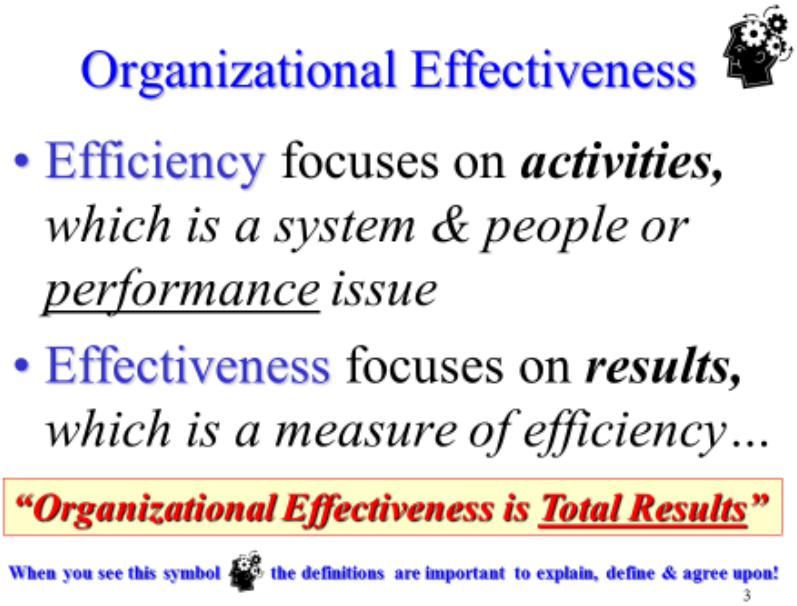
ENGT 1200 Test Review

Chapter 1 Introduction to Industrial and Systems Engineering & Course Focus

We discussed how significant the definition of words and learning it is, and gave relevant examples. To achieve consistency, we must agree, and to achieve synergy, we must speak the same language, which allows for effective communication. You may need to learn to paraphrase a definition specifically for your application. And as this course is very much about performance the following should be considered.



Memorizing verbatim is not always the best way to remember long term, so paraphrasing may be the best for you.

As long as the words convey the issue being delivered, I will accept it.…

Both Flow Charts and Measurement can be used independently,

But both must be possible if we actually need to accomplish or do it!

These four simple questions need to be addressed for many different problem solving scenarios.

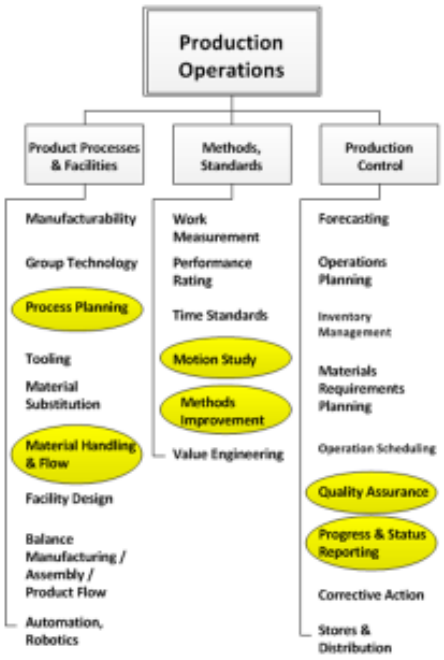
Learning them will give order to planning, projects, or presentation, and give them structure in the

This course will focus on the floor level Production or System Flow Process applications most used by those responsible for actual work or performance…

In short we will strive to always know:

- Where are we
- Where do we want to go
- How will we get there
- How will we know we have arrived

By learning ISE Processes, Tools, & Techniques



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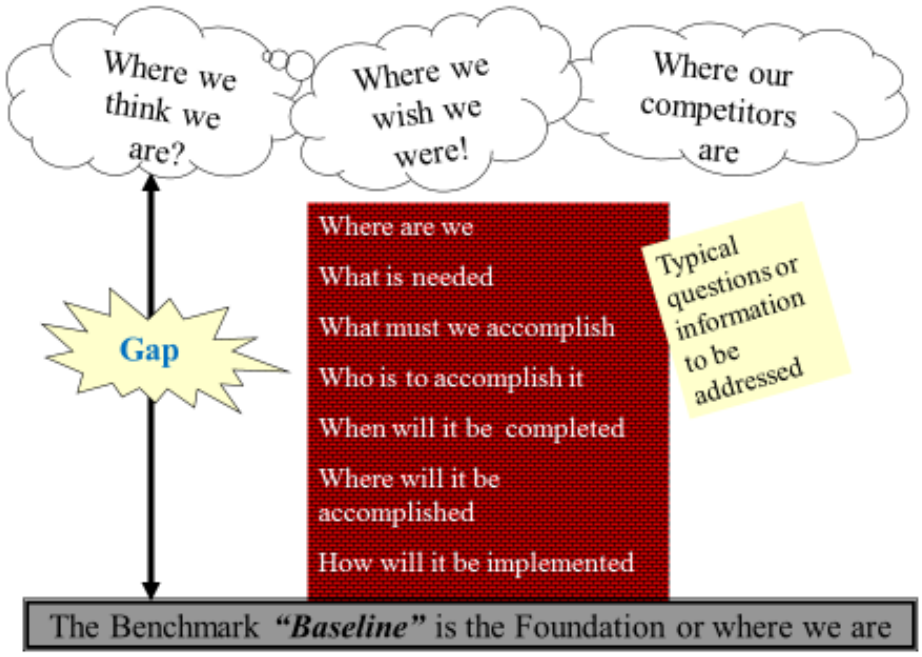
Broad-Spectrum View



Gap Analysis is simply developing a Benchmark Baseline or "where are we"and comparing it to "where we want to be", such as compared to a competitor!

Competency

"Competency: the demonstrated ability to perform a specific task or project by oneself or with others in a team activity, in a specific manner, & sometimes in a specific environment. Measured by observation or testing against work instructions, checklist, legal requirements, standards, such as TSI 16949, ANSI/NCSL Z540.3, ISO 17025, etc. And always measured Pass/Fail"!

- ***Competency based training is critical if we are dealing with certification or licensing issues.***

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All elements if this definition are critical to your organization if it wishes to be world class.

All Quality Standard Certification Processes today require documenting what you do and doing what you documented.

All auditors will look for objective evidence that this is true.

Understanding this slide will help you throughout your career as there is always room for improvement.

And the quest need never be perfect or achieve 100% improvement.

10% of $100,000 dollars is $10,000 dollars and can be celebrated…

Reality

There are no perfect system, people, machines! There has never been a measurement on anything that did not contain error! Nothing round has ever been produced! And still we consider life as Pass/Fail.

A quality manager in a typical factory has control of approximately 15% of the quality issues and 85% of the problems are designed in by engineers or management!

Zero Defects – a term coined by Mr. Philip Crosby. It did not mean so in literary term but it refers to a state where waste is eliminated and defects are reduced. It means ensuring quality standards and reducing defects to the level of zero in projects.

It is a quest! It is a ISE goal to achieve!

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Education and Training Summary

Education and Training are fundamental to total quality because they represent the best way to improve people on a continual bases.

- **It is through education that people become knowledgeable and more trainable.**
- **It is through training that people become more efficient, learn to work smarter, and safer.**

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The main difference between Training & Education is the Measurement.

Education is A, B, C, D, & E. So a 94% is an A, but leave 6% unaccounted for.

Training is considered Pass / Fail as consumers expect it to work, be safe, last as expected, etc.

Education and Training Summary

- **Todays ISE Technician needs to understand and embrace these concepts as they are to be a leading force in their organization to create consistency, or competence in a workforce.**
- **They will use teams and tools to both develop hypothesis of change and assure implementation of change…**

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"Change is inevitable, but growth is optional…To be a positive change it must be controlled and measured". That's Engineering

Teams

By involving people, not driving, lashing or motivating them we have the better chance of implementation and sustaining change.

- First explain the problem
- Second ask them causes of the problem or Why it is happening.
- Third ask the for solutions…

These three simple steps when done correctly will assure involvement. Then using a tried and true format and quality tools we assure success and we will define success as anything that improves safety, the work environment, the bottom line, quality or performance, etc.

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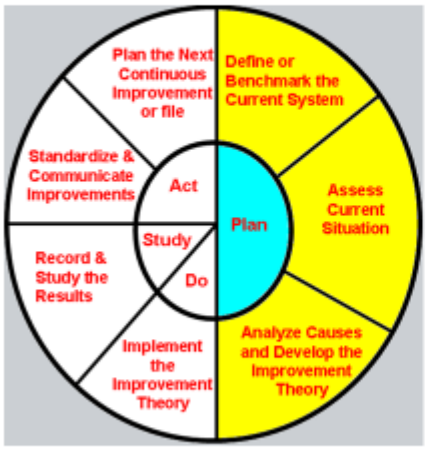
Implementation is the last and hardest thing to accomplish.

Getting those involved to put their name on it is the best method of implementation I know of…

PDSA is a System Approach to Continuous Improvement



PLAN INCLUDES:

1. **Identify the output**
2. **Identify the customer**
3. **Identify customer requirements**
4. **Identify inputs**
5. **Identify Steps in the process**
6. **Select measurements**
7. **Determine process capabilities**
8. **Identify and select problem**
9. **Analysis Problem**
10. **Generate potential solution**

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The PDCA Cycle is a tried and true method of accomplishing an Improvement Project!

The inner circle is: Plan, Do, Study, and Act.

The outer circle is: Define, Assess, etc., But Mainly Analyze!

PDSA is a System Approach to Continuous Improvement

DO INCLUDES:

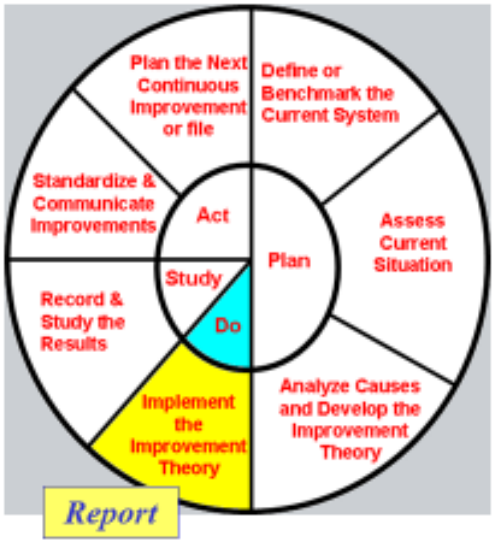
11. Select and plan to test the solution.

    This is transforming the theory into performance steps to accomplish an improvement.

    Improvement is the elimination or closing the gap between our baseline, the "AS Is," and the "Desired" performance level.

    Planning includes developing measurements to assess the key performance output variables or KPOVs.

    Report; then implement the solution on a test basis. This stage is closely monitored and measured



This is a Communication Point

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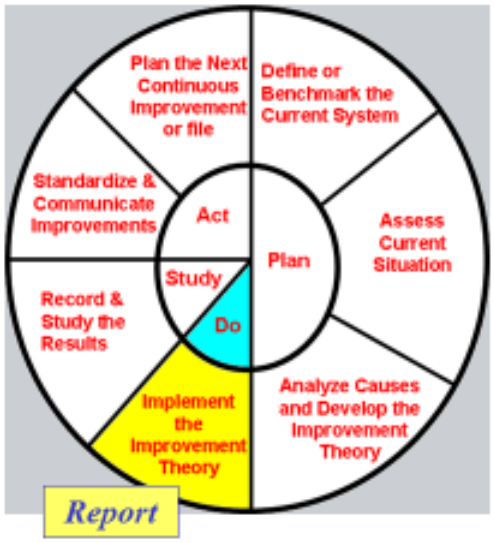
PDSA is a System Approach to Continuous Improvement

DO INCLUDES:
After selecting and planning, but before implementing. the team should communicate or better yet make a presentation to management at this point.

We also need to communicate to those who will be affected by the pilot test.



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PDSA is a System Approach to Continuous Improvement

STUDY INCLUDES:

13. Evaluate the solution, this evaluation involves the team and the administration as a decision is needed to accept the project and proceed, or to maintain the status quo…

This is also a Communication Point

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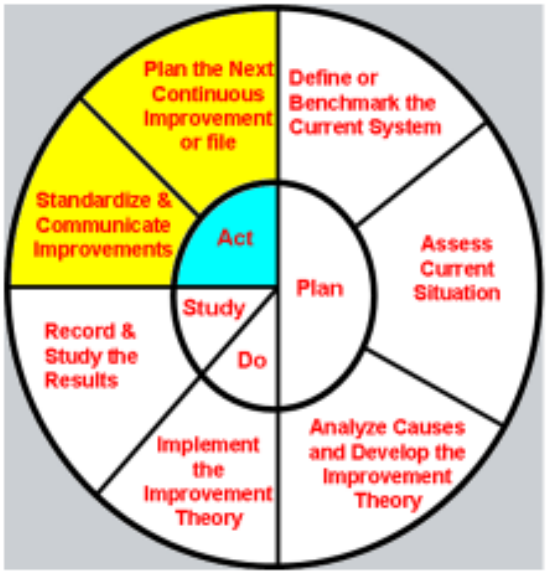
PDSA is a System Approach to Continuous Improvement

ACT INCLUDES:

14. Monitoring the results
15. Implementing the new process where appropriate.
16. Plan the next *CI* improvement, address any learned issues, left on the table issues, or file the project for a future benchmark and resource…



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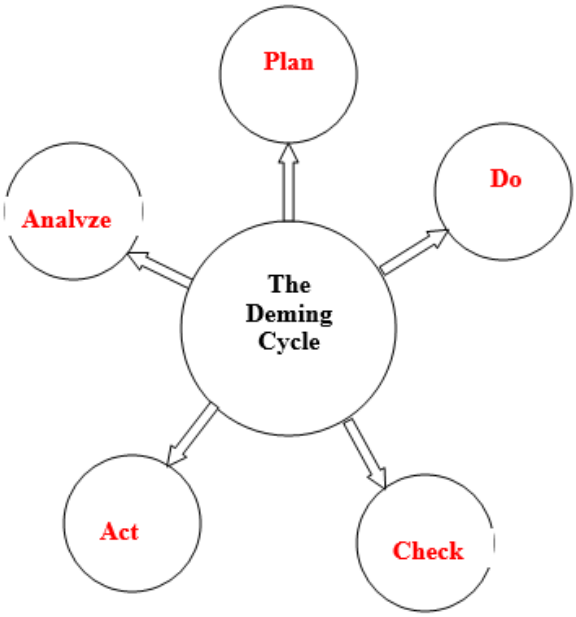
The PDSA Cycle can be simplified an example is:



Also remember the DMAIC Cycle promoted in Six Sigma Text is the same thing renamed.

Paradigms

We also discussed Paradigms in chapter one and viewed a video.
You should be able to describe a Paradigm and give an example of one:

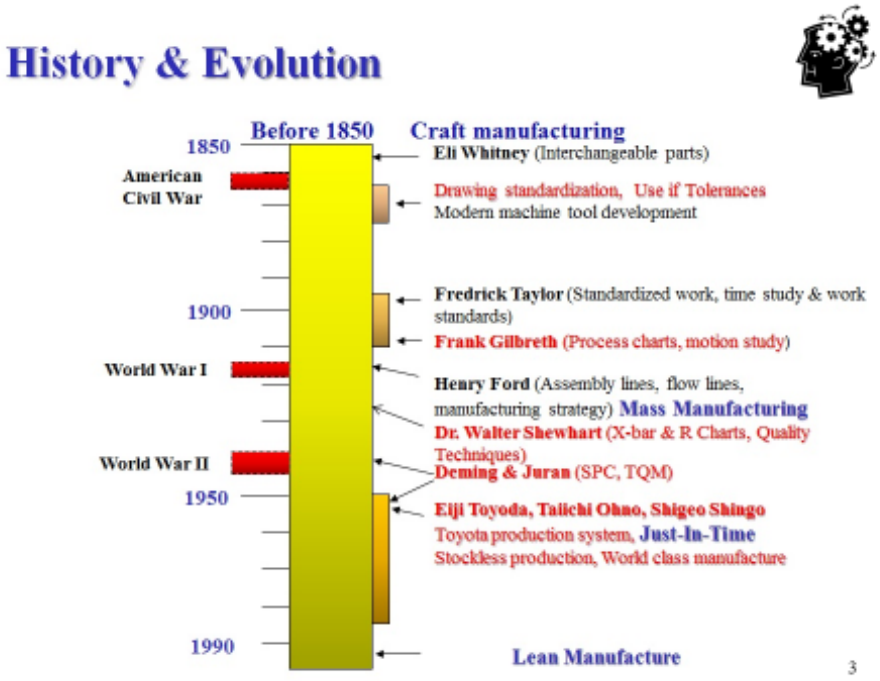
The first broad skill all engineers need to develop is "paradigm flexibility". "Paradigms" are the filters through which we interpret data and information. These filters are created by the environment and experiences observed in the time and location we live in. "Remember a fish would be the last thing to discover water" in a given pond, during a specific time frame, a fish could only experience so much…All fish may or may not experience ice or pollution, all fish may or may not experience large predator's, or drought, etc. so time is an issue as is environment or location.

Our paradigms (how tightly we hold to them and how flexible we are to adopt new ones) greatly affects the solutions we arrive at. Even if the pond is as big as the Atlantic or Pacific pond the time frame, location, temperature of the water would be an issue.

Think of People who lived in warm regions of the world before the 1700s trying to understand the concept of ice…remember the world was flat at that time for many!

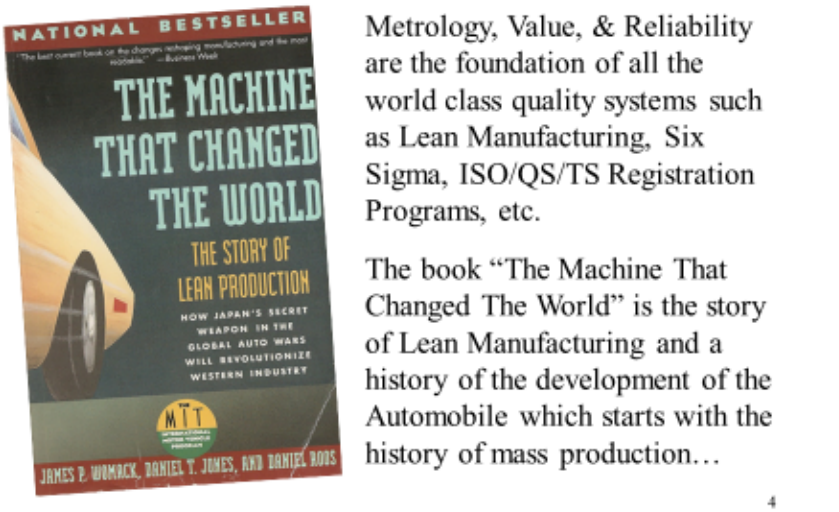
As we learned in the video, Paradigms are "a model / pattern / theory / filter/ mindset / set of rules (however you want to say it) - that basically do 2 things: set the limits or boundaries by which we interpret data and guide our behavior based on our reasoning through that lens".

Chapter 2 History of the Lean Machine, Sequencing, and Selection



Modern ISE had its roots planted by Fredrick Taylor and Henry Ford. But the systems & tools used today came from Dr. Walter Shewhart, the Grand Father of Modern Statistics & Eiji Toyoda the Father of the JIT – Just-in-Time Manufacturing System

The term Lean Manufacturing was coined in this book to describe the JIT Manufacturing System



Mass Production

Henry Ford and the Quadricycle, 1896.

The story of mass production did not begin with Henry Ford, but he should be credited with its perfection and success… Ford manufacturing beginning with the original Model A in 1903 and the quest for mass production also began

1908 Model T

Ford was very much an assembler and bought engines and chassis from the Dodge brothers until 1931, his early focus was the perfection of interchangeable parts, assembly lines, tools that could cut hardened metals and interchangeable workers

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Mass Production

By 1915 Ford had perfected the interchangeable worker at the newly built Highland Park Plant where 7000 workers newly hired at the Detroit facility came directly from or were right off the boat and new to the United States.

- **A survey revealed that more than 50 languages were spoken in plant, but workers need only accomplish the task at their work station on the moving assembly** line…It took years to train the skilled worker, but only 5 minutes to show the assemble how to do their job!
- The more skilled worker was removed from production and concentrated on the production and maintenance of fixtures and tools…

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The Model T

The Model T was Henry Ford's twentieth design over a five year period that began with the original Model A. With the Model T Ford achieved two objectives

- **He had designed a car for manufacture**
- **He had designed a car that was user friendly**

These two point are the basis for his success and far outweigh the prominence given to the assembly line…

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Design for Manufacture

The design for manufacture was achieved through Henry Fords obsession with using standard gauging systems and measurements to achieve interchangeable parts.

- **He insisted on working to a gauge**
- **He worked to reduce needed parts**
- **He realized the payoff on simplicity of parts and the savings to be realized in assembly**

This was the groundwork for "Reliability Engineering" and reduced the cost of an automobile significantly a Value Engineering issue…

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If asked "what Henry Ford should be famous for"?

Consider these two slides

Design for Use

The friendly use of the Model T was by design and he achieved an unprecedented ease of operation and maintenance for the day.

- **He assumed his buyer would be a farmer with modest tools and mechanical skill…**
- **He wrote the Model T's owners manual in a question-and-answer form. In sixty four pages he explained how owners could use simple tools to solve any of the 140 problems likely to crop up with the car…**

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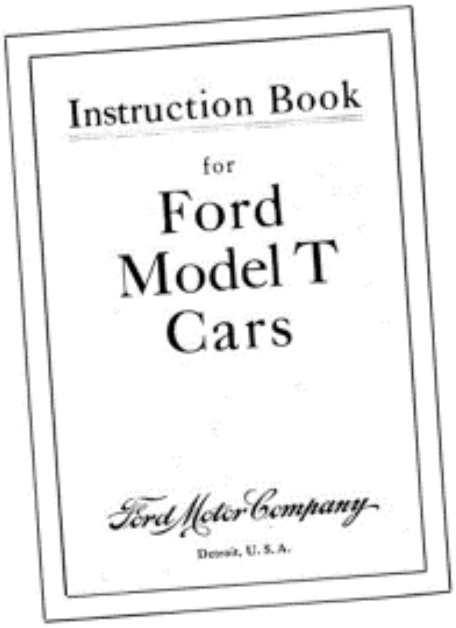
Customer Focus



Identifying the customer and the environment the product would be use in this book was a great seller or the product.

- As there were no paved roads in most towns or any in the country the Model T was indeed the first SUV.
- The distance to a dealer or repair shop was an issue to be solved.
- The vehicle was to be used as a replace a horse and as a tool…

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The Affect on Businesses!

The start of second source parts was mainly because of the success and the volume of the Model T.
Everyone realized that making it more useful, more reliable, or easier to operate would result in a profit and more jobs…

Mass Production had started…

Mass Production was the dominate manufacturing system in the world until 1950 when Toyoda Manufacturing System was introduced.

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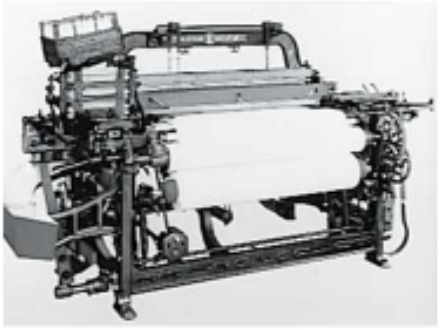
The Term Lean


Sakichi Toyoda

Lean in the manufacturing environment also refers to the Toyota Production system established by the Toyota Corporation, originally the Toyoda Automatic Loom Works.

- Sakichi Toyoda, born in 1867, invents the wooden Toyoda handloom in 1890 Sakichi Toyoda was the inventor of automatic looms who founded the Toyota Group.
- He invented a loom in 1902 that would stop automatically if any of the threads snapped. His invention opened the way for automated loom works where a single operator could handle dozens of looms.



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Toyoda History & Lean

Within the organization, four prominent gentlemen are credited with developing the system:

- **Sakichi Toyoda, who founded the Toyoda Group in 1902;**
- **Kiichiro Toyoda, son of Sakichi Toyoda, who headed the automobile manufacturing operation between 1936 and 1950;**
- **Eiji Toyoda, Managing Director between 1950 and 1981 and Chairman between 1981 and 1994; and**
- **Taiichi Ohno, the Father of the Kanban System.**

1936 AA Sedan

- ***1930 Kiichiro Toyoda experiments with gasoline engines.***
- ***1933 Automobile Department is established in Toyoda Automatic Loom Works, Ltd.***

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1937 Toyoda Become Toyota

The family name Toyoda means "abundant rice fields" in Japanese.

- A contest to make a distinction between the two family businesses, but many believe to be a publicity stunt was conducted, and the name "Toyota" was the winner…
- The name Toyota has no meaning in Japanese and only takes 8 strokes to write which is considered lucky, versus the ten stokes needed to write Toyoda!
- The last and perhaps most significant motivation why "Toyota" was preferred was because Japanese people feel that it has a clearer sound than "Toyoda".

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Toyoda Post WWII History & Lean

The history of Kiichiro Toyoda contribution to Toyoda was considered a failure but warrants a closer look…

- In 1930 the Japanese Government urged the company to build trucks for the war effort & hindered their efforts to develop or produce a car.
- The War itself put the company at risk and they were scheduled to be targeted by B29s when the war ended narrowly escaping destruction.
- Post war Japan was in chaos with new laws, new freedoms and changes in the workforce for the employees…

In thirteen years of effort by 1950 they had produced a total of 2,685 cars, Ford was producing 7000 a day!

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Toyota Production System

- **Post World War II, Most of Japan & Toyota were almost bankrupt.**
- **Factories, power systems, communication systems, were mostly destroyed.**
- **Manpower was limited as a result of the WWII casualties.**
- **Between 1945 &1950 Japan under military occupational rule endured turbulent times…**
- **In the spring of 1950 Eiji Toyoda spent 3 months at the Ford Rouge Plant in Detroit. His Uncle Kiirhiro had visited in 1929. The Japanese greatly admire the Mass Production System accredited to Ford & believed it was a major reason for the loss of WWII**

Eiji Toyoda is the most prominent of Toyotas' as he is most responsible for the Toyoda Manufacturing System we know today.

He and other, such as Taiichi Ohno, visited the United States to study the Mass manufacturing System.

They admired Henry ford and Post WWII tried to copy his methods

After WWII the returning Japanese soldier and their leaders Did not believe they lost the war due to their soldier efforts, and accredited the loss to the Mass manufacturing ability of, The United States. Japan Industrialist following Eiji Toyota's lead were handicapped in trying to adopt the mass manufacturing as they were short on Manpower, Factories, Machinery, Capital, Materials, & Money. So the need to eliminate waste from mass manufacturing was imperative.

Toyota Production System

- Post war demand was low and minimising the cost per unit through economies of scale was inappropriate. This led to the development of demand-led pull systems.
- The Japanese could not afford the expensive mass production facilities of the type used in the USA so they instead focused on reducing waste and low cost automation.
- Likewise, Toyota could not afford to maintain high inventory levels.

Under Eiji Toyoda leadership and his collaboration with Taiichi Ohno and Shigeo Shingo the world was about to change.

1955

In 1955 the competitive edge held by the United States had all but ran its course as most of the world were using the mass manufacturing system devised by Henry Ford.

- **The exception was Japan, which was a champion of the system, but could not make it work**
- **Eiji Toyoda, unlike most Japanese, realized mass manufacturing would not work in Japan and must devise way to use resources better.**
- **without the elimination of waste and the essential conservation of recourses a system would not work...**
- **Two of the best engineers in Japan working in this endeavor were Toyota employees**

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Quality Development in Japan

Starting with the need to improve the quality of the communications and power systems Quality Gurus from the United States, such as, W. Edwards Deming and Joseph Juran, were asked to teach quality in Japan.

With the realization of the need to eliminate waste on the table Twenty of Japans top industrialist were exposed to W. Edward Deming's Quality Philosophies.

He convinced them of it potential and they bought it Hook, Line, & Sinker

Engineers at companies like Honda, & Toyota became Gurus on their own, one of which was Taiichi Ohno!

Taiichi Ohno

Ohno went to the United States to visit automobile plants, but his most important U.S. discovery was the supermarket. Japan did not have many self-service stores yet, and Ohno was impressed. He marveled at the way customers chose exactly what they wanted and in the quantities that they wanted. Ohno admired the way the supermarkets supplied merchandise in a simple, efficient, and timely manner.

- In later years, Ohno often described his production system in terms of the American supermarket

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What he saw is what is called FIFO today "First in First Out". Milk is loaded from back of the rack in a cold storage room and unloaded by the shopper from the front, keeping the flow in order…many will reach as far back as possible looking for a later date today, something that was not on the bottle in Ohno's day.

Taiichi Ohno

Using the super market format Ohno devised the Pull System, which driven by the needs of the following lines.

- It contrasted with conventional push systems, which were driven by the output of preceding lines.

Ohno developed a number of tools for operating his production format in a systematic framework.

- The best known of those tools is the kanban system, which provides for conveying information in and between processes on instruction cards.

Taiichi Ohno's development of the Kanban System was a Just-in-Time tool that pull materials through the system.

The JIT System is referred to as a Pull System & the Mass Manufacturing is referred to as a Push System

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Taiichi Ohno

Western methods to supply the needed stamped part to build a car and save time on changeovers was to simply buy more presses and dedicate them to a specific part…

Ohno knowing the capital was not available to match this solution.

- Using a few presses he devised a plan to stamp a whole car
- His idea was to develop simple die-change techniques and change dies frequently
- Starting in the late 1940s by the late 1950s he had reduce change-over from a day to 3 minutes.
- Change-over specialist were eliminated and accomplished by the operator.

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Just-in-Time Manufacturing

Toyota had fully worked out the principles of Lean Production by 1960 and most of Japans auto firms followed their lead.

- In 1960 Japan had around 6% share of the worlds motor vehicle production.
- By 1980 they had almost 30% of the worlds vehicle production

The text outlines circa 30 years of history laced with events and circumstances that took them a different path and why Toyota developed into todays benchmark for manufacturing!

1957 Toyota USA Established 41

Taiichi Ohno's change over system is today referred to as SMED or "Single Minute Exchange of Dies" Program.

They could produce all parts needed to produce a car with a single machine or a many fewer than used in the US.

Going into 1980 many US companies were awash with presses and operators that required as much as 24 hours to change over.

The result was making more parts than needed and storing them in warehouses. A waste of the Mass Manufacturing System.

JIT Just-in-Time Manufacturing

"In the broad sense, an approach to achieving excellence in a manufacturing company based upon the continuing elimination of waste (waste being considered as those things which do not add value to the product). In the narrow sense, JIT refers to the movement of material at the necessary time. The implication is that each operation is closely synchronised with subsequent ones to make that possible"

APICS Dictionary 1987.

JIT became part of Lean Manufacturing after the publication of James Womack's The Machine that Changed the World in 1991

Chapter 3 Process Analysis

Check Sheet Example

Check sheets make it easy to compile and analyze data. They're used to determine how often an event occurs over a designated period of time. Information is usually collected for events as they happen.

Less frequently, check sheets are used to record events that already have occurred. Although check sheets are intended mainly to track (not analyze) data, they often help to indicate why a problem may be occurring.

- All sorts of data can be tracked using check sheets:
- Number of times something happens.
- Length of time it takes to get something done.
- Cost of a certain operation over a period of time.
- Frequency of occurrence -- by unit, program, level, work area, etc.
- Impact of an action over a period of time.

Check Sheet

Check Sheet Example

Putting it to work:

There are two questions that must be answered when setting up a check sheet:

- **What do you want to know?**
- **What is the most reliable way to collect the data?**

Information on a check sheet is usually collected in categories: by work unit code, branch, date, shift, sub process, and so on.

When creating a check sheet, make sure categories are logical and easily understood.

This is important not only for the people who will be interpreting the gathered data, but also for those who use the check sheet to collect the data.

They should not have to make difficult judgments about when and where to enter a check mark on the form..

Check Sheet

SURVEY

Surveying is much like interviewing - but on paper. Instead of responding to interviewers, people answer items on a questionnaire.

The major advantage is that you can get a great deal of information from a lot of people very economically. The downside is that people may interpret the questions somewhat differently than intended. Their answers may be ambiguous as well, and there's no opportunity to test understanding.

Putting it to work:

Follow these simple steps to ensure a successful survey:

- Identify the information you need.
- Decide who has this information in its most reliable form.
- Plan how you will use the information when you have it in hand.
- Develop a series of questions that will enable respondents to provide the information accurately and unambiguously.
- Keep the questionnaire short, simple and clear.
- Try out the questions with several people to uncover any unclear questions. Conduct several "test surveys" to work out the bugs.
- Questionnaires can be "closed" with a limited number of responses from which to choose

Example: How long have you worked in your present job? Circle one:

Less than 1 yr. 1 - 3 years more than 3 years

Beginning Steps in Developing an Attitude Instrument

1. **Review literature in the domain which you wish to measure (i.e., "computer attitudes")**
2. **Develop a list of categories (subscales) that you wish to sample from the domain. The domain may be "Computer Attitudes" and the categories may be "ease of use of computers" and "usefulness in education".**
3. **Write 8 to 10 items/statements (operational definitions) for each category (i.e., "Computers will help students learn material faster."). Avoid common survey pitfalls when writing your statements.**
4. **Give the items to at least 5 experts for classification (Content Validity). The panel of experts will attempt to match the operational definitions with their appropriate categories within the domain.**
5. **Develop an instrument with the successfully classified items. Use a Likert scale to design your instrument. You may wish to rewrite some of the items that were not successfully classified.**
6. **Field test the instrument (6 to 10 people per item on the instrument) with the populations for which the instrument is being developed.**
7. **Run a factor analysis (exploratory) on the field test responses. More advanced students may wish to do a confirmatory factory analysis.**
8. **Name each factor (category) based on the items which loaded on it (>.40)**
9. **Review whether each item conceptually belongs with its factor (subscale) and remove those which do not.**
10. **Run Cronbach's Alpha Reliability for each factor/category (subscale) to investigate internal consistency reliability.**
11. **Modify and retest the instrument if necessary (alpha<.70).**

Likert Scale

FREQUENCY

• **Very Frequently** • **Frequently** • **Occasionally** • **Rarely** • **Very Rarely** • **Never**	• **Always** • **Very Frequently** • **Occasionally** • **Rarely** • **Very Rarely** • **Never**	• Always • Usually • About Half the Time • Seldom • Never	• Almost Always • To a Considerable Degree • Occasionally • Seldom
• A Great Deal • Much • Somewhat • Little • Never	• Often • Sometimes • Seldom • Never	• Always • Very Often • Sometimes • Rarely • Never	

Example:

Converting a Likert Scale survey into a Quantifiable Data Source.

As it is we can get a view of what the student thought of the sample questions, but how would you quantify it as is? An example of a simple technique: First let's assign numbers giving 5, the heaviest weight to Always and (0) to never…

- **Always = (5)**
- **Very Frequently = (4)**
  Occasionally = (3)
- **Rarely Very = (2)**
- **Rarely = (1)**
- **Never = (0)**

A student survey to assess your opinion of the quarter startup each quarter and quality of classes at CSCC Directions: Using the Likert Scale Place an X in the box that describes your experience with the question asked. Years at CSCC _4_ Male _X_ Female___	Never	Very Rarely	Rarely	Occasionally	Very Frequently	Always
Example: The food in the courtyard is always good					X	
The parking is convenient and easy			X			
Books are easy to find at the bookstore					X	
Registration is uncomplicated and easy			X			
Finding classrooms is always easy				X		
Help is always available when I need assistance					X	
Classes are always ready to start and well organized					X	
Instructors are always competent and friendly						X
Class sizes always allow for personal help					X	
Textbooks and class materials are always up to date						X

The top score is 5 and we have 9 lines or a total of 45 points for a perfect score Looking down the form we see instead of Xs 2, 4, 2, 3, 4, 4, 5, 4, and 5 which equals 33 We then calculate the acceptance measurement 33/45=.7333 or 73%

The Nature of Information

- **There is never enough information to assure a correct decision.**
- **But the decision risk is reduced proportionally to the quality of information used to make a decision.**

Training is a key element here: Knowing How, Why and the Importance Of!

The Nature of Information

- **Making a decision using *Bad Data* is superior to making a decision using no data.**
- **Using *No Data* is nothing but guessing or taking for granted…**

The Nature of Information

- **Data Collection can be explained using an operational definition or process procedure…**
- **Data can be described in terms of confidence level…**
- **Data Collection Processes can be improved!**

The language of Quality, Reliability & Engineering is Statistic. You will learn the value of statistics in MECH2270 Engineering Statistics…

The Nature of Information

- **Involving the affected people in gathering information enhances the thoroughness of the process and increases the likelihood of reaching a consensus.**

Brainstorming is a Powerful tool to get a team to put their name on or take ownership of a project!

BRAINSTORMING PROCESS

Brainstorming is a powerful way to generate input.
Working in a team setting, people express their ideas the moment they think of them. Brainstorming is an informal process in which:

- No one evaluates the ideas as they're announced.
- Wild ideas are encouraged.
- People build on the ideas of others.
- Everyone strives for quantity. The more ideas, the better!

Putting it to work:
The team leader (or facilitator) presents the topic for which ideas are sought.

- The wording should encourage specific, tangible ideas -- not abstract or vague thoughts.
- Make sure everyone in the team understands the topic that's the focus of the brainstorming as well as the process to be followed.

Brainstorming

BRAINSTORMING PROCESS

There are three methods of brainstorming.

- The most familiar is **freewheeling**, in which:
  Group members call out their ideas spontaneously.
  The scribe records the ideas as they are suggested.

- **In round-robin brainstorming:**
  The leader or scribe asks each member, in turn, for an idea.
  Members may pass on any round.
  The session continues until all members have passed during the round.
  Ideas are recorded as in freewheeling brainstorming.

- **The slip method** differs markedly from the other two approaches:
  The leader asks members to write down their ideas on small slips of paper or index cards

  The ideas are then collected and organized. *See Affinity Diagramming*

Brainstorming

Affinity Diagrams

If you ever find yourself wrestling with too much information, unable to organize it in an effective way, the affinity diagram is for you. This powerful tool pulls together an enormous volume of ideas, leaving you with well-sorted groups that give the information clear meaning.

Putting it to work:

- **Begin by writing the issue to be considered. Keep it neutral and concise, and write it on a flip chart so all can see. For example: "What do our customers want from us?" Another example: "What implementation issues do we need to address as a steering committee?" Discussion and editing will likely be necessary as the team works to decide on the exact phrasing. Make sure there is consensus support for the final version.**

- **Spend the next 15 or so minutes brainstorming ideas in response to the phrase. Have one person record the statements on a flip chart - while a second person uses a thick marker to write each statement on a separate note card or Post-It-Note. (Post-It-Notes work best, especially for displaying the finished product on a wall or flip chart. However, make sure they're big enough?) These responses should be concise (no more than seven words), yet they should be thorough and understandable.**

Affinity Diagrams

Affinity Diagrams

- **Consider the issue. "What do our customers want from us?" Vague responses include "quality" and "service". A richer response would be: "Answer call-in questions within five minutes." Another brief; yet to-the-point response: "Receive all the necessary info by mail."**

- **Continue generating responses while following all the guidelines of brainstorming. All ideas are accepted without criticism and without editing by the recorder. The more ideas, the better.**

- **After all the ideas have been put forward, take the cards (or Post-It Notes) and spread them out on a large table. At this point, there's no need to organize them. In fact, it's better if they are mixed up in a completely random fashion.**
  See exhibit A.

Affinity Diagrams

- **Now it's time to sort. Have the team members locate and place side-by-side two cards that are connected in some way - perhaps they deal with the same subtopic, or they touch on activities done by the same group of people, or they have something else in common.**

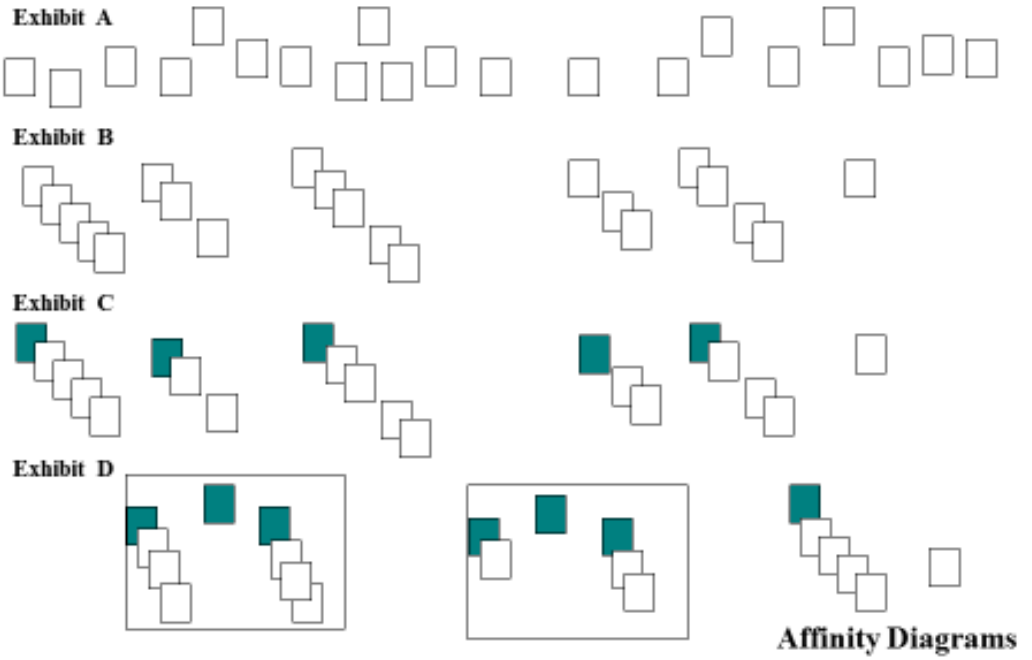
- **This matching process continues, with people building groups of related cards, until the random bunch of ideas has been transformed into 5 - 10 groupings. If one card seems completely unrelated to all the other cards, no problem, simply let it stand alone as its own grouping. See exhibit B. (For an interesting twist to this step, have tem members do their sorting in silence. If one person wants to move a card from one grouping to another, let it happen. Consensus will eventually emerge.)**

Affinity Diagrams

- **Now that the cards have been sorted, look through each grouping for the one card that conveys the main idea of that grouping and ties all the various ideas together. This become the "header" card and is placed at the top, while the other cards are positioned vertically beneath it. If a grouping doesn't seem to include an all-encompassing header card, create one and put it at the top. See exhibit C.**

- **Do one last sort. Looking at the header cards, move the groupings so that related ones are next to each other on the table. If you're working with cards, tape them in sorted order on a flip-chart sheet (or, more likely, on several!) If you've opted for Post-It-Notes, all you need to do is press them on. Finish up by drawing a box around the related groupings, and create a "super header" for each of these. You now have a detailed analysis of the issue. It's clearly presented and ready to share.**

Affinity Diagram Example



The Nature of Information

- **Consensus leads to consistency in the way we collect, use or interpret data, thus it is easier to analyze the results and determine the quality of the data.**

The Nature of Information

- **Consistency is reliability, that is it is quantifiable or a stable process and can be measured it terms of acceptability….this is a foundation of quality!**

Scientific Information or Data Collection is:

- **Deliberate activities resulting from planned procedures.**
- **Planning and documenting operational definitions answers the why, who, what, when, where and how questions about the source of the data …**

Dwight David Eisenhower said: ***"Nothing ever happens without a plan and no plan ever works!"***

Scientific Information or Data Collection:

- The Existing Work Instruction or Operational Definition is a Benchmark
  - It does not assure good data, just explainable data.
  - It should always be considered as something that can be improved when we get smarter, or when technology gives us a better tool…
  - Upgrading the Operational Definition will improve any system!

"You can manage what you can measure; you can measure, what you can define; you can define, what you can understand".

The operational definition is the first step towards effective management. It helps us build a clear understanding of a concept or a phenomenon so that it can be unambiguously measured.

If it can be measured it can be controlled!

Rules for Success

- Organizations are at their best when high levels of inspiration, competence, accountability & collaboration exist in the workplace.
- It is in this environment that the world-class organizations evolve…
- **No organization can improve until the people improve!**

Flow Charts

A flow chart is a picture or graphical representation of a process (sequence of events, steps, activities, or task) which transform inputs into outputs in a system.

- **Flow charts are drawn with standard symbols which represent different types of activities or task.**
- **Many software programs are available to develop flow charts but, Microsoft Word & PowerPoint have most of the capability needed by the beginning Action Teams.**

Flow Chart

Types of Flow Charts

Types of Flow Chart Palettes include:

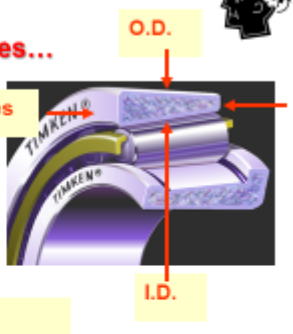
- **Organization Charts**
- **Total Productive Maintenance**
- **Business Process**
- **Dataflow**
- **Audit**
- **Process**
- **Process Mapping**
- **Schematic**
- **Network**
- **Office**
- **Quality**
- **Quality – ISO**
- **Telecommunication**
- **Din**

Flow Chart

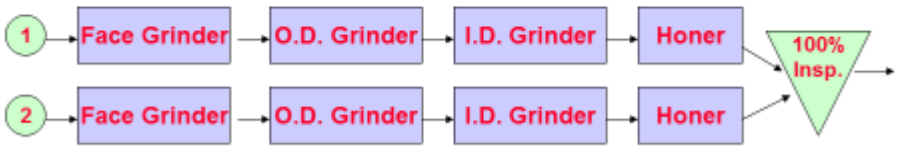
Takt Time Example

Two Cup Grinding Line took 26 second to produce a cup each or 13 seconds with 2 lines…

The Cup is finished on the Faces, the O.D. Outside Diameter and I.D. Inside Diameter

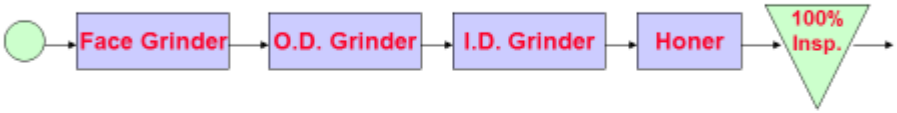


Cup Finishing Process 2 Line Configuration



Takt Time Example

Cup Finishing Process Analysis

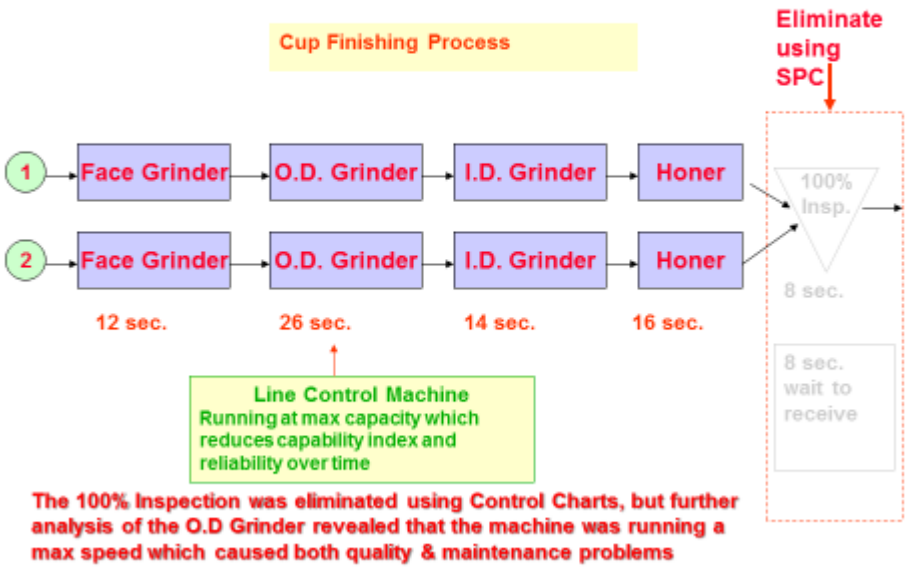


12 sec.	26 sec.	14 sec.	16 sec.	8 sec.
14 sec. wait to send	12 sec. delay to send	12 sec. wait to receive	2 sec. delay to receive	8 sec. wait to receive

Analysis of the various machine time revealed that the O.D Grinder at 26 Seconds was the control machine and it was not cost effective to replace the machine and speeding it up would produced grind burn injury to the bearing surface…

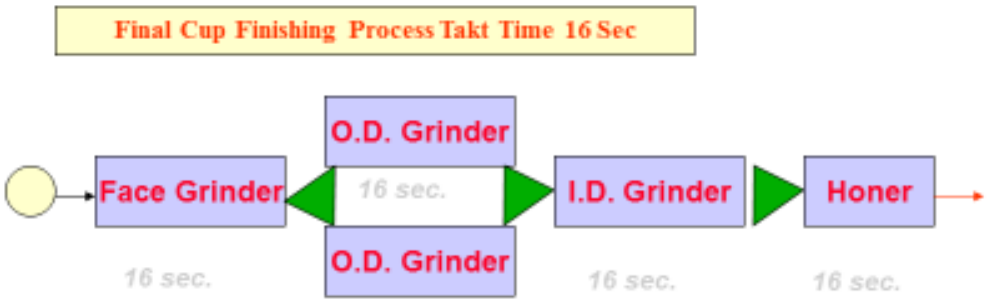
Takt Time is also referred to as Line Balancing and in effect makes the system move as a chorus line. The benefit of slowing the line down to the control machine speed is usually more line uptime and increased quality.

Takt Time Example



The 100% Inspection was eliminated using Control Charts, but further analysis of the O.D Grinder revealed that the machine was running a max speed which caused both quality & maintenance problems

Takt Time Example



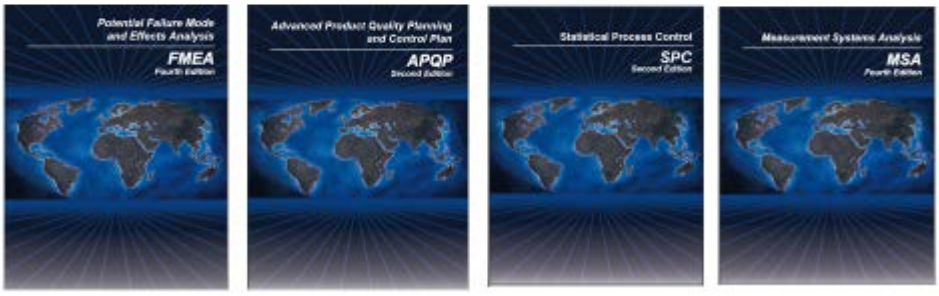
The solution was to remove the O.D. grinder from the second line and put it in parallel with the other O.D grinder. This eliminated the need for three machines that could be used for other purposes and a trained operator, who could be used on another product line.

The Takt time of 16 seconds for each machine satisfied the production need, improved the quality, Balanced the Line, reduced down time, and maintenance time…

FMEA

With the advent of QS9000 a US Standard, which became TS16949 an International Standard, which is now IATF19649. Process FMEA was one of several items identified by the AIAG Automotive Industry Action Group to supplement the ISO 9000 standard.

FMEA stands for Process Failure Mode & Effects Analysis. It is a tool typically used by Engineering for design and/or Quality that identifies and quantifies risk associated with potential product and process failures.



Process Function / Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.
Prime spray: Cover facia at specified thickness for proper paint adhesion	Dirt contamination	Surface defects	7		Dry, crumbly overspray booth	8	Maintenance Dept. monitors and cleans		

Failure & Mode Effects Analysis

FMEA

The FMEA is one of several tools developed By the AIAG Automotive Industry Action Group to supplement the ISO 9000 Certification Quality System.

The called the enhanced system QS 9000 and today it's the IATS 16949 Standard.

The process is performed by a committee of informed people who develop a criteria of risk numbers that are multiplied to create a RPN or Risk Priority Number.

This Process give insight into area of most concern in any design or product.

The Review of Statistical Data over time is the calculation of the System Reliability…

Estimating occurrence

- Review statistical data from similar process
  - Cpk values
  - Cumulative number of failures per 1,000 parts
  - Scrap/repair rates
- Alternative: make subjective assessment
- Be consistent in applying criteria

Failure & Mode Effects Analysis

Occurrence

Probability of Failure	Ranking	Possible Failure Rates	Cpk
Very high. Failure almost inevitable.	10	> 1 in 2	< 0.33
	9	1 in 3	≥ 0.33
High. Failure occurs often in similar processes.	8	1 in 8	≥ 0.51
	7	1 in 20	≥ 0.67
Moderate. Occasional failures in similar processes.	6	1 in 80	≥ 0.83
	5	1 in 400	≥ 1.00
	4	1 in 2,000	≥ 1.17
Low. Isolated failures in similar processes.	3	1 in 15,000	≥ 1.33
Very low. Only isolated failures in almost identical processes.	2	1 in 150,000	≥ 1.50
Remote. Failure is unlikely. No failures in almost identical processes.	1	< 1 in 1,500,000	≥ 1.67

Failure & Mode Effects Analysis

Detection

Likelihood of Detection	Description	Ranking
Absolute certainty of non-detection	Controls will not or cannot detect a defect.	10
Very low	Controls probably will not detect a defect.	9
Low	Controls have a poor chance of detecting a defect.	8 7
Moderate	Controls may detect a defect.	6 5
High	Controls have a good chance of detecting a defect. (Process automatically detects failure.)	4 3
Very high	Controls will almost certainly detect a defect. (Process automatically prevents further processing.)	2 1

Failure & Mode Effects Analysis

Process Function / Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.
Prime spray: Cover facia at specified thickness for proper paint adhesion	Dirt contamination	Surface defects	7		Dry, crumbly overspray booth	8	Maintenance Dept. monitors and cleans	5	

Failure & Mode Effects Analysis

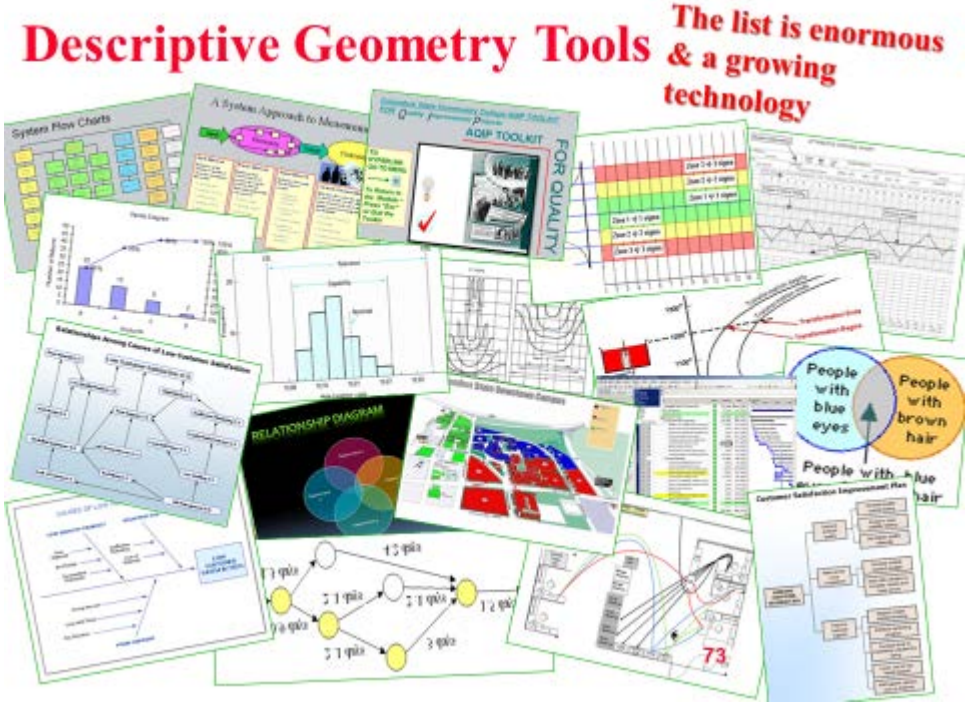
Example of Risk Priority Number Calculation

Process Function / Requirements	Potential Failure Mode	Potential Effect(s) of Failure	Sev	Class	Potential Cause(s)/ Mechanism(s) of Failure	Occur	Current Process Controls	Detec	R.P.N.
Prime spray: Cover facia at specified thickness for proper paint adhesion	Dirt contamination	Surface defects	7		Dry, crumbly overspray booth	8	Maintenance Dept. monitors and cleans	5	280

Risk Priority Number 7x8x5=280

Open copy of Excel Flashlight FEMA

Failure & Mode Effects Analysis



Descriptive Geometry

Descriptive Geometry is a multitude of tools that use a visual to explain pages of dialog, data, etc.

Examples are:

Photos, Expanded Views, Cut Away Views Blue Prints, Flow Charts, Pert Charts, Maps, Pareto Diagrams, Cause and Effect Charts, Gantt Charts, Venn Charts, Histograms, Line Charts, Relationship Diagrams, Organization Charts, etc. etc.

Just-in-Time (JIT)

Just-in-Time is a name given the Toyota Production System developed by Taiichi Ohno at Toyota after WWII (resumed work started by Kiichiro Toyoda before the war) and sometimes referred to as:

- **Lean Manufacturing**
- **Focused Factory**
- **Demand Flow, Demand Flow Technology**
- **Pull System Manufacturing**

Just-in-Time (JIT)

Just-in-Time permits the production of only what is needed, when it is needed, and in the quantity that is needed.

- **In this mode there is no warehouse, no waste, no resources needed for wasted activities.**
- **JIT is more related to manufacturing activities than warehousing or supplier activities.**

–it is much more than having your suppliers deliver material right before/as you are ready for it

Names

You should have noticed by now we have a lot of names for the same thing.

Actually TQM or Total Quality Management is the parent of all quality systems, which we will discuss later.

TQM started in 1951 before computers we in great supply, so when PCs became common place and software, such as Microsoft Office, Minitab etc. became common place, PCs and their analysis and mathematical ability greatly influenced the quality fields.

Six Sigma is just TQM on steroids, or TQM with Minitab to create real time analysis and charts at the highest level or JIT

Why do it

- **To save dollars**
- **Only produce what is needed, do not depend on marketing forecasts, which are difficult to do accurately**
- **Save money within the plant by reducing on hand inventory, WIP, time spent shifting material, storage costs, etc.**

Why do it?

When comparing lean Manufacturing to Mass Production. The book " The Machine That Changed The World" by James Womack, Daniel Jones and Daniel Roos, claimed that Lean Production vs. Mass production requires:

- **½ the human effort**
- **½ the manufacturing space**
- **½ the investment tools**
- **½ the engineering hours**
- **½ the development time for new products**

All of theses are significant Cost, Time Issues & ISE Topics…

If Asked Why Do It?

These Slides Explain it All

What is it?

The Text " The Machine That Changed The World" outlined the following principle of "Lean Production which included:

- **Teamwork**
- **Communication**
- **Efficient use of resources and elimination of waste**
- **Continuous Improvement**

What's Wrong with Mass Production?

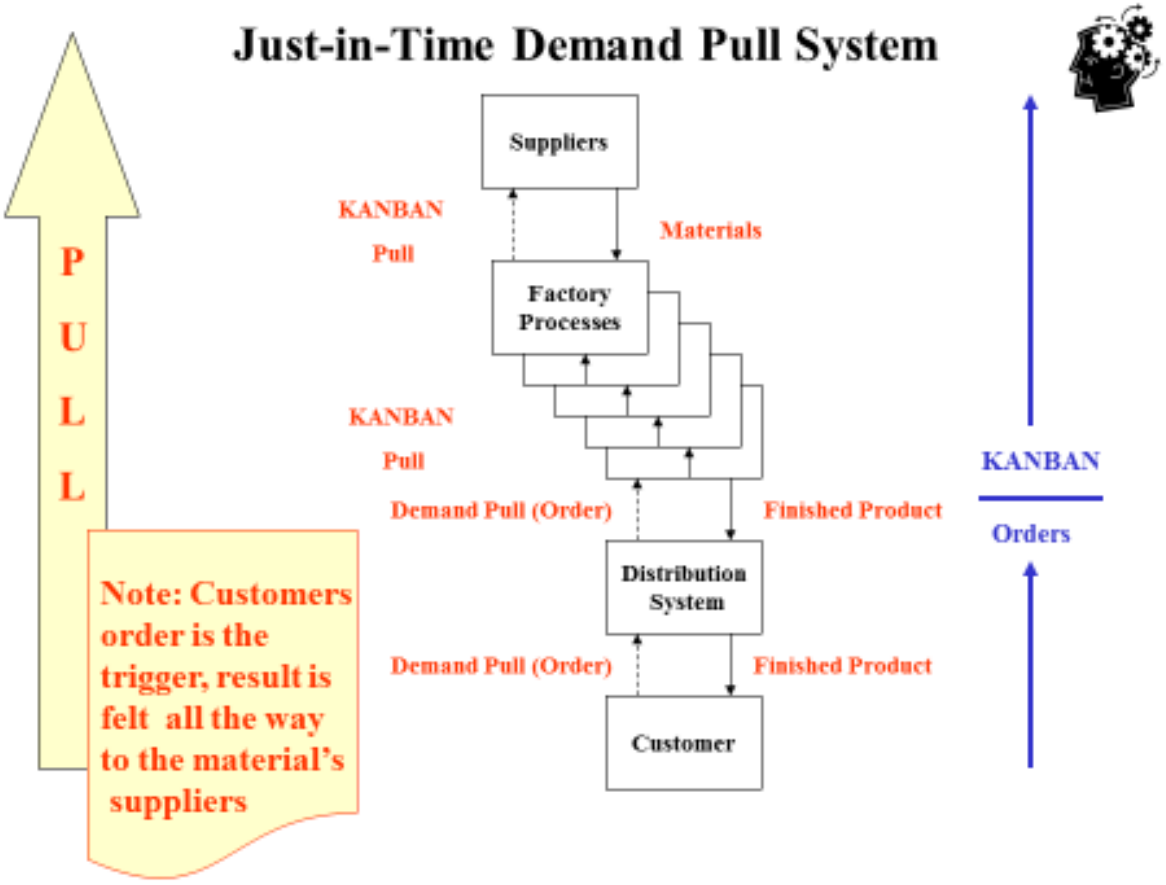
- **Inflexible: Machines are often run constantly just because they are expensive; changeover to different product lines is very time consuming**
- **Wasteful: Always pumping out product under the assumption that a high volume is needed**
- **To 'save for a rainy day' parts are overproduced and stored**

JIT Demand Pull System

JIT is a pull system where a production schedule does not originate in a forecast.

- **The customer originates the production demand…**
- **The finish production line pulls the product through the factory…**
- **The factory pulls needed supplies from their suppliers, etc...**

Just-in-Time Demand Pull System



JIT Eliminates the 7 Wastes…

1. **Overproduction: storage and inventory of finished products**
2. **Waiting: downtime due to setup changes, equipment breakdown, material or part shortages**
3. **Transporting: moving materials or people**
4. **Processing: minimize the number of process steps, such as by reducing the number and kinds of fasteners**

JIT Eliminates the 7 Wastes…

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JIT Eliminates the 7 Wastes

5. Unnecessary stock: raw materials or WIP in storage
6. Unnecessary motion: eliminate processes are actions which do not add value (like getting WIP from a storage area)
7. Producing defective goods: if defective goods are being produced, stop the process

Internal (JIT) MUDA Relationships

Internal Supplier-Customer Relationships:

MUDA is a the Japanese word for waste. Originally the 7 waste, but the 8th has been added to address the waste of human capital

1. **Overproducing**
2. **Waiting**
3. **Transporting**
4. **Processing itself**
5. **Having unnecessary stock on hand**
6. **Using unnecessary motion**
7. **Producing defective goods**
8. **Human Resource Potential**

8 Classic Forms of Waste

Process improvement requires elimination of waste.
Remember ***TIM P WOOD***

Transportation (unnecessary conveyance)
Inventory
Motion
People Underutilization
Waiting (delays)
Over processing (doing extra steps)
Overproduction (doing work not requested)
Defects (includes rework/repair rime to correct mistakes)

Lean Tools and Techniques

- Lean thinking generates process improvement by following five key steps:
  - 1. Study the process by directly observing the work activities, their connections and flow.
  - 2. Study the process to systematically eliminate wasteful activities, their connections and flow.
  - 3. Establish agreement among those affected by the process in terms of what the process needs to accomplish and how the process will accomplish it.
  - 4. Attack and solve problems using a systematic method, like the PDCA Cycle.
  - 5. Integrate the above approach throughout the organization

Lean Tools and Techniques

- Lean tools include:
  - Kaizen
  - Value stream process mapping
  - 5 S
  - Kanban
  - Error proofing
  - Preventive and predictive maintenance
  - Setup time reduction
  - Reduced lot sizes
  - Line-balancing
  - Schedule leveling
  - Standardized work
  - Visual Management

Kaizen

Kaizen is the name given by Japanese to the concept of continual incremental improvement.

- ***Kai* means change**
- ***Zen* means good**

Kaizen uses all the quality tools, philosophies and techniques we have discussed to date and more…

Trained Teams such as yourselves are empowered to evaluate and change the undesirable to a improved state…

Kaizen Philosophy

If the kaizen philosophy is in place, all aspects of an organization should be improving all the time.

- **People**
- **Processes**
- **Management Practices**
- **Products**

Kaizen Value System

The underlying value system of kaizen can be summarized as continual improvement of all things, at all levels, all the time, forever.

Elements of Kaizen

Kaizen and Problem Solving

The starting point for improvement is to recognize the need, which comes from recognition of a problem!

If no problem is recognized there is no recognition of the need for improvement!

Complacency is the arch-enemy of Kaizen

The Kaizen Five-Step Plan

The Five-Step Plan is the Japanese approach to implementing Kaizen.

Step 1: Straighten up

Step 2: Put things in Order

Step 3: Clean up

Step 4: Personal Cleanliness

Step 5: Discipline

Lean Tools and Techniques

- The American version of the Five Step is the 5S Programs: we will discuss in Lecture 5. The Japanese words for the 5S are:
  - Seiri — Separate
  - Seiton — Arrangement
  - Seiso — Cleanliness
  - Seiketsu — Repeat seiri, seiton, and seiso at regular intervals
  - Shitsuki — Discipline

Why Technique or Root Cause Analysis

"WHY" TECHNIQUE

Some of the tools for continuous improvement require number-crunching, graphing and analysis -- but not all of them. Perhaps one of the most powerful tools is also one of the most basic. It has less to do with number crunching and more to do with simple curiosity. We refer to that old standby question: "Why?"

By asking "why," you can peel back the layers to discover the root cause of a problem. This may require you to ask "why" more than once -- sometimes as many as five to six times. Keep probing to find why the symptom (or "effect") is occurring. You'll eventually come to the root cause.

The process is also called "Root Cause Analysis"

Why Technique or Root Cause Analysis Example

PROBLEM: SUPPLY ORDERS AREN'T FILLED ON TIME

1ST LAYER	**WHY** aren't supply orders filled in time? ***Because the supplies are not in stock.***				
	2nd LAYER	**WHY** aren't the supplies in stock? ***Because the supply shipment has not been received.***			
		3rd LAYER	**WHY** hasn't the supply shipment been received? ***Because the order was placed late.***		
			4TH LAYER	*WHY was the order placed late?* ***Because the order / request for supplies takes 3 weeks to get approved.***	
				5th LAYER ***THE ROOT CAUSE***	**WHY** does the order / request for supplies take 3 weeks to get approved? ***Because it is in transit for 12 days, going from one approval authority to another (total approvals needed = 5).***

Why Technique Example

(The "Five Whys")

Effects of not getting to the systemic failure

	Level of Problem	Corresponding Level of Countermeasure
	Puddle of oil on the shop floor	Clean up the oil
Why?	Because the machine is leaking oil	Fix the machine
Why?	Because the gasket has deteriorated	Replace the gasket
Why?	Because we bought gaskets made of inferior material	*Change gasket specifications*
Why?	Because we got a good deal (price) on those gaskets	*Change purchasing policies*
Why?	Purchasing is evaluated on short-term cost savings	*Change the evaluation policy for purchasing*

The Ability to address the issue changes here ←

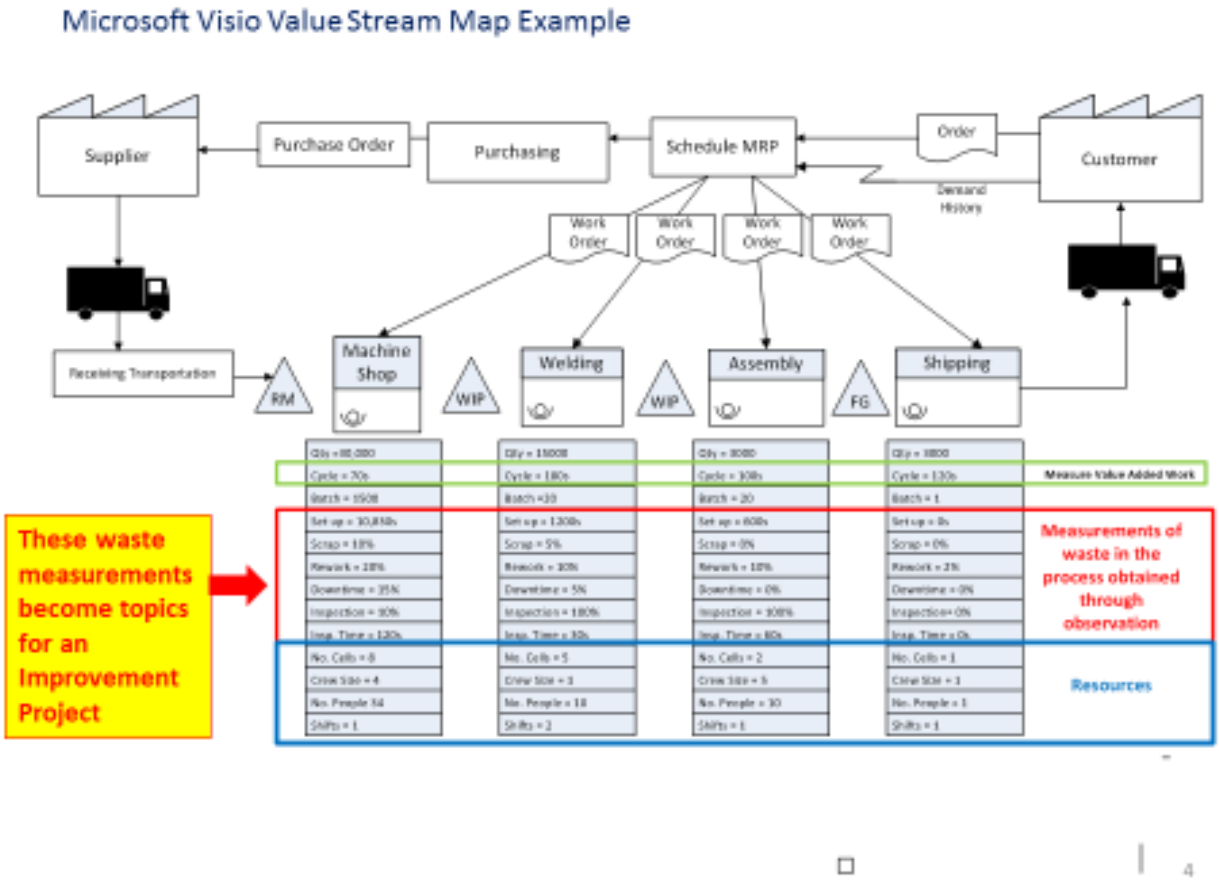
This may require higher lever authority!

Deal with that within our power & communicate without fear that which must be dealt with at a higher level!

Chapter 5 Value Stream Mapping

Lean Tools and Techniques

- Value Stream Process Mapping
  - Value streams are the actions required to create a product or service from raw material until it reaches the customer.
    - A value stream may include both value and non-value added activities.
  - Value stream process maps seek to capture the activities taking place while people do the work they do.
  - Value stream process maps will show where improvements can be made to eliminate non-value added activities.



Value Stream Mapping Definitions

Value Stream Mapping (VSM)

- A special type of flow chart that use, measurements and symbols known as "the language of lean"
  - They illustrate, measure, and improve the performance elements of a flow chart.
  - They are indicators of undesirable areas in need of improvement of inventory and information flow.

Value Stream Mapping Purpose

To provide optimal value to the customer through a complete value process with minimal waste in:

- Design from concept to delivery to the customer.
- Build from the order to the delivery to the customer.
- Warranty (through life cycle of service).

Why Do It?

- Kaizen events or a Continuous Improvement Project is not enough.
  - These are limited events…
- Value Stream Mapping & Analysis strengthen the gains by providing vision and tactics that connect all improvement activities
- It is a tool that allows you to visualize waste and eliminate it!

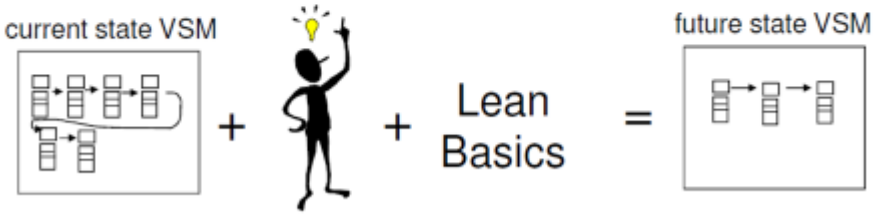
Value is What The Customer is Buying!

Defined by the customer as a capability provided:

- Of the highest value.
- At the right time and place.
- At an appropriate price

What Is Value Stream Analysis?

Planning tool to optimize results of eliminating waste



What is Value that Flows

Viewing value from the perspective of the customer ask how you current products, services, and processes dissatisfy your customers expectations such as:

- Price
- Quality
- Reliability
- Delivery
- Response to changing requests

What Flows?

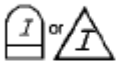
"Items" flow through a value stream

- In Administration internal customer needs are items.
- In Design & Development the design and specs are items.
- In Manufacturing parts, assemblies, and materials are items.
- In Service external customers needs are items.

Value Stream Mapping Process Symbols

	Customer/Supplier Icon: represents the Supplier when in the upper left, customer when in the upper right, the usual end point for material
	Dedicated Process flow Icon: a process, operation, machine or department, through which material flows. It represents one department with a continuous, internal fixed flow.
	Shared Process Icon: a process, operation, department or workcenter that other value stream families share.
	Data Box Icon: it goes under other icons that have significant information/data required for analyzing and observing the system.
	Workcell Icon: indicates that multiple processes are integrated in a manufacturing workcell.

Value Stream Mapping Material Symbols

	Inventory Icons: show inventory between two processes
	Shipments Icon: represents movement of raw materials from suppliers to the Receiving dock/s of the factory. Or, the movement of finished goods from the Shipping dock/s of the factory to the customers
	Push Arrow Icon: represents the "pushing" of material from one process to the next process.
	Supermarket Icon: an inventory "supermarket" (kanban stockpoint).
	Material Pull Icon: supermarkets connect to downstream processes with this "Pull" icon that indicates physical removal.

Value Stream Mapping Material Symbols (Cont.)

	FIFO Lane Icon: First-In-First-Out inventory. Use this icon when processes are connected with a FIFO system that limits input.
	Safety Stock Icon: represents an inventory "hedge" (or safety stock) against problems such as downtime, to protect the system against sudden fluctuations in customer orders or system failures.
	External Shipment Icon: shipments from suppliers or to customers using external transport

Value Stream Mapping Information Symbols

	Production Control Icon: This box represents a central production scheduling or control department, person or operation.
	Manual Info Icon : A straight, thin arrow shows general flow of information from memos, reports, or conversation. Frequency and other notes may be relevant.
	Electronic Info Icon : This wiggle arrow represents electronic flow such as electronic data interchange (EDI), the Internet, Intranets, LANs (local area network), WANs (wide area network). You may indicate the frequency of information/data interchange, the type of media used ex. fax, phone, etc. and the type of data exchanged.
	Production Kanban Icon : This icon triggers production of a pre-defined number of parts. It signals a supplying process to provide parts to a downstream process.
	Withdrawal Kanban Icon : This icon represents a card or device that instructs a material handler to transfer parts from a supermarket to the receiving process. The material handler (or operator) goes to the supermarket and withdraws the necessary items.

Value Stream Mapping Information Symbols (Cont.)

	Signal Kanban Icon : used whenever the on-hand inventory levels in the supermarket between two processes drops to a trigger or minimum point. It is also referred as "one-per-batch" kanban.
	Kanban Post Icon : a location where kanban signals reside for pickup. Often used with two-card systems to exchange withdrawal and production kanban.
	Sequenced Pull Icon: represents a pull system that gives instruction to subassembly processes to produce a predetermined type and quantity of product, typically one unit, without using a supermarket.
	Load Leveling Icon : a tool to batch kanbans in order to level the production volume and mix over a period of time.
	MRP/ERP Icon : scheduling using MRP/ERP or other centralized systems.

Value Stream Mapping Information Symbols (Cont.)

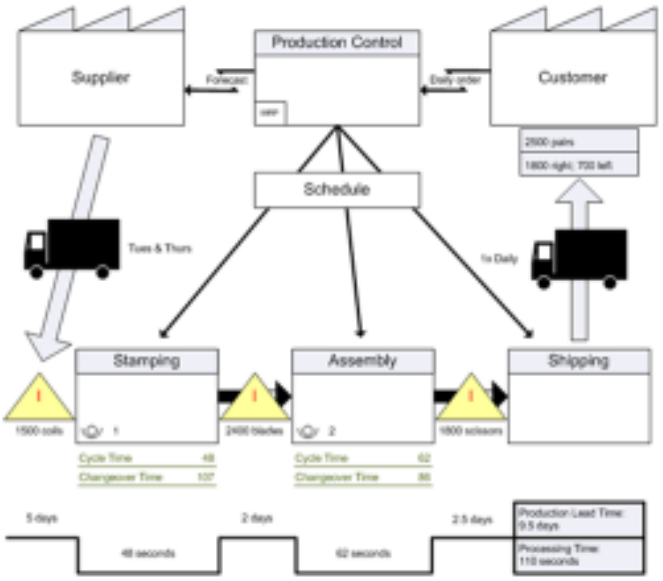
	Go See Icon : gathering of information through visual means.
	Verbal Information Icon: represents verbal or personal information flow.

Visio Example

A Microsoft Visio example from Microsoft Support gives us the visual of flow with the measurements to establish a baseline benchmark.

Undesirable measures can be addressed using tool we have already learned and many more yet to be explained

The following example shows a simplified current state diagram.



What is Value Analysis?

Value Analysis is a systematic, creative approach to ensure that the essential functions of a product, process, procedure, or service are provided at a minimum total cost consistent with the required performance, reliability, quality, and maintainability.

Value Analysis is the systematic application of recognized techniques that:

- Identify the functions of a product or service
- Establish a value for those functions
- Endeavor to provide those functions, reliably, at the lowest total cost.

For Example: What is the function of a Light Bulb…

If we picked to signal from the list, how many things could you think of rapidly...Can you describe a value for the items pictures?

Other functions of a light bulb are: Provide Heat to warm food or hatch eggs, Light rooms, Light streets, light parking lots, advertise, project pictures, direct airplanes to gates, etc.

Value Analysis is a technique for identifying and removing Unnecessary Cost

- **What are unnecessary**

Unnecessary Costs

These are costs that do not contribute to the accomplishment of the required junctions. They can be removed without impairing the essential performance, quality, reliability, maintainability, sale-ability, etc.

Some of the more common reasons for unnecessary costs are:

- Lack of information (cost, usage) or inaccurate information, before decisions are made
- Lack of ideas or alternatives
- Expediency or temporary circumstances –shortage of time
- Honest but wrong beliefs, mental blocks in certain areas
- Habits and attitudes of persons or organizations
- Policies, procedures, and traditions of organizations, companies, or industries
- Lack of value measurement
- Impact of technological advances
- Insufficient-or excessive -standardization or N.I.H.* factor. (*Not Invented Here.)

Chapter 6 Stability & Standardization

"I would argue that Lean Tools & Techniques require the knowledge of Descriptive Geometry & Descriptive Statistics to be both Efficient & Effective in the workplace.

You may master the engineering skills needed and be a top notch mathematician, but if you cannot communicate with Visual Descriptive Tools & apply Visual Application Tools, no one may ever know it!"

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Lean Tools and Techniques

Visual Management is all around us today! When driving my car gauges tell me the tank is full and warn me to fill up with a little light, I stay between white lines that indicate my lane on the freeway and yellow line tell me not to pass.

My GPS alerts me to lane changes miles ahead of time and if going to the airport international signs tell all regardless of language barriers all that's needed to park and navigate to restrooms, baggage check-ins and boarding procedures.

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Lean Tools and Techniques

Visual Management

- Visual management reduces training & work time.
- Visual management keeps us from getting lost
- Visual management transcends language barriers.
- Visual management reduces ergonomic issues & makes us safer.
- Visual management enables someone looking at a job or a work space to know in at a glance that something has been misplaced or mismanaged.
- Visual management encourages a place for everything, everything to have its place & eliminating unneeded item.

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Make it Visual

To make it visual we must learn to communicate with things we see:

Example:

- We clean the workplace and put up a sign that said "Keep it Clean"…it got dirty over time!
- We cleaned the workplace, *Used a 5s Tool and* , took a picture of it clean and put it under the Keep it Clean sign, we then wrote on the sign this is what clean looks like…it stayed clean!

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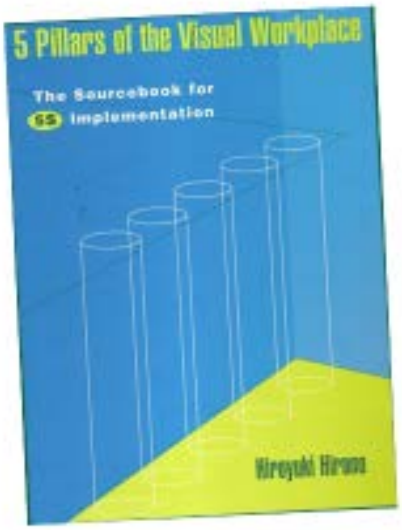
The American Standard Kaizen or the 5S's



The author Hiroyuki Hirano was born in 1946 and graduated from Senshu University's School of Economics in 1970 He joined a large software company to work in the consulting division.

- There he laid the conceptual groundwork for Japans first full fledged production management system.
- His personal interpretations of the JIT or Just-in-Time philosophy revolutionized the Toyoda Manufacturing System
- His philosophy which emphasized the elimination of waste resulted in what we call Lean Manufacturing today!

The whole idea of 5-S is to organize and clean up your workspaces in order to improve safety, efficiency, and effectiveness as well as to eliminate waste and frustration in your daily work…

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5S's Origin

The 5S's originate from 5 Japanese words that have been translated into English.

As with most interpretations variations will exist due to usage…

Japanese Term	English Comparable
Seiri	**Sort**
Seiton	**Set In Order**
Seiso	**Shine**
Seiketsu	**Standardize**
Shitsuke	**Sustain**

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The 5S's - an English "translation"

1. *Sort:* Clearing the work area
2. *Set in Order:* Designating locations
3. *Shine:* Cleanliness & workplace appearance
4. *Standardize:* Everyone doing things the same way
5. *Sustain:* Ingraining the 5S's into the culture

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5s Step 1

1st Step ~ Sort Clearing the area means organizing the workplace so that it is a more effective, more efficient place to work.

- During this process items not needed are eliminated.
  - Define what is needed.
  - Define what is NOT needed.
  - Disposition the items is determined, keep, move to new location, trash, sell, etc.
  - Take action: Sort out (move out) what is not needed and move in what is needed (and is not there now).

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5s Step 2

Step 2 ~ Set in Order or designating locations is about organization and orderliness.

- It means that there is a place for everything and everything must be in its place.
  - Creating 5s designated locations enables employees to exert visual control over everything needed in the work area.
  - At a glance, employees are able to see if things are in-place or out-of-place and if more materials, supplies, or tools need to be ordered.

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5s Step 3

Step 3 ~ The Shine phase is more than making the work area spic and span.

- There are three aspects of shine: getting the workplace clean, maintaining its appearance, and using preventive measures to keep it clean.
  - Continued housekeeping is one way to keep the work area, tools, and equipment clean, but cost money.
  - Root cause analysis, mistake-proofing, and the use of preventive measures are important to keep the workplace clean and orderly & save money.

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5s Step 4

Step 4 ~ Standardize, the fourth of the 5S's, involves putting the systems in place to ensure that everyone does things the same way.

- The methodology for Sorting needs to be standardized
- The approach to Set in Order needs to be standardized, and Shine especially needs to be standardized.
- In order to standardize roles and responsibilities must be clear and consistently applied.

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5s Step 5

Step 5 ~ Sustain is perhaps the most difficult phase of the 5S's.

- Sustaining the 5S effort takes a lot of work. It takes commitment and involvement by everyone to keep the effort going and to prevent the organization from just sliding back into the old ways of doing things.
  - Sustaining requires keeping everyone involved, continually reinforcing what and why the 5S's are important.
  - Audits can serve as on-going checks on 5S activities.

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The 5S's lead to Improved Processes and Ultimately:

- Reduced set-up times
- Reduced cycle times
- Increased floor space
- Lowers safety incident/accident rate
- Has less wasted labor
- Improved equipment reliability

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5s & The Seven Waste

The Seven Waste

1. Over Production
2. Unnecessary Stock
3. Inefficient Transportation
4. Unnecessary Motion
5. Waiting Time
6. Rejects & defects
7. Inappropriate Processing

The use of the 5s to attack the Seven Waste is the basis of todays Lean Manufacturing and tomorrows Flexible Manufacturing Systems

tpf

Graphic Source http://www.tpfeurope.com/cms/view/44

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Shigeo Shingo & Poka Yoke

Shigeo Shingo was one of the industrial engineers at Toyoda who has been credited with creating and formalizing **(ZQC)**, Zero Quality Control, an methodology of quality management that relies on the use of Poka-Yoke devices.

Poka-yoke (pronounced POH-kah YOH-kay) is Japanese for mistake-proofing. These devices are used to eliminate mistakes caused by human error such as plugging in an electrical cord backwards with the ground wire hot and the hot wire used as a ground.

Today electrical devices are designed to only assemble in the correct orientation, even batteries will only fit one way!

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Poka-Yoke Examples

This file cabinet has a sign to warn user that they may be harmed by opening too many drawers…wonder where that instruction manual is?

For some file cabinets, opening one drawer locks all the rest, a poke-Yoke solution for reducing the chance of the file cabinet tipping and causing injury to a user.

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Poka-Yoke Examples

Sensor to stop grandkids from opening sliding door on van when the gas cap door is open and causing damage.

Fueling area of car has three fuel system mistake-proofing devices:

- filling pipe insert keeps larger, leaded-fuel or diesel fuel nozzle from being inserted and prevents damage to the engine and exhaust systems.
- gas cap tether does not allow the motorist to drive off without the cap.
- gas cap is fitted with ratchet to signal proper tightness and prevent over-tightening.

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Poke-Yoke Examples

This bathroom sink has a mistake-proofing device. It is the little hole near the top of the sink that helps prevent overflows.

This microwave oven stops operating when the door is opened, which prevents injuries.

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The Kanban

When Taiichi Ohno, considered the father of the Toyoda Manufacturing System, introduced the concept of control from the output level of a factory he also introduced the "Kanban", a Japanese word meaning card, to trigger activity.

- When a succeeding process uses the output from a preceding process it issues a *kanban* or card to the preceding process to produce another…
- Today it is more than just the issuing of cards. It is a bin, spot, a conveyor belt with a predetermined capacity, or a loading mechanism…

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Kanban Management Tool

- Kanban (Pull Inventory Management)
  - Kanban improves process management by focusing on visual control of the process.
  - Kanban devises, slots, spaces, etc. tell the worker what must be produced as well as what has been produced.
  - Workers can not do more than the Kanban device allow them to do.

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Kanban Locations

- A kanban is a signal to trigger replenishment of inventory.
- The kanban signals it is time to pull inventory from storage & to start the next production run.
- A kanban space includes full boxes, peg boards with a specific number of openings or slots, and containers for predetermined quantities.
- Signs above the kanban areas that note the item and maximum quantities that should be stored in the space control *WIP*

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Follow the 6 Kanban Rules…

- Never send defective parts to a downstream process
- The downstream process can only take what is needed when it is needed
- The upstream process can only make as many parts as will be requested by the downstream process *at a given time*
- Smooth the process: so that there is little waiting around for a new Kanban request, use takt time…

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Follow the 6 Kanban Rules

- Follow the rules while fine tuning.
  - this is the only way you can see where adjustments need to be made
- Stabilize and Rationalize the process
  - establish uniform methods
  - reduce confusing and unreasonable steps

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SETUP TIME REDUCTION

Companies, such as Honda in Marysville uses Just-In-Time (JIT) manufacturing which involves the frequent delivery of small lots of material. To supply small lots suppliers must practice Setup Time Reduction a technologies that enable JIT replenishments while raising productivity, lowering inventory, slashing lead time, and improving quality.

Reviewing the slide from our first chapter 12 lecture the waste of storage space, material handling, and cost of large inventories, etc. are eliminated because of the development of Setup Time Reduction Processes

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What is Lean: setup reduction?

Lean: setup reduction is the process of reducing changeover time (i.e., from the last good piece of the previous run to the first good piece of the next run).

- Since setup activities add no marketable form, fit, or function to the product, they are by definition non-value adding.
- By reducing setup time, more setups can be completed each day.

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What are the benefits of Lean: setup reduction?

Implementation of Lean: setup reduction will help reduce batch size, leading to increased frequency of production for each model.

- reduce lead time, resulting in improved delivery.
- improve documentation of setup processes, leading to improved quality.
- decrease inventory and costs, while increasing capacity.

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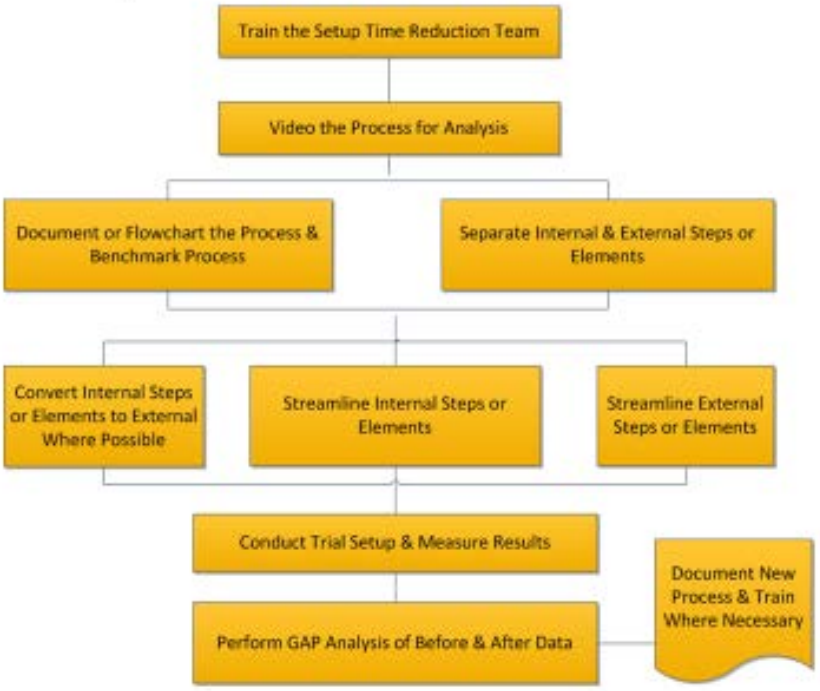
Setup Time Reduction Process



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Total Time

During any CNC machine's usage, there are really only three activities. The machines is down (for either maintenance, or lack of production), is in setup or is running production.

- Setup Time & maintenance time is the total time the machine is down between production runs.
- Cycle Time is the time it takes to complete a Production Run divided by the number of good work pieces produced.

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Setup Time Reduction Process

The setup process is the key function in the total process as it affects all the other time factors

- First allows for orderly, consistent, time saving setups that do not unnecessarily overly burden operators. Rushing, disorientation, and fatigue can cause errors
- It frees up more time to address takt time, and for preventive maintenance, both of which affect quality.
- It ultimately reduces cost & increases quality which aids in sales or more orders.

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Much is Directly Related to Setup:

- Tearing down the old setup
- Putting old tooling away
- Cleaning the machine
- Making the new setup
- Cutting tool tasks
  - Assemble, measure, and enter offsets
  - Assign program zero
  - Measure position and enter fixture offsets
- Load program
- Verify program
- Optimize program

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And some non-productive setup activities:

- Time spent gathering needed items
- Personal time
- Time spent waiting:
  - Looking for lost items
  - For inspection
  - For tool crib attendant
  - For fork lift operator

These are all normal items found during a setup reduction program!

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But maybe some non-productive activities that can be eliminated or done prior to a setup:

- Time spent gathering needed items
  - Hand tools
  - Cutting tools
  - Fixtures
  - Gauges
  - Material
  - Paperwork
  - Storage containers

Tool carts used to store only the setup tool needed can be laid out in an orderly fashion to be most efficient & Designated Setup Carts used to store the last setup for future use and another Designated Setup Cart for the new part number or next setup.

The old setup can be inspected to replace worn items and immediately stored for reuse.

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Setup Cost Savings

Down Time Reduction and Production Time Increases will pay for any cost occurred developing carts, storage containers, etc. use to organize tools & setup materials.

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