Basic Concepts on lean manufacturing

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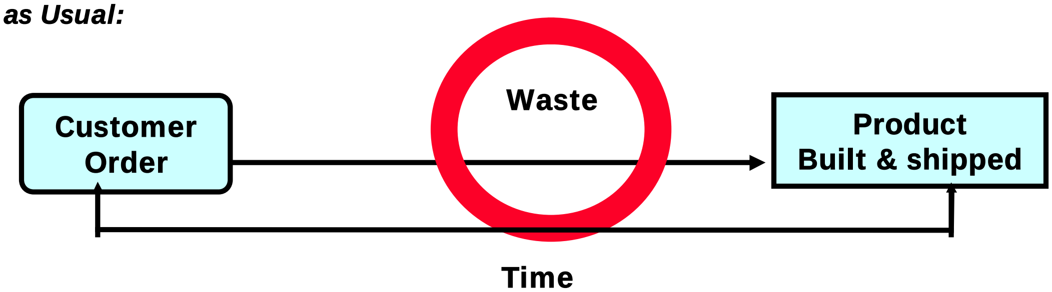
Part-1: Introduction to Lean Manufacturing

Definition of Lean Manufacturing:

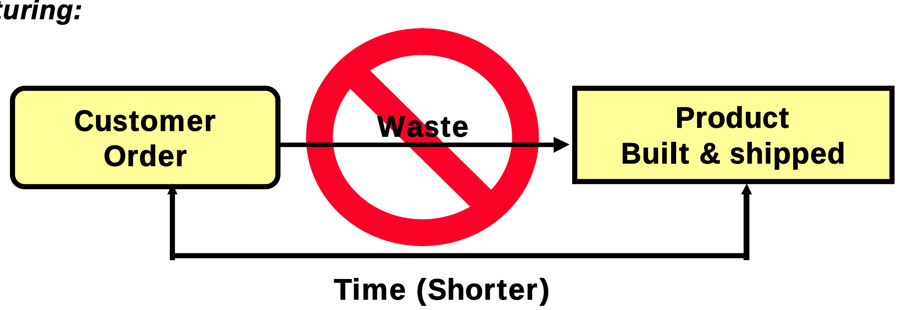
"A systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection."

The main benefits of lean manufacturing are lower production costs; increased output and shorter production lead times, higher flexibility.

Business as Usual:



Lean Manufacturing:



Historical Back Ground of Lean Manufacturing:

1860: The industrial revolution has begun.

1885: After 1885 the Henry Ford model of assembly line production caused a manufacturing transformation from individual craft production to mass production. Ford was able to transform iron ore into an automobile in just 33 hours.

1894: Sakichi Toyoda learned carpentry from his father and eventually applied that skill to designing and building wooden spinning machines. In 1894 he began to make manual looms that were cheaper but worked better than existing looms.

1918: Sakichi Toyoda establishes Toyota Spinning & Weaving Co., Ltd, later referred to as Japan's King of Inventors.

1925-1928: By 1925, and even though GM's cost always remained higher than Ford's, Sloan's strategy was working. He commented: "Ford's precious volume, upon which all depended, began slipping." Ford responded by cutting prices to the bone, to no avail: the fact was that even at this price, the Model T no longer provided an attractive value proposition to the customer, and by 1928 was driven from the market.

Ford made history of the horse and buggy, so too did GM's Alfred P. Sloan make history of the Model T. Ford made Model T-Car which was mass produced and was cheap. *Customer could get any color of model T as long as it was black*. Sloan repositioned the car companies to create a five-model product range from Chevrolet to Cadillac. The challenge in manufacturing during the 1930s shifted to product variety.

1926: As Sakichi found that his mother, grand mother & their friends had to so hard spinning & weaving. In 1926, He started Toyoda Automatic Loom Works with the help of steam engine.

1929: His mistake-proof loom (when thread breaks, the m/c stopped) became Toyoda's most popular model, and in 1929 he sent his son, Kiichiro, to England to negotiate the sale of the patent rights to Platt Brothers, the premier maker of spinning and weaving equipment. His son negotiated a price of $500,000 and in **1930** he used that capital to start building the Toyota Motor Corporation.

1933: Automobile Department is created within Toyoda Automatic Loom Works.

Sakichi Toyoda was undoubtedly aware that the world was changing and power looms would become yesterday's technology while automobiles were tomorrow's technology. But more than this, he had put his mark on the industrial world through loom making and wanted his son to have his opportunity to contribute to the world. He explained to Kiichiro:

"Everyone should tackle some great project at least once in their life. I devoted most of my life to inventing new kinds of looms. Now it is your turn. You should make an effort to complete something that will benefit society."

Kiichiro's father sent him to the prestigious Tokyo Imperial University to study mechanical engineering; he focused on engine technology. Despite his formal engineering education, he followed in his father's footsteps of **learning by doing.**

1935: First Model A1 passenger car prototype is completed through trial & error. (Over four five years in rural village, industrious almost illiterate pheasant, automotive factory develop, after few years first car rolled out)

Kichiro built Toyota Automotive Company on his father's philosophy and management approach, but added his own innovations. For example, while Sakichi Toyoda was the father of what would become the jidoka pillar of the Toyota Production System, Just-In-Time was Kiichiro Toyoda's contribution. His ideas were influenced by a study trip to Ford's plants in Michigan to see the automobile industry as well as seeing the U.S. supermarket system of replacing products on the shelves just in time as customers purchased them.

1937: Toyoda Automatic Loom Works is renamed as Toyota Motor Co., Ltd.

1950: As the 1950s began, demand for specialized products started to take hold. Not only were products more specialized, but they also had limited life cycles. Batch manufacturing methods had arrived! What is the optimum amount? How much is too much?

1950-1956: In the 1950s, American style supermarket appeared in Japan in Japan, intitiated new thinking & limited application. In 1956, Ohno visited America to learn first hand (genchi genbutsu) how supermarket operated.

Around the early **1960s,** as computing power began to be more cost effective, early pioneers began the development and installation of the early computer-based MRP systems. While an MRP system is a valuable weapon in the manufacturing arsenal, practitioners continue to grapple with the still conflicting objectives of batch manufacturing and optimizing inventories.

During the **1950s and 1960s** Toyota contended that the standard thinking of **Cost + Profit = Sales Price** was incorrect. It believed that **Profit = Sales Price – Costs**. From this premise, Toyota concentrated on the management of costs means wastes and wastes of all varieties were targeted for elimination.

Key areas targeted were **work-in-process inventory and safety stock**. While many companies in the United States and Europe were attempting to calculate the optimum batch sizes for production, Toyota worked toward the goal of being able to build a mix of products in a one-piece flow. Having the capability to build a mix of products in a one-piece flow (mixed-product Lean line) satisfied many key objectives for Toyota, raising productivity and reducing costs and inventory while simultaneously creating rapid customer response.

Through **the 1960s and into the 1970s**, these two models of manufacturing developed down separate paths. One sought better ways to manage batch production by making ongoing improvements to the MRP planning model, while the other concentrated on finding and fine-tuning ways to allow a one-piece flow of a mix of products

By the **1980's** Toyota had increasingly become known for the effectiveness with which it had implemented Just-In-Time (JIT) manufacturing systems. Many product markets in the United States and Europe started to come under pressure from Japanese manufacturers. Western manufacturers began to lose market share. Some manufacturers faded away while others began to look diligently for better ways to compete. Many abandoned the old batch manufacturing models in favor of the more responsive method of Toyota

1990: The term "Lean Manufacturing" or "Lean Production" first appeared in the book "*The Machine that Changed the World*" by Jams Womack.

At Present: Toyota has 52 plants in 27 countries having 2,90,000 manpower.

Value & Wastes:

"Never Surrender to Never-Ending Wastes"

In Lean Manufacturing, the **value** of a product is defined solely based on what the internal & external customer actually requires and is willing to pay for. Production operations can be grouped into following three types of activities:

Value-added activities are activities which transform the materials into the exact product that the customer requires.

Non value-added activities are activities which aren't required for transforming the materials into the product that the customer wants. Anything which is non-value-added may be defined as waste. Anything that adds unnecessary time, effort or cost is considered non value-added. Another way of looking at waste is that it is any material or activity for which the customer is not willing to pay. Testing or inspecting materials is also considered waste since this can be eliminated insofar as the production process can be improved to eliminate defects from occurring.

Incidental activities (necessary non value added work) : are activities that don't add value from the perspective of the customer but are necessary to produce the product unless the existing supply or production process is radically changed. This kind of waste may be eliminated in the long-run but is unlikely to be eliminated in the near-term. For example, high levels of inventory may be required as buffer stock, although this could be gradually reduced as production becomes more stable.

For Example:

In Cutting Section	**In Sewing Section** / **In Finishing Section**
Swatch Cut Transfer fabric to Spreading Table Fabric loading to spreader machine Movement of spreader m/c in forward direction Fabric spreading during backward direction Marker placement **Cutting** Transfer cut panels to sticker attaching table Sticker attaching Bundling Reject part replacement Transfer to sewing section **Only cutting is the value added activities others are non value added activities.**	**In Sewing Section** Matching, transfer garments from one m/c to another m/c, waiting for next processing, **sewing**, garments alter or reject, WIP **Alls are Non value added activities except sewing.** **In Finishing Section** Re-ironing, tag mistake, WIP in ironing-tag attachment-poly-folding. **In finishing section, ironing, tag attachment, folding, poly are value added activities others are non value added.**

Eight Deadly Wastes:

1. Overproduction:

Over-production is unnecessarily producing more than demanded or producing it too early before it is needed. This increases the risk of obsolescence, increases the risk of producing the wrong thing and increases the possibility of having to sell those items at a discount or discard them as scrap also causes overstaffing and storage and transportation costs because of excess inventory.

In Toyota, the fundamental waste is considered to be overproduction, since it causes most of the other wastes. Producing more than the customer wants by any operation in the manufacturing process necessarily leads to a build-up of inventory somewhere downstream.

Big buffers (inventory between processes) lead to other suboptimal behavior, like reducing your motivation to continuously improve your operations, problems will be hidden.

[Why worry about preventive maintenance on equipment when shutdowns do not immediately affect final assembly anyway? Why get overly concerned about a few quality errors when you can just toss out defective parts? Because by the time a defective piece works its way to the later operation where an operator tries to assemble that piece, there may be mix of bad parts in process and sitting in buffers.]

2. Waiting (time on hand):

Waiting is idle time for workers or machines due to next processing step, tool, supply, part, etc., or just plain having no work because of Stock outs, lot processing delays, equipment downtime, and capacity bottlenecks or inefficient production flow on the factory floor. Waiting also includes small delays between processing of units. Waiting results in a significant cost insofar as it increases labor costs and depreciation costs per unit of output.

3. Unnecessary transport or conveyance:

Transportation includes any movement of materials that does not add any value to the product, such as carrying work in process (WIP) long distances, creating inefficient transport, or moving materials, parts, or finished goods into or out of storage or between processes.

The idea is that transportation of materials between productions stages should aim for the ideal that the output of one process is immediately used as the input for the next process. Transportation between processing stages results in prolonging production cycle times, the inefficient use of labor and space and can also be a source of minor production stoppages.

4. Over processing or incorrect processing:
Correction, or reprocessing, is when something has to be re-done because it wasn't done correctly the first time. Taking unneeded steps to process the parts, inefficiently processing due to poor tool and product design, causing unnecessary motion and producing defects. Waste is generated when providing higher-quality products than is necessary.
This not only results in inefficient use of labor and equipment but the act of re-processing often causes disruptions to the smooth flow of production and therefore generates bottlenecks and stoppages. Also, issues associated with reworking typically consume a significant amount of management time and therefore add to factory overhead costs.

5. Excess inventory:
Inventory waste means having unnecessarily high levels of raw materials, works-in progress and finished products. Extra inventory leads to higher inventory financing costs, higher storage costs excess raw material, WIP, or finished goods causing longer lead times, obsolescence, damaged goods, transportation and storage costs, and delay. Also, extra inventory hides problems such as production imbalances, late deliveries from suppliers, defects, equipment downtime, and long setup times.

6. Unnecessary movement:
Motion includes any unnecessary physical motions or walking by workers which diverts them from actual processing work. For example, any wasted motion employees have to perform during the course of their work, such as looking for, reaching for, or stacking parts, tools, difficult physical movements due to poorly designed ergonomics, which slow down the workers. Also, walking is waste.

7. Defects:
Production of defective parts or correction, repair or rework, scrap, replacement production, errors in paperwork, provision of incorrect information about the product, late delivery, and inspection mean wasteful handling, time, and effort.

8. Unused employee creativity: Losing time, ideas, skills, improvements, and learning opportunities by not engaging or listening to your employees.

Part-2: Lean Related Topics

Economy of Scale:

Reduction in cost per unit resulting from increased production, realized through operational efficiencies. Economies of scale can be accomplished because as production increases, the cost of producing each additional unit falls.

Considering the economy of scale, we have to produce in batches as a result of over production, waiting occurs & lead time increases. For example: if distances between is long, it leaves us to transport at large lot which in turn will increase several wastes such as transportation, waiting, higher WIP etc.

Mass Production vs Lean Production:

Overall organizational characteristics:

	Traditional mass production	**Lean production**
Leadership	Leadership by executive command	Leadership by vision and broad participation
Organization	Hierarchical structures that encourage following orders and discourage the flow of vital information that highlights defects, operator errors, equipment abnormalities, and organizational deficiencies.	Flat structures that encourage initiative and encourage the flow of vital information that highlights defects, operator errors, equipment abnormalities, and organizational deficiencies.
Cultural	Culture of loyalty and obedience, subculture of alienation and labor strife	Harmonious culture of involvement based on long-term development of human resources
Production	Large-scale machines, functional layout, minimal skills, long production runs, massive inventories	Human-scale machines, cell-type layout, multi-skilling, one-piece flow, zero inventories
Operational capability	Dumb tools that assume an extreme division of labor, the following of orders, and no problem solving skills	Smart tools that assume standardized work, strength in problem identification, hypothesis generation, and experimentation
Maintenance	Maintenance by maintenance specialists	Equipment management by production, maintenance and engineering people

Manufacturing methods:

	Traditional mass production	**Lean producton**
Production schedules are based on…	Forecast — product is pushed through the facility	Customer Order — product is pulled through the facility
Products manufactured	Replenish finished goods inventory	Fill customer orders (immediate

to...		shipments)
Manufacturing lot size quantities are...	Large, with large batches moving between operations; product is sent ahead of each operation	Small, ideally based on one-piece flow between operations
Plant and equipment layout is...	By department function	By product flow, using cells or lines for product families
Quality is assured...	Through lot sampling	100% at the production source
Workers are typically assigned...	One person per machine	With one person handling several machines
Worker empowerment is...	Low — little input into how operation is performed	High — has responsibility for identifying and implementing improvements
Inventory levels are...	High — large warehouse of finished goods, and central storeroom for in-process staging	Low — small amounts between operations, ship often

EOQ & Changeover time:

EOQ:

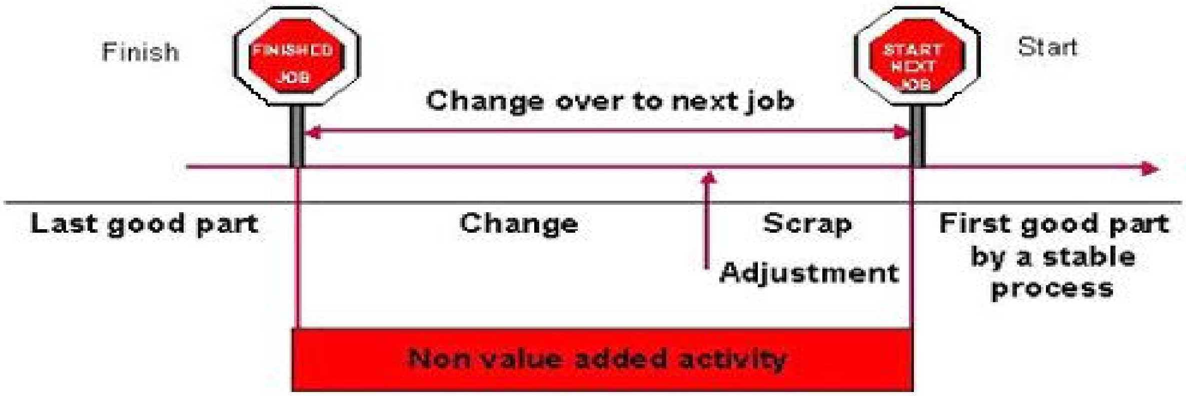
Economic Order Quantity (EOQ) is the quantity of parts manufactured that results in the lowest part cost while considering:

For a manufactured part, the considerations are:
1. The cost to manufacture the part
2. The cost for setup of the equipment
3. The cost for holding the part in stock, if all of the parts are not used immediately

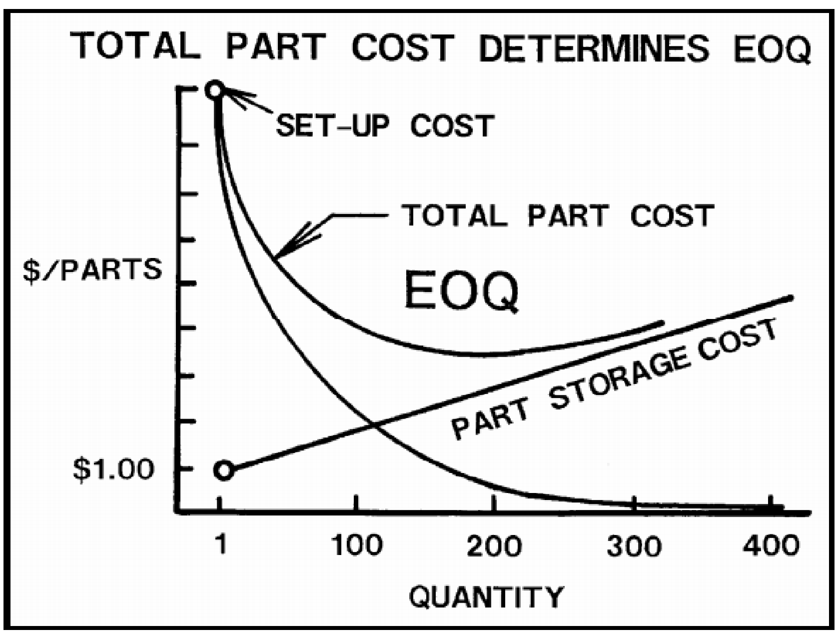
To determine the Economic Order Quantity (EOQ), it is required to know not only the part cost and setup cost, but also the manufacturing rate, annual demand for the part, and the cost for holding the part in stock on an annual basis. There are only two ways to reduce the EOQ. Either the cost of storage or the cost of setup must be reduced. If the cost of setup equals zero, the EOQ becomes one.

Changeover Time:

Elapsed time between the last good piece from previous product, and the first good piece from next product at the right speed.



Lean Manufacturing aims to reduce unnecessary downtime due to machine setup or product changeovers since machine downtime is a significant source of unnecessary waste. This requires a culture of continuous improvement in which the company is continuously trying to find ways to reduce changeover and setup times. Often quicker changeover times can be achieved to some degree by having very standardized (and well-documented) configuration settings for the production of particular products so that there is no uncertainty about how to reconfigure the equipment during a changeover. Companies with a wide range of product mix, color and specifications often underestimate the conversion cost every time the production process is halted to replace molds, clean leftover materials with a different color or specification, adjust machine settings, etc.
Other ways to minimize the changeover/setup time include changing the physical layout of a process, having all materials and tools needed available, and using dual/spare storage bin to eliminate cleaning downtime.



JIT:

Just-in-time (JIT): JIT is an approach with the objective of producing the right thing (training, information, material) part in the right place at the right time (in other words, “just in time”). Right Thing means with right quantity and right quality. JIT should improve profits and return on investment by reducing inventory levels (increasing the inventory turnover rate), reducing variability, improving product quality, reducing production and delivery lead times, and reducing other costs (such as those associated with machine setup and equipment breakdown) focusing on long time perspectives. Toyota uses multipurpose machineries and multi skilled employees to support Just in time philosophy.

Respect for People:

Toyota made respect for people one of the pillars of the Toyota Way. Employees should be treated fairly, given clear goals, trusted to achieve them in the best way, and held to account for results. Employees are made believed that every people have thinking capability & capability of solving problem. Toyota never chooses a way that is risk for human safety.

The best Toyota managers were asked how they show respect for people. The as follows:

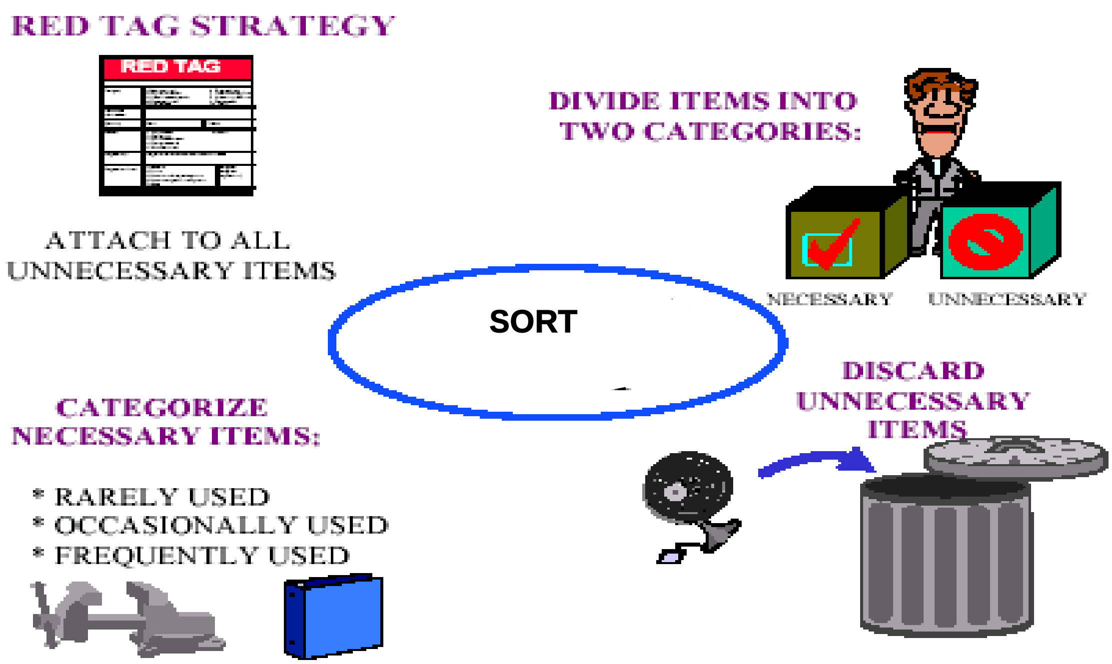
- Managers begin by asking employees what the problem is with the way their work is currently being done. Next they challenge the employees' answer and enter into a dialogue about what the real problem is.
- Then they ask what is causing this problem and enter into another dialogue about its root causes.
- Then they ask what should be done about the problem and ask employees why they have proposed one solution instead of another.
- Then they ask how they – manager and employees – will know when the problem has been solved, and engage one more time in dialogue on the best indicator.
- Finally, after agreement is reached on the most appropriate measure of success, the employees set out to implement the solution.

Part-3: Lean Tools & Techniques

5S:

The Five S's are some rules for workplace organization which aim to organize each worker's work area for maximum efficiency.

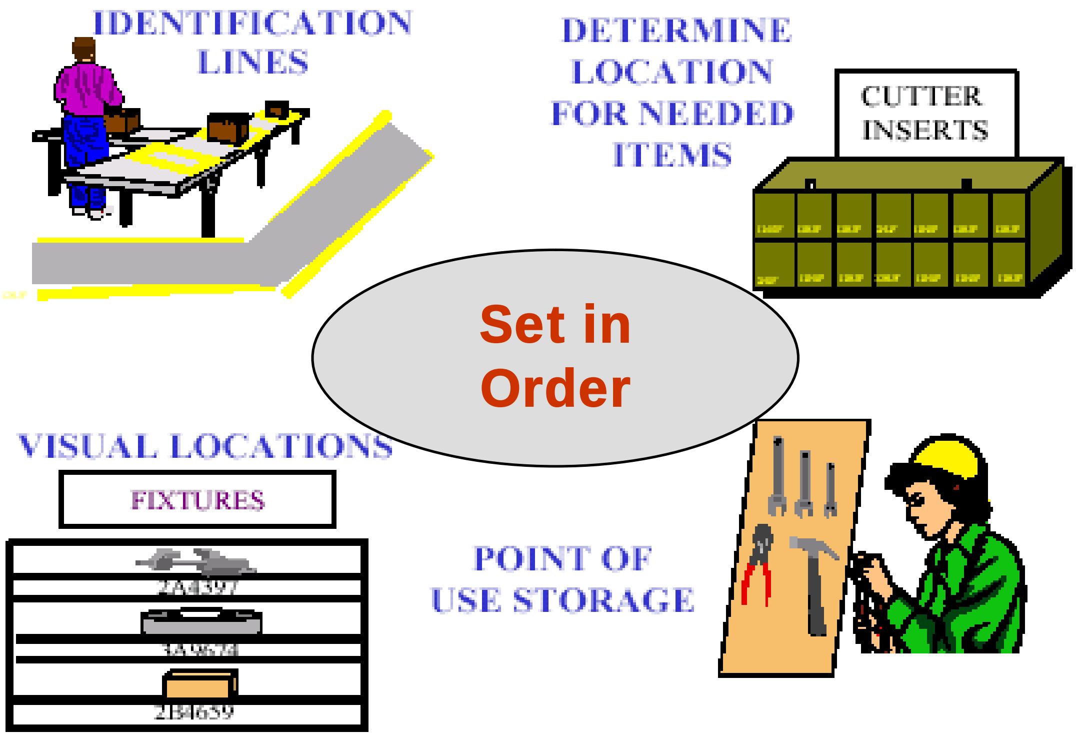
1. Sort – Sort what is needed and what is not needed so that the things that are frequently needed are available nearby and as easy to find as possible. Things which are less often used or not needed should be relocated or discarded.
An effective visual method to identify these unneeded items is called "red tagging", which involves evaluating the necessity of each item in a work area & dealing with it appropriately. A red tag is placed on all items that are not important for operations or that is not in the proper location or quantity.



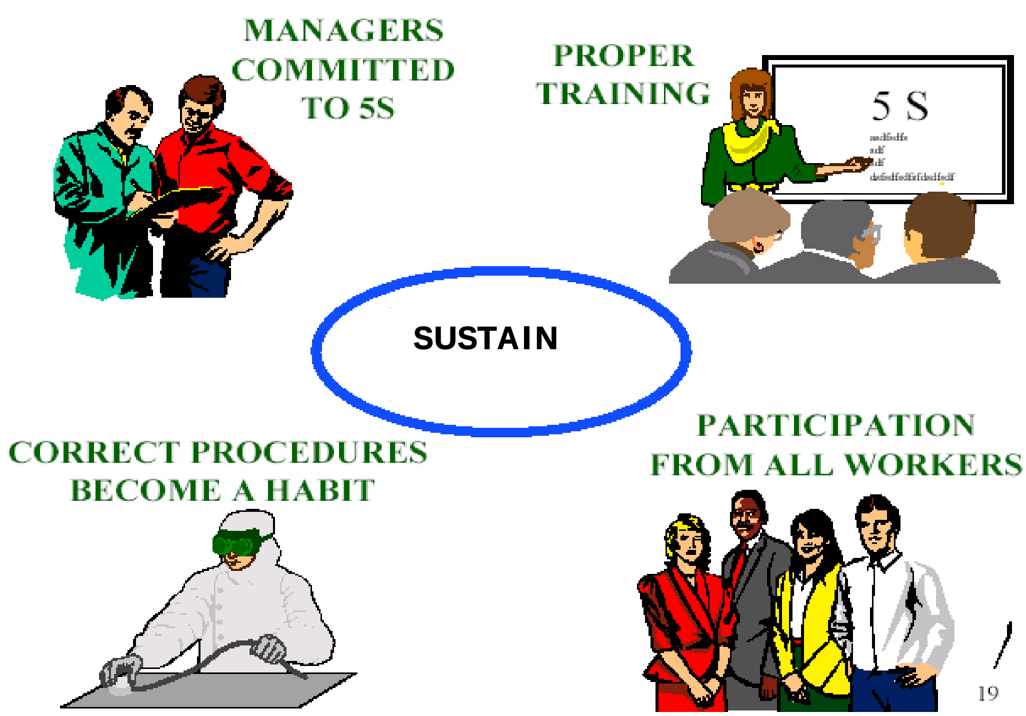
2. Set in t
of motion required in order for workers to do their jobs. For example, a tool box can be used by an operator or a maintenance staff who must use various tools. In the tool box, every tool is placed at a fixed spot that the user can quickly pick it up without spending time looking for it. This way of arrangement can also help the user be immediately aware of any missing tools.

3. Shine: Keep machines and work areas clean so as to eliminate problems associated with un-cleanliness. In some industries, airborne dust is among the causes of poor product surface or color contamination. To be more aware of dust, some companies paint their working places in light colors and use a high level of lighting.

4. Standardize: Make the first 3S's a routine practice by implementing clear procedures for sorting, straightening and scrubbing.



5. Sustain – Promote, communicate and train in the 5 S's to ensure that it is part of the company's corporate culture. This might include assigning a team to be responsible for supervising compliance with the 5 S's.



The Benefits of 5S:

- Improves safety
- Better working environment

- 5S can significantly improve space utilization space
- Easy retrieval of material, information, tools etc.
- Reduce quality problems
- Lower costs
- Increased customer satisfaction and
- Discipline in workplace etc.

Visual Management:

Visual Management systems enable factory workers or anyone interested to be well informed about production procedures, status and other important information for them to do their jobs as effectively as possible. Large visual displays are generally much more effective means of communication to workers on the factory floor than written reports and guidelines and therefore should be used as much as possible. When it comes to improving compliance with a process, visual presentation helps the team better understand a complicated process including the correct sequence of events, the correct way to perform each action, internal and external relationships between actions, and other factors which may help them to improve. These visual tools may include the following:

1. **Visual Displays** - Charts, metrics, procedures and process documentation which are reference information for production workers. For example, trend chart of yield performance, % variation of defect rate, month-to-date shipping volume status, etc.

2. **Visual Controls** – Indicators intended to control or signal actions to group members. This may include production status information, quality tracking information, etc. For example, color-coded panel for temperature or speed setting control limits that help an operator quickly identify process is out of the control range. Kanban cards are another example of visual controls. Lines on the floor to delineate storage areas, walkways, work areas etc, Lights to indicate production status.

3. **Visual process indicators** – These communicate the correct production processes or flow of materials. For example, this would include the use of painted floor areas for non-defective stock and scrap or indicators for the correct flow of materials on the factory floor.

Visual Workplace Supports the "Eight Zeros"

- Zero waste
- Zero defects
- Zero downtime
- Zero customer complaints
- Zero injuries
- Zero delays
- Zero loss
- Zero changeovers

Standardization:

Standard work (also called "standardized work" or "standard process") means that production processes and guidelines are very clearly defined and communicated, in a high level of detail, so as to eliminate variation and incorrect assumptions in the way that work is performed. The goal is that production operations should be performed the same way every time, except insofar as the production process is intentionally modified. When production procedures are not highly standardized, workers may have different ideas of what the correct operating procedure are and easily make incorrect assumptions. **Standardization is the basis for continuous improvement and employee empowerment.**

A high level of process standardization also makes it easier for the company to expand capacity without disruption. In Lean Manufacturing, standard work has several main elements:

1. **Standard work sequence** - This is the order in which a worker must perform tasks, including motions and processes. This is clearly specified to ensure that all workers perform the tasks in the most similar & economical ways possible so as to minimize variation and therefore defects. Ideally this is so detailed as to clearly describe every single hand movement by a worker. For example, in wood cutting, the standard work sequence would describe every specific cut and operating step from machine setup to materials handling, cutter adjustment, manual movements and processing time. In an assembly process, it would describe the exact sequential step-by step motions by which the item is assembled.

2. **Standard timing** – Takt time is the frequency with which a single piece is produced. Takt time is used to clearly specify and monitor the rate at which a process should be occurring at various production stages. For lean manufacturers, the Takt time of each production process is actively managed and monitored so that a continuous flow can occur.

3. **Standard in-process inventory** – This is the limit of maximum unit of materials, consisting primarily of units undergoing processing, which are required to keep a cell or process moving at the desired rate. This should be clearly determined since it is necessary to maintain a minimum amount of in process inventory in order to not cause unnecessary downtime.

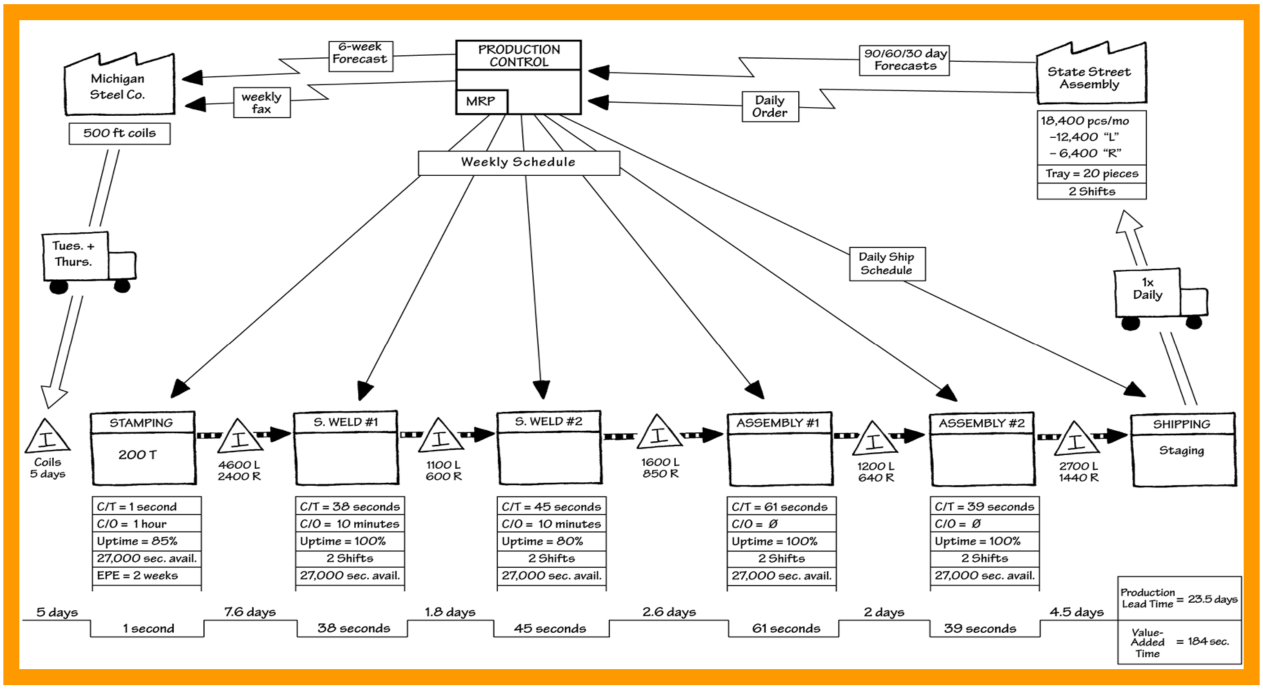
“Pursuing perfection requires great discipline—create a standard, follow it, and find a better way”

Introduction to VSM:

Value stream mapping (VSM) is the visual representation or documentation of the flow of information material, and/or people from receipt of customer order to delivery of finished product. It can be applied in manufacturing industries as well as service industries.

The objective of value stream mapping is to identify value-added activities and non value-added activities. Value stream maps should reflect what actually happens rather than what is supposed to happen so that opportunities for improvement can be identified. Value Stream Mapping is often used in process cycle-time improvement projects since it demonstrates exactly how a process operates with detailed timing of step-by-step activities. It is also used for process analysis and improvement by identifying and eliminating time spent on non value-added activities.

Example:



Problem & Root Cause: A problem can be defined as the difference between things as perceived and things as desired.

"What is" vs. "what should be"

Problems should not necessarily be regarded as negative rather an opportunity for improvement. Problems give us a chance to use our brain & solve it forever.

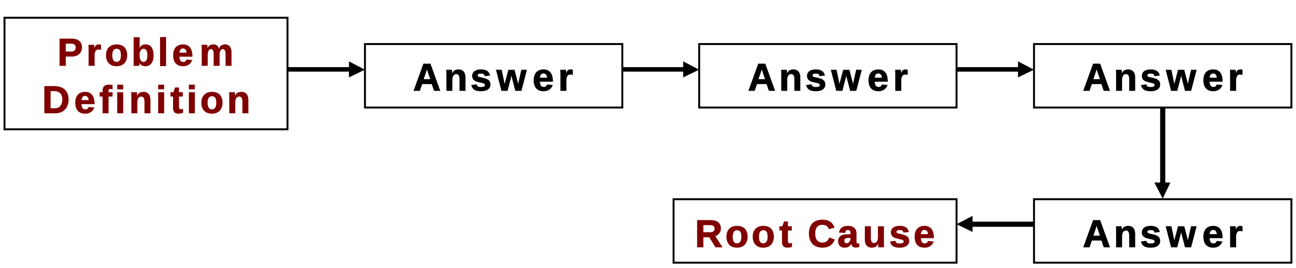
Mr. John Gardner describes problems are ***"marvelous opportunities brilliantly disguised as insolvable problems"***.

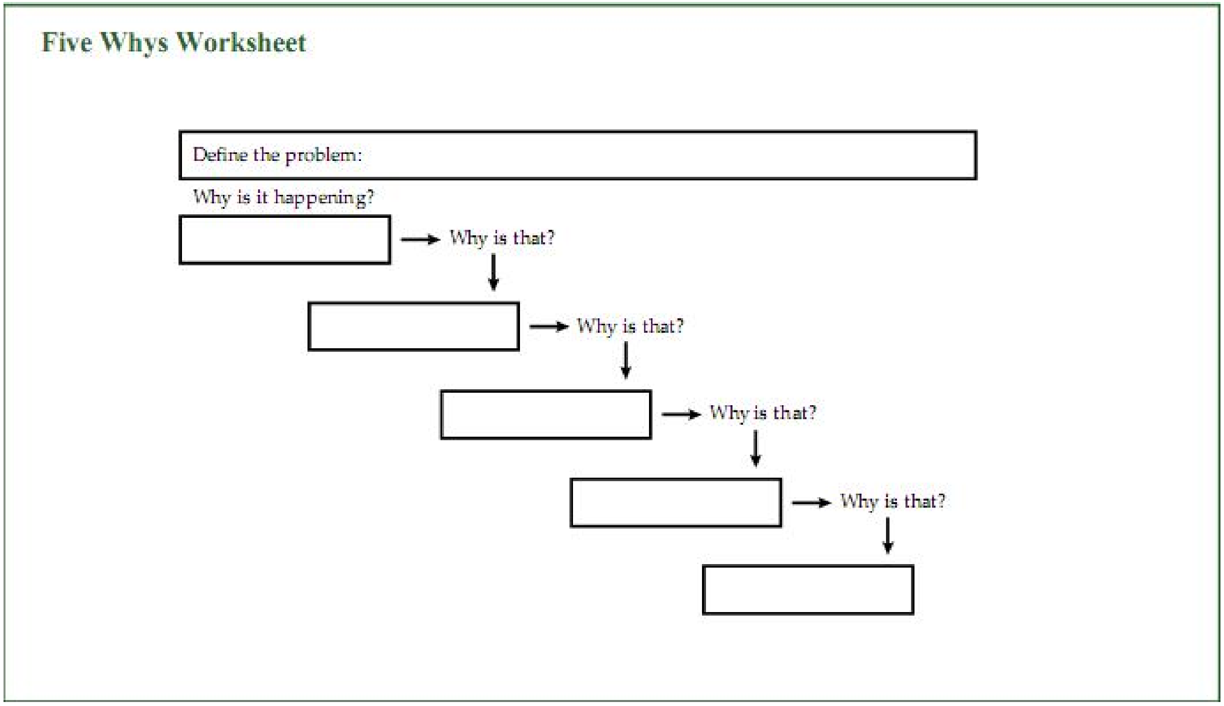
The simple idea is to keep asking "Why" (usually five times) to ensure that the root cause(s) to the effects are fully understood. The reasoning is that the result of each time the Why is asked gives a different answer, in essence peeling back the onion as follows:

- First Why -Symptom
- Second Why -Excuse
- Third Why- Blame
- Fourth Why- Cause
- Fifth Why -Root Cause

Understand the root causes—the problem behind the problem.

Root cause analysis is a systematic way of uncovering the root, or underlying, cause of an identified problem or a symptom of a problem. To solve a complex problem, we have to break it down into different causes and then ask 5 why's.





Tip:
The 5 Whys technique is a simple technique that can help you quickly get to the root of a problem. But that is all it is, and the more complex things get, the more likely it is to lead you down a false trail. if it doesn't quickly give you an answer that's obviously right, then you may need more sophisticated technique problem solving techniques like those found in our problem solving section.

General Motors uses a "Drill Deep and Wide" method. There are 3 separate 5Ys for Predict, Prevent & Protect. This can help split up issues where you really have more than one problem. For example a defect is passed onto the customer, so you have 2 major issues here, Why was the defect made, and Why was it passed onto the customer.

Example-1: Let's take a look at a slightly more humorous example modified from Marc R.'s posting of 5 Whys in the iSixSigma Dictionary.

Problem Statement: You are on your way home from work and your car stops in the middle of the road.

1. Why did your car stop?
   - Because it ran out of gas.
2. Why did it run out of gas?
   - Because I didn't buy any gas on my way to work.

3. Why didn't you buy any gas this morning?
   - Because I didn't have any money.

4. Why didn't you have any money?
 - Because I lost it all last night in a poker game.

5. Why did you lose your money in last night's poker game?
 - Because I'm not very good at "bluffing" when I don't have a good hand.

What should we do? What is the root cause? It depends on your belief.

Example-2:
A simple fictitious example demonstrates use of the tool well. A problem in London's Trafalgar Square is that Nelson's Column requires frequent, expensive repairs.

First Why: Why does the column need frequent, expensive repairs?

Answer: Frequent washing is damaging the stone.

Obvious solutions in this case include investing in less abrasive cleaning mechanisms and perhaps different detergents. However, this still doesn't reduce the frequency of washing.

Second Why: Why does it need to be washed so much?

Answer: There is a build up of pigeon droppings.

Pigeons are a popular sight in Trafalgar Square and obvious solutions in this case might include investing in a pigeon-scaring device or placing devices to stop pigeons landing on the column. Unfortunately pigeons are arguably part of the tourist attraction itself, so this could be difficult to implement.

Third Why: Why are the pigeons gathering on top of the column?

Answer: The pigeons eat the spiders on the column.

Obvious solutions might include spraying the column regularly with pesticide to kill the spiders. The use of pesticides is frowned upon at the best of times in a highly populated area, but on such a visible landmark there could be major opposition. Also, the impact of the pesticide on the stone itself would have to be examined.

Fourth Why: Why are there spiders on the column?

Answer: The spiders eat the insects on the column.

The solution to the third Why still seems to work. The pesticide would kill both the spiders and the insects.

Fifth Why: Why are the insects there?

Answer: They are attracted to the brightly lit surface in the evening.

Proposed solution: Delay turning on the lights for 30 minutes and they are attracted elsewhere.

“A right solution is one in which the optimal outcome is achieved with the minimal expenditure of effort and expense.”

Effective problem-solving is possible only if there is a fundamental corporate openness, honesty, trust and collective and individual willingness to learn from errors.

As it is difficult to quantify how good a potential countermeasure or solution is going to be prior to implementation, there is a method of gauging the capability of proposed countermeasures that will help in putting a rigor test around propositions for change. The methods are:

Issue/Problem	Countermeasure	Best Result
Productivity	Increase	Zero Muda
Cycle time	Decrease	Zero Cycle time
Quality	Increase	100% Quality
Control/Consistency	Increase	Zero Variations

Genchi Genbutsu:

(Go and See) Genchi genbutsu is a central Toyota Way principle that means the actual place, the actual part. The principle is to go and see the actual place and understand the real situation through direct observation.

“Go and see for yourself to thoroughly understand the situation.”

You cannot solve problems and improve unless you fully understand the actual situation—which means going to the source, observing, and deeply analyzing what is going on, or genchi genbutsu. Do not solve the problem remotely by theorizing only on the basis of reported data or looking at computer screens. If you are responsible for a problem and make recommendations on possible solutions, you might be asked whether you went and looked at the situation yourself in person. If the answer is, “No, but I saw the reports,” you better be prepared for an assignment to go and see for yourself. There is a basic belief in Toyota that people solving problems and making decisions need to have a deep understanding that can only come from personally verified data: seeing for yourself. Even high-level managers and executives should go and see for themselves as much as possible. Summarizing reports by subordinates when you yourself have only a superficial understanding is not acceptable in the Toyota culture.

Kaizen:

One Million Ideas

That’s how many ideas Toyota implements each year. Do the math: 3000 ideas a day. That number, more than anything else, explains why Toyota appears to be in a league all their own, playing offense on a field of innovation, while their competitors remain caught in a crossfire of cost-cutting.

Here’s the thing: it’s not about the cars. It’s about ideas. And the people with those ideas. But not just any ideas. Mostly tiny ones, but effective ones nonetheless—elegant solutions to real world problems. Not grand slam homeruns, but groundball singles implemented all across the company by associates that view their role not to be simply doing the work, but taking it to the next level…every day, in some little way. **Good enough never is. When an entire organization thinks like that, it becomes unstoppable.**

Kaizen is a Japanese term for “continuous improvement”, with an emphasis on small incremental improvements. A main theme of Kaizen is to create a culture of continuous improvement, largely by assigning responsibility to workers, and encouraging them, to identify opportunities for improvement.

A company can never be perfectly efficient. Lean Manufacturing requires a commitment to continuous improvement, and preferably a systematic process for ensuring continuous improvement, whereby the company constantly searches for non value-added activities and ways to eliminate those. The focus of continuous improvement should be on identifying the root causes of non value-added activities and eliminating those by improving the production process.

Two main opportunities for improvement are:

1. The elimination of Muda (waste) from processes

2. The correction of any issues/problems within processes in addition to Muda

The relevance of Muda is that it both directly causes problems and also hides or disguises other issues or problems that are occurring within a process. It is therefore **the most important element to eliminate from a process.**

“Let Failure be your Teacher”

Worker Involvement:

In Lean Manufacturing, workers are assigned clear responsibility to identify sources of non value-added activities and to propose solutions to those. Lean Manufacturers typically believe that the majority of useful ideas for eliminating non value-added activities typically originate with workers involved in those processes.

In order to ensure that ideas for eliminating non value-added activities are acted upon, the power to decide on changes to the production processes are pushed down to the lowest level possible (i.e. normal workers) but any such changes are required to meet certain requirements. For example, at Toyota workers are encouraged to implement improvements to the production processes but the improvement must have a clear logic which is in accordance with the scientific method, the improvement must be implemented under the supervision of an authorized manager and the new process must be documented in a high level of detail covering content, sequence, timing and outcome.

Kaizen event will be carried out mainly in two cases:

1. Reduce or eliminate wastes
2. Any other problem/issue other than waste which will improve cost, quality, lead time, and or flexibility.

Toyota initially implements the proposed changes on a small scale on a trial basis and if the improvement is effective, Toyota will implement the change across its manufacturing operations. Two common ways to encourage worker involvement in the continuous improvement process are:

1. Kaizen Circles:

One way of increasing the levels of worker involvement is to implement Kaizen Circles in which groups of 6-8 workers are formed to generate ideas for solving particular problems. Typically a Kaizen Circle will meet for around one hour per week for 6-8 weeks and at the end of that period will present some proposals to their managers on how to solve particular problems. Active involvement/support by managers is critical to the success of Kaizen Circles.

2. Suggestion Programs:

Another way of increasing worker involvement is having an active suggestion program where people are strongly encouraged to make suggestions and rewarded for suggestions that are successfully implemented. Often the cost of the reward is quire small relative to the value that is created for the company by implementing the improvement.

Some experts in lean manufacturing maintain that high levels of worker involvement in continuously suggesting improvements is a critical success factor in the implementation of lean and is the key thing which differentiates Toyota from other companies in terms of its success at implementing lean manufacturing principles.