Unit - V

Robust Design and Taguchi Method, Design Failure Mode & Effect Analysis, Product Reliability Analysis, Case study on Six Sigma in Product Development, KIzen, 5S, etc.

Robust Design and Taguchi Method, Design Failure Mode & Effect Analysis, Product Reliability Analysis, Case study on Six Sigma in Product Development, KIzen, 5S, etc.

5.1 Robust Design and Taguchi Method

What is Robust Design?

- Robust design is an "engineering methodology for improving productivity **during research and development** so that high-quality products can be produced quickly and at low cost"(Phadke, 1989)
- A design whose performance is insensitive to variations.
- An experimental method to achieve product and process quality through designing in an insensitivity to noise based on statistical principles.

5.1 Robust Design and Taguchi Method

- Robust design of Product
- Robust design of Process

Robust product design

- It is defined as reducing variation in a product without eliminating the causes of the variation.
- Making the product or process insensitive to variation.

The variation (sometimes called noise) can come from a variety of factors and can be classified into three main types:

- Internal variation
  - Internal variation is due to deterioration such as the wear of a machine, and aging of materials.
- External variation
  - External variation is from factors relating to environmental conditions such as temperature, humidity and dust.
- Unit to unit variation
  - Unit-to-unit variation is variations between parts due to variations in material, processes and equipment.

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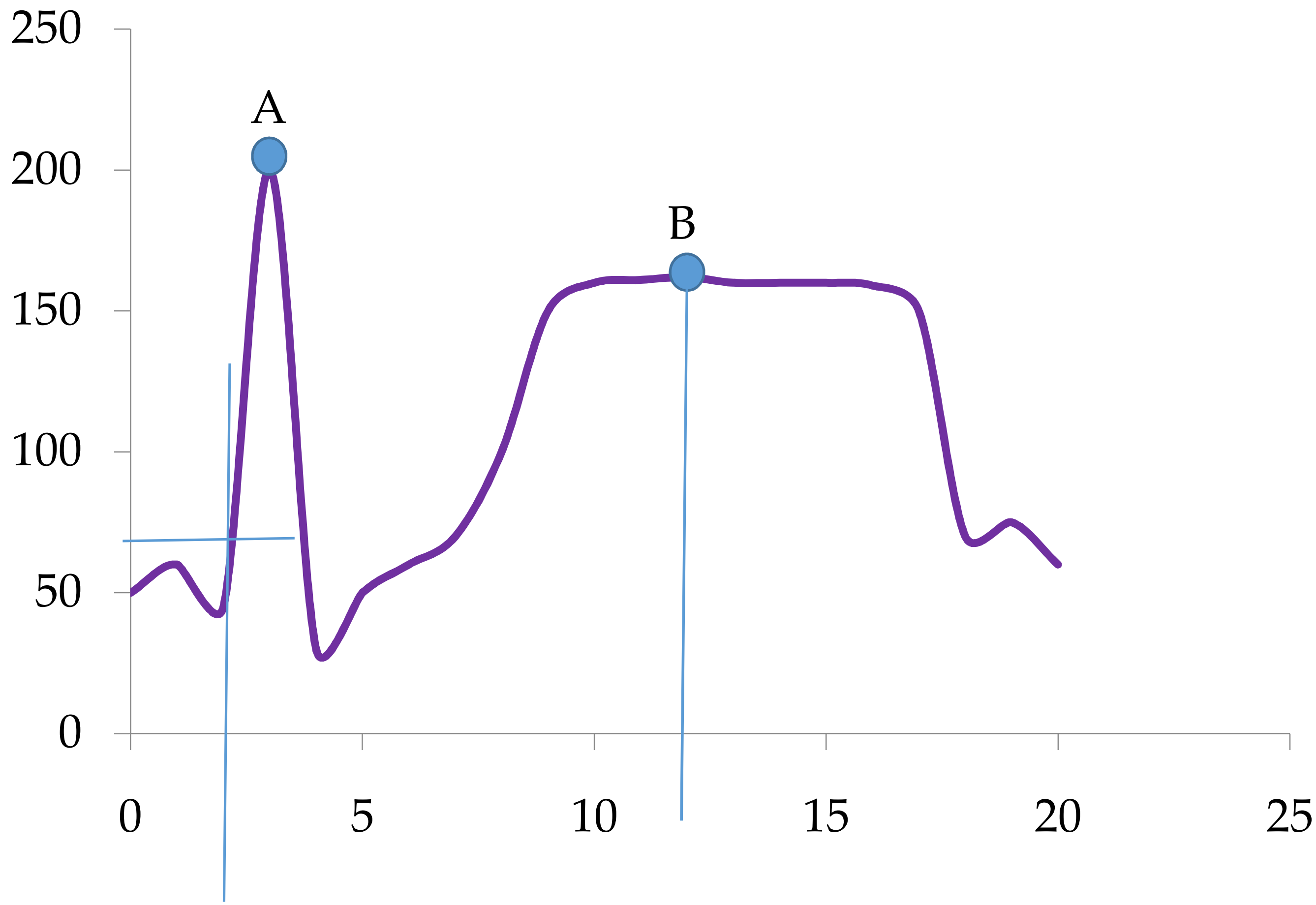
5.1 Robust Design and Taguchi Method

What is Robust Design?



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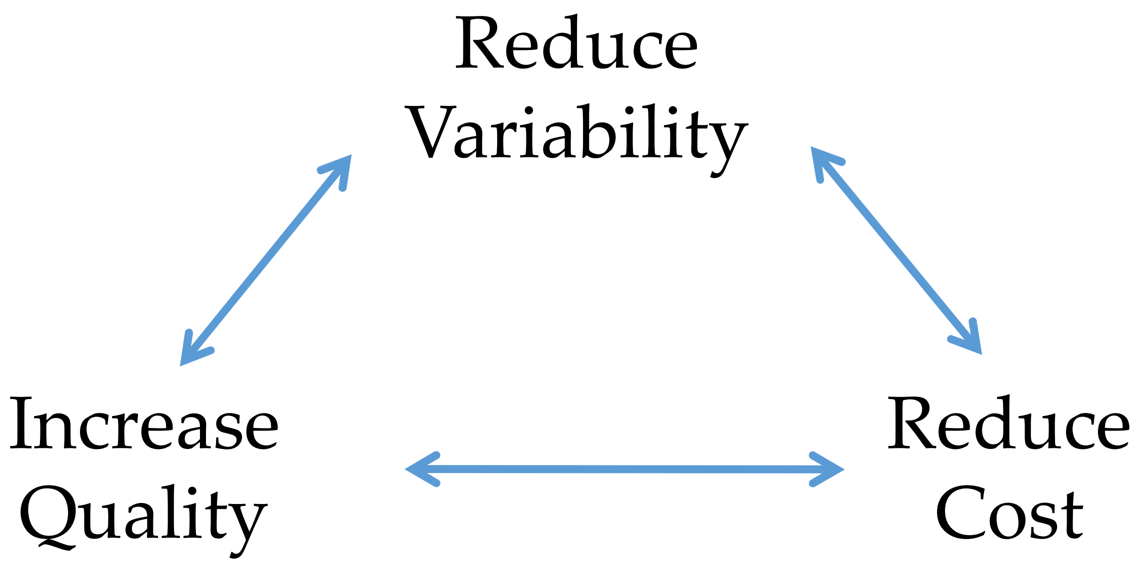
5.1 Robust Design and Taguchi Method

The Basic Idea Behind Robust Design

ROBUSTNESS ≡ QUALITY



5.1 Robust Design and Taguchi Method

Applications of Robust Design: (Examples)

An automobile manufacturer wants to improve the quality of the painted surface of its cars. Quality is measured by the gloss reading of the surface. The manufacturer wants the painted surface to have a higher gloss reading (i.e., maximize the response) and to be robust against the environment. Environmental factors, particularly temperature and humidity, are known to affect the painted surface. Thus, a robust design will be used here.

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5.1 Robust Design and Taguchi Method

Applications of Robust Design: (Examples)

- ✓ Umbrella fabric that will not deteriorate when exposed to varying environments (external variation)
- ✓ Food products that have long shelf lives (internal variation)
- ✓ Replacement parts that will fit properly (unit-to-unit variation).

5.1 Robust Design and Taguchi Method

- Systemized statistical approach to product and process improvement developed by Dr. Genichi Taguchi
- Approach emphasizes moving quality upstream to the design phase
- Based on the notion that minimizing variation is the primary means of improving quality
- Special attention is given to designing systems such that their performance is insensitive to environmental changes

5.1 Robust Design and Taguchi Method

History of the method

- Dr. Genichi Taguchi in Japan: 1949-NTT
  - develops "Quality Engineering"
  - 4 time winner of Demming Award
- Ford Supplier Institute, early 1980s
- American Supplier Institute, ASI
  - Engineering Hall of Fame
- Statistics Community
  - DOE
  - S/N Ratio

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5.1 Robust Design and Taguchi Method

Who uses Taguchi's Methods

- Lucent
- Ford
- Kodak
- Xerox
- Whirlpool
- JPL
- ITT
- Toyota
- TRW
- Chrysler
- GTE
- John Deere
- Honeywell
- Black & Decker

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5.1 Robust Design and Taguchi Method

Documented Results from Use

- 96% improvement of NiCAD battery on satellites (JPL/ NASA)
- 10% size reduction, 80% development time reduction and 20% cost reduction in design of a choke for a microwave oven (L.G. Electronics)
- $50,000 annual cost savings in design of heat staking process (Ann Arbor Assembly Corp)
- 60% reduction in mean response time for computer system (Lucent)
- $900,000 annual savings in the production of sheet-molded compound parts (Chrysler)
- $1.2M annual savings due to reduction in vacuum line connector failures (Flex Technologies)
- 66% reduction in variability in arrival time and paper orientation (Xerox)
- 90% reduction in encapsulation variation (LSI Corp)

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5.1 Robust Design and Taguchi Method

Insensitivity to Noise

- Noise = Factors which the engineer can not or chooses not to control
  - Unit-to-unit
    - Manufacturing variations
  - Aging
    - Corrosion
    - UV degradation
    - wear
  - Environmental
    - human interface
    - temperature
    - humidity

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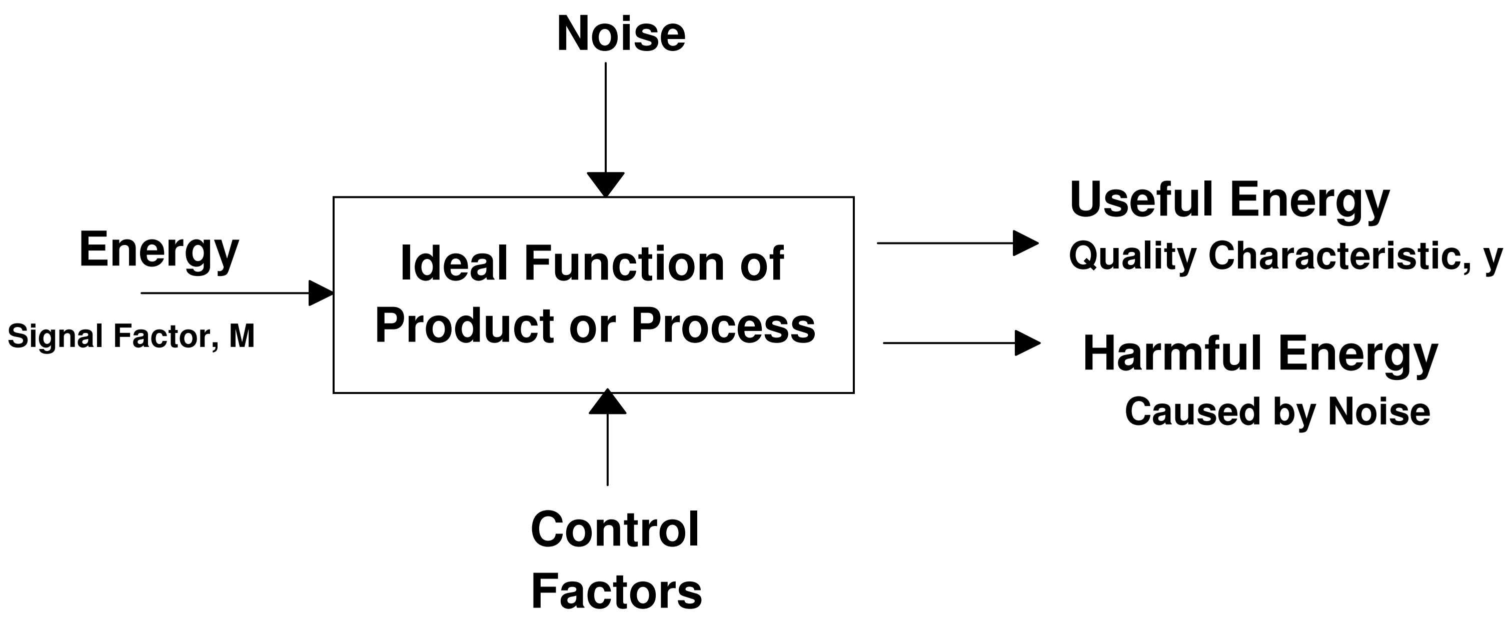
5.1 Robust Design and Taguchi Method

How Noise Affects a System



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5.1 Robust Design and Taguchi Method

How Taguchi's Method Differs from Traditional Design of Experiments

- Focused on reducing the impact of variability rather than reducing variability
- Focused on noise effects rather than control factor effects
- Clearly focused cost function - maximizing the useful energy
- Tries to reduce interaction between control factors rather than study them Requires little skill in statistics
- Usually lower cost

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5.1 Robust Design and Taguchi Method

The Robust Design method or the Taguchi approach makes it possible for engineers to:

- Improve processes and products which are intended under a broad variety of consumer's circumstances in their life cycle and making processes reliable and products durable
- Capitalize and get the most out of robustness by developing the planned function of a product by improving and expanding insensitivity to factors of noise which somehow discredit performance
- Alter and develop formulas and processes of a product to arrive at the performance desired at a reduced cost or the lowest rate possible but, at the shortest turnaround or time frame
- Make designs easier and processes at a reduced cost

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5.2 Design Failure Mode & Effect Analysis

Failure Mode and Effect Analysis (FMEA)

- It is a process that identifies all the possible types of failures that could happen to a service and potential consequences of those failures.
- A structured approach to:
  - Identifying the ways in which a process can fail
  - Estimating risk associated with specific causes
  - Prioritizing the actions that should be taken to reduce risk
  - Evaluating design validation plan (design FMEA) or current control plan (process FMEA)

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5.2 Design Failure Mode & Effect Analysis

History of FMEA

- First used in the 1960's in the Aerospace industry during the Apollo missions to check the space hardware
- In 1974, US Navy developed MIL-STD-1629 regarding the use of FMEA
- In the late 1970's, the automotive industry was driven by liability costs to use FMEA
- Later, the automotive industry saw the advantages of using this tool to reduce risks related to poor quality

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5.2 Design Failure Mode & Effect Analysis

FMEA Terms

- Failure mode
  - The way in which something might fail
  - Things that could go wrong
  - The way in which the steps and / or the process could fail to perform its intended function
  - Failure modes may be the result of upstream operations or may cause downstream operations to fail
- Effects analysis – studying the consequences of the various failure modes to determine their severity to the customer

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5.2 Design Failure Mode & Effect Analysis

- Design Failure Mode and Effect Analysis (DFMEA) is a systematic group of activities used to determine how to recognize and evaluate potential systems, products or process failures.
- DFMEA identifies the effects and outcomes of failures, actions that could eliminate or mitigate the failures and provides a historical written record of the work performed.
- It is a method used for identifying potential risks introduced in a new or changed design of a product or service.
- It analyze the product design before it is released to manufacturing. It identifies design functions, failure modes and their effects on the customer with corresponding severity ranking / danger of the effect.
- It also tracks improvements through Risk Priority Number (RPN) reductions by comparing the before and after RPN.

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5.2 Design Failure Mode & Effect Analysis

Why DFMEA ?

- Early risk identification helps in verified mitigation prior to program launch.
- Risks are identified on designs, which if left unattended, could result in failure. It is applied when:
  - There is a new design with new content.
  - There is a current design with modifications, which also may include changes due to past failure.
  - There is a current design being used in a new environment or change in duty cycle.

5.2 Design Failure Mode & Effect Analysis

Objective

- To define and guide a logical design process.
- To identify, quantify and reduce design risk.
- To provide a traceable document for design and development.
- To justify design activities.
- To provide a means for continuous product improvement.

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5.2 Design Failure Mode & Effect Analysis

Responsibility & Scope

- The DEMEA is a team function
- All team members should participate.
- Multi-disciplinary expertise and input is beneficial.

Input from all engineering fields is desirable.

- Representatives from all areas (not just technical cfsciplines) are generally

included as team members.

The DFMEA is not a one meeting activity

- The DFMEA will be refined and evolve with the product.
- Numerous revisions are required to obtain the full benefit of the DFMEA.

The DEMEA includes all systems, sub-systems, and components in the

product design.

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5.2 Design Failure Mode & Effect Analysis

DFMEA Methodology

There are 11 steps to complete DFMEA:

1. Design Review.
2. Brainstorm Potential Failure Modes.
3. List Potential Failure modes.
4. List potential effects of failure modes.
5. Assign the severity ranking.
6. Assign the occurrence ranking. (1 to 10)
7. Assign detection ranking.
8. Calculate SOD.
9. Develop action plan.
10. Implement the improvement identified.
11. Calculate RPN and DO mistake proofing.

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5.2 Design Failure Mode & Effect Analysis

DFMEA Inputs

- Product Design Requirements
  - Design requirement document
  - Legal and technical regulations
- Bill of Materials (BOM) and Specific Hardware
  - List of components
  - Components and/or samples as supplied by the customer
- product Definition
  - Drawings, sketches, animations, and simulations
  - Description of systems and components
  - What are the functions of the components listed on the BOM?
- Previous Experience (Lessons Learned from Others)
  - Experience with similar concepts, designs, and DFMEA
  - Customer and supplier inputs
  - Design guides and design standards (for example ASME codes)

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5.2 Design Failure Mode & Effect Analysis

DFMEA Outputs

- RPN: Risk Assessment Number
  RPN = (Severity) x (Occurrence) x (Detection)
  - Identification Of both systems and components with high RPN values represents a summary of high risk items.
  - Ranking Of RPN to provide guidance on critical design issues
  - Address the highest RPN items first!
- Identification of Critical and Significant Characteristics
  - This is also normally required by a customer
- The DFMEA is an Output to the Customer
  - Be aware that the customer may be internal or extemal
  - Internal customers may include other engineering groups or non-technical groups such as procurement, manufacturing. safety, etc.

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5.2 Design Failure Mode & Effect Analysis

Benefits

- Identifies foreseeable failure modes and ranking failure according to their impact on the product.
- Analyzes product design before it is released to production.
- It analyzes systems and subsystems in early concept and design stages.
- It provides critical input for the planning Of effective design test and development programs.
- It provides an open issue format for recommending and tracking risk reduction actions.

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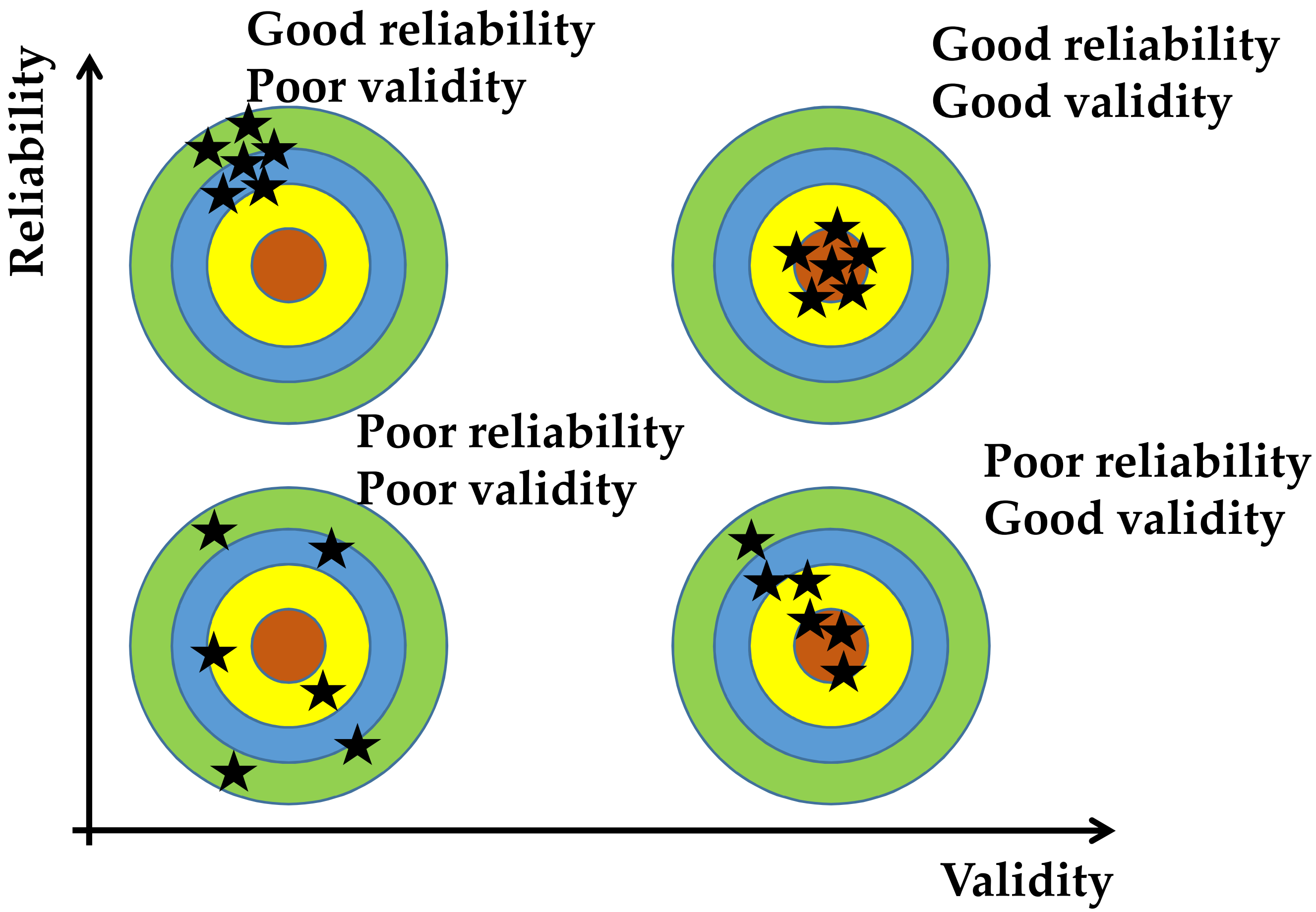
5.3 Product Reliability Analysis

Reliability

Reliability is the overall consistency of a measure.



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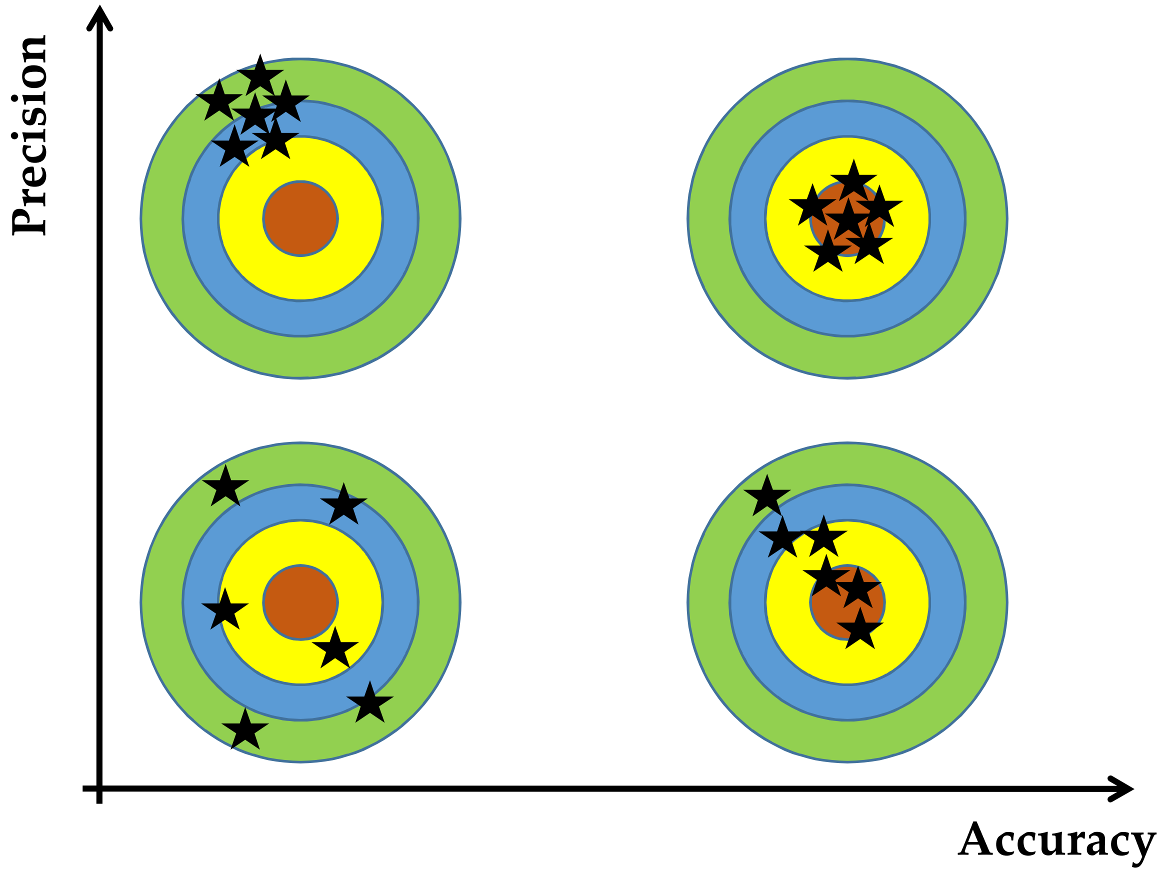
5.3 Product Reliability Analysis

Reliability : Reflection of "Precision"



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5.3 Product Reliability Analysis

Reliability: A measure of how dependably an observation is exactly the same when repeated. It refers to the measuring procedure rather than to the attribute being measured.

Simply put: Will one get the same values if the measurements are repeated?

Validity: The extent to which the study measures what it is intended to measure.

Simply put: Are the values describing what was supposed to be measured?

Lack of validity is referred to as '**Bias**' or '**systematic error**'.

Accuracy: The degree to which a measurement represents the true value of something.

Simply put: How close a measurement is to the true value

Precision: The degree of resemblance among study results, were the study to be repeated under similar circumstances.

Simply put: How close the measurements are to each other

Lack of precision is referred to as **'random error'.**

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5.3 Product Reliability Analysis

Product Reliability

Product Reliability is defined as the probability that a device will perform its required function, subjected to stated conditions, for a specific period of time. Product Reliability is quantified as MTBF (Mean Time Between Failures) for repairable product and MTTF (Mean Time To Failure) for non-repairable product.

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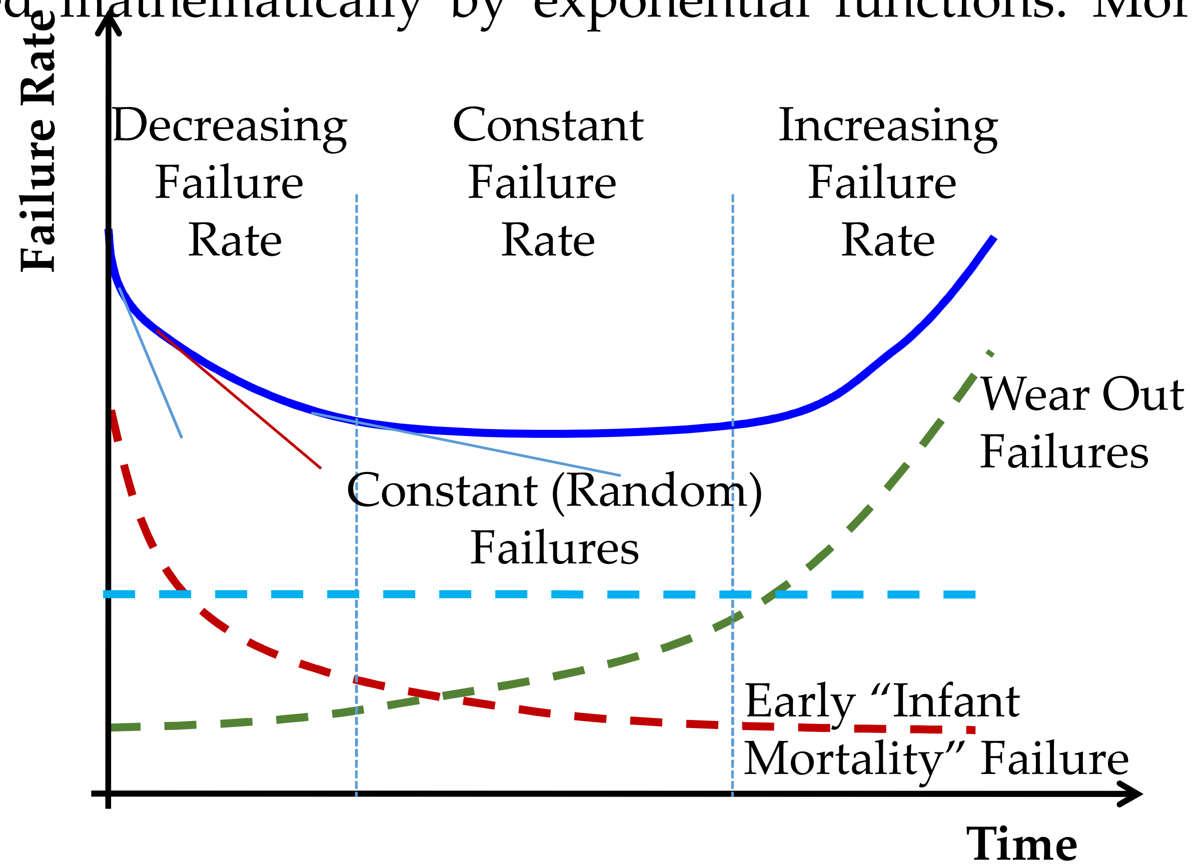
5.3 Product Reliability Analysis

The Famous Bathtub Curve

The reliability "bathtub curve" which models the cradle to grave instantaneous failure rate vs. time, which we would see if we were to wait long enough and keep good records for a given lot of devices. This curve is modeled mathematically by exponential functions. More on this later.



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5.3 Product Reliability Analysis

The Famous Bathtub Curve

The life of a population of devices (a group of devices of the same type) can be divided into three distinct periods:

Early Life

If we follow the slope from the leftmost start to where it begins to flatten out this can be considered the first period. The first period is characterized by a decreasing failure rate. It is what occurs during the "early life" of a population of units. The weaker units fail leaving a population that is more rigorous.

Useful Life The next period is the flat bottom portion of the graph. It is called the "useful life" period. Failures occur more in a random sequence during this time. It is difficult to predict which failure mode will occur, but the rate of failures is predictable. Notice the constant slope.

Wearout The third period begins at the point where the slope begins to increase and extends to the rightmost end of the graph. This is what happens when units become old and begin to fail at an increasing rate. It is called the "wearout" period.

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5.3 Product Reliability Analysis

Engineering Considerations

Early Life Engineering Considerations

Many methods to ensure the integrity of design are used. Some of the design techniques include: burn-in (to stress devices under constant operating conditions); power cycling (to stress devices under the surges of turn-on and turn-off); temperature cycling (to mechanically and electrically stress devices over the temperature extremes); vibration; testing at the thermal destruct limits; highly accelerated stress and life testing; etc. All of these methods are designed to bring us to the useful life period before the customer sees the product.

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5.3 Product Reliability Analysis

Engineering Considerations

Useful Life Engineering Considerations

As the product matures, the weaker units fail, the failure rate becomes nearly constant, and devices have entered what is considered the normal life period. This period is characterized by a relatively constant failure rate. The length of this period is also referred to as the “system life” of a product or component. It is during this period of time that the lowest failure rate occurs. Notice how the amplitude on the bathtub curve is at its lowest during this time. The useful life period is the most common time frame for making reliability predictions.

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5.3 Product Reliability Analysis

Engineering Considerations

Wearout Engineering Considerations

As components begin to fatigue or wear out, failures occur at increasing rates. Wearout in industrial electronic devices is usually caused by the breakdown of electrical components that are subject to physical wear and electrical and thermal stress. It is this area of the graph that the MTBFs calculated in the useful life period no longer apply. A product with an MTBF of 10 years can still exhibit wearout in two years. No parts count method can predict the time to wearout of components. Industrial electronic devices are designed so that the useful life extends past the design life (when the device is obsolete). This way wearout should never occur during the useful life of a device.

5.3 Product Reliability Analysis

The formula for calculating the MTBF is

MTBF= T/R

where T = total time and

R= number of failures

MTTF stands for Mean Time To Failure. To distinguish between the two, the concept of suspensions must first be understood. In reliability calculations, a suspension occurs when a destructive test or observation has been completed without observing a failure.

5.3 Product Reliability Analysis

The formula for calculating the MTBF is

MTBF calculations do not consider suspensions whereas MTTF does.

MTTF is the number of total hours of service of all devices divided by the number of devices. It is only when all the parts fail with the same failure mode that MTBF converges to MTTF.

MTTF= T/N

where T = total time and

N = Number of units under test.

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5.4 Case study on Six Sigma in product development

Six Sigma: An Overview

Sigma is a statistical concept that represents the amount of variation present in a process relative to customer requirements or specifications.

A statistical concept that measures a process in terms of defects – at the six sigma level, there 3.4 defects per million opportunities

Commonly denoted as 6σ, 6 Sigma, or 6s

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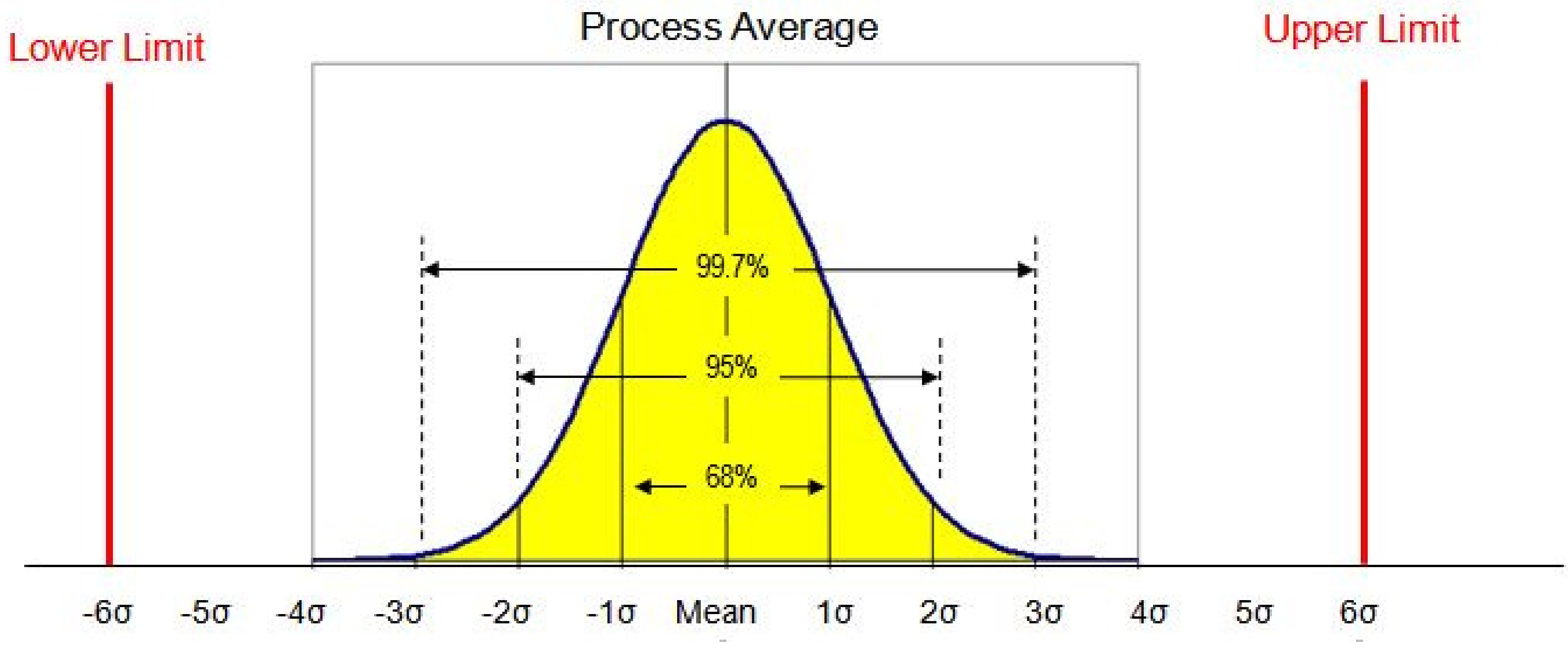
5.4 Case study on Six Sigma in product development

Six Sigma



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5.4 Case study on Six Sigma in product development

Six Sigma

Sigma	% Good	% Bad	DPMO
1	30.9	69.1	691462
2	69.1	30.9	308538
3	93.3	6.7	66807
4	99.38	0.62	6210
5	99.977	0.023	233
6	99.9997	0.00034	3.4

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5.4 Case study on Six Sigma in product development

Case Study 1

Six Sigma was introduced into Korea in 1997. The First National Quality Prize of Six Sigma was given to two companies. One is Samsung and other is LG electronics ; which are virtually the leader of six sigma in Korea. Samsung SDI was founded in 1970 as a producer of the black/white Braun tube. It began to produce the color Braun tube from 1980, and now it is the number one company for braun tubes in the world. The market share of Braun tubes is 22%. The major products are CDT (color display tube), CPT (color picture tube), LCD (liquid crystal display), VFD (vacuum fluorescent display), C/F (color filter), li-ion battery and PDP (plasma display panel). The total sales volume is about $4.4 billion and the total number of employees is about 18,000 including 8,000 domestic employees. It has six overseas subsidiaries in Mexico, China, Germany, Malaysia and Brazil.

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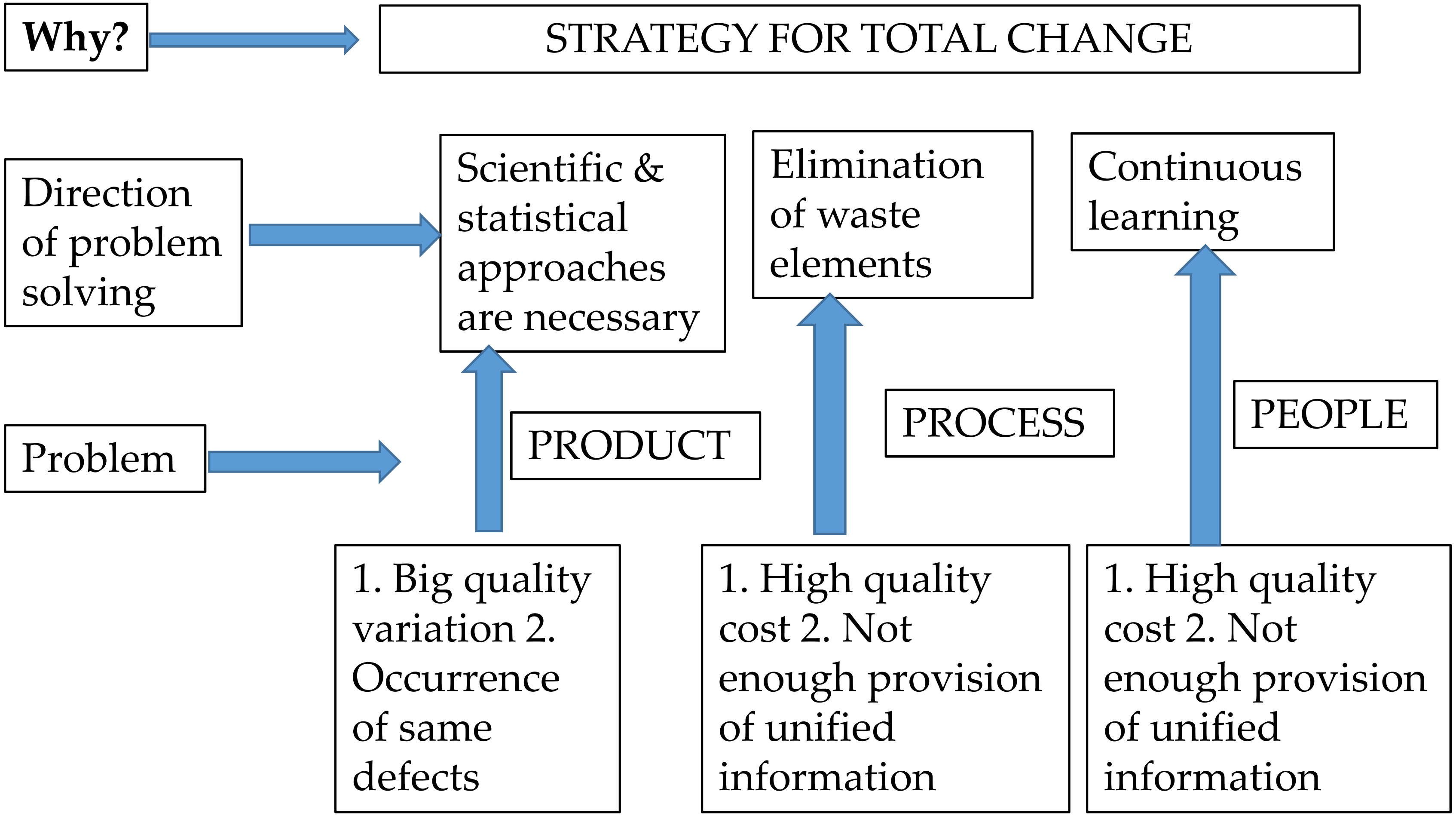
5.4 Case study on Six Sigma in product development



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5.4 Case study on Six Sigma in product development

Six Sigma

The problems were in the large quality variations in many products, repeated occurrences of the same defects, high quality costs(in particular, high failure costs), insufficient unified information for quality and productivity, manufacturing-oriented small group activities, and infrequent use of advanced scientific methods. The company concluded that the directions for solving these problems lay in scientific and statistical approaches for product quality, elimination of waste elements for process innovation, and continuous learning system for people. These directions in turn demanded a firm strategy for a complete overhaul, SDI made a paradigm shift to (Six Sigma Samsung implying a new contract with SBTI Six Sigma. Break-through Inc.) for Six Sigma consultation in 1999. It was a one-year, $3.4 million contract in which SBTI was supposed to help the company in every aspect of Six Sigma.

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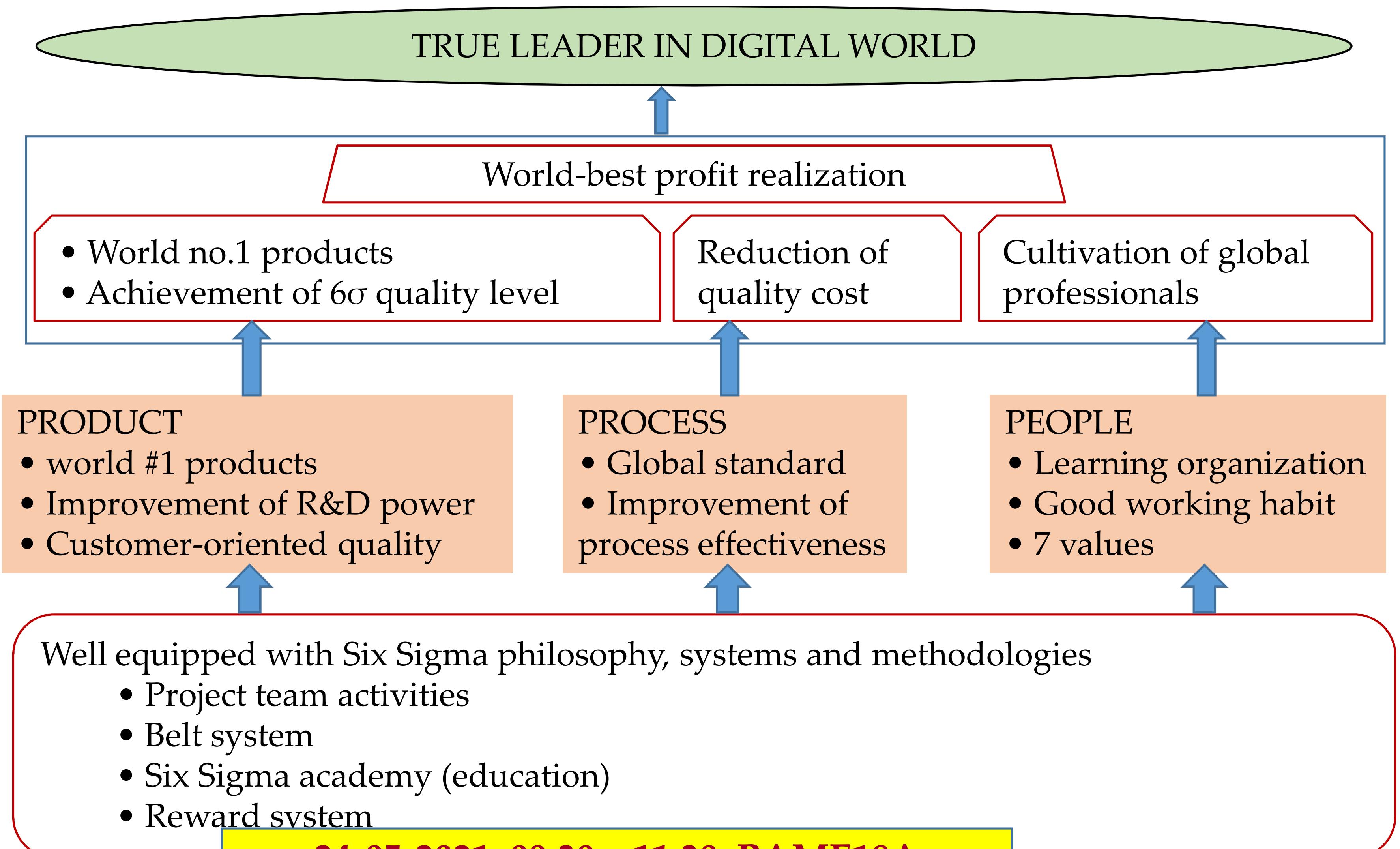
5.4 Case study on Six Sigma in product development



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5.5 Kaizen

What is Kaizen?

It is a Japanese business philosophy of **continuous improvement** of working practices, personal efficiency, etc.

Introduction

- Masaaki Imai is known as the developer of KAIZEN.
- ‘KAI’ means ‘Change or the action to correct’.
- ‘ZEN’ means ‘Good’.
- Kaizen is small incremental changes made for improving productivity and minimizing wastes

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5.5 Kaizen

3 Main Principles of KAIZEN

1. Consider the process and the results.
2. The need to look at the entire process of the job at hand and to evaluate the job as to the best way to get the job done.
3. Kaizen must be approached in such a way that no one is blamed and that best process is put into place.

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5.5 Kaizen

Features Of Kaizen

- Widely applicable.
- Highly effective and result oriented.
- A learning experience.
- Team based and cross-functional.

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5.5 Kaizen

Phases in Kaizen

A. Select an event.
B. Plan an event.
C. Implement an event.
D. Follow-up an event.

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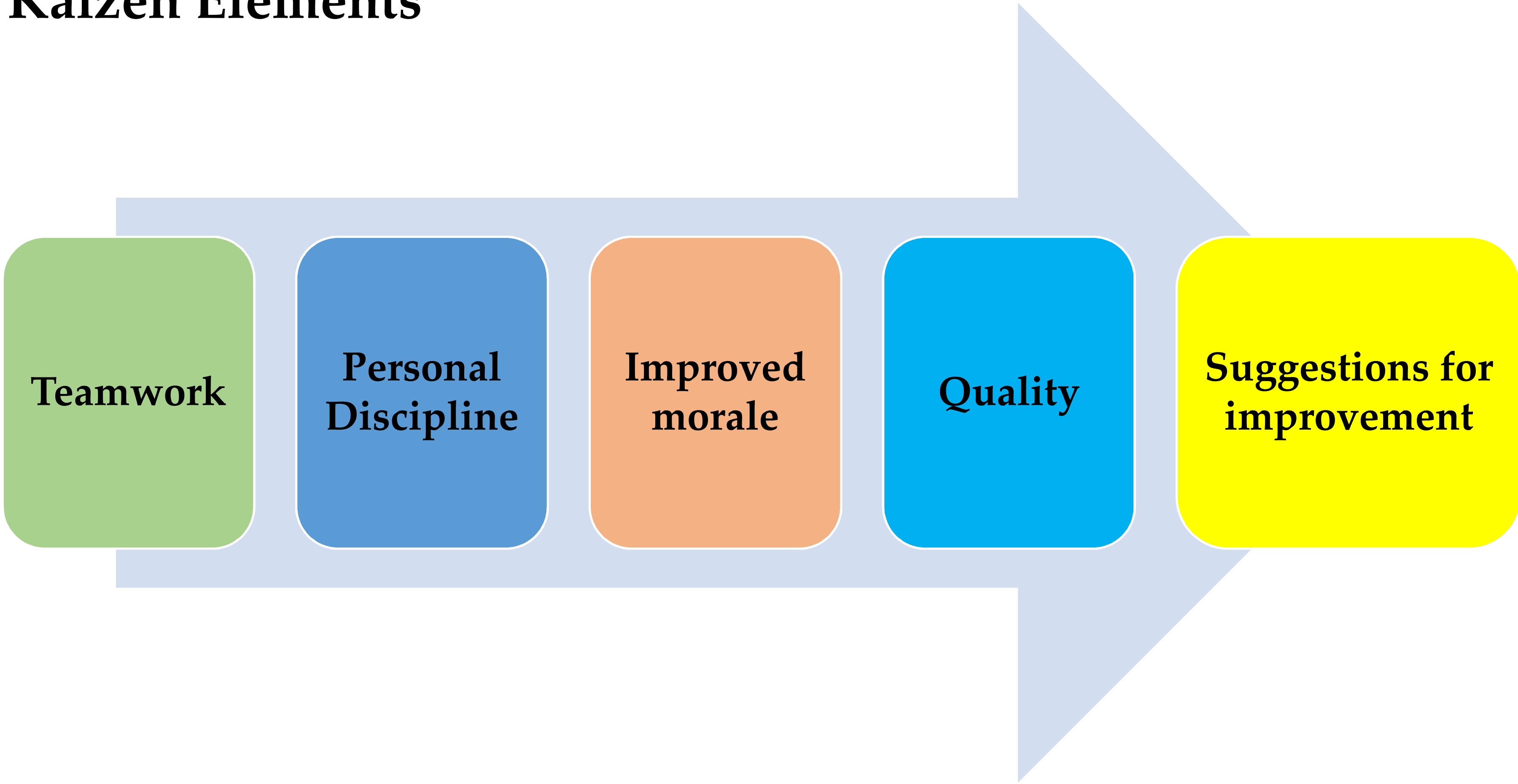
5.5 Kaizen

Kaizen Elements



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5.5 Kaizen

Benefits Of Kaizen

- Kaizen reduces waste - like inventory waste, time waste and workers motion.
- Kaizen improves space utilization and product quality.
- Results in higher employee moral and job satisfaction.
- Teaches workers how to solve every day problems.

5.5 Kaizen

Example: Toyota production system is know for kaizen, where all line personnel are expected to stop their moving production line in case of any abnormality and, along with their supervisor, suggest an improvement to resolve the abnormality which may initiate a kaizen.

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5.5 Kaizen

Pit Falls in Kaizen

- Resistance to change.
- Lack of proper procedure to implement.
- Too much suggestion may lead to confusion and time wastage.
- Difficult to implement in large scale process, where analyzing requires a lot of time.

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5.6 5S

Idea behind 5S

In order to achieve high levels of quality, safety, and productivity, workers must have a conducive working environment

Robust Design and Taguchi Method, Design Failure Mode & Effect Analysis, Product Reliability Analysis, Case study on Six Sigma in Product Development, KIzen, 5S, etc.

5.6 5S

Discovery of 5S

- Thirty years ago researchers started studying the secret of success of Japanese manufacturing companies
- 5S turned out to be the most impressive "secret"
- The factories were so well organized that abnormal situations were readily apparent
- Equipments were so clean and well maintained that any problem such as a loose bolt or leaking oil could be easily seen
- This passion of cleanliness and orderliness became a hallmark of Japanese organizations

Robust Design and Taguchi Method, Design Failure Mode & Effect Analysis, Product Reliability Analysis, Case study on Six Sigma in Product Development, KIzen, 5S, etc.

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Advantages of 5S

- If tools and materials are conveniently located in uncluttered work areas
- Operators spend less time looking for items
- This leads to higher workstation efficiency, a fundamental goal in mass production
- A clean and tidy workplace leads to greater well being and increased motivation
- Company image improves
- Health and Safety is ensured
- Machine maintenance
- Quality
- Productivity
- Lean Manufacturing

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Advantages of 5S (Contd…)

- Results in a place easier to manage
- Smooth working - no obstruction
- No deviation, no problems
- B/c everyone knows where the things are supposed to be
- Time saving
- Quick retrieval
- Accidents & mistakes minimized
- Increases space
- Creates workplace ownership
- Foundation of all qc tools
- Continuous quality improvement
- Lean manufacturing
- Kindergarten of quality tools & techniques

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Advantages of 5S (Contd…)

- Visual management system
- Visual control to see the abnormalities
- Simple signals that provide an understanding of the condition(normal/ abnormal)
- A look at the process reveals its direction (right/wrong)

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5.6 5S

What is 5S?

- 5S is a workplace organization methodology that uses a list of five Japanese words which are seiri, seiton, seiso, seiketsu and shitsuke.

SEIRI	: Organisation/Sort out
SEITON	: Orderliness/Systemize
SEISO	: The Cleaning/Shining
SEIKETSU	: STANDARDIZE
SHITSUKE	: Sustain/Discipline

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5.6 5S

1. Sorting (seiri)

- Eliminate all unnecessary tools, parts, and instructions.
- Keep only essential items and eliminate what is not required
- Prioritizing things per requirements and keeping them in easily-accessible places.◎ Everything else is stored or discarded.
- Decide what you need
- Remove unnecessary clutter
- All tools, gauges, materials, classified and then stored
- Remove items which are broken, unusable or only occasionally used

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5.6 5S

1. **Sorting (seiri)**
   Red Tag Technique

RED
TAG

- Give staff red labels
- Ask staff to go through every item in the work place
- Ask if needed & those that are needed, in what quantity
- Not needed- red tag it
- Store in the red tag area

For wavering items

- Place the suspected items in the red tag area for one week
- Allow the staff to reevaluate the needed items
- At the end of week those who need items should be returned

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1. Sorting (seiri)

Organisation

Priority	Frequency of use	How to use
Low	Less than once per year Once per year	Throw away Store away from the workplace
Avg.	Once per month Once per week	Store together but offline
High	Once per day	Locate at the workplace

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5.6 5S

2. Straightening or setting in order / stabilize/ Orderliness (Seiton)

- Once you have eliminated all the unneeded items
- Now turn to the left over items
- There should be a place for everything and everything should be in its place.
- The place for each item should be clearly labeled or demarcated.
- Items should be arranged in a manner that promotes efficient work flow, with equipment used most often being the most easily accessible.

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2. Straightening or setting in order / stabilize/ Orderliness (Seiton)

Organise layout of tools and equipment

- Designated locations
- Use tapes and labels
- Ensure everything is available as it is needed and at the "point of use"

Workplace Checkpoints

- Positions of aisles and storage places clearly marked?
- Tools classified and stored by frequency of use?
- Pallets stacked correctly?
- Safety equipment easily accessible?
- Floors in good condition?

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5.6 5S

3. Shining or systematic cleaning (Seiso)

- Create a spotless workplace
- Identify and eliminate causes of dirt and grime –remove the need to clean
- Sweep, dust, polish and paint
- Clean the workspace and all equipment, and keep it clean, tidy and organized.
- At the end of each shift, clean the work area and be sure everything is restored to its place.
- Maintaining cleanliness should be part of the daily work – not an occasional activity initiated when things get too messy.

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5.6 5S

3. Shining or systematic cleaning (Seiso) Contd..

- Create a spotless workplace
- Divide areas into zones
- Define responsibilities for cleaning
- Tools and equipment must be owned by an individual
- Focus on removing the need to clean

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5.6 5S

4. Standardizing (Seiketsu)

- All work stations for a particular job should be identical.
- All employees doing the same job should be able to work in any station with the same tools that are in the same location in every station.
- Everyone should know exactly what his or her responsibilities are for adhering to the first 3 Ss.
- Generate a maintenance system for the first three
- Develop procedures, schedules, practices
- Continue to assess the use and disposal of items
- Regularly audit using checklists and measures of housekeeping
- Real challenge is to keep it clean

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5.6 5S

5. Sustaining the discipline orself-discipline (Shitsuke)

- Means inoculate courtesy & good habits
- Driving force behind all 5S
- Deming's point number 1: Constancy of purpose
- Make it a way of life
- Part of health and safety
- Involve the whole workforce*
- Develop and keep good habits
- Maintain and review standards.
- Maintain focus on this new way and do not allow a gradual decline back to the old ways.
- While thinking about the new way, also be thinking about yet better ways.

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5.6 5S

Benefits of 5S

- ✓ Neat & clean workplace
- ✓ Smooth working
- ✓ No obstruction
- ✓ Safety increases
- ✓ Productivity improves
- ✓ Quality improves
- ✓ Wastage decrease
- ✓ Machine maintenance
- ✓ Visual control system
- ✓ Employees motivated
- ✓ Workstations become spacious
- ✓ Improves organizational efficiency
- ✓ Reduces waste in all forms◎ cuts down employee frustration when "the system doesn’t work“
- ✓ Improves speed and quality of work performance
- ✓ Improves safety◎ creates a visually attractive environment

5.6 5S

Objectives of 5S

- Productivity
- Safety
- Reduced Waste
- Worker Commitment

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5.6 5S

Conclusion

- The 5-S practice is a well-recognised methodology used by the Japanese for improving the work environment.
- It was found to be key to quality and productivity.
- The 5-S practice helps everyone in the organisation to live a better life.