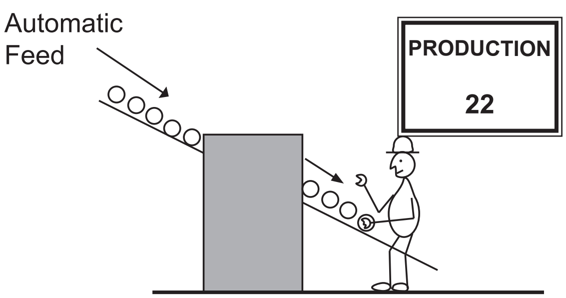
An effort to eliminate on cause of waiting is the concept of <u>autonomation</u>. This is the ideal state of separating man from machine. Having operators watch machines adds no value to the end product. In order to successfully accomplish separating man and machine, we must first employ machines that are capable of monitoring the process for abnormal conditions. Once an abnormal condition is detected, such as a defect, broken tool, or depletion of parts supply, the machine must notify the operator.

Not until companies make use of concepts such as autonomation, cells, visual production control boards, and teams will the waste of waiting be significantly reduced.

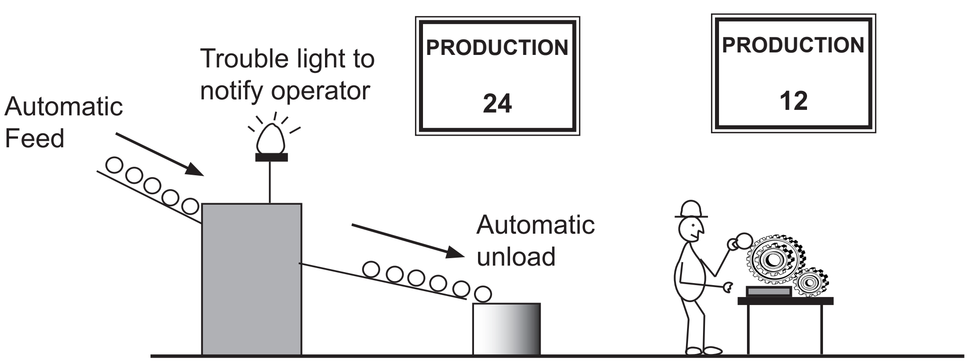
Waiting



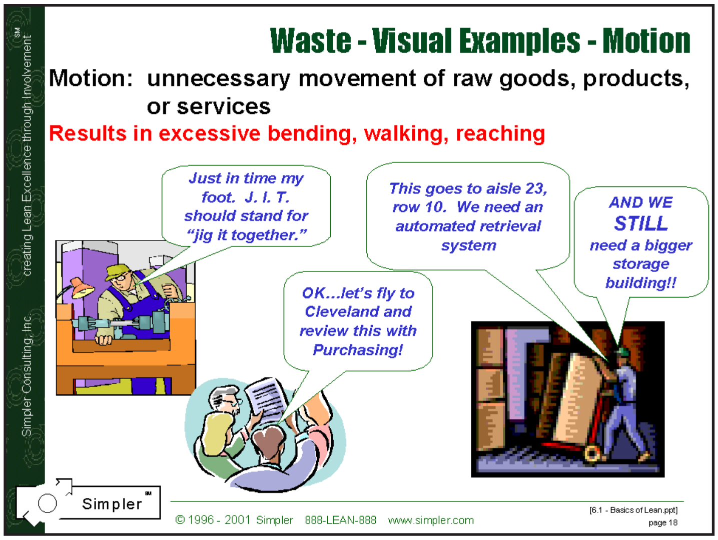
Operator performs most of the work



Operator unloads machine and watches manual cycle



Operator is assigned to a more value-adding operation



List some of the motion you see in your workplace. Does it add value?

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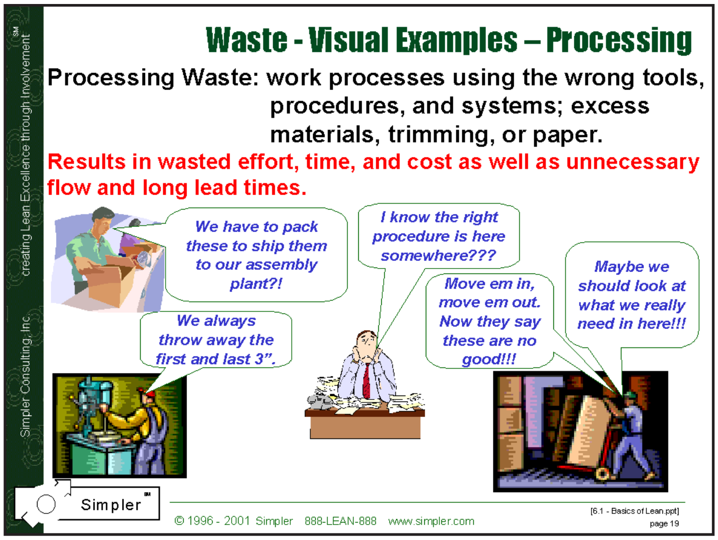
Remember what we said about value adding and non-value adding time. Any time not spent adding value to the item or product is waste and should be eliminated. Another fact to remember it that Motion does not necessarily equal Work.

Have you ever had a day when you got home you were tired, but you didn't feel like you got anything accomplished? You created a lot of motion, but probably didn't add much value. Workers will do a lot of stuff to keep busy... move parts, look for tools or paperwork, search for a supervisor, set-up machines or workstations... all of which is Motion that does not add value.

Motion comes in many forms. Walking is motion. A poor layout will increase the amount of walking done by associates without adding any value to the product. Pick and Place is another form of motion that can be reduced with some attention and teamwork.

Think about all the movement going on in your workplace. How much of it is necessary and actually adds value to your product? Value in the eyes of your customer. Walk out to the plant or place where your company adds value and observe the activity. Do this 5 times a day and make a list of what you see. Use this list as a guide to begin your quest to eliminate wasted motion.



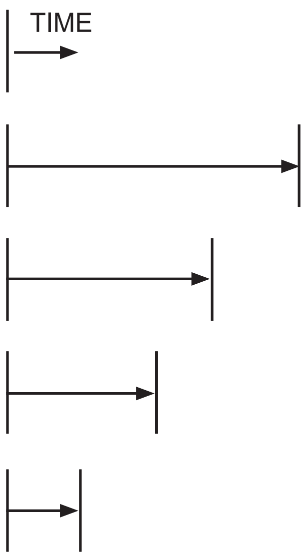
Sometimes the process itself can be the source of waste. Extra steps that are added because the process is not designed properly or machines and fixtures are not properly maintained are wasteful and can be eliminated.

Think about the de-burring operation taking place after a machining operation. Or the sanding operation on a die casting to remove extra material created by a misalignment of the molds or poor maintenance of the tooling.

When designing and maintaining fixtures, tools, and machines, consideration must be given to eliminating non-value added "extra" operations such as de-burring, sanding, masking, sealing and possibly painting.

Often times by adding some cheap, simple mechanical devices to existing machines, or by improving fixture design, we can drastically reduce product cycle times.

Material yield is often the largest contributor to processing waste. Sub-optimization of material length or sizes leads to significant "throw-away" material.



Operator loads, watches, and unloads machine.

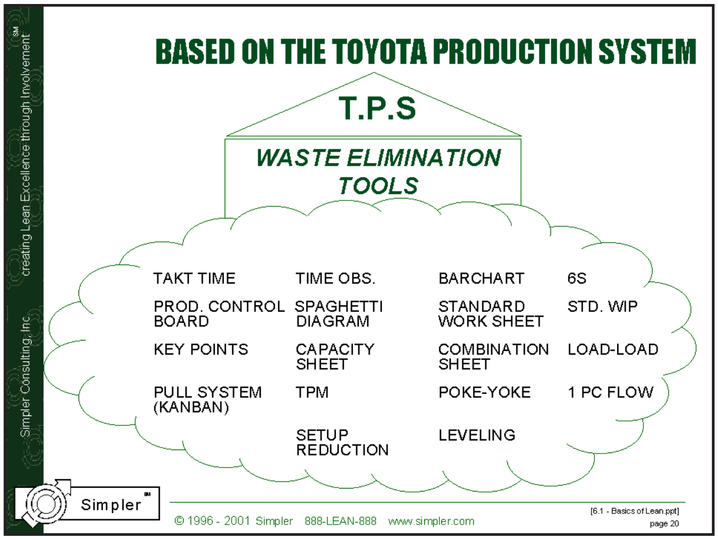
Improved fixture design.

Operator loads machine and part is automatically ejected.

Part is loaded and ejected automatically.

Operator is now freed up to perform more value adding tasks.

Processing

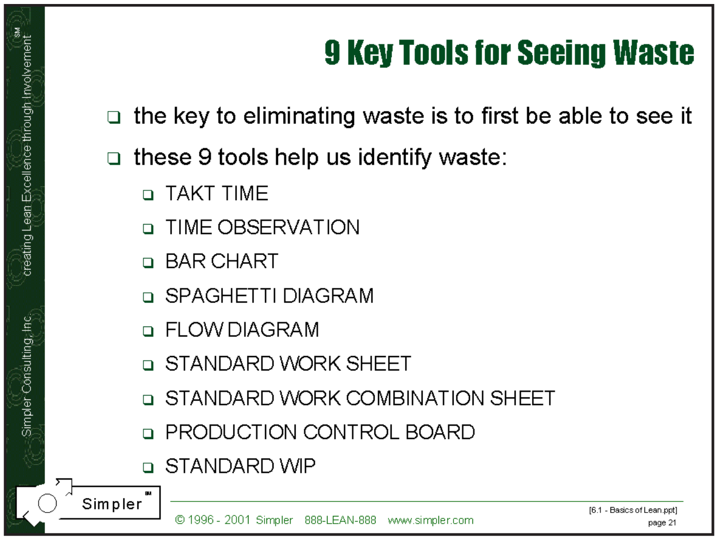


The tools employed in the Lean Conversion process are based on the Toyota Production System, a revolutionary production method developed over 50 years ago by Taiichi Ohno, an engineer with the Toyota Motor Corporation. After the war, Toyota was faced with a very grave situation. Demand for their product had eroded and they had very little capital to invest in their company. They were forced to develop a production methodology that produced a higher quality product at substantially higher productivity levels than their competitors. And this all had to be done on a very tight budget.

The result was a set of tools, listed on the left, and a process for using these tools to drive waste out of the process. The process for applying these tools is the “Rapid Improvement Event”. Two other modules have been created that explain What are Rapid Improvement Events and How to Lean Rapid Improvement Events. But it is important for beginners on the Lean journey to understand that improvement begins with the creation of “cells”.

During the Rapid Improvement Event a team will create or improve an existing cell using some of these tools to help identify and eliminate waste. Other tools help manage the process after the event. And yet others are used to improve existing cells and are not usually employed until an organization is well on their way down the Lean path.

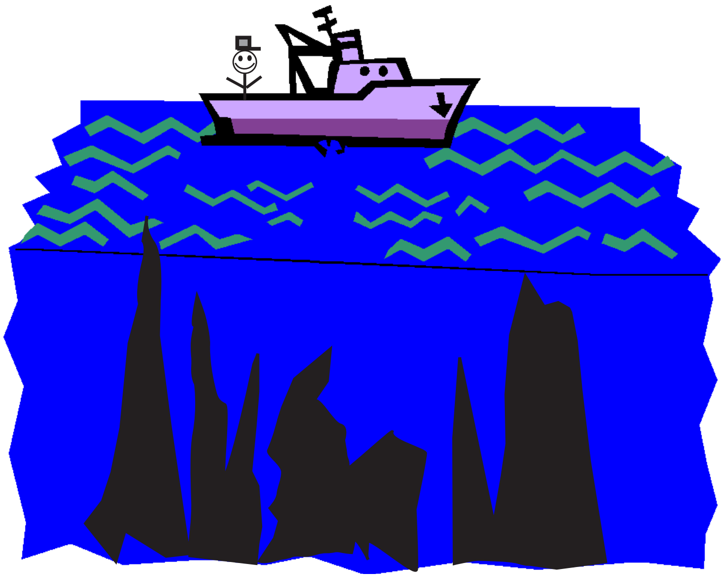
A critical factor to your success in a Lean Conversion is to apply the right combination of these tools at the correct time. Simply applying these tools individually will not get you there.

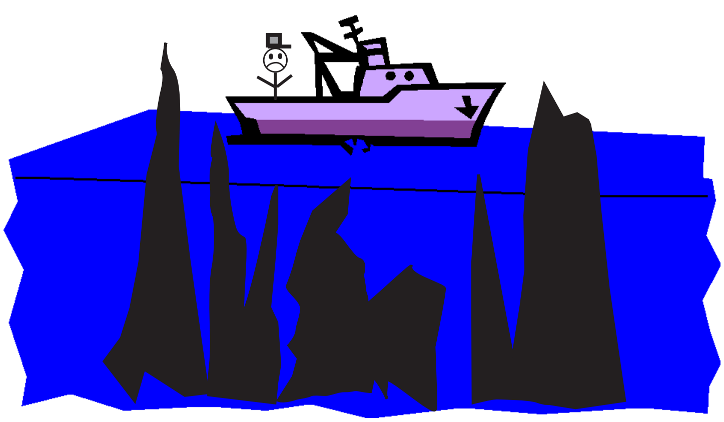


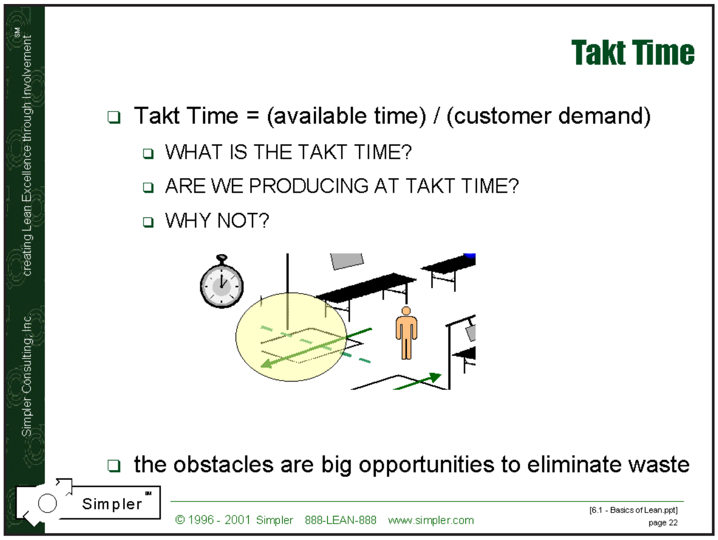
Now that we understand there is a lot of "waste" in every company, we must begin the process of identifying the waste. On the left are listed 9 key tools used for identifying or "seeing" waste. Each of these tools is explained on the following pages.

These tools will help you uncover the wastes that exist in your organization. Like water covering rocks, wastes such as inventory, overproduction, and waiting cover problems in every organization.

By using these tools to lower the water, you will expose the underlying problems. It is at this point where you must take action to correct the problems and not allow the water to 'rise up' again.







What is the Takt Time? Remember we're producing at the pace of customer demand - - no faster, no slower.

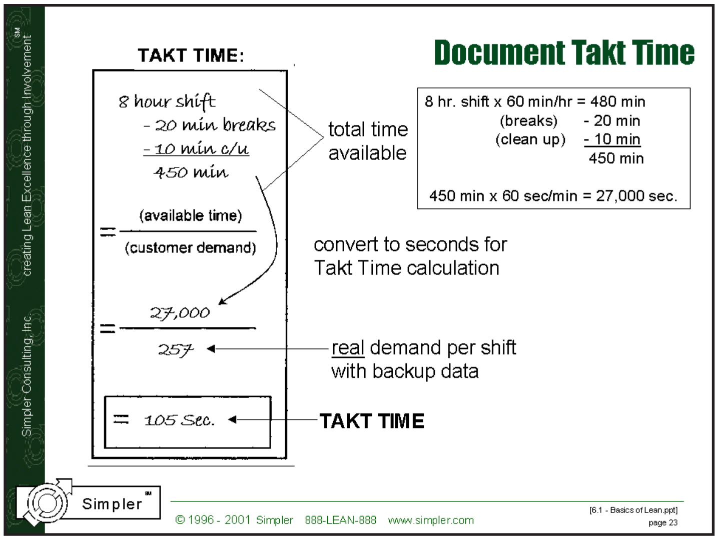
The Takt Time is just that - the rate at which your customers are ordering or "pulling" items from you. Takt is a German word meaning "Beat". Every company has a Takt Time, even if they are not doing Lean. But by calculating your Takt time, and beginning to understand your Takt Time and making decisions based on it, you are taking the first step toward becoming a Lean organization. The concept of Takt Time is the tool that separates Lean from other process improvement initiatives. By understanding true customer demand you can make decisions on ***staffing*** and ***work assignments*** that will have a tremendous effect on productivity, inventory, and delivery lead times.

Knowing the Takt Time and seeing if it's actually happening is the first step in identifying waste.

Ask yourself:

Are we actually producing at Takt Time?

If not, why not?



Step #1: Calculate available time:
8 hr. shift x 60 min/hr = 480 min per shift
- 20 min (breaks)
<u>- 10 min (clean up/pm)</u>
450 min

Convert 450 min to sec.
450 min x 60 sec/min = 27,000 sec.

Step #2: Divide available time by customer demand = 27,000 / 257 units = 105 sec T/T

If a car is able to drive 120 mph, even though the speed limit is only 60 mph, should it?

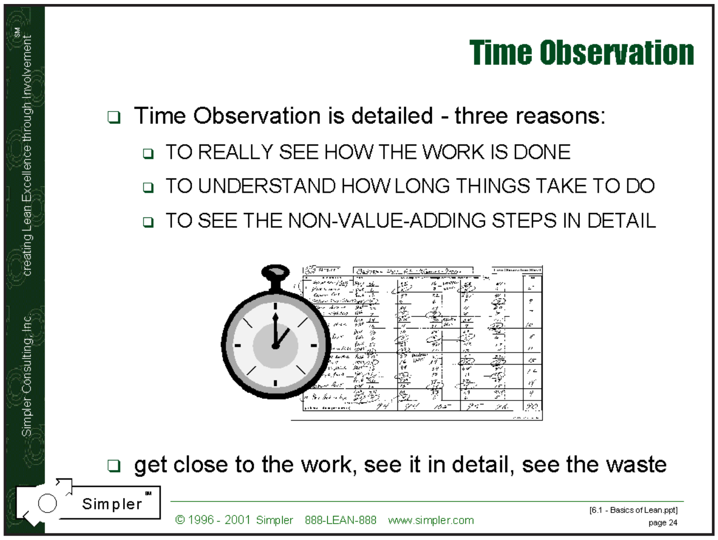
If our machines or processes are able to produce 1 item every 10 seconds, even though our customer's are ordering only 1 item every 100 seconds, should they?

The concept of Takt Time IS the driving force in a Lean production system. We need to ask ourselves on a regular basis, "How often are our customers ordering our items?". And understand that any production faster than this rate is WASTE.

An example of how to calculate Takt Time is shown to the left. First, convert the total time available in a shift to minutes. Then subtract out ONLY the allowable time for scheduled breaks and clean-up. It is very important that you do not allow time for fatigue, machine breakdown, or time for searching for tools or material. This will only build waste into your system. The Takt Time is simply how often you need to produce an item in the cell to meet customer demand. Do not build waste into your operation. Identify it, and find ways to eliminate it!

Convert the final number of available minutes into seconds. Divide this number by the REAL customer demand. This number must be based on ACTUAL customer demand. Do not use a forecasted number here. Review current orders and short term history, only!

Again, it is critical that we not discount this time for unexpected downtime or for operator fatigue. We need to recognize that any variation in processing times we observe is a result of wasteful activity. Identify and eliminate the waste.



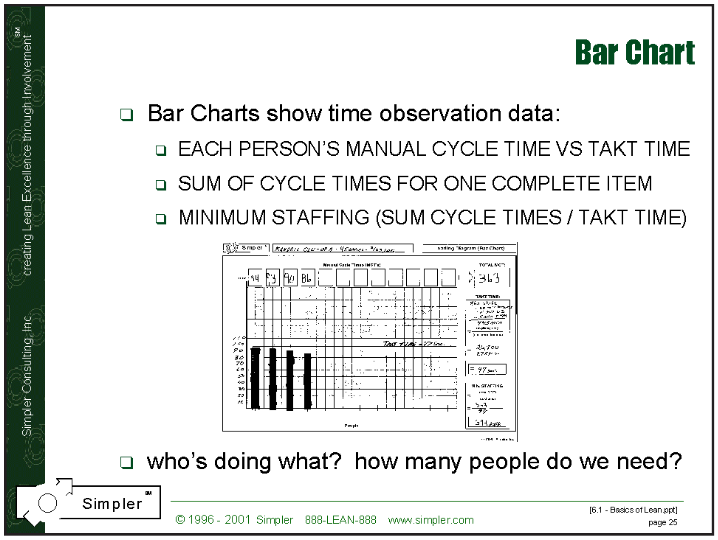
Performing time observations is the best way to actually see waste. This step accomplishes two important goals:

- we get real facts and data about the operation - for improvement and for Standard Work

- we see the work being done (closely enough to really see non-value-adding waste)

Simpler ™ | MANDREL CELL-OP.A - 45series - 2/23/00 | Time Observation Sheet

	#	DESCRIPTION	POINT	DATA (top half - watch readings, bottom half - subtraction, right - notes)					TIME
1	1	START SAW / Pick slug WALK to Lathe	HAND ON DOOR	6	5	8 DROPPED SLUG	5	6	5+1
2	2	Remove Part Insert Slug-Start	PUSH START	7	8	6	9	7	7+1
3	3	Place Part in Drill-Tighten	DROP TOOL	9	7	7	8	7	7+1
	4	Drill Hole	PUSH STOP	12	11	21 BROKE DRILL	9	10	10
	5	Remove Part	DROP TOOL	6	5	5	5	6	5
4	6	Place Part in Mill	PUSH START	11	11	12	13	11	11
5	7	Walk to Lathe Flip Part	PUSH START	15	16 DROPPED PART	14	15	15	15
6	8	WALK to Mill Remove Part	DROP TOOL	12	12	13	11	12	12
7	9	Deburr Part	PUSH STOP	12	15	14	14	15	14
8	10	Place Part in box	PUSH START OR SAW	4	4	5	6	5	4+1
		Time Per Cycle: (at least 1 sheet per person)		94	94	105	95	96	90 +4

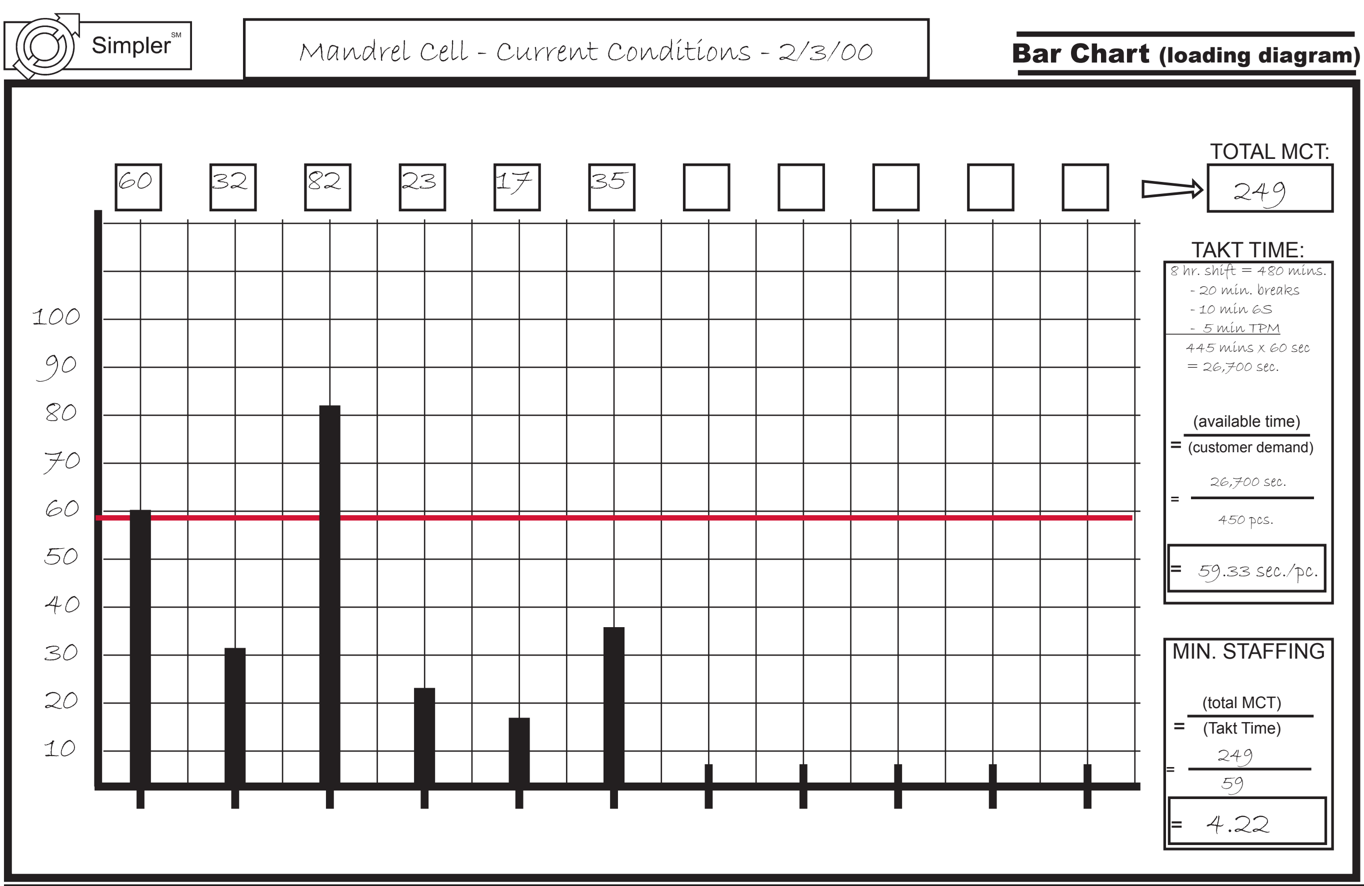


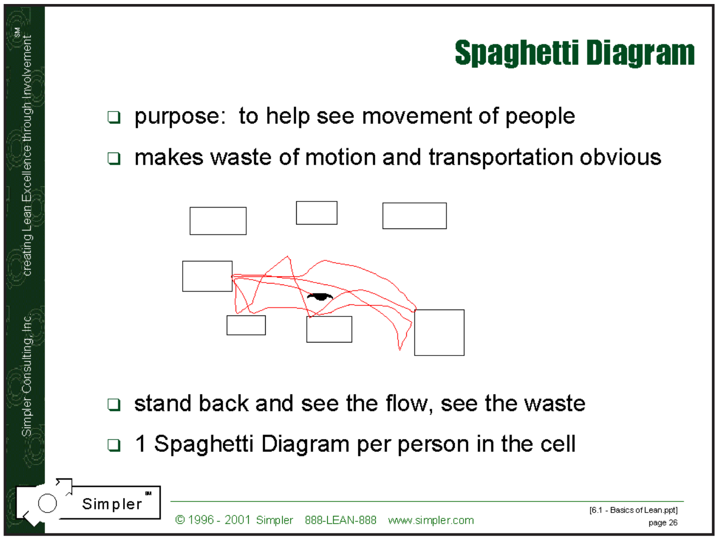
The Bar Chart (sometimes called a Loading Diagram) has a few important pieces of information:

- calculation of the takt time
- loading of each person (how long is their work sequence compared to the takt time)
- compares total cycle time to make 1 unit vs. Takt Time
- what is the "minimum staffing" needed in the cell (sum of manual cycle times divided by the takt time)

The Bar Chart gives us a visual summary of how work is distributed in the cell, and highlights the best places to start improvement activities in.

The Bar Chart also helps identify sources of waste (idle time, overproduction, inventory).





The Spaghetti Diagram is a very useful graphic that shows us how things flow in our layout.

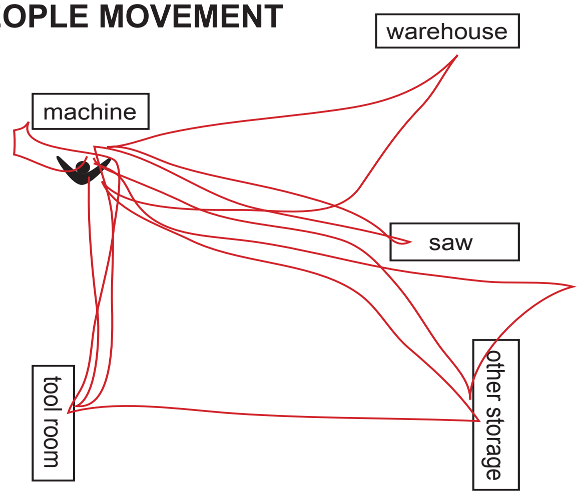
It is created from a simple layout sketch (CAD not necessary… keep it simple). On the layout sketch, colored lines show the flow of specific items as they move through our facility.

A rule of thumb for layout accuracy: Draw your layout accurate enough so that you may use the same layout and cut out "paper dolls" for future use.

Look to eliminate walking and movement of persons in the cell.

The extra waste in transportation becomes obvious.

PEOPLE MOVEMENT



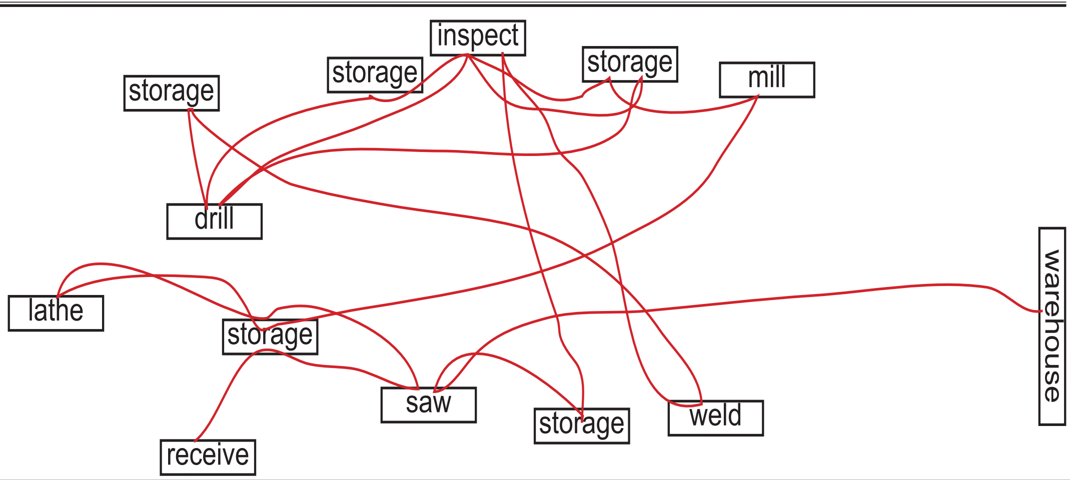
Total Distance Traveled = **793** ft.

Time from receipt of order to first part = **2 hr. 43 min.**

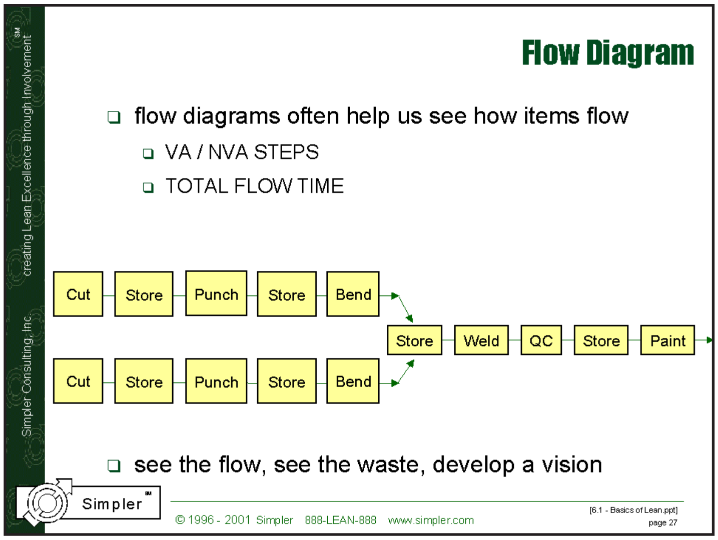
Total Distance Traveled = **1,976** ft.

Time from receipt of material to warehouse = **4 weeks 3 days**

MATERIAL MOVEMENT



4. Spaghetti Diagram



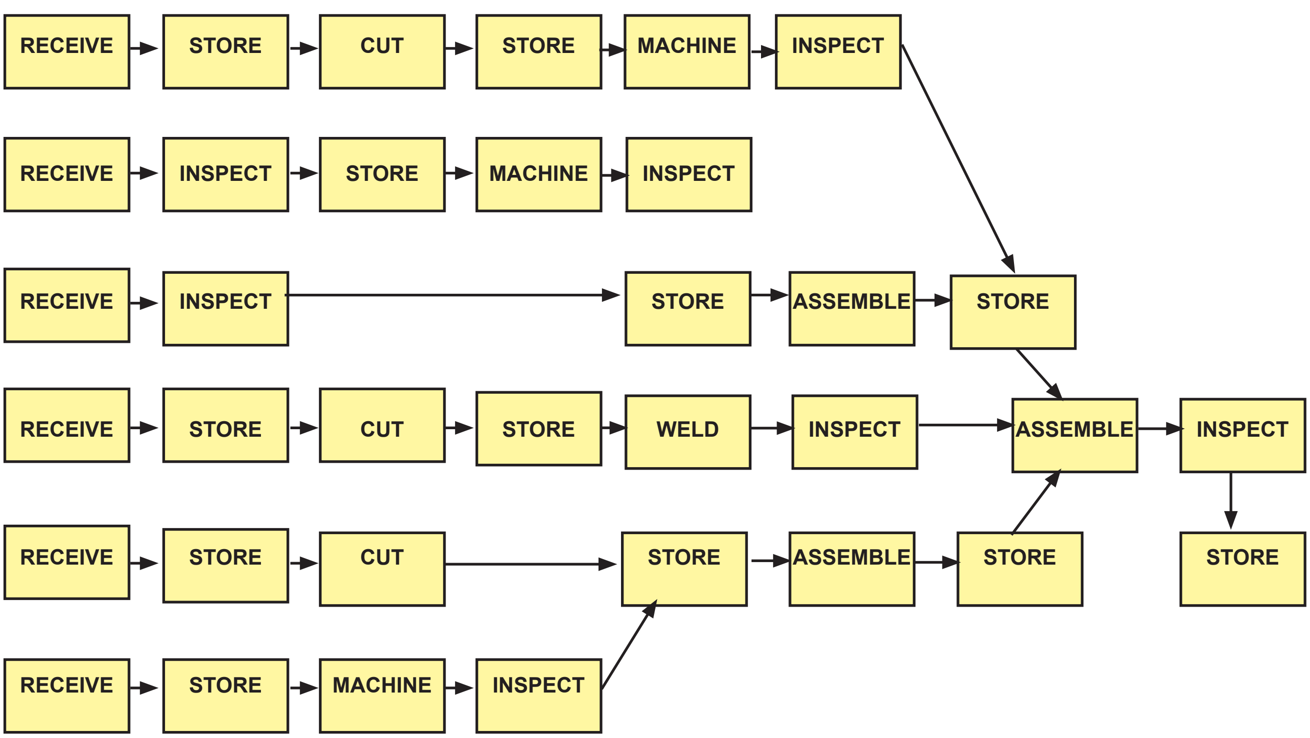
The Flow Diagram documents quickly and visually the flow of items in some part of the Value Stream.

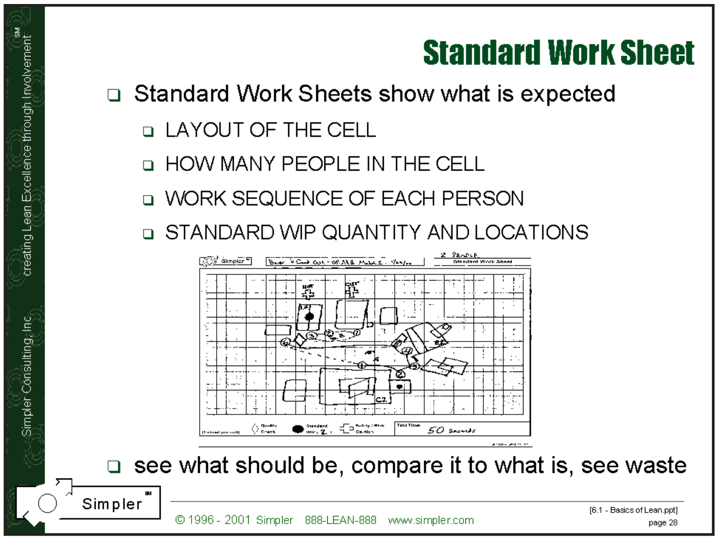
This is done quick and simple using post-it notes and markers. It helps everyone see the non-value adding steps.

For more complex analysis of flow, we suggest you apply Value Stream Analysis using the Value Stream Mapping symbols instead.

Rule: Post-It for every material "stop" in the process

Machining
Assembly
Storage
Sorting
Inspection





The Standard Work Sheet shows visually how many people are in the cell and where they should be working. It clearly shows each person's work sequence and the takt time. It also shows where the Standard WIP should be.

A quick review of this sheet while looking at what's actually happening in the cell helps identify waste quickly.

The cell manager posts the Standard Work Sheet on the Standard Work Board and can refer to this often in evaluating the performance of the cell.

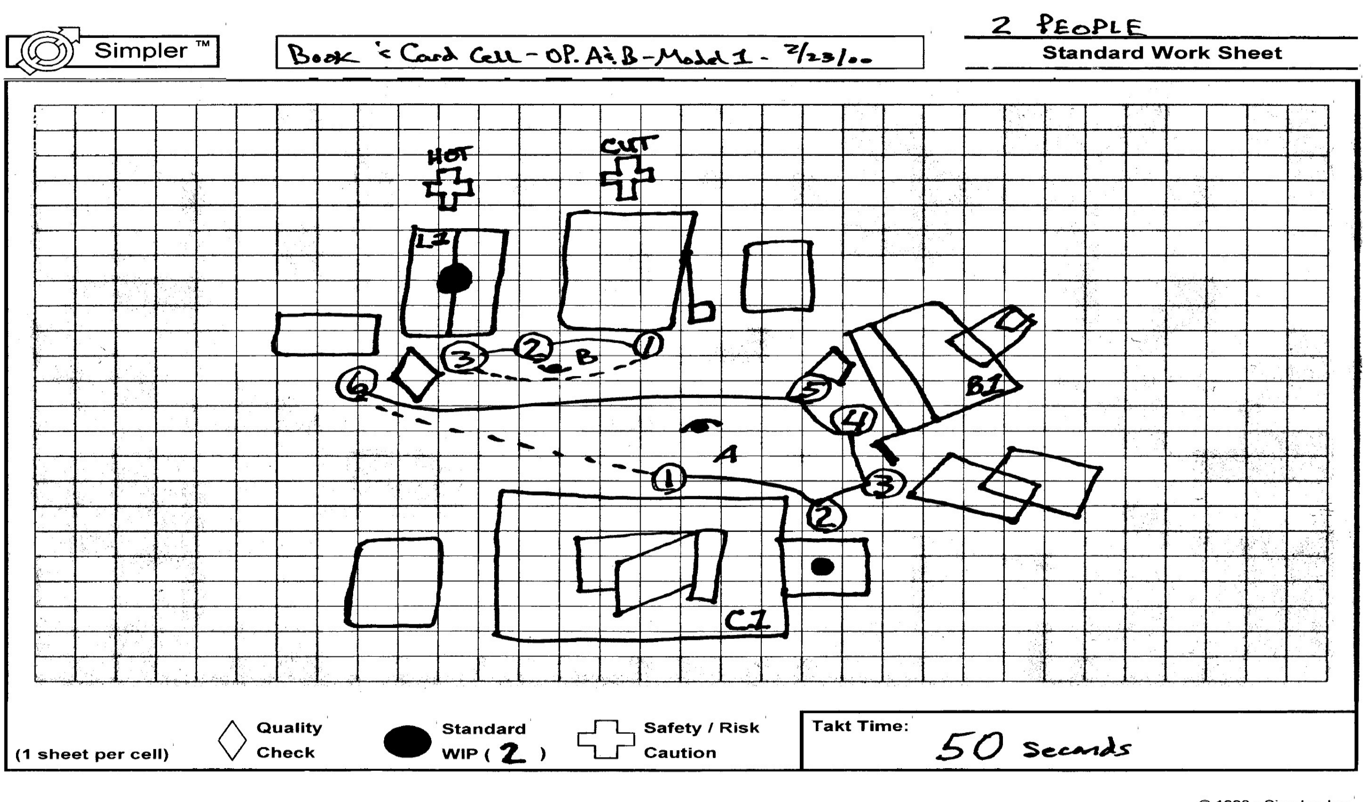
Is everyone following the Work Sequence?

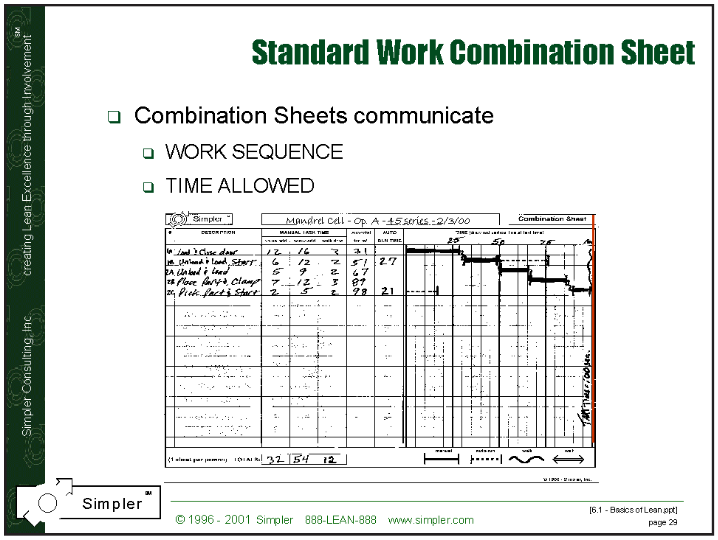
Is there extra WIP?

The Takt Time is written on the Standard Work Sheet, along with the exact Work Sequence of every person in the cell and the Standard WIP, showing how many pieces and where they should be.

In documenting the Work Sequence and the machine locations, the Standard Work Sheet establishes very clearly the work assignments of everyone in the cell.

Each machine is placed on the Standard Work Sheet as they are laid out on the shop floor.





Create the graph as shown below. Draw the Takt Time line in red on the graph. If the auto run time line goes past the Takt Time line, wrap it around back to the start again. If it collides with the operation again, then you know you'll have a problem. This will allow you to see if the machine will be completed when the operator gets back to the machine again.

Simpler

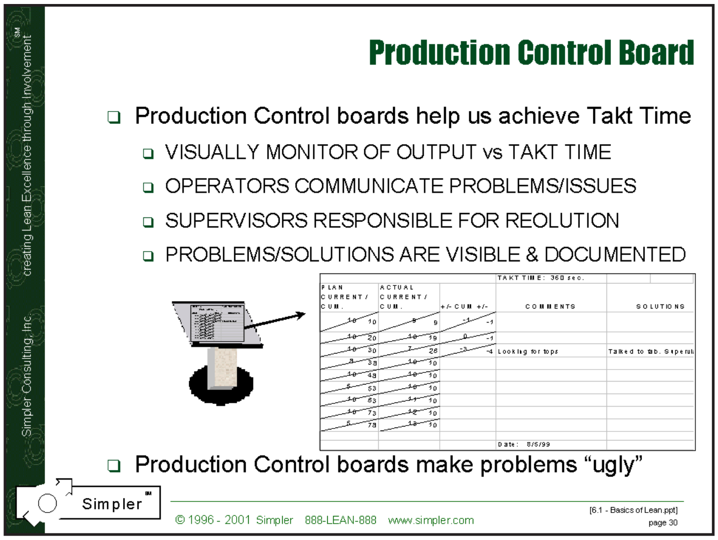
Mandrel Cell - Operator A- 2/3/00

Combination Sheet

#	DESCRIPTION	MANUAL TASK TIME value-added	non-v-added	walk time	sub-total for ref.	AUTO Run Time	TIME (draw red vertical line at Takt Time) 25 50 75 100 125
1A	LOAD & CLOSE DOOR	12	16	3	31		
1B	UNLOAD & LOAD, START	6	12	2	51	27	
2A	UNLOAD & LOAD	5	9	2	67		
2B	PLACE PART & CLAMP	7	12	3	89		
2C	PICK PART & START	2	15	2	98	21	TAKT TIME = 100

(1 sheet per person) TOTALS: 32 | 54 | 12

manual auto-run walk wait



The Production Control Board is the foundation of Visual Management at a cell level. It gives us a quick way to check hour by hour if the cell is producing at takt time. It highlights shortfalls and the reasons for them.

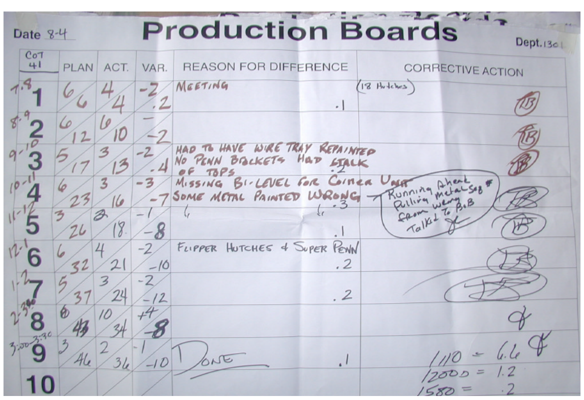
This becomes the basis for "real world" problem-solving and corrective action.

Comments must be recorded on the Production Control Board after each hour if the actual falls below the planned. This provides feedback to the supervisor on problems that occurred to prevent the cell from working to Standard Work.

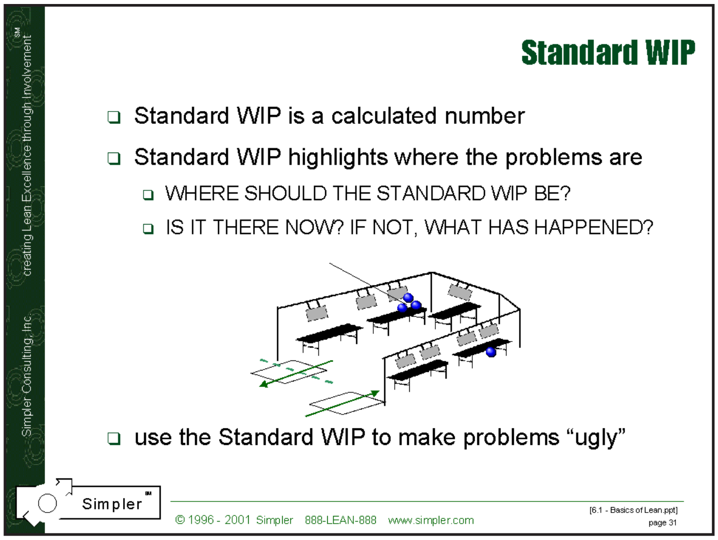
Comments can be recorded for other events or improvement ideas, as well. I.e., What we did to produce more than planned. Positive comments can be used to improve the Standard Work. Comments should provide enough detail for the supervisor to be able to solve the problem. (done by cell members)

The Production Control Board is only useful if information is captured and problems are solved. It is the basis for getting "real world" problems solved.

Production Control Board



The Production Board pictured above is a great example. It shows the communication that occurs between the operators and supervisors and provides a place for operators to document their real wold problems. And perhaps most importantly, the Production Control Board is used by the supervisor to manage problems. Note: Supervisor initials under corrective action!



Standard WIP is two things.

One, it is the absolute minimum amount of WIP we need in the cell for each person to perform their Work Sequence.

And two, it is a very good barometer for identifying problems. Once we have defined the minimum amount of Standard WIP, we can see very visibly if people are following the Standard Work and where there are problems. When we start and end each day, there should be no more or less WIP in the cell than what we have defined as the Standard WIP. If there is more or less, then we have a problem we need to address. More WIP will result in excess handling and storage (waste). Less WIP will result in people standing around waiting (also waste).
Standard WIP is a critical Visual Management tool for a cell manager.

At a glance, cell managers know if there is a problem somewhere in the cell by looking for the locations of the Standard WIP. Extra or missing pieces indicates something is wrong.

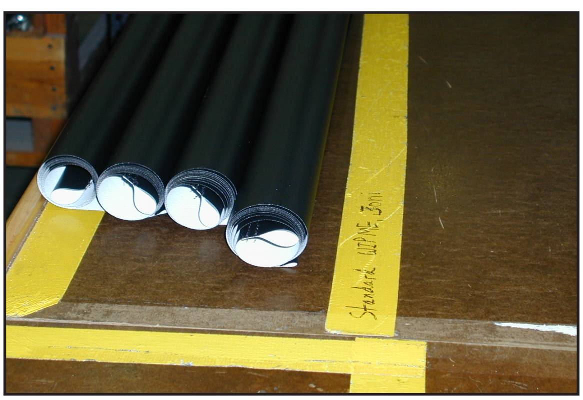
If WIP is building up where it shouldn't be, what does it tell you?

- Is an operator taking too long?
- Are there bad parts?
- Did something change?
- Why isn't the other operator helping solve the problem?
- Are we working out of the Standard Work?

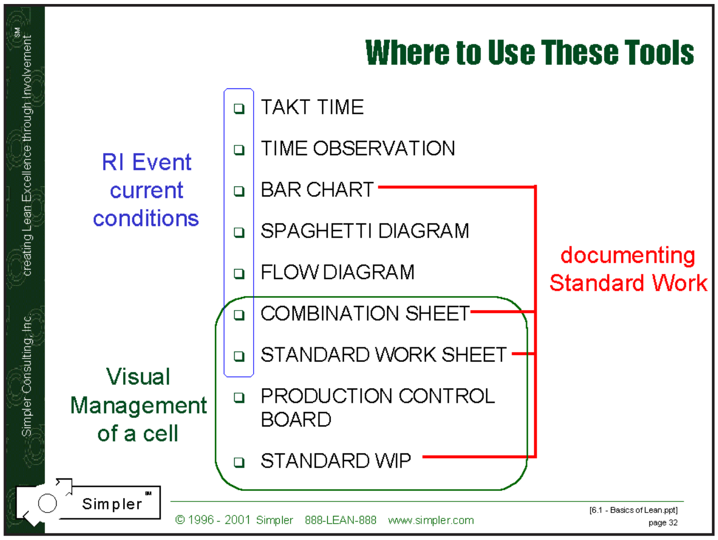
If the Standard WIP is too low, what is really happening?

- Should we reduce the Standard WIP in the cell? (THIS IS GOOD!)

STANDARD WIP



An example of the Standard WIP required in this cell. The yellow "box" should be filled; no more, no less. This is the amount required to allow every member to start work at the same time and to keep the cell running smoothly.



On the first day of an RI Event, use six of these tools to help document current conditions:

- Takt Time
- Time Observation
- Bar Chart
- Spaghetti Diagram
- Flow Diagram
- Standard Work Sheet

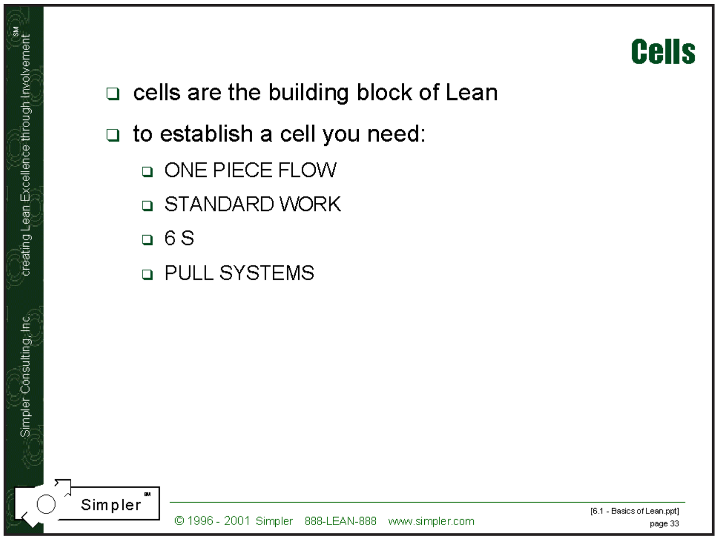
When establishing and documenting Standard Work, use four of these tools:

- Time Observation
- Bar Chart
- Standard Work Sheet
- Standard WIP

(note… completing Standard Work documentation will also involve use of these documents: Capacity Sheet, Combination Sheets, Key Points Sheets)

When managing a cell visually, focus on these three tools:

- Production Control Board
- Standard WIP
- Standard Work Sheet (part of the Standard Work Board)



A **cell** is a grouping of work elements or machines used to create an item or product from beginning to end. These work elements or machines are grouped as close together as possible in order to improve efficiency, communication, and space utilization while providing only enough room to accomplish the work sequence.

Cells need to be established before they are improved. Establishing involves four steps:

1-PIECE FLOW: changing the Value Stream so that items flow one by one, non-stop.

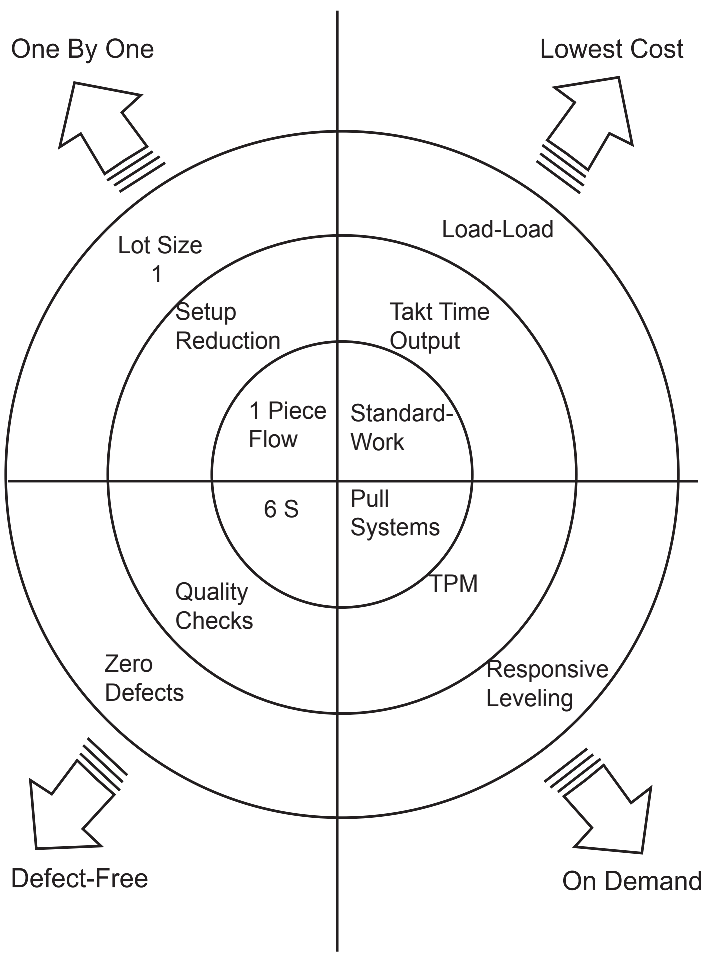
STANDARD WORK: is a management system for cells. It is the key to cell productivity.

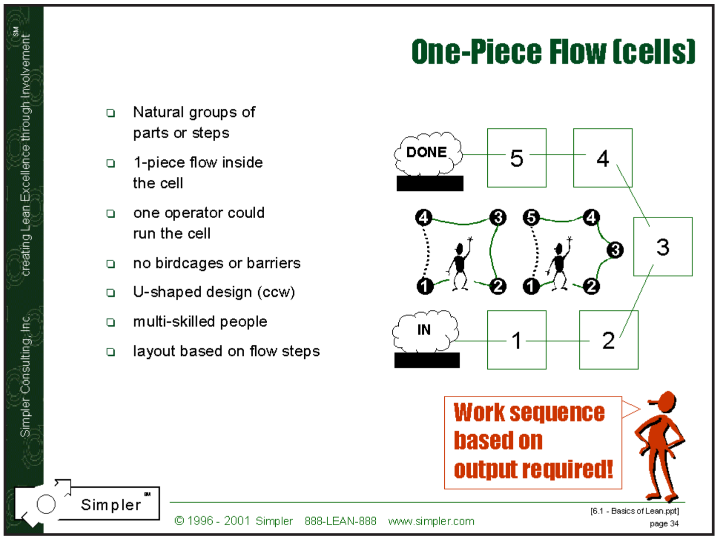
6-S: enables visual management to occur (production control boards, standard work combination sheets, standard wip...)

PULL SYSTEMS: link cells together, and link customers and suppliers.

After establishing a cell, it can be improved. The diagram on the left shows the progression of a cell based on the four key philosophical points of producing ON DEMAND, DEFECT FREE, ONE-BY-ONE, and at the LOWEST COST.

As you progress along in your Lean conversion, you will begin to utilize the tools on the outer rims of the circle. DO NOT attempt to move to the outer circles until you have satisfied the inner-most circle. You must establish 1-Piece Flow, Standard Work, 6S, and Pull Systems (where needed) before moving on.





Mass Production vs. Lean Production

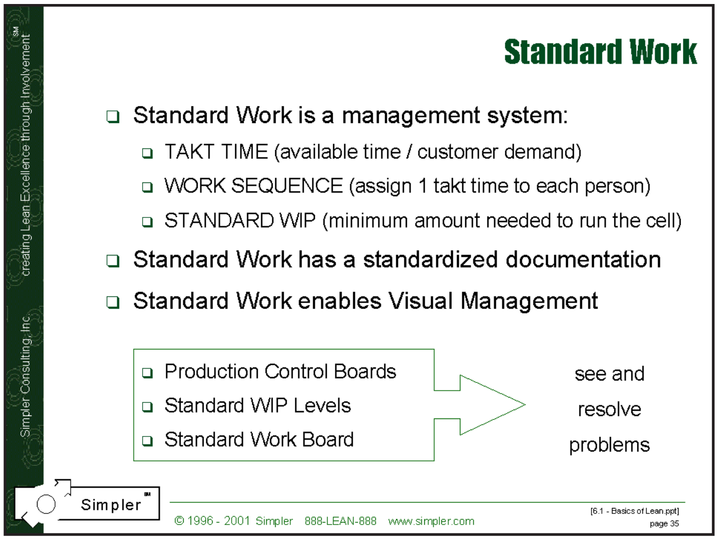
	GM Framington	Toyota Takaoka
Gross Assembly Hours per Car	40.7	18.0
Adjusted Assy. Hours per Car	31	15
Assembly Defects per 100 Cars	130	45
Assembly Space per Car (sq. ft.)	8.1	4.8
Inventories of Parts (Average)	2 weeks	2 hours

*Adjusted hours incorporates adjustments for standard activities and differences in product attributes

SOURCE:
Title: THE MACHINE THAT CHANGED THE WORLD
Authors: James P. Womack, Daniel T. Jones, and Daniel Roos
ISBN: 0-89256-350-8

There are some basic rules to follow when designing cells.

1. Group the machines or processes for a natural "group" or family of parts or processes. Don't try to make bowling balls and bicycles in the same cell.
2. Insist on 1-piece flow inside the cell. Once you pick up the part, do as much work on it as possible... ideally finish it.
3. Ask yourself... can one operator run the cell? Do not over-staff. The Bar Chart will help you determine staffing requirements.
4. Do not place people on an island or in a "birdcage" or place barriers between people. Encourage everyone in the cell to help one another out. Barriers will limit the amount of cross-training and helping that goes on in the cell. Remember... the goal is get the product from start to end quickly, efficiently, and safely.
5. Where possible, try to layout the cell in a U shaped design. This may not always be feasible, but is preferred. Flow the cell in a counter-clockwise direction. The majority of people are right-handed and studies have shown that right-handed people are more efficient when working from the right to the left.
6. Once you create a cell and begin to work in the new environment, you'll find that your people need to be cross-trained. A welder may now weld and assemble. Cross-training becomes crucial as multi-skilled people are absolutely necessary for the cell to produce parts most efficiently.
7. Layout the cell based on the flow of material. Actual work sequences of the operators within the cell may not follow the same path.



Standard Work is a management system for cells. It is the key to productivity of the whole Value Stream.

There are three key elements of Standard Work:

Takt Time - the heartbeat of the cell: it is calculated as:
(available time per shift) / (customer demand per shift)

Work Sequence - who does what (a repeating sequence for each person)

Standard WIP - what is the absolute minimum WIP required (and no more), and where is it supposed to be.

Standard Work has a standardized documentation system. It is expected that the cell manager document Standard Work personally. Keep it simple.

Using the Standard Work system, cell managers can visually manage their cells. This starts with choosing the right number of people to have in the cell based on each day's takt time. Then, three key visual management tools make it easy to see and resolve problems:

Production Control Boards - hour-by-hour output with comments and corrective action

Standard WIP Levels - where's the WIP? Where should it be? Why isn't it right?

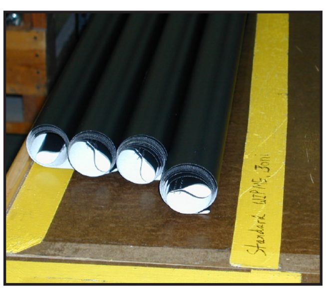
Standard Work Boards - standard work doc's posted… are they happening?

TAKT TIME

8 hr. shift x 60 min/hr = 480 min
- 20 min (breaks)
- 10 min (clean up)
450 min
450 min x 60 sec/min = 27,000 sec.

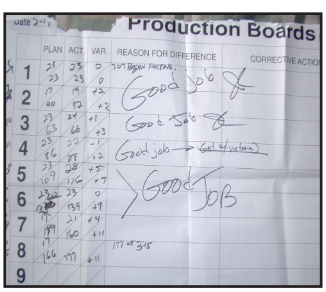
27,000 = available time
257 pcs. = REAL demand during that time

27,000 / 257 = 105 sec. **Takt Time**



STANDARD WIP

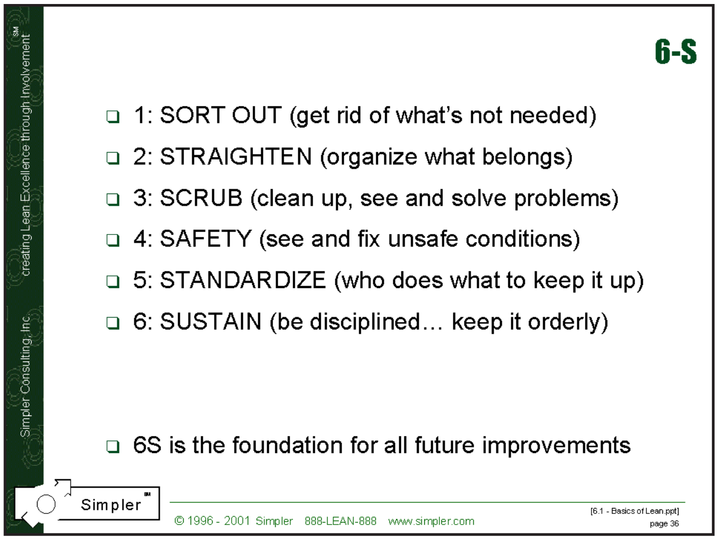
An example of the Standard WIP required in this cell. The yellow "box" should be filled at the beginning and end of each shift. There should never be more than a box full. This is the amount required to allow every member to start work at the same time and to keep the cell running smoothly.



PRODUCTION CONTROL BOARDS

An example of a Production Control Board. These boards keep an hour by hour tally of planned and actual production, but are most effective when used as a communication and problem solving tool.

Standard Work



BEFORE

AFTER

1: SORT OUT: Before you can organize anything or expect it to stay clean, neat and orderly, you need to get rid of all the things that don't belong in the area. This is obvious but rarely done. This step challenges you to be ruthless about not keeping things just in case. The "red tag" process helps you tag things that need to be removed or resolved.

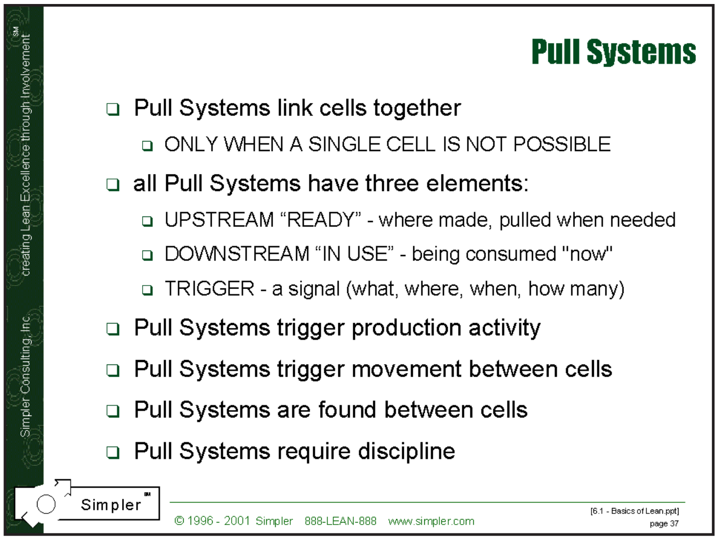
2: STRAIGHTEN: After getting rid of all the things that don't belong in an area, it's time to organize what does belong. This starts by clearly understanding where the items are needed and used. Then, put the items there in a way that makes it absolutely obvious where they belong.

3: SCRUB: Clean up… not just once, but to set a new standard of how the area should look. While cleaning, you have an opportunity to see and solve problems you discover.

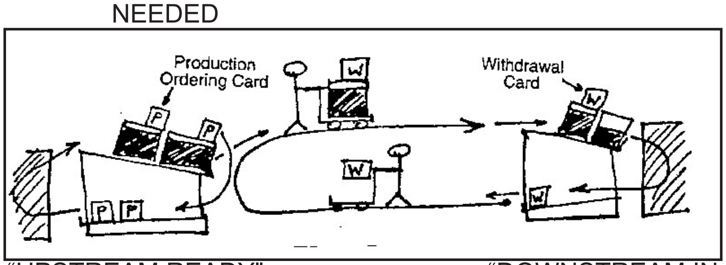
4: SAFETY: Safety is a must! By this point, you should have already corrected unsafe conditions (including poor ergonomics). Review the area closely looking only for unsafe conditions and risky situations. Find ways to prevent injury.

5: STANDARDIZE: Determine who should do what to keep the area in its new and improved condition. This includes daily and weekly tasks. Make sure it's clear who "owns" the tasks (visual zones on the Standard Work sheet help). Manage the completion of the tasks visually (when anything is out of place, it should be obvious.

6: SUSTAIN: This is the point when 6-S comes to life (or doesn't). It all boils down to self-discipline and problem-solving. Do what you said you'd do. Resolve new problems.



"FLOW" TO DOWNSTREAM CELL HAPPENS WHEN CHARGER USES WITHDRAWAL CARD TO PICK UP WHAT'S NEEDED



"UPSTREAM READY" ITEMS WITH P-CARDS ATTACHED

"DOWNSTREAM IN USE" ITEMS CAUSE W-CARD TO BE RELEASED WHEN ITEMS ARE USED

"TRIGGER" IS A W-CARD:
1: CAUSES CHARGER TO GO UPSTREAM TO GET MORE
2: THE PICK-UP FREES UP A P-CARD WHICH TELLS THE UPSTREAM CELL TO MAKE MORE

Cells need to have information fed to them. The most important information a cell needs to know is what to do next. Pull Systems are a simple alternative that helps a cell serve its customers while also eliminating the need for complex, expensive information systems.

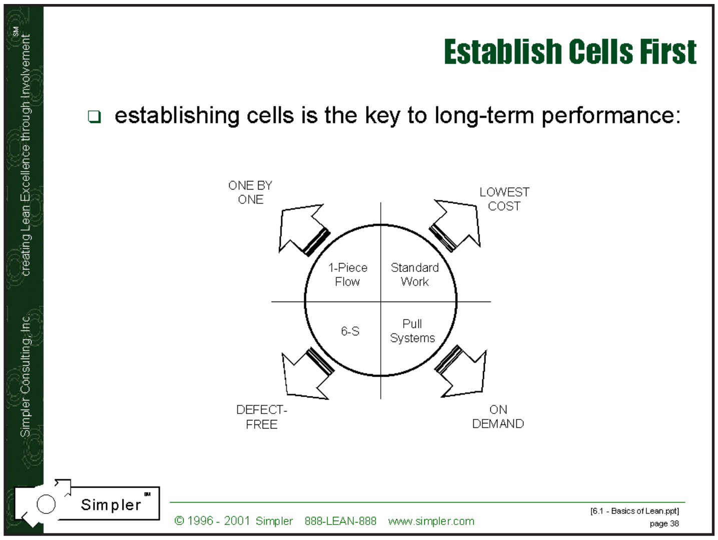
Pull Systems trigger work to be done in a cell. They are found between a cell and its customers. Most cells are on the supplier end of a pull system that helps it serve downstream customers, but are also on the customer end of pull systems that help the cell get what it needs from its suppliers.

Pull Systems are one of the keys to Just-In-Time… producing (not storing) what's needed, when it's needed, in the quantity needed. They exist because of natural breaks in flow in a Value Stream. Pull Systems link cells together. Each Pull System has three elements:

1: UPSTREAM "READY" ITEMS - these are items that are completed by the upstream cell (the supplier) and ready for the downstream cell to pick up. Remember that items are stored where they are made, and pulled when they're needed.

2: DOWNSTREAM "IN USE" ITEMS - these are the items that the people in the downstream cell have already pulled from the upstream cell and are in the process of using (example - a partly used bin of parts that are on an assembly bench)

3: A TRIGGER - in order for a Pull System to "come to life", there needs to be a signal or trigger that causes action to happen. The trigger tells the people who work in the Pull System what to get or create, when to do this, where to pick up and deliver items and also how many items to get or create (example - empty bin with label, marked space on floor).



The first step in creating 1-piece flow is to establish flow cells. Establishing cells involves four steps:

1-PIECE FLOW: … changing the Value Stream so that items flow one by one, non-stop.

STANDARD WORK: … a management system for cells. It is the key to cell productivity.

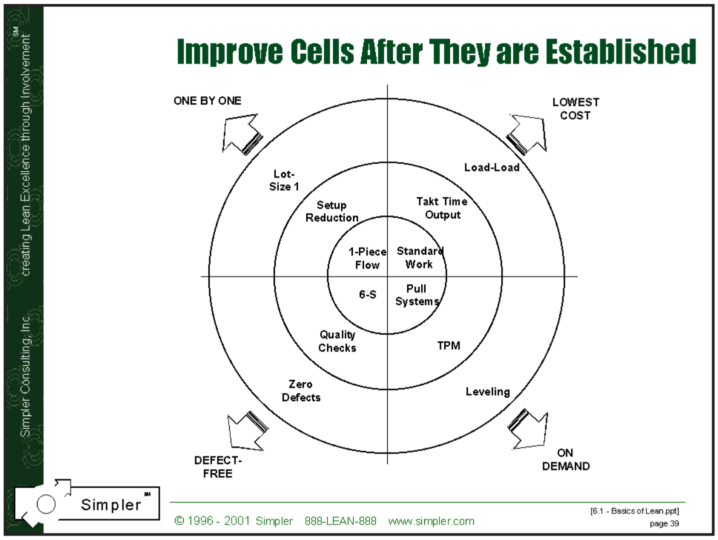
6-S: enables visual management to occur (production control boards, standard work combination sheets, standard wip...)

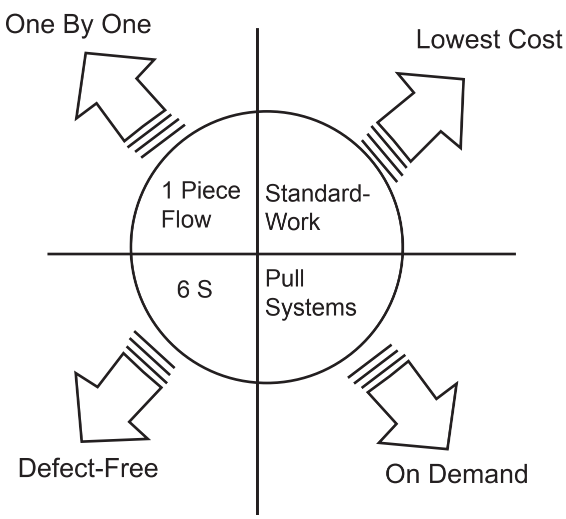
PULL SYSTEMS: … link cells together, and link customers and suppliers together with pull systems.

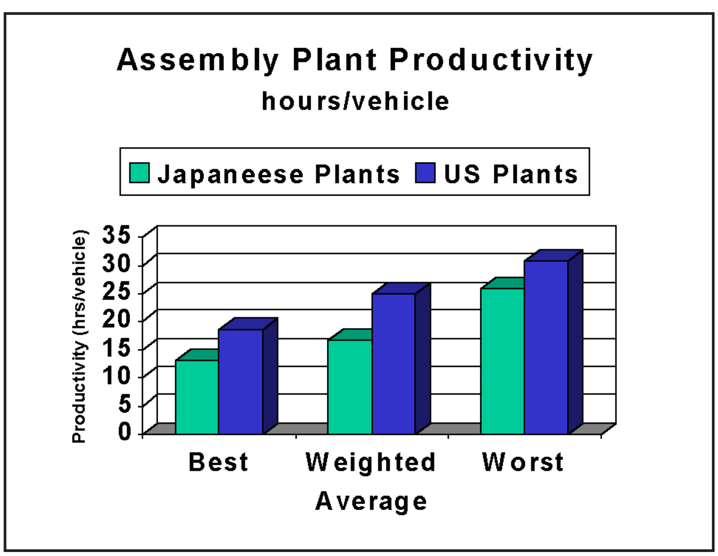
Assembly Plant Characteristics

	Lean	Batch
Performance:		
Productivity (hrs/vehicle)	16.8	25.1
Quality (defects/vehicle)	60.0	82.3
Inventories (days for 8 sample parts)	.2	2.9
Layout:		
Space (sq. ft./vehicle/yr.)	5.7	7.8
Size of repair area (as % of assembly sq. ft.)	4.1	12.9
Workforce:		
% in Teams	69.3	17.3
Job Rotation (0=none, 4=frequent)	3.0	.9
Suggestions/employee	61.6	.4
# of job classifications	11.9	67.1
Training of new workers (hours)	380.3	46.4
Absenteeism	5.0	11.7

SOURCE:
Title: THE MACHINE THAT CHANGED THE WORLD
Authors: James P. Womack, Daniel T. Jones, and Daniel Roos
ISBN: 0-89256-350-8







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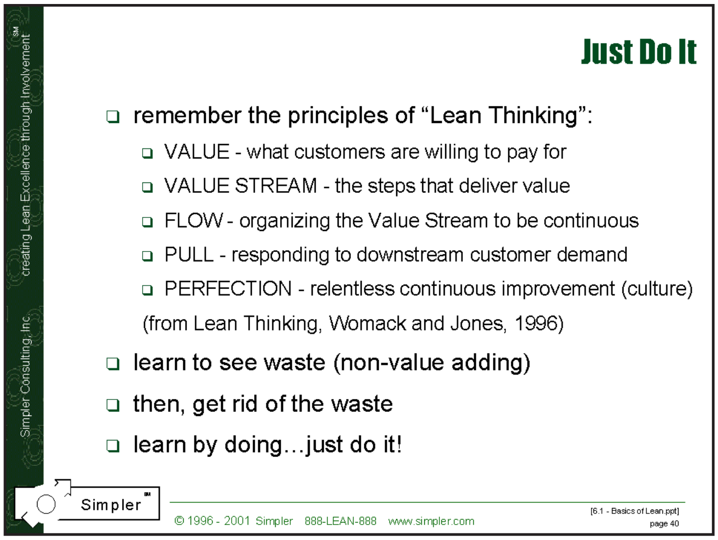
Cells need to be established before they can be improved. Cells create outstanding performance of the whole Value Stream. "Just-in-time" means producing what's needed, when it's needed, in the quantity needed. We think of this performance as:

> **On Demand, Defect-Free, One By One at the Lowest Cost**

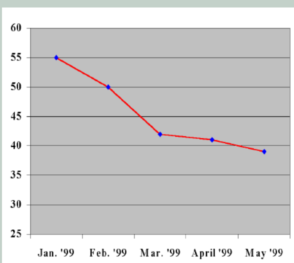
The middle circle of this diagram shows the four parts of establishing a cell. The outer two circles are the steps and tools involved in improving a cell. The following slides introduce these outer two circles.

CAUTION: Avoid applying the tools in the outer two circles before establishing a cell (doing what's in the middle circle). Don't think too much about the diagram above before satisfying the diagram on the left.

NOTE: All processes can become cells or parts of cells. Even single-machine processes can become single-machine cells… a single machine becomes a cell when it is run using Standard Work, has basic 6-S and has Pull Systems with its customers and suppliers. But... avoid creating single-machine cells when you should be creating better flow.



ACTUAL RESULTS



INVENTORY
days supply on hand

29% Reduction in 5 months!

Reflect back to the 5 key principles of Lean Thinking.

VALUE: Exactly what are customers willing to pay for? Who is the end-customer? What are they buying?

VALUE STREAM: ...is "everything that goes into" creating and delivering the "Value" to the end-customer.

FLOW: Flow challenges us to reorganize the Value Stream to be continuous… "one by one, non-stop".

PULL: Pull challenges us to only respond "on demand" to our downstream customers.

PERFECTION: Perfection challenges us to also create compelling quality ("defect free") while also reducing cost ("lowest cost").

Go out and start doing it! Use the tools to identify waste, and then be relentless about eliminating it!