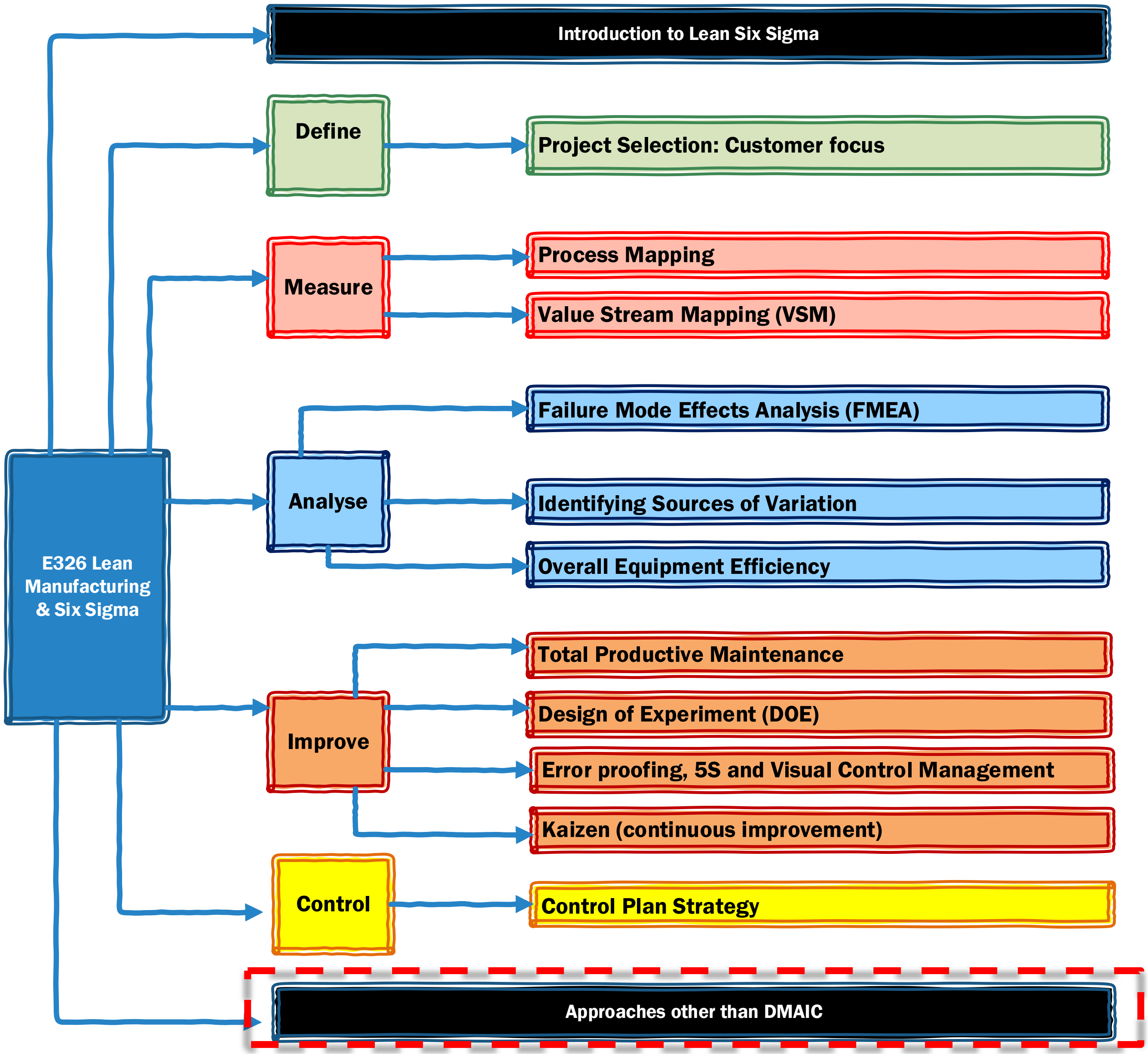
Problem 13
Totally New

E323 – Lean Manufacturing & Six Sigma

SCHOOL OF ENGINEERING

E326 Lean Manufacturing and Six Sigma Topic Tree



Toyota Production System (TPS)

The Toyota Production System (TPS) empowers team members to optimise quality by constantly improving processes and eliminating unnecessary waste in natural, human and corporate resources.

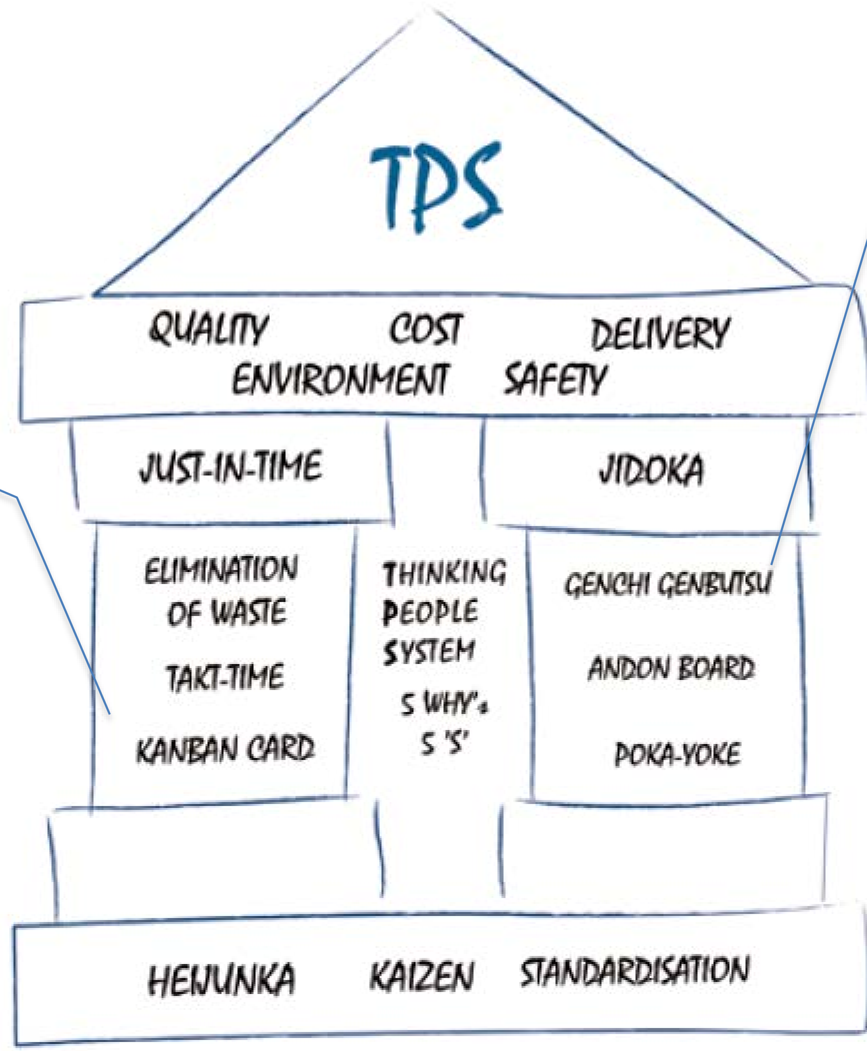
TPS influences every aspect of the organisation and includes a common set of values, knowledge and procedures.

It entrusts employees with well-defined responsibilities in each production step and encourages every team member to strive for overall improvement.

Toyota Production System (TPS)

Kanban cards are scheduling devises that authorize a production line to produce more units.

The Kanban card helps the manufacturing flow and other departments communicate what needs to be produced and what materials are needed for the production process.



Genchi Genbutsu means "**go and see**" and it is a key principle of the Toyota Production System. It suggests that in order to truly understand a situation one needs to go to gemba or, the 'real place' - where work is done

Toyota Production System (TPS)

Just-in-time production relies on finely tuned processes in the assembly sequence using only the quantities of items required, only when they are needed. Just-in-time offers a smooth, continuous and optimised workflow, with carefully planned and measured work-cycle times and on-demand movement of goods, reduces the cost of wasted time, materials and capacity.

Just-in-time is itself, based on four key principles that work together to support this unique concept at every level: Heijunka, Elimination of waste, Takt time and Kanban.

Toyota Production System (TPS)

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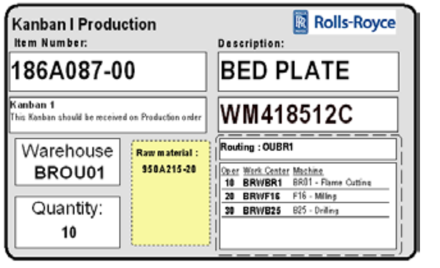

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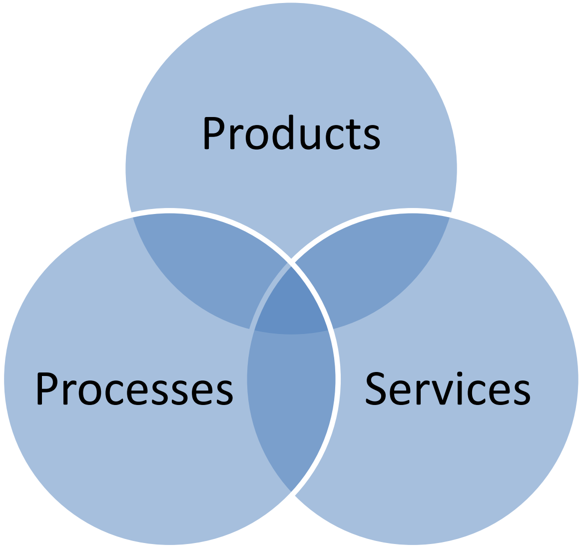
Design for Six Sigma (DFSS)

- A systematic methodology using tools, trainings and measurements to enable the design of product, services and processes that meet customer expectations at Six Sigma quality levels

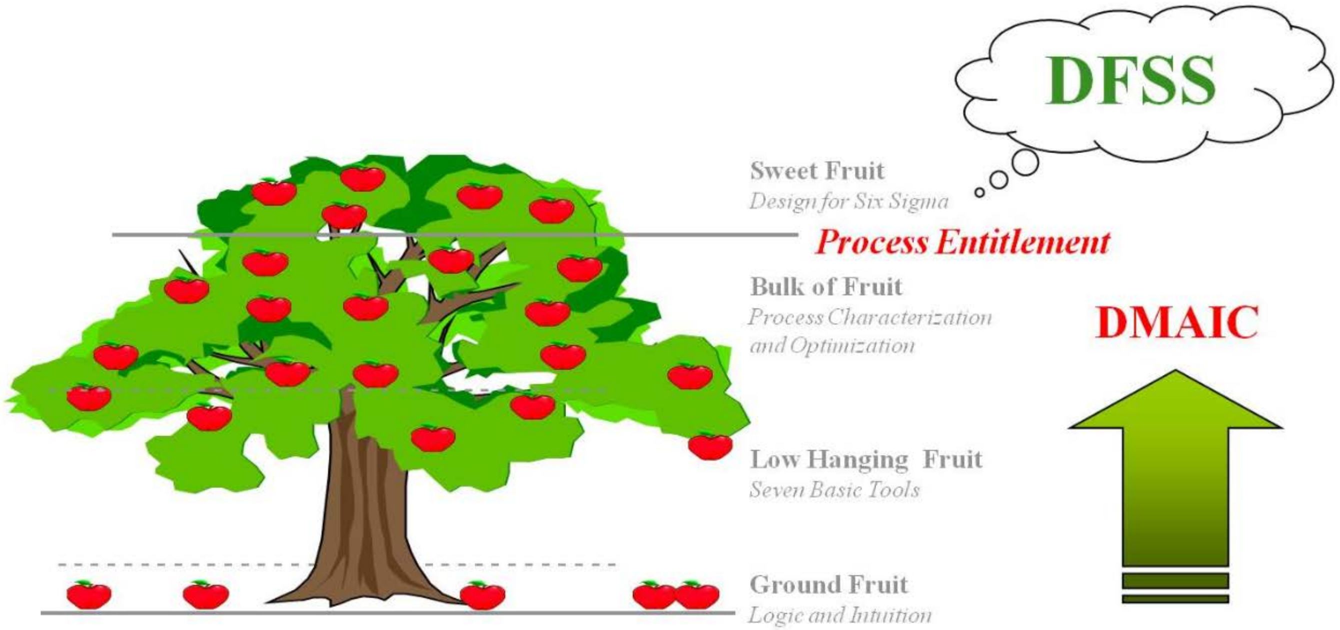


- In the early stages of DFSS, there is a stronger focus on customer requirements.

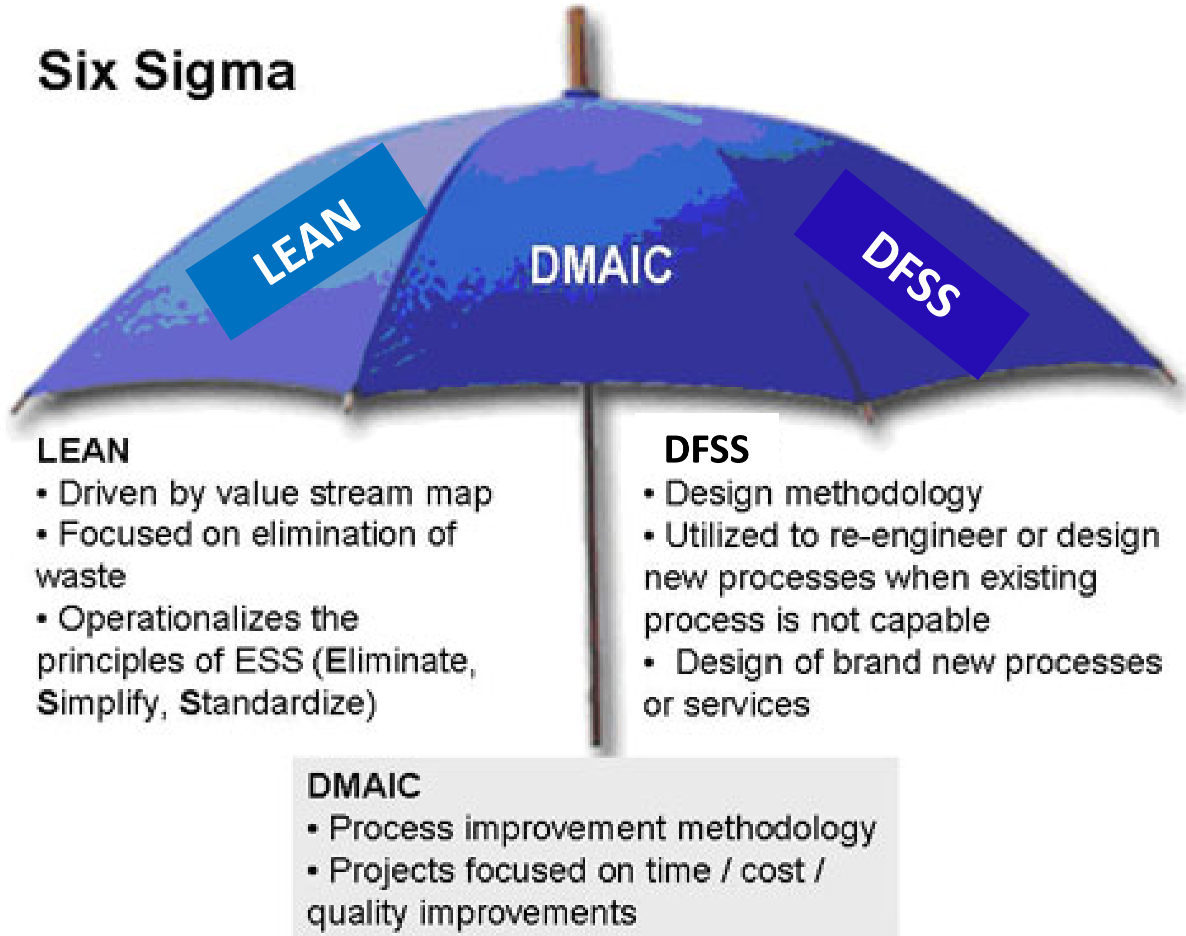
- Measure and Analysis is broadly similar for Six Sigma and DFSS except there is more exploring and use of computer based process simulation in DFSS.

When to use DFSS?

- DFSS is used when:
  - the undertaking covers a large scope, budget or impact
  - substantial improvement and not incremental change is required
  - the project involves radical or new process innovation
  - meeting the customer expectations is vital for success



Integration of Lean, DMAIC & DFSS



Approaches for DFSS

- DFSS differs from Six Sigma in a number of ways. There has to be a stronger emphasis on new product, service or process design in DFSS.
- Unlike the DMAIC methodology in Six Sigma, the phases or steps of DFSS are not universally recognized or defined.
- Every company or training organization will define DFSS differently. Most companies will implement DFSS to suit their business, industry and culture. E.g. DMADV and IDOV are commonly used in manufacturing world.
- Other companies will implement the version of DFSS advised by the consulting company assisting in their deployment. Thus, DFSS is more of an approach than a defined methodology.
- Most companies will start with Six Sigma DMAIC improvement projects. Then proceed to small scale DFSS projects, before making it a company-wide effort.

Approaches for DFSS

The following are some of the approaches for DFSS:

- **IDOV**: Identify – Design – Optimize – Verify
- **DMADV**: Define – Measure – Analyse – Design – Verify
- **DMADOV**: Define – Measure – Analyse – Design – Optimize - Verify
- **DMCDOV**: Define – Measure – Characterize – Design – Optimize – Verify
- **DCOV**: Design – Characterize – Optimize – Verify
- **DCCDI**: Define Customer – Concept – Design – Implement
- **DMEDI**: Define - Measure – Explore - Develop – Implement
- **DMADIC**: Define – Measure – Analyse – Design – Implement – Control
- **RCI**: Define & Develop Requirements, Concepts and Improvements

Tools used in implementing DFSS

- Although the approaches to DFSS differ in some respects, they proceed through similar steps towards the same basic goals using common tools.
- Examples of tools:

. Advanced control charts
. Affinity diagramming
. Analytic Hierarchy Process (AHP)
. ANOVA
. Automated data acquisition
. Benchmarking
. Certification
. Chi-square methods
. Correlation studies
. Critical-To-Quality (CTQ)

. Defects data and probability
. Distribution goodness-of-fit
. Design simplification
. Design of Experiment (DOE)
. Engineering specification
. EVOP designs
. Expert judgment
. F-test Factorial designs
. Finite Element Analysis (FEA)
. FMEA

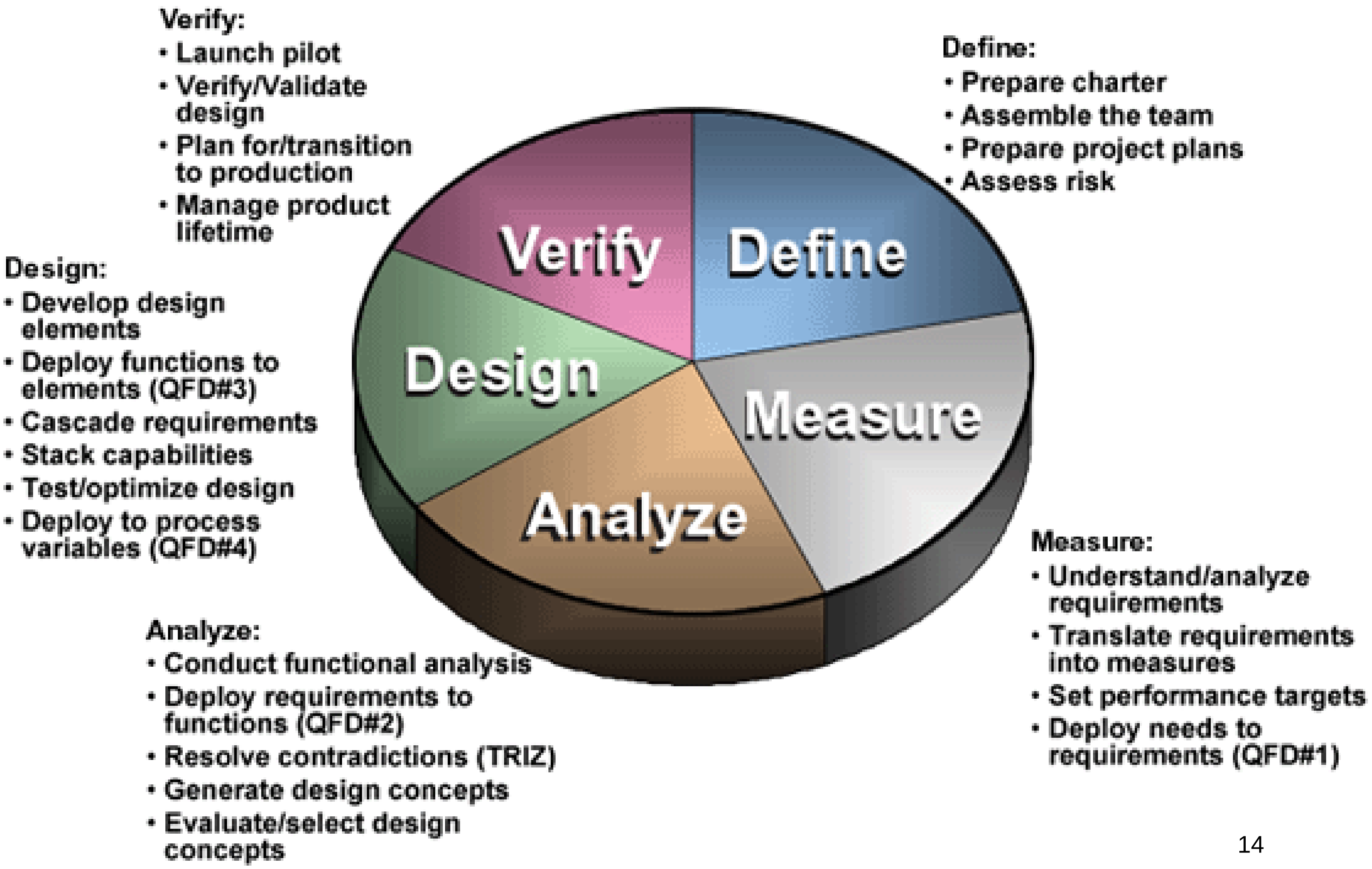
Tools used in implementing DFSS

. Feedbacks
. Interaction plots
. Kano Model
. Graphing package
. Inspection history files
. Industrial standards
. Literature reviews
. Measurement system analysis
. Mathematical models
. Monte-Carlo simulation
. Non-parametric tests
. OR programming methods
. Physical models
. Poka-yoke methods
. Process audit

. Process Mapping
. Project Charter
. Quality Function Deployment (QFD)
. Random sampling
. Response Surface Design (RSM)
. Regression
. Risk Analysis
. Scorecard
. Taguchi Design
. Tolerance Analysis
. Time series Analysis
. Voice of Customer (VOC)
. Worst case analysis
. “What-if” scenario

Note: This list of tools is not exhaustive. Any suitable tools could be used in DFSS

DMADV approach



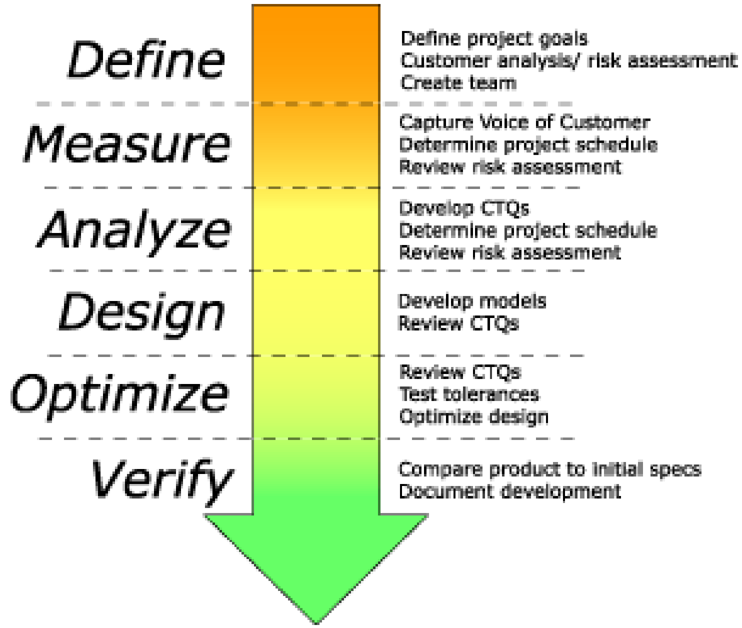
IDOV approach

BREAKTHROUGH DESIGN

Design Phase	Design Step	Objective		Roles
Identification	Project Planning	Identify key business issues related to project start up		Executive
	Client Voice	Project Definition Collect Voice of Client	Design Projects to Achieve Objectives	Champion Design Black Belt
Design	Conceptual Preliminary Detail	Create designs that satisfy client needs		Design Team Design Black Belt
Optimization	Robust Design Pilot/ Prototype	Pilot designs Complete planned iterations		
Validation	Implement/ Launch	Full scale Product/ Service/ production		Design Black Belt Implementation Team Champion Executive

- Identify - represents market needs, customer requirements (CTS), regulatory requirements, process optimization requirements, sub-system design requirements, etc. It can occur in a variety situations and phases. The data should be in a ranking format (Ordinal scale) to permit some cost and performance trade-off decisions to be made.
- Design - represents both the initial concept generation or any re-designs required accommodating technology limitations.
- Optimisation - encompasses a variety of activities and utilizes the majority of the DFSS tools. This is where the design concept is repeatedly adjusted and modified to produce a simple robust design of a known and verifiable cost and quality level.
- Validate - represents all the detail, product, and prototype testing as well as verification of the product/process interaction.

DMADOV approach



- Define - Define project goals and customer needs.
- Measure - Measure customer requirements, review industry and competitor benchmarks.
- Analyze - Review information, generate concepts and develop processes.
- Design - Review risks and financial, begin build of models, analyze ongoing development.
- Optimize - Review initial design, test for tolerances, optimize design.
- Verification - Review initial design specifications and predictions against final product.

Parts Standardization

The goal of parts standardization is to improve operational readiness and reduce lifecycle costs by promoting the use of common, available, cost effective, and reliable parts.

An efficient parts standardization program has far reaching benefits

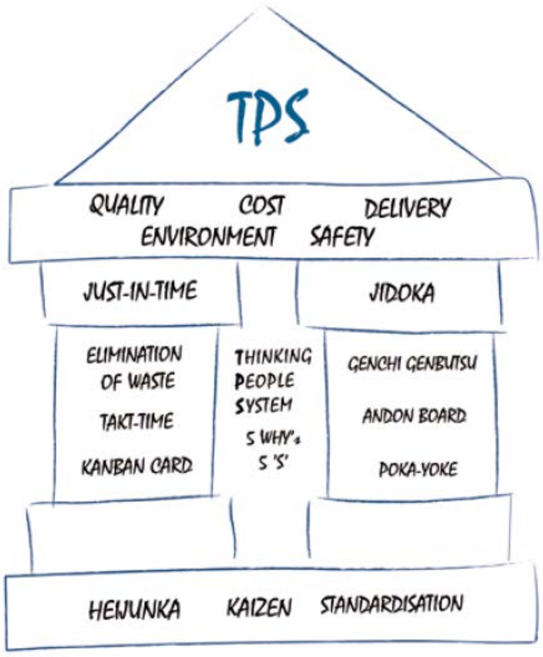
- Reductions in annual cost to maintain a supplier
- Reductions in annual cost to maintain a part
- Reduce “near duplicate” designs
- Better Product Quality – Increasing re-use of known “good” parts can reduce warranty costs
- Reductions in Engineer’s time searching for parts
- Reduction in new product re-designs by avoiding obsolete, long lead-time, or non-compliant parts

Problem 13
Suggested Solution

Toyota Production System (TPS)

The company can adopt production system philosophy of the Toyota Production System (TPS) during the production based on setting standards aimed at eliminating waste through participation of all employees to reduce the delivery lead time.

Applying the Just-In-Time (JIT) concept to produce and deliver the right parts, in the right amount, at the right time using the minimum necessary resources. This system will help to reduce inventory, and strives to prevents both early and over production.



Suggested Approach

- Base Ltd can initiate Design for Six Sigma to re-design all their current processes (e.g. using Simulation or QFD) and work closely with their suppliers and vendors
- This approach has to be deployed to the entire organisation, scrutinising all business activities from product development to distribution and even sales processes
- The company can begin their DFSS efforts with smaller projects and eventually evolve into full-scale company initiative

Suggested Approach (using DMADV)

Base Ltd can adopt the DMADV approach:

- **Define** – Define the goals of design activity
- **Measure** – Measure customer input to determine what is critical to quality from the customers' perspective. Use special methods when a completely new product or service is being designed.
- **Analyse** – Analyse innovative concepts for products and services to create value for the customer.
- **Design** – Design new processes, products and services to deliver customer value.
- **Verify** – Verify that new systems as expected. Create mechanism to assure continued optimal performance.

Suggested Approach

- Current Processes required: 21 process steps

Silicone ear cap compression molding
- 5 processes

PC Board: units mounting and testing
- 6 processes

Mechanical components installation
- 6 processes

Testing: Power and Sound
- 2 processes

Packaging
- 2 processes

- Post DFSS processes required: 6 process steps

Outsource silicone ear cap
- 0 process

Shared PC Board
- 1 process

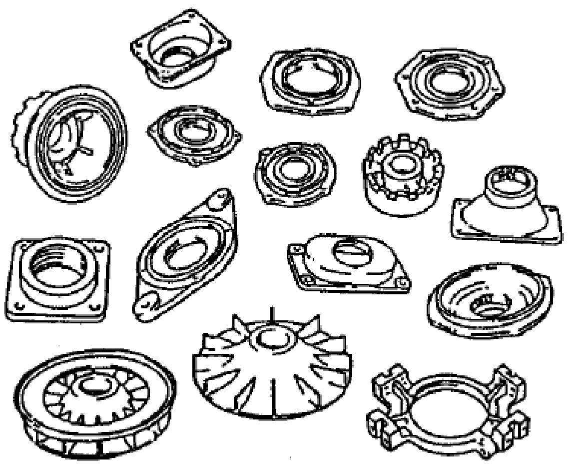
Grouped components installation
- 1 process

Testing: Power and Sound
- 2 processes

Packaging
- 2 processes

Group Technology

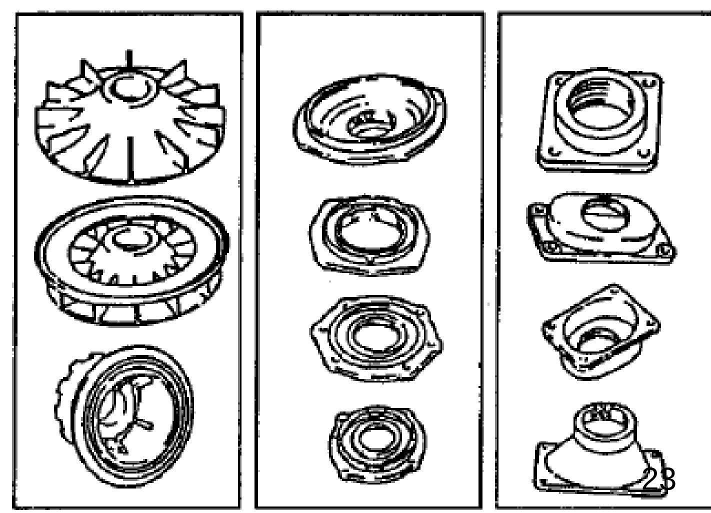
Ungrouped Parts



The most important role for Group Technology is **the formation of part families from hundreds, thousands or tens of thousands of seemingly unique products**. Each family uses a group of machines for its manufacture and this machine group forms the nucleus of a work cell.

1. Group Technology benefits manufacturing in many ways. **It reduces the number and variety of parts.** Process planning for the remaining parts is easier and more consistent.
2. Group Technology cells reduce throughput time and Work-In-Process. They simplify schedules, reduce transportation and ease supervision.

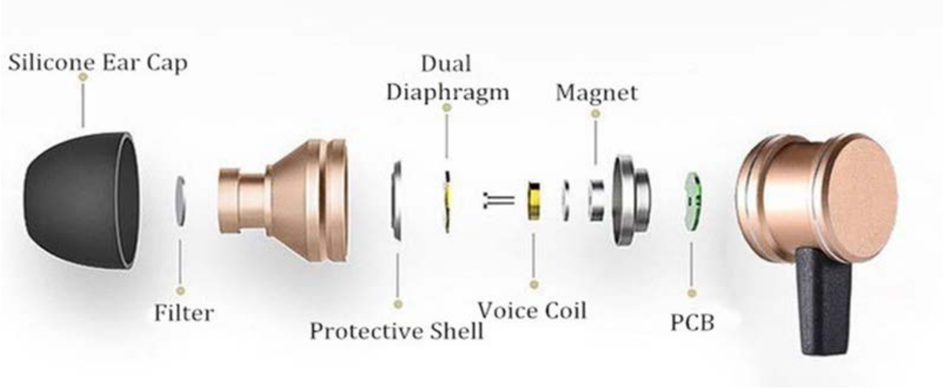
Grouped Parts



Part Standardization

Examples of parts that the company can consider to standardize for Base Ltd Bluetooth earphones:

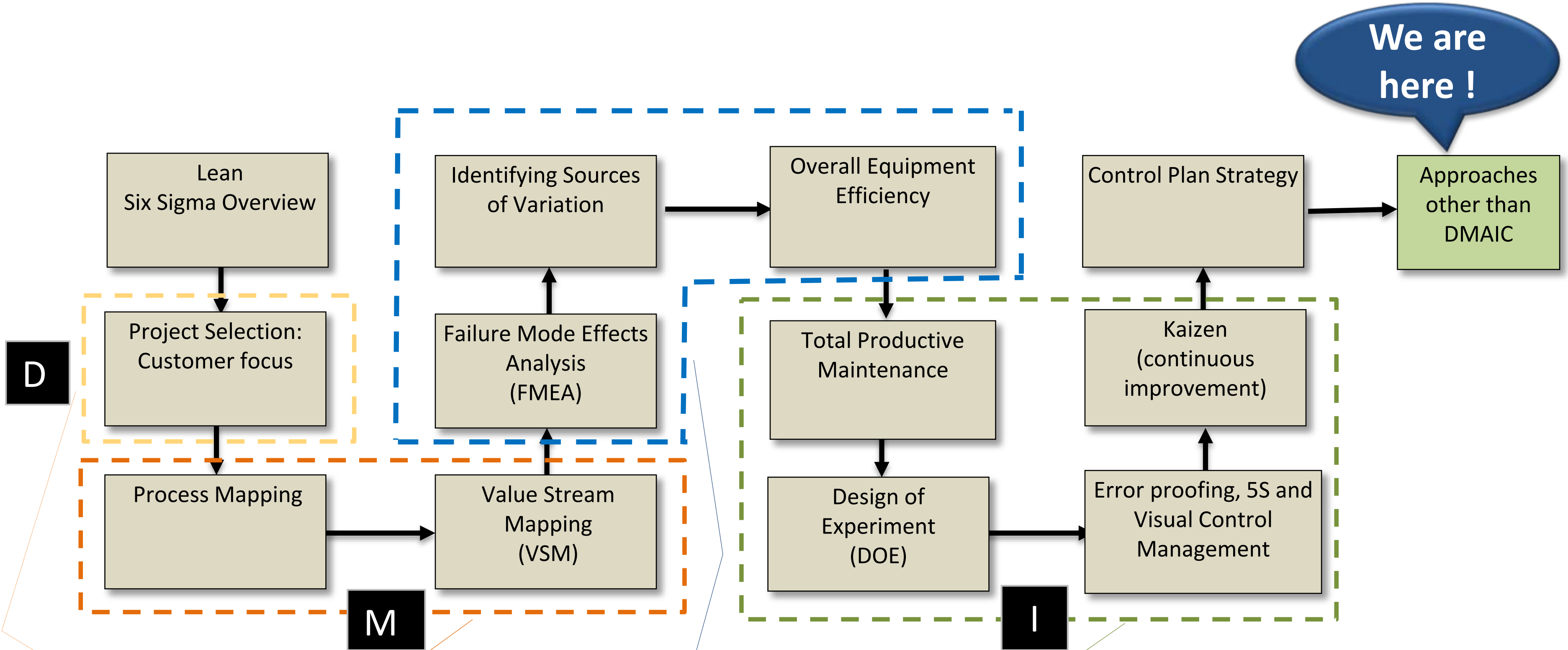
- Carton Box
- Instruction Manual
- Packaging materials
- Filter
- Protective shell
- Voice coil



Learning Objectives

- Explain and apply the production system philosophy of Toyota Production System (TPS)
- Explain the limitations of DMAIC
- Appreciate Design for Six Sigma (DFSS)
- Differentiate between DMAIC and DFSS
- Describe the approaches for DFSS
- Apply tools for DFSS

Overview of E326 Lean Manufacturing and Six Sigma

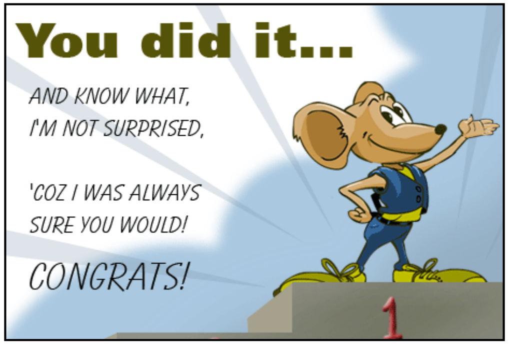


Identify improvement opportunity
Define-M-A-I-C

Establish project baseline and measurable
D-**Measure**-A-I-C

Extract useful information and identify variation in data
D-M-**Analyze**-I-C

Improve process/operations
D-M-A-**Improve**-C



Congratulations !