


# Principles of Lean Thinking

## Tools & Techniques for Advanced Manufacturing

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# Background of Lean Thinking

**Lean Thinking** is a highly evolved method of managing an organization to improve the productivity, efficiency and quality of its products or services. Japanese and American management specialists developed the ideas and methods over the latter half of the last century. These management techniques have been employed both in the aerospace industry (Boeing) and in the auto sector (Toyota). In the manufacturing sector, the concept is sometimes referred to as World Class manufacturing or High Performance Manufacturing. Lean Thinking is best illustrated by using the manufacturing example.

**Lean Manufacturing** is derived from the methods of the successful Japanese automobile manufacturer, Toyota. Lean Manufacturing became internationally recognized as a result of the book, *The Machine That Changed The World*, by James Womack and Dan Jones. The focus at Toyota, according to Taiichi Ohno, was “the absolute elimination of waste,” where waste is anything that prevents the value-added flow of material from raw material to finished goods. A firm’s customers are the final judges as to whether or not the firm has created value. The Lean approach leads its practitioners to improve their organizations by focusing on the elimination of any and all *waste*. Lean focuses on improvement and advocates techniques to control the flow of material on the shop floor. As companies implemented Lean in North America, there were many variations of the same theme, but a number of principles were generally agreed upon.

1. The batch-and-queue mode of operation, which encourages large-batch processing and focuses on the efficiency of individual machines and workers, was an outdated model.
2. Lean manufacturing, which views continuous, one-piece flow as the idea, and emphasizes optimizing and integrating systems of people, machines, materials, and facilities, can lead to significant improvements in quality, cost, on-time delivery, and performance.
3. Lean manufacturing is fundamental transformation of an enterprise and needs to be approached as a total organizational and cultural transformation.

Lean tools in manufacturing, such as Value Stream Mapping, Quick Changeover/Setup Reduction, Single Minutes Exchange of Dies (SMED), Kaizen, Cellular/Flow Manufacturing, Visual Workplace/5S Good Housekeeping, Total Productive Maintenance (TPM), and Pull/Kanban Systems, are used to produce change. Companies and organizations employing these lean tools report significant gains in productivity and overall effectiveness within their specific entities.

**Lean Manufacturing** “uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing floor space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also it requires keeping far less than half the needed

inventory on site (and) results in ... fewer defects ...” This is accomplished through: Teamwork, Communication, Efficient Use of Resources & Continuous Improvement.

**Lean Enterprises** work to precisely define value in terms of specific products with identified capabilities offered at set prices through a dialogue with their customers. The process involves learning to adopt and employ a series of tools and techniques to achieve incremental improvements in an organization. Above all, Lean Thinking methods are inclusive of all employees and involve a major change in the embedded attitudes of the individuals that make up the organizations.

“**LEAN IS...** A mindset, or way of thinking, with a commitment to achieve a totally waste-free operation that’s focused on your customer’s success....It is achieved by simplifying and continuously improving all processes and relationships in an environment of trust, respect and full employee involvement....It is about people, simplicity, flow, visibility, partnerships and true value as perceived by the customer.” Ref: David Hogg, High Performance Solutions.

“**LEAN IS – from an operations perspective...** Lean production cuts costs & inventories rapidly to free cash, which is critical in a slow economy. It also supports growth by improving productivity and quality, reducing lead times and freeing huge amounts of resources.

For example: Lean production frees office and plant space, and can increase capacity, enabling companies to add product lines, in-source component production and increase output of existing products, without acquiring new facilities. Companies implementing Lean will now be able to take advantage of renewed growth by increasing sales without increasing costs.”

#### **Additional Resources:**

- ***Becoming lean : inside stories of U.S. manufacturers*** / Jeffrey K. Liker, editor. Portland, Or. : Productivity Press, c1997.
- ***An Introduction to Lean Manufacturing*** [videorecording]. Dearborn, MI : Society of Manufacturing Engineers, 2000.
- ***The Lean company : making the right choices*** / James A. Jordan, Jr., Frederick J. Michel. Dearborn, MI : Society of Manufacturing Engineers 2001.
- ***Lean thinking : banish waste and create wealth in your corporation*** / New York Simon & Schuster c1996.
- ***Lean thinking : banish waste and create wealth in your corporation*** / James P. Womack. - **Revised and updated.** New York : Free Pr Simon & Schuster c2003.
- ***The Lean toolbox*** / by John Bicheno. 2nd ed. Buckingham : PICSIE Books, 2000. HD 31 .B48 2000
- ***The Machine that changed the world : how Japan's secret weapon in the global auto wars will revolutionize western industry*** / James P. Womack, Daniel T. Jones, Daniel Roos. New York, NY : Harper Perennial, 1991.

# The Principles of Lean Thinking

**Achieving the Lean Enterprise requires a departure from traditional thinking. Lean Enterprise thinkers will:**

1. *Define value precisely from the perspective of the end customer, in terms of a specific product, with specific capabilities, offered at a specific price and time.*

As Taiichi Ohno, one of the creators of the Toyota Production system put it, all industrial thinking must begin by differentiating value for the customer, from muda – the Japanese term for waste.

2. *Identify the entire value stream for each service, product or product family and eliminate waste.*

The value stream is all the specific actions required to bring a specific service or product through three critical activities in any business:

Product/Service definition – from concept through detailed planning through launch

Information management – from order taking through detailed scheduling to delivery

Physical transformation – initial concept, to the receipt of the service/product by the customer

Identifying the value stream almost always exposes enormous amounts of waste in the form of unnecessary steps, backtracking, and scrap, as the throughput travels from department to department and from company to company.

3. *Make the remaining value-creating steps flow.*

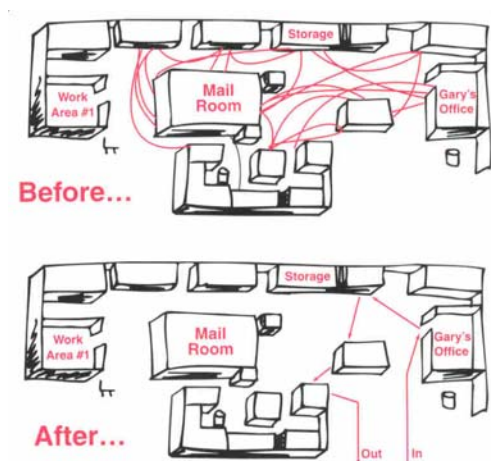
Making steps flow means working on each design, order, and product continuously from beginning to end so that there is no waiting, downtime, or waste, within or between the steps. This usually requires introducing new types of organizations or technologies and getting rid of “monuments” – obstructions whose large scale or complex technology necessitates operating in a batch mode.

4. *Design and provide what the customer wants only when the customer wants it.*

Letting the customer pull the product/service from the value stream eliminates the following types of waste: designs that are obsolete before the product is completed, finished goods, inventories, elaborate inventory/information tracking systems, and “left overs” no one wants.

5. *Pursue perfection.*

A lean thinking enterprise sets their sights on perfection. The idea of total quality management is to systematically and continuously remove the root causes of poor quality – with the ultimate goal of achieving Zero defects.



### **Additional Resources:**

- ***All I need to know about manufacturing I learned in Joe's garage : world class manufacturing made simple*** / William B. Miller, Vicki L. Schenk. Walnut Creek, Calif. : Bayrock Press, c2000.
- ***Becoming lean : inside stories of U.S. manufacturers*** / Jeffrey K. Liker, editor. Portland, Or. : Productivity Press, c1997.
- ***Lean thinking : banish waste and create wealth in your corporation*** / New York : Simon & Schuster c1996.
- ***Lean thinking : banish waste and create wealth in your corporation*** / James P. Womack. - Revised and updated. New York : Free Pr Simon & Schuster c2003.
- ***The Machine that changed the world : how Japan's secret weapon in the global auto wars will revolutionize western industry*** / James P. Womack, Daniel T. Jones, Daniel Roos. New York, NY : Harper Perennial, 1991.
- ***Value stream management for the lean office : 8 steps to planning, mapping, and sustaining lean improvements in administrative areas*** / Don Tapping and Tom Shuker. New York : Productivity Press, c2002.
- ***World class manufacturing : the lessons of simplicity applied*** / Richard J. Schonberger. New York : Free Press, 1986

# Mapping the Value Stream

Value stream mapping is said to be the first item in your Lean Tool Kit -- the first step in creating your company's lean strategy. The "value stream" (VS) refers to ALL the activities and processes in your company – everything that you must do to design, order, produce and deliver your products.

Womack and Jones (Lean Thinking, 1996) visualize the value stream as this: raw materials along with knowledge and information enter the system upstream (the suppliers); and, products or services of value flow out from the system downstream (the customers). The individual processes that take place in between are those that add value to the product or service as it flows through them. It is a simple but powerful model. If an activity or process does not add value, it is eliminated.

The value stream map, developed at Toyota, is a tool that:

- Allows you to diagram your current value stream;
- Identifies the bottlenecks that prevent you from making what your customers want, when they want it;
- Develops a vision of what your future lean system should look like.

Value stream mapping gives you the "**Aha!**" feeling – things become obvious.

Mass production thinking causes people to focus on optimizing pieces of the system instead of looking at the whole value stream. Why is it important to change? With a VS vision, you will know **WHY** you need to improve, what you need to improve, by seeing the whole – a significant leap up from a simple process flow chart. Process maps or charts are not the same as VS mapping because they do not show you the **WHY**.

## Easy Steps to Mapping the Value Stream:

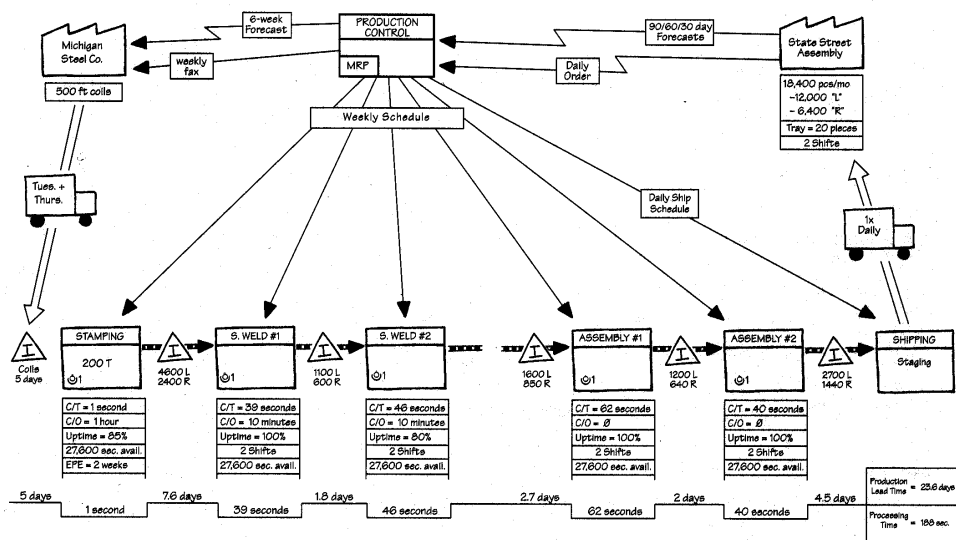
1. Select the product or product family you want to map. You may want to begin with your biggest customer and select the product you deliver to them.
2. Draw the current state value stream map.
3. Draw the future state value stream map.
4. Implement the action plan.

*"Whenever there is a product for a customer, there is a value stream. The challenge lies in seeing it."*

Mike Rother & John Shook, *Learning to See*

**The key is to eliminate the non-value-added waste in the value stream.**

## Value Stream Map (from *Learning to See*, Rother and Shook)



### Additional Resources:

- **Creating continuous flow : an action guide for managers, engineers and production associates** / by Mike Rother and Rick Harris. Brookline, MA: The Lean Enterprise Institute 2001.
- **Creating mixed model value streams : practical lean techniques for building to demand** / by Kevin J. Duggan. New York : Productivity Press, 2002.
- **Lean manufacturing : a plant floor guide** / edited by John Allen, Charles Robinson, David Stewart Dearborn, MI : Society of Manufacturing Engineers 2001.
- **Lean production simplified : the nuts and bolts of making assembly operations flow** / by Pascal Dennis.
- **Learning to see : value stream mapping to create value and eliminate muda** / by Mike Rother and John Shook. Brookline, Mass. : Lean Enterprise Institute [1999], c1998.
- **Mapping your value stream** [videorecording]. Dearborn, Mich. : Society of Manufacturing Engineers, 2001.
- **Seeing the whole : mapping extended value stream** / by Dan Jones and Jim Womack; foreword by John Shook Version 1.0 Brookline, Mass. Lean Enterprise Institute 2002.
- **Value stream management for the lean office : 8 steps to planning, mapping, and sustaining lean improvements in administrative areas** / Don Tapping and Tom Shuker. New York : Productivity Press, c2002.



# What is Lean Manufacturing?

More recently the focus of many companies has been on Lean Manufacturing, which strives for simplicity. The essential principles of Lean manufacturing are “Define Value” as seen through the eyes of the customer and then, “Eliminate Waste to Make Value Flow.” The processes left standing after testing against these principles are simple and cost effective.

## Define Value

So, with customers demanding more variety and more features in less time, how do we create simple processes? The key to success comes through understanding what features are a built-in that the customer doesn't need or want in their own “use environment.”

Easier said than done? – not if you work closely with the customer during the design process, establish a 2-way information flow and ensure that prototypes are tested under “actual use” conditions.

## Identify Waste

Having discovered the customer's definition of Value, we then need to look at the existing processes and uncover the waste. The best way to identify waste is to collect the data and “map” the current process.

But, if we have a complex mix with many products, and many operations, how can we first simplify?



## Find the Common Elements

What are the product families that will simplify the process view? Families may be defined by grouping products with similar size, shape, materials or parts.

The question to ask is “What criteria lead to a grouping by common process flow?” In recognizing those key elements, we can then create a product-process matrix that shows which products flow through which operations. The families that represent 80% of the mix will form the basis of the map.

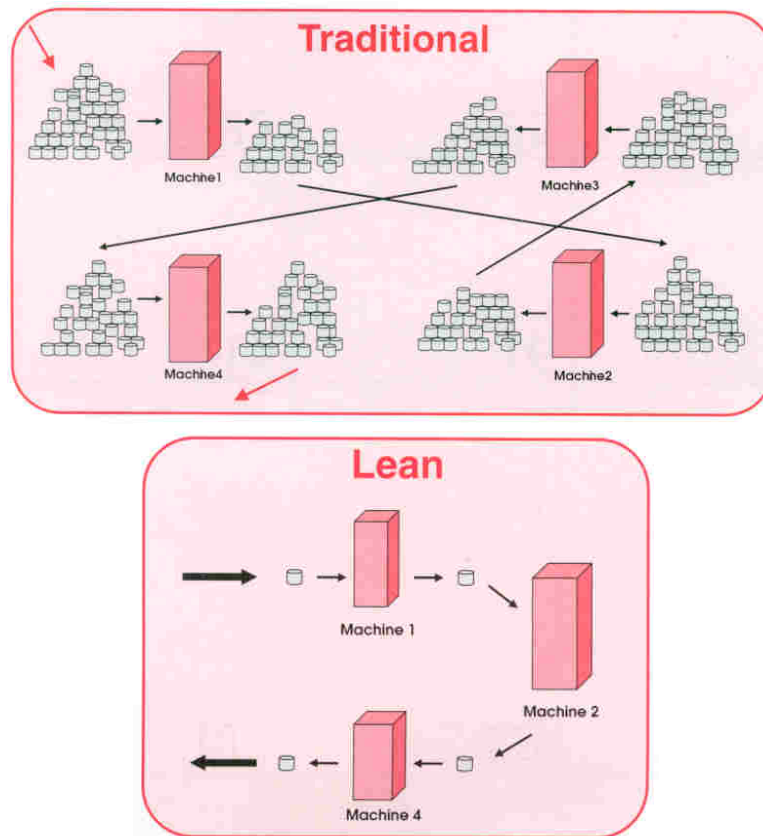
## Additional Resources:

- ***All I need to know about manufacturing I learned in Joe's garage : world class manufacturing made simple*** / William B. Miller, Vicki L. Schenk. Walnut Creek, Calif. : Bayrock Press, c2000.
- ***An introduction to lean manufacturing*** [videorecording] Dearborn, MI : Society of Manufacturing Engineers, 2000.
- ***Lean manufacturing at Miller SQA*** [videorecording]. Dearborn, MI: Society of Manufacturing Engineers, 2000.
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- ***Lean manufacturing : a plant floor guide*** / edited by John Allen, Charles Robinson, David Stewart Dearborn, MI : Society of Manufacturing Engineers 2001.
- ***Lean manufacturing : tools, techniques, and how to use them*** / by William F. Feld. Boca Raton, FL : St. Lucie Press ; Alexandria, VA : APICS, c2001.
- ***Lean manufacturing for the small shop*** / Gary Connor Dearborn, MI Society of Manufacturing Engineers c2001.
- ***Lean production simplified : the nuts and bolts of making assembly operations flow*** / by Pascal Dennis. New York : Productivity Press, c2002.
- ***Running today's factory : a proven strategy for lean manufacturing*** / by Charles Standard and Dale Davis ; [foreword by Jeffrey K. Liker]. Cincinnati, OH: Hanser Gardner Publications, c1999.
- ***World class manufacturing : the lessons of simplicity applied*** / Richard J. Schonberger. New York : Free Press, 1986

# Plant Layout for Continuous Flow

In the past two decades most manufacturing improvement efforts have been mistakenly focused on direct labour costs. Typically these direct labour costs range between 5 and 15% of total manufacturing cost. At the same time, plant overhead costs range from 30-40% with materials making up the other 50-60% of cost. Yet, continually the efforts of the manufacturing and industrial engineers have been directed at reducing labour costs – or automating them out of existence. The larger targets of materials and overhead have not received the attention they warrant.



## Hidden costs of inventory:

- Handling damage
- Material handling equipment and labour
- Obsolescence
- Time to detect errors
- Hidden problems, equipment and quality
- Long lead times increased the need for forecasting

**All of these symptoms contribute to poor product quality, scrap and rework and add substantially to overhead costs. NONE adds value to the product.**

Plant layout is the key to eliminating these problems. Continuous flow production will ensure that value is constantly being added to the product for the time the product is in the plant. The deal situation is one-

piece flow at – and between – processes. The intent of a good plant layout is to increase the velocity of products and make the production cycle predictable.

A good gauge of an unbalanced plant is the existence of inventory between cells or assembly. Do not give parts a change to do anything but follow a prescribed, fully controlled path through the plant.

**Additional sources:**

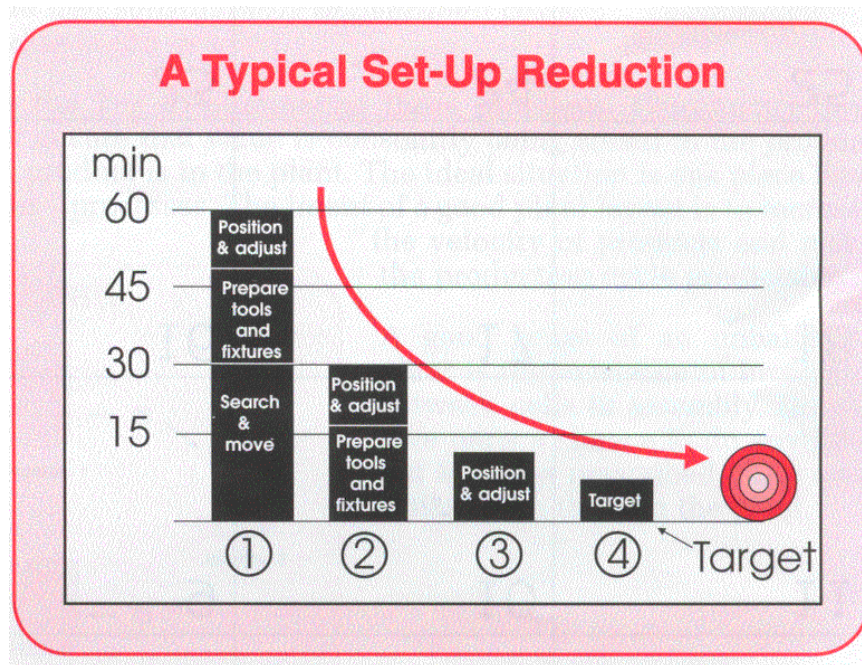
- ***One-piece flow : cell design for transforming the production process*** / by Kenichi Sekine. Cambridge, Mass. : Productivity Press, c1992.
- ***Creating continuous flow : an action guide for managers, engineers and production associates*** / by Mike Rother and Rick Harris / Brookline, MA: The Lean Enterprise Institute 2001.
- ***One-piece flow cell design for transforming the production process*** / by Sekine, Kenichi / Cambridge: Productivity Press 1991.

# Reduction of Set-Up or Changeover Time

*Set-up Time Reduction directly impacts inventory levels, the ability to run small lot sizes, reduced lead times, linked continuous flow, quality improvements and more.*

## **The Method**

- Identify the set-up.
- List every step.
- Measure the time required for every step. Use a video camera to record the procedure
- Distinguish internal and external steps (internal = while the machine is stopped)
- Plot the current set-up time graph
- Convert as many internal steps to external steps as possible
- Reduce the time for internal steps
- Reduce the time for external steps
- Plot the improved set-up time graph
- Define the ideal set-up
- Plot the ideal graph and strive toward it
- Practise and improve



Set-up time is the time taken from the last good piece of the previous run until good product is coming off the machine again!

## **Additional Resources:**

***Non-stock production of the Shingo system for continuous improvement*** / Shigeo Shingo.  
Cambridge, MA : Productivity Press, 1988.

**Quick changeover for lean manufacturing** [videorecording]. Dearborn, MI : Society of Manufacturing Engineers, 2000.

**Revolution in manufacturing : the SMED system** / Shigeo Shingo. Cambridge, MA : Productivity Press, 1983.

**The study of the Toyota production system from an industrial engineering viewpoint** / Shigeo Shingo. Cambridge, MA : Productivity Press, 1989.



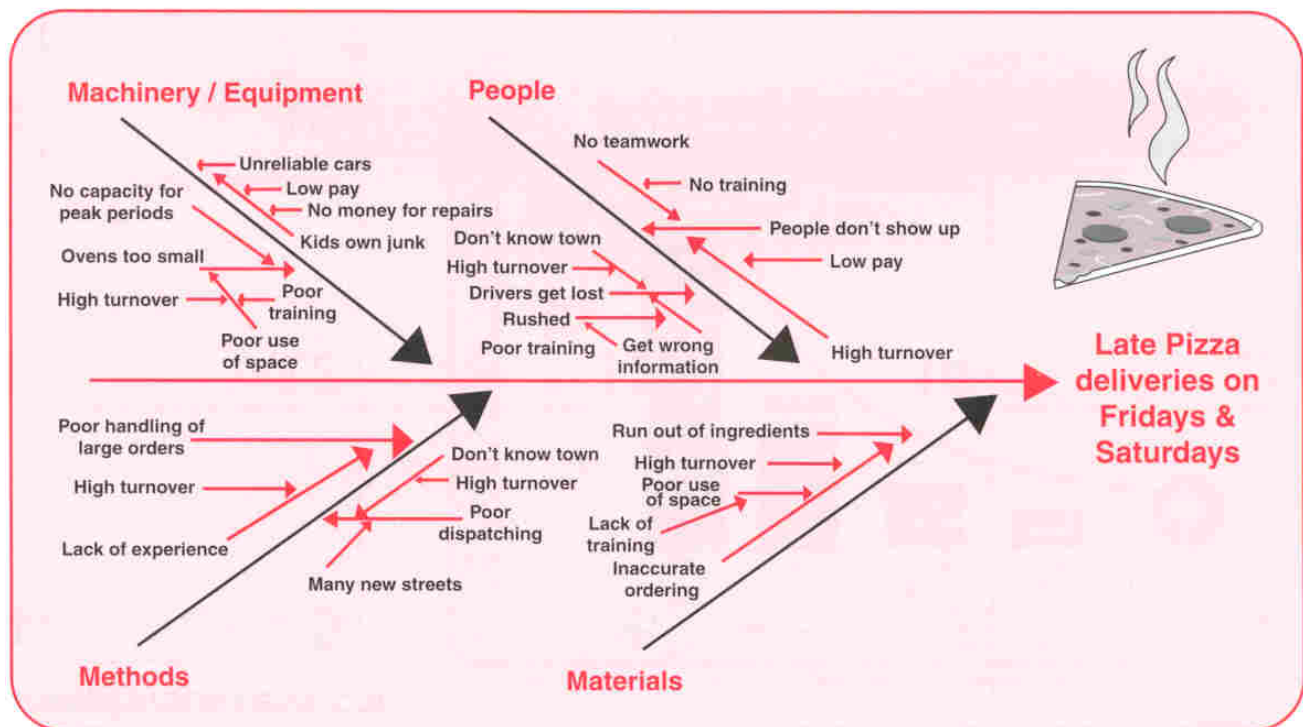
## Getting to the Root Cause – Together

This is one powerful, visual, problem-analysis tool that can be used by anyone, anywhere, anytime. Often called the fish-bone or Ishikawa diagram, this simple diagram makes it easy to see just how a certain effect resulted from many root causes – hence the name ‘Cause and Effect (C-E) diagram.’ Its use focuses everyone’s attention in a structured way on the real root causes of a problem and avoids getting sidetracked onto symptoms.

*Visible tools are powerful tools since 83% of what we know has come from a visual source. The ‘Fishbone’ enable everyone to bring their piece of knowledge ... and leave with the whole. Mere words can never achieve this.*

No one ever has all the pieces of a given problem or solution. The real power of this simple tool enables everyone to contribute their piece while seeing how it relates to those contributed by others. Its impact as a communication tool generates much animated discussion and new understanding.

Most problems are caused by recurring families of causes. In manufacturing, the families may include the 5Ms consisting of Manpower (people/staff), Materials, Methods (processes), Machines (equipment), and Measurement. In the service industry you may hear about the 5Ps – People (staff/employees), Provisions (supplies), Procedures (processes), Place (environment), and Patrons (customers/patients). Another is the 4 Ws of What, Why, When, Where.



**Steps:** Begin with a crystal clear statement of the problem. Draw the fish’s spine and then the cause families that apply. You can brainstorm right onto the ‘fishbone.’ To help ensure you really do have a root cause, apply the 5 Whys (repeatedly asking the question “Why” – 5 is a general ruled of thumb) to each cause brainstormed. Together, identify the factors that most strongly impact the effect. You can

now establish the first root cause to eliminate and attack it using PDCA (Plan, DO, Check, Act) or other methods. Good fishing!

**Additional Resources:**

- ***Cause and effect lean : lean operations, six sigma and supply chain essentials*** / John Bicheno. Buckingham : PICSIE Books, c2000.
- ***Developing new products with TQM*** / Charles D. Gevirtz. New York ; Montreal McGraw-Hill, Inc. c1994
- ***Implementing Six Sigma : smarter solutions using statistical methods*** / Forrest W. Breyfogle III. New York : John Wiley, c1999.
- ***Making the numbers count : the accountant as change agent on the world class team*** / Brian H. Maskell. Portland, Or. : Productivity Press, c1996.
- ***The quality improvement handbook*** / editors, John E. Bauer, Grace L. Duffy, Russell T. Westcott. Milwaukee, Wis. : ASQ Quality Press, 2002.
- ***Total quality management handbook*** / Jack Hradesky. New York : McGraw-Hill, c1995.



# Performance Measurement for Lean Culture

## *Select Measures to Drive Behavior Change*

“Changing Organization Culture” is a key approach to “Overcoming Barriers to Performance Improvement” according to respondents both this year and last year in the Management Issues Survey of the Canadian Manufacturers and Exporters. Bu how do you change culture? One key element is performance measurement. “What gets measured, gets done!” And if we want to get Lean, we need to use performance measures that promote Lean behavior.

## *Measure What You Want to Change*

So if measurement motivates, we need to measure the things we want to change. In a traditional “push” plant, we measured output and efficiency by department and machine. The goal was to keep people and machines busy and these measures made that the focus. In retrospect, it’s not surprising that we built up piles of inventory between departments, and extended our Total Production Leadtime, i.e., the time from first operation to last operation.

In a Lean plant we want Value to Flow. We want leadtimes to be as short as possible. How can we drive that change? Measure leadtimes and show the results to those who can make it happen. Similarly, if changeover times need to be reduced, measure them and feed back the results on a team information board.

## *“Feedback is the Breakfast of Champions!”*

If we want to succeed in our journey to Lean, the feedback must support the change. Therefore, discard old measures that encourage sub-optimizing behaviour, and replace them with good Lean measures that drive the Flow of Value to the customer.

**M**easure  
**E**verything  
**T**hat  
**R**esults  
**I**n  
**C**ustomer  
**S**atisfaction

***“No one retires at night with deep satisfaction, unless they have measured their achievements against standards they hold credible.”***

## *Additional Resources:*

- ***Keeping score : using the right metrics to drive world-class performance*** / Mark Graham Brown. New York : Quality Resources : Distributed by AMACOM Books c1996.

- ***Making the numbers count : the accountant as change agent on the world class team*** / Brian H. Maskell. Portland, Or. : Productivity Press, c1996.
- ***Reorganizing the factory : competing through cellular manufacturing*** / Nancy Hyer and Urban Wemmerlöv. Portland, Or. : Productivity Press, c2002.

## 5S – Steps to Visual Management

One definition of the Visual Workplace is ‘an environment where, within 5 minutes, a stranger can recognize the area’s vision, their mission, and the key performance measures critical to their success.’ All this is determined without the need for a conversation of any kind. In addition, the visible measures – or ‘dashboard indicators’ – clearly show at a glance how successful the process owners are in achieving their vision. Joint selection of the right indicators is essential to ensure true ownership.

Such an environment begins with the discipline of “5-S” which is wrapped in management’s envelope of support. Housekeeping alone is not just a desirable thing to do – it’s crucial, as more potential customers ‘walk-through’ their supplier’s workplace before committing to a supplier-customer agreement. Every employee plays a role in presenting an image of organization, order, and cleanliness to potential customers. What’s more, employees find this new order produces a better workplace. The 5 pillars to the visual workplace, *which must work in conjunction with each other*, are:

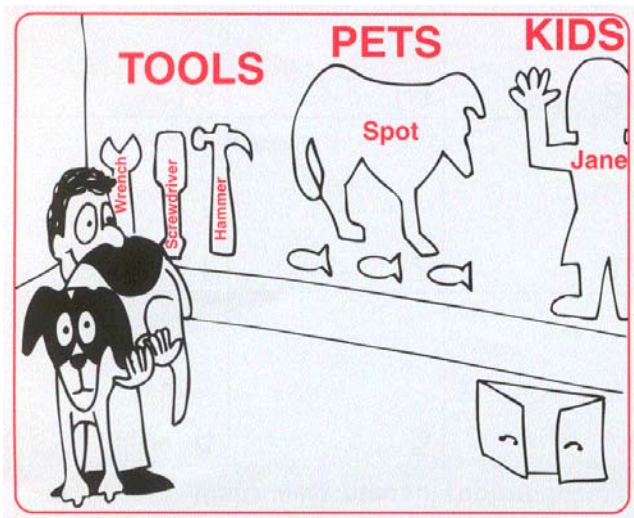
**Organization (seiei)** – *keeping on hand only what’s needed for the process – the rest is red-tagged & removed, making it easy to see the naked process in it’s uncluttered state.*

**Orderliness (seiton)** – *a place for everything and everything in its place for immediate retrieval and use.*

**Cleanliness (seiso)** – *Keep the workplace clean, spotless, and shining. A necessity as we begin to achieve global defect rates of 10 faulty parts per million and less.*

**Standardized Cleanup (seitetsu)** – *It’s the condition we achieve when we maintain the first 3 pillars. Everyone plays a role.*

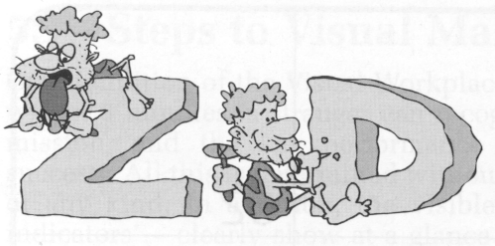
**Discipline (shitsuke)** – *Through the strength of personal will and self-esteem, make a habit of maintaining the established procedures every day.*



**Additional Resources:**

- ***Lean production simplified : the nuts and bolts of making assembly operations flow*** / by Pascal Dennis. New York : Productivity Press, c2002.
- ***Lean tooling : the right tool at the right time*** / Tom Fabrizio, Don Tapping. Dearborn, MI : Society of Manufacturing Engineers, c2003.
- ***Superfactory lean toolkit*** / [Computer laser optical disk] / San Luis Obispo, CA Agilonics [2002?]
- ***Visual controls*** / [videorecording] Dearborn, MI : Society of Manufacturing Engineers, 2000.
- ***The visual factory : building participation through shared information*** / Michel Greif. Cambridge, Mass. : Productivity Press, c1991.

## Zero Defects.... The Ultimate Standard



Setting an ultimate standard as a goal is depressing unless people believe they know how to reach it. A few companies ship no “known” defects. But shipping ‘no known defects’ doesn’t ensure satisfaction – only that you’re perfectly executing what you set out to do.

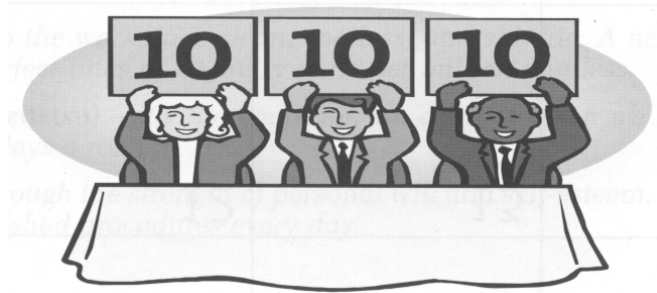
So what works? It begins with the thinking and a clear vision of the need for perfection and what it will mean to your customers and all stakeholders. Once the vision’s clear, muster the courage to measure precisely where you are today with all the warts. You now have both ends of the journey. The task now is to jointly set the milestones that are possible which in turn will make the vision believable and doable.

Since there are no two companies alike, how you achieve your milestones will be uniquely yours and the tools you use may include, Theory of Constraints, Lean Thinking, DFE, Six Sigma, etc... there are hundreds of tools and processes to consider. We’re blessed with such over-choice that working with networks or like minded companies can help us see the way. No company can live long enough to make all the mistakes itself – so let’s lever what we have to our mutual advantage.

Attending the 2003 Largest Lean Conference ever with key team members could be a start.

“ZD thinking” begins with a vision of a defect free operation that results in an environment that motivates everyone to take it as their own. As Henry Ford put it, “Whether you think that you can, or that you can’t, you are usually right.” So if you’re stuck on the belief that “everyone makes mistakes” look for another line of work. To be world class you must adopt not only the thinking – but a practice of producing zero defects. Winners think every day about how to eliminate mistakes before they happen as they apply continuous improvement and... Shingo’s 3 components of ‘defect elimination’:

1. **Source inspection** - check for causes... not just the resulting defect
2. **100 percent inspection** – use low cost mistake-proofing devices to detect errors, or, defective conditions
3. **Immediate action** – When a defect occurs stop instantly. Don’t resume until it is corrected



### **Additional Resources:**

- ***Design for manufacturability : optimizing cost, quality, and time to market*** / David M. Anderson. 2nd ed. Cambrian, Calif. : CIM Press, c2001.
- ***The new manufacturing challenge : techniques for continuous improvement*** / Kiyoshi Suzaki. New York : Free Press ; London : Collier Macmillan Publishers, c1987.
- ***Non-stock production the Shingo system for continuous improvement*** / Shigeo Shingo. Cambridge, MA : Productivity Press, 1988.
- ***Quality maintenance : zero defects through equipment management*** / Seiji Tsuchiya. / Cambridge, MA : Productivity Press, 1992.
- ***A study of the Toyota production system from an industrial engineering viewpoint*** / Shigeo Shingo. Revised edition Cambridge, MA : Productivity Press, c1989.
- ***Superfactory lean toolkit*** / [Computer laser optical disk] / San Luis Obispo, CA Agilonics [2002?]

# Pull Systems

The traditional “push” system kept people and machines busy. We asked them to “push” the product along the production line to the next operation. Sounds logical, right? But, what happens to the production not yet needed by either an internal or external customer? Waste is born.

As inventory is created, so too is the risk of obsolescence, quality defects and handling damage. The solution lies in a “pull” system where the customer, either internal or external, controls what is produced. We make only what is necessary, when it is necessary.

How does it work? Simple... a signal commands that production make only what is required. The signal to produce is called a “Kanban” and it may be an empty square marked on the floor, an empty shelf, a card describing the parts required, or an electronic signal. “What” it is doesn’t matter but, it can’t work without a Kanban!

*No signal = no production*

*Signal = produce exactly what is asked for,  
no more, no less, and make it right the first time.*

- Take time – synchronizing the pace of production to match the pace of sales
- Developing continuous flow wherever possible
- The use of “production kanban” and withdrawal kanban”
- Types of signals; card systems, two bin kanbans, FIFO lanes, light signals, shelves, computer signals
- Production leveling and pitch

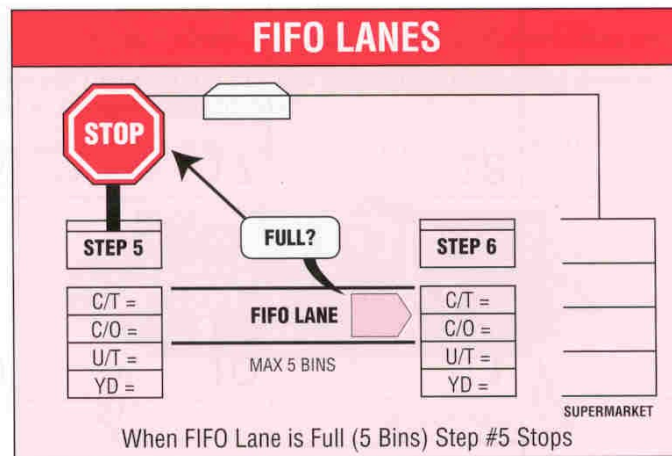
***The suppliers replace what the customer has consumed (nothing more)***

***The customer only pulls what he consumes (nothing more)***

***Stocks are maintained at their minimum***

***100% correct quality and quantity***

*Making only what the customers – when they need it – is not only competitively right... it’s also right for the environment.*



### **Additional Resources:**

- **Introduction to lean tooling** / [videorecording] Dearborn, Mich. : Society of Manufacturing Engineers, 2002.
- **Japanese manufacturing techniques : nine hidden lessons in simplicity** / Richard J. Schonberger New York : The Free Press, 1982.
- **Kanban: just-in-time at Toyota management begins at the workplace** / Revised ed. Cambridge, Mass. : Productivity Press, 1985.
- **Lean production simplified : the nuts and bolts of making assembly operations flow** / by Pascal Dennis. New York : Productivity Press, c2002.
- **Lean tooling : the right tool at the right time** / Tom Fabrizio, Don Tapping. Dearborn, MI : Society of Manufacturing Engineers, c2003.
- **Lean tooling in action** / [videorecording] Dearborn, Mich. : Society of Manufacturing Engineers, 2002.
- **The new manufacturing challenge : techniques for continuous improvement** / Kiyoshi Suzuki. New York : Free Press ; London : Collier Macmillan Publishers, c1987.
- **Pull Production for the Shopfloor** / Productivity Press Development Team. Cambridge, Mass. : Productivity Press, 2002.
- **Running today's factory : a proven strategy for lean manufacturing** / by Charles Standard and Dale Davis ; [foreword by Jeffrey K. Liker]. Cincinnati, OH: Hanser Gardner Publications, c1999.



# “Seven plus One” Types of Waste

## 1. Overproduction

- Producing more than the internal or external customer needs
- Producing sooner than the internal or external customer needs

Why is it waste? Overproduction results in obsolescence, handling damage and undetected defects. It requires extra handling, extra space, extra interest charges, extra machinery and extra labour.

Causes? Lack of communication, inappropriate reward system, focus on keeping busy rather than meeting customer needs

## 2. Delays (waiting time)

- People waiting for: Machinery, Tooling, Raw Materials, Maintenance, etc.
- Machinery waiting for: Maintenance, People, Materials, Tooling etc.

Causes? Inconsistent work methods, long changeover times

## 3. Transportation

- Moving materials or people over long distances can double or triple handling

Causes? Poor layout, lack of co-ordination of processes, poor housekeeping, poor workplace organization, multiple storage locations

## 4. Processes

- Unnecessary or inefficient processing e.g. removing burrs caused by dull tools

Causes? Inappropriate tooling or equipment, poor tooling maintenance, failure to combine operations

## 5. Inventories

- Inventory hides problems and causes extra handling, extra paperwork, extra space and extra cost

Causes? Long changeover times, unreliable equipment, unbalanced flow, incapable suppliers, inaccurate forecasting, large batch sizes

## 6. Motions

- Any motion of people or machines which does not add value to the product or service

Causes? Lack of workplace organization, poor layout, inconsistent work methods, poor machine design

## 7. Defective products

- Scrap, rework, customer returns, customer dissatisfaction

Causes? Incapable processes, insufficient training, lack of standardized procedures

## 7 + 1. Defective Design

- Designs which do not meet customers needs, unnecessary extra features

Causes? Lack of customer input in design, over-design

### **Additional Resources:**

- **Creating continuous flow : an action guide for managers, engineers and production associates** / by Mike Rother and Rick Harris / Brookline, MA: The Lean Enterprise Institute 2001.
- **Fast track to waste-free manufacturing : straight talk from a plant manager** / John W. Davis. Portland, Or. : Productivity Press, c1999
- **Lean thinking : banish waste and create wealth in your corporation** / New York Simon & Schuster c1996
- **Learning to see : value stream mapping to create value and eliminate muda** / by Mike Rother and John Shook ; forward by Jim Womack and Dan Jones. Version 1.2. Brookline, Mass. Lean Enterprise Institute [1999], c1998

# Lean Product Design

**92% of all production problems would be eliminated if designers used the Six Sigma Processes in the design stage!**

## Designs for Lean Manufacturing

Investment in quality and cost reduction at the design stage is 100 times as cost effective as an investment after production begins. How do you Design for Lean Manufacturing? Let's look at Complexity, Reuse, Design for Quality, Modular Design and Mass Customization, Lean Machines, FMEA and Activity Based Costing.

**Complexity** – Keep it simple! Complexity equals opportunity for waste and increased cost.

**Reuse** – Don't "re-invent the wheel." Standardize and reuse design elements e.g. parts, subassemblies, circuit elements, mechanical designs, and software modules. Don't forget that an essential part of standardization is ensuring that documentation and interface standards are followed.

**Design for Quality** – Design for process capability. Build six sigma performance in from the start. Identify all critical design tolerances and maximize acceptable ranges as much as possible. Then, choose the manufacturing processes, determine process variation and plot capability ratios.

**Modular Design and Mass Customization** - System architecture and product-line synergy can reduce overall costs. Develop families of products based on core product platforms, rather than independent point designs.

Think "Mass Customization". Assemble features and options onto a standard platform as late in the manufacturing process as possible.

To use a Modular approach, group like functions into logical and separable sub-assemblies, and share common elements.

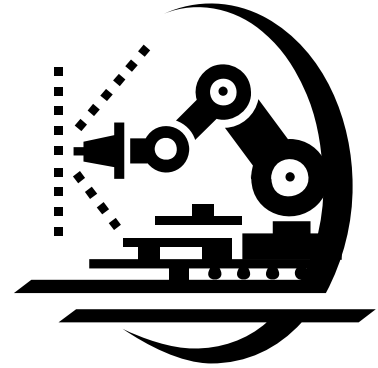
**Lean Machines** - Select machinery for the manufacturing process with Lean in mind. Smaller, simpler, dedicated machines often work better in a lean environment than large multi-purpose equipment.

**FMEA** – Failure Modes and Effects Analysis is a process for examining what could go wrong with the system or design in the manufacturing process, in use, or in service.

**Activity Based Costing** – Allocate all costs to individual products, rather than to cost centres. Calculate the real cost of complexity.

## Additional Resources:

- **Building a project-driven enterprise : how to slash waste and boost profits through lean project management** / Ronald Mascitelli / Northridge, CA Technology Perspectives 2002.
- **Design for Environment Guide** – Industrial Research Assistance Program, National Research Council Canada, [http://dfe-sce.nrc-cnrc.gc.ca/home\\_e.html](http://dfe-sce.nrc-cnrc.gc.ca/home_e.html)
- **Design for manufacturability handbook** / 2nd ed. New York McGraw-Hill, c1998.



- ***Design for manufacturability : optimizing cost, quality, and time to market*** / David M. Anderson. 2nd ed. Cambrian, Calif. : CIM Press, c2001.
- ***Design for manufacture : the case of a pump body*** / [videorecording] Woodstock, ON : Canadian Learning Company, c1992.
- ***Greener manufacturing and operations : from design to delivery and back*** / editor, Joseph Sarkis Sheffield : Greenleaf, 2001.
- ***Lean manufacturing : tools, techniques, and how to use them*** / by William F. Feld. Boca Raton, FL : St. Lucie Press ; Alexandria, VA : APICS, c2001.
- ***Product development for the lean enterprise : why Toyota's system is four times more productive and how you can implement it*** / by Michael N. Kennedy ; [foreword by Allen Ward]. Richmond, Va. : Oaklea Press, 2003.
- ***Sustainable solutions : developing products and services for the future*** / contributing editors, Martin Charter and Ursula Tischner. Sheffield : Greenleaf, 2001.

# Steps to the Crucial World Class “No Blame” Environment

People want to do a good job. They really do! And doing a good job today means working in a safe-from-ridicule environment where we can learn from mistakes and look at them as opportunities to learn more about our processes in order to make them more trouble-free. *It's this kind of thinking that gets us into the parts per million defect range and beyond!*

Our greatest fear is the fear of being humiliated. So it's not surprising that folks hide their mistakes and avoid saying and doing unusual things so they won't be ridiculed. *And yet, these unusual things – and what we can learn from our mistakes – may be just what's needed to solve a problem.*

Everyone's contribution is needed. We can't tolerate the old thinking of looking for someone to blame. No-blame environments produce decreased problems, fewer defects, increased productivity, higher profits – and – more genuine employee involvement and ownership. In short, work becomes a more fun place as the focus switches to satisfying the customer by achieving results. A no-blame environment does not mean people aren't accountable – far from it . . . they are more so. And proud of it!

## Key Points for Building and Growing a No-Blame Environment

- **You build a “no-blame” environment every day – one conversation at a time.** Use every conversation as an opportunity to build another's self-esteem.
- **Managers and workers are partners** in the improvement process. They share facts daily through straight talk and generous listening.
- Mistakes are part of the “facts” in everyone's work life. **Use mistakes as opportunities for improvement – not vehicles for discipline.**
- **Emphasize fact finding, not fault finding.** Fact-finders observe, listen, ask questions, reserve judgement, analyze and conclude the facts. They replace the words “I think ...” with, “Here is what the data tells us ...”
- Point fingers only at processes – **not people.**
- Managers are responsible for creating a safe-from-ridicule, no-blame environment of trust & integrity. Their role is to coach & **lead by example.**
- Workers are responsible for supporting & reinforcing the **positive behaviours of fellow workers & management.**



**You start the process by beginning to live it.** Remember, real change takes place through the conversations we have every day with each other. It is in your own best interest to make every conversation an opportunity to build another person's self-esteem. This approach can work wonders in your supply chain.

*“People bestow loyalty on leaders who help them grow – This loyalty makes team members harder to hire away. Our effort every day is to make our company the one our employees want to work for.”*



## High Mix Low Volume (HMLV)

**“The soft underbelly of North American Competitiveness\*\*”**

The world is evolving toward high-mix manufacturing because customers are demanding more solutions that fit their needs. The manufacturers that are slow to increase the breadth and depth of their offerings cost-effectively will cease to exist.

Our thinking must move toward ‘time based, and one-piece flow thinking’ as people, processes, & technology are brought together rapidly and effectively to compete and win against the best.

While non-repetitive, job-shop and make-to-order are the norm, most manufacturing knowledge focuses on the repetitive manufacturing model. **Here are some questions to prepare for increased agility:**

1. Do you have a plan to increase customer contact significantly to better understand just what they will need?
2. Are the wastes in the design cycle that inhibit the accuracy and flow of information made just as visible, and pursued with the same vigor, as the wastes on the shop floor?
3. As design, engineering, & production must ‘live together’ like never before, are you making plans to move them physically closer together? Enough room on the floor for all?
4. In every step, from customer order to delivery, is ‘cycle time’ awareness, thinking, and reduction discussed everyday? Are references found in casual conversation?
5. Do all managers, supervisors, and leads understand that ‘time is the currency of success’ and include this awareness and urgency in their conversations every day?
6. Is one-piece flow thinking on everyone’s mind no matter whether you are there or not?

With repetitive manufacturing, winning is largely determined by ‘cost and quality’ ... today, the paradigm is shifting to ‘delivery and responsiveness’ – and that means increased attention to processing time, capacity constraints, sequencing decision, lot sizing.



### **Additional Resources:**

- **High Mix Low Volume Manufacturing** / R. Michael Mahoney. Upper Saddle River, NJ : Prentice-Hall, 1997.
- **Quick response manufacturing : a companywide approach to reducing lead times** / Rajan Suri. Portland, Or. : Productivity Press, c1998.

\* Don Guild



## Consortiums Because . . .

***“No company can live long enough to make all the mistakes themselves.”***

With the sheer speed of response expected by customers today, and the huge volume of choices available – finding someone – a non-competitor – to exchange ideas with can make the difference. Call them Networks, Consortiums, Clusters, Self-Help Groups – the name does not matter. But what is needed is a united passion to improve, to learn, and, a firm belief that “other people have good ideas we can learn from.”

Over the last 20 years one major change has been the increased willingness to ‘go into someone else’s back yard’ for a solution. Leaders have stated that much of our future success will come from reaching out – because many of the solutions we need will not be found in our sectors.

The grocery industry has much value to share with manufacturing in the handling of inventory, hospitals have much to learn industry, and industry has much to learn from the military to instill the kind of leadership that will generate the followers needed to advance the journey to zero defects and world class competitiveness.

It is the will not the size that will matter. In rural or urban communities, the value lies in cultivating the thinking that ‘we must think globally while we act locally’ to develop the self confidence and the discipline needed to deploy and drive robust and stable processes capable of the quality needed to compete. Easy driving distance from each other is the rule.

The steps to successful consortiums include:

1. A clear vision and an agreed reason to exist
2. A commitment to openness, trust, & integrity
3. The belief that if it makes business sense we’ll do it
4. A living plan and road map aligned with the vision that must be generated & owned by the members themselves
5. Flexibility – since every heartbeat is different
6. Clear expectations and measures in a no-blame environment
7. Committed facilitation and ongoing communication
8. Long-term commitment to win
9. The strength to retire members whose contribution wavers

*“If we are to build and maintain the strength required to cope with the problems of this age, we must cooperate one with the other, every section with all others, each group with its neighbors.”*

*Dwight D. Eisenhower*

*Consortiums are now functioning in 6 of Canada's 10 provinces, the U S, and in Australia where new manufacturing consortiums are underway in Victoria State.*

**Additional Resources:**

- **A Leveraged Learning Network** / Ian Stewart. Sloan Management Review, Reprint 3946.
- **Canadian Resource to High Performance Manufacturing** – Canadian Consortia listing:  
<http://www.strategis.ic.gc.ca/lean.manufacturing>

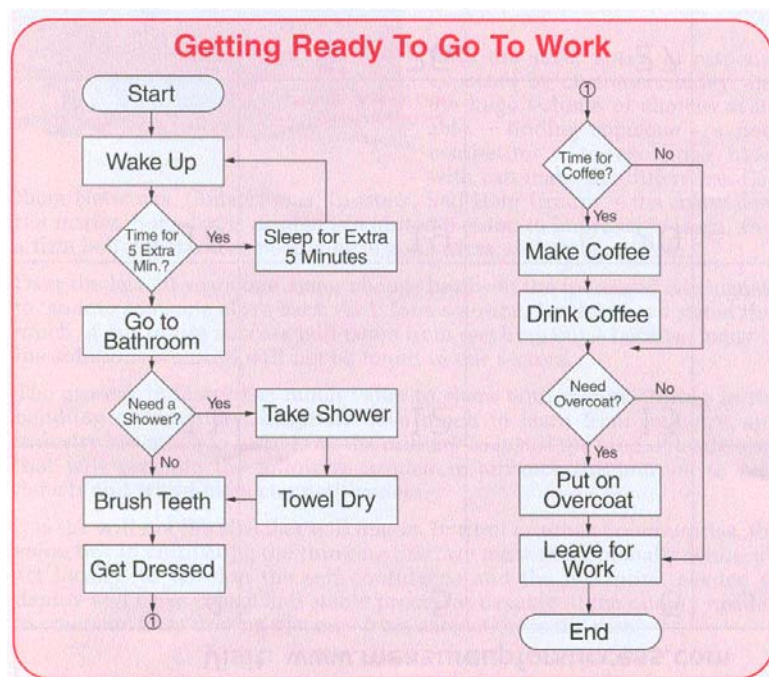


## Bringing People Together with Simple Flow Charts

Flow charts are powerful visual tools that enable us to see quickly those process steps we must eliminate in our drive for simplicity and the reduction of waste. It helps to realize that we are, indeed, visual creatures, as eighty-three percent of what we know has come from our sense of sight – our eyes. The “Measure Up For Success”<sup>™</sup> calendar highlights powerful, simple, and highly visual tools used by our best competitors to improve what they do as they help their customers succeed. Play with these tools and put them to work for you.

Everyone can visualize a process step – whether the step is getting out of bed in the morning or more clearly understanding steps in a work process. However, in a busy environment the simple flow from one step to the next gets blurred. We need to regularly take a deep breath and ‘map’ our process steps in their natural flow – and flow charts are one of the most simple, and underutilized tools we have. They can describe any process you can imagine in your day-to-day world. Continuous improvement only begins with an understanding and a ‘map’ of the process. And using a box (process step), a diamond (decision step), and an arrow (direction indicator) can be a powerful aid in picturing what’s going on in your corner. Mapping a process in this way can awaken the sleeping visual acuity that brings people together in their understanding.

Try it. Analyze your next party, or that one work process that's not running smoothly. Share your chart and don't be surprised if the answers jump off the page.



### Additional Resources:

- **The visual factory : building participation through shared information** / Michel Greif. Cambridge, Mass. : Productivity Press, c1991.
- **The team handbook : how to use teams to improve quality** / Peter R. Scholtes. Madison, Wis. : Joiner Associates, c1988.

# Use Meetings to Get Results

Meetings are necessary tools – but not in the manner many are run. Let’s recognize we’re all to blame for ineffective meetings. Good meetings, like good time management, come from a clear model of how time should be spent, plus the self-discipline to make it so. Applied to a regular meeting format, these guidelines can gain more time for you, but you’ll need to recruit some colleagues to really make them work.

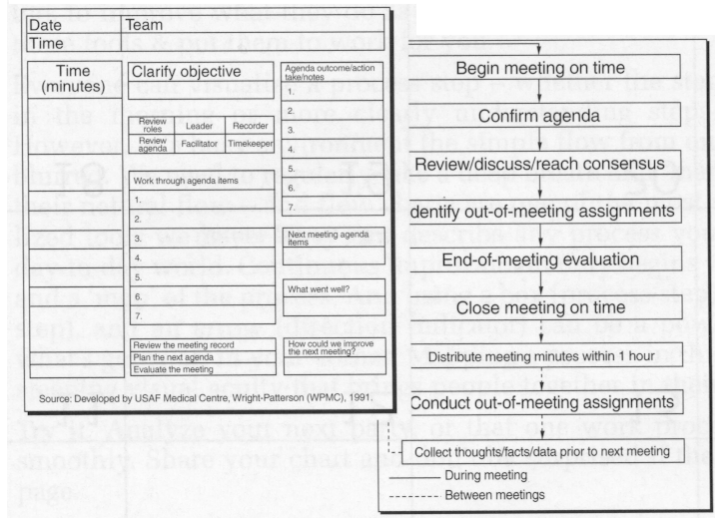
**It begins with a ‘can-do, let’s get results’ mindset.**

Begin with a positive win-win attitude. Start looking at time wasted as squandered human life... yours! Start thinking ‘how can we make the process a win-win for everyone?’ Begin by determining if you even need a meeting in the first place... and if so, ask yourself these 3 questions:

1. **What** do I want? (be selfish)
2. **Who’s** involved in my getting what I want? (will limit the number of participants) and, finally,
3. **What** do they want” ... This is a key question. If you don’t know what they want, the meeting will be twice as long as it needs to be. If you don’t know – get the facts and talk to people in advance. The more you know, the more bargaining chips you have to ensure a win-win solution.

## Key Points

- Ensure agenda states the purpose and provides a ‘roadmap’ with times shown for all items.
- Start on time with a direct restatement of the purpose, the time frame, & the agenda
- Don’t begin the meeting until everyone agrees to the agenda & the time frame
- After each item – summarize! And only then fill in the ‘meeting minutes form’
- Summarize at the end of the meeting, highlighting assignments & achievements
- Set agenda for next meeting... As you close the meeting, go once around the room for everyone’s last words (no discussion) on the meeting & how to make the next one better. Everyone comments. Uses of **meeting minute forms** enable you to hand out the minutes on the way out. If it is not your meeting to chair – be proactive. Never hesitate to ask “are we on topic?” or, “let’s hold that idea until our next meeting so we can complete this item.” Help the chair succeed – **don’t just sit there.**



*“Applying Lean Thinking to meetings will result in much fewer meetings and more time for the things that really matter – like customers.”*

## Additional Resources:

- **The team handbook : how to use teams to improve quality** / Peter R. Scholtes. Madison, Wis. : Joiner Associates, c1988.
- **The memory jogger II** / Michael Brassard & Diane Ritter. Salem, NH : GOAL/QPC, 1994. (p. 154)

# The Power of a Simple Vision – Clearly Understood – is Awesome!

Everyone needs a vision – *a clear view of a future desired state to which they are committed.*

Winning visions are understandable as they resonate with our values and aspirations. A broad corporate vision indicates the direction of the ship, which is the ‘true North’ for each branch, department, team, and individual’s specific vision. Visioning must never be a word-smithing exercise – it’s a serious process executed to align the minds and hearts of everyone in a single direction.

Only vision provides direction. It’s the light that draws us to that future desired place. It gives relevance to our mission, and to our pursuit of competitiveness and excellence. Coupling out actions to our vision should be our task every day.

Winning visions are:

- 1. Leader initiated
- 2. Brief and clearly remembered
- 3. Shared and supported by all
- 4. Comprehensive & detailed
- 5. Positive & inspiring

***Values guide our direction.***

***Only vision determines our destination.***



***“Vision without Action is merely a dream; Action without Vision just passes the time; Vision with Action can change the world.”***

Joel Arthur Barker, The Power of Vision

**Additional Resources:**

- ***The fifth discipline*** / Peter M. Senge. New York : Doubleday, 1990.
- ***The power of vision*** / narrated by Joel Barker . a video by Charthouse productions
- ***The seven habits of highly effective people : restoring the character ethic*** / Stephen R. Covey. New York : Simon and Schuster, c1989.

# Case Studies

## Sight for sore eyes

**THE COMPANY:** Melet Plastics Inc. (Winnipeg, Manitoba), designers and manufacturers of a variety of custom and proprietary products, including folding aluminum mobility canes for the sight impaired.

**THE CHALLENGE:** Decrease inventory levels, eliminate unneeded equipment, furniture and materials and improve key performance indicators.



### THE PROJECT OBJECTIVES:

- Reduce distance traveled and space consumed by 50 percent;
- Reduce excess inventory and implement a pull system for molded plastic parts;
- Reduce overall process cycle time by 50 percent;
- Remove unneeded equipment, furniture and materials from the work area;
- Implement 5S & visual management;
- Implement one-piece flow.

### MEASURED RESULTS:

The Kaizen blitz team studied the value stream, coming up with times and distances for each step and observed a need to:

- Reduce the distance traveled and time wasted through the entire process by setting up a U-shaped cell and having orders delivered electronically.
- Set up a visual cue for shipping to take away packaged product.
- Remove unneeded items from the work area.

### WHAT THESE ACTIONS ACHIEVED:

- Reduced non-value added process steps.
- Cycle time reduction of 51 percent.
- Distance traveled reduced 77 percent.
- Reduced space consumption by 35 percent.

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*Advanced Manufacturing News*, November 2002.

## Forming cylinder cells

**The company:** Regina-based Brandt Engineered Products Ltd., boasts the largest and best-equipped machine shop in southern Saskatchewan. Brandt Engineered Products Ltd is a recognized and leading provider of engineered-to-order equipment and machinery for heavy industry throughout North America.

**The product:** Hydraulic cylinders

**The challenge:** Increase annual production while reducing customer lead times and internal cycle times.

**The project objectives:**

- Reduce current lead-time from 23 days;
- Reduce input costs per cylinder;
- Eliminate delays due to departmentalized production processes.

**Primary actions taken:**

- Measured all component parts in terms of time to produce, distance travelled, and machinery/processes utilized to produce these parts;
- Designed and implemented a manufacturing cell to include all possible machines including milling, lathe, welding and assembly.

**Measured results:**

- Required production space reduced by 30 percent;
- Travel distance between processes reduced by 85 percent;
- Lead time for first off production reduced by 80 percent.



*Above: Before the lean transformation, the area was cluttered and ineffective. Below, the revamped production area streamlined production and led to greater throughput.*

Content provided by Lean Manufacturing Solutions, Hamilton, Ont. Reprinted with permission. *Advanced Manufacturing News*, July/August 2003.

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- Tim Mitchell, NRC-IRAP, Winnipeg MB – <http://irap-pari.nrc-cnrc.gc.ca>
- Trish Wainikka, Manitoba Quality Network, Winnipeg MB – <http://www.qnet.mb.ca> (QNET)
- North America's Largest Lean Manufacturing Conference, October 6-10, 2003, [www.measureupforsuccess.com](http://www.measureupforsuccess.com) (calendar). Used with permission (D. Hogg).

