

An Introduction to Design for Six Sigma concepts

Dr Jane Marshall
Product Excellence using 6 Sigma
Module

Objectives of the session

- History of Six Sigma
- Describe the Six Sigma Philosophy
- Introduce DFSS
- Key points in DFSS
- DFSS background
- DFSS process
- Differences between DFSS and Six Sigma

Introduction to Six Sigma



- **Six Sigma is:**
 - A business process
 - Proactive approach to designing and monitoring key activities
 - Philosophy
 - Methodology
 - A process that is customer focussed and profit driven

Introduction to Six Sigma



- **It works by:**
 - Being adopted by the whole company;
 - Creating an internal infrastructure within the company;
 - Using metrics to measure processes and changes to processes
 - Using scientific methods, changing the working culture and introducing business process management

Six Sigma Background



- Motorola employee investigating variation in various processes
- Acted on results using tools to reduce variation
- Improved the effectiveness and efficiency of the processes
- Engaged CEO
- GE is the company that made SIX Sigma a management philosophy

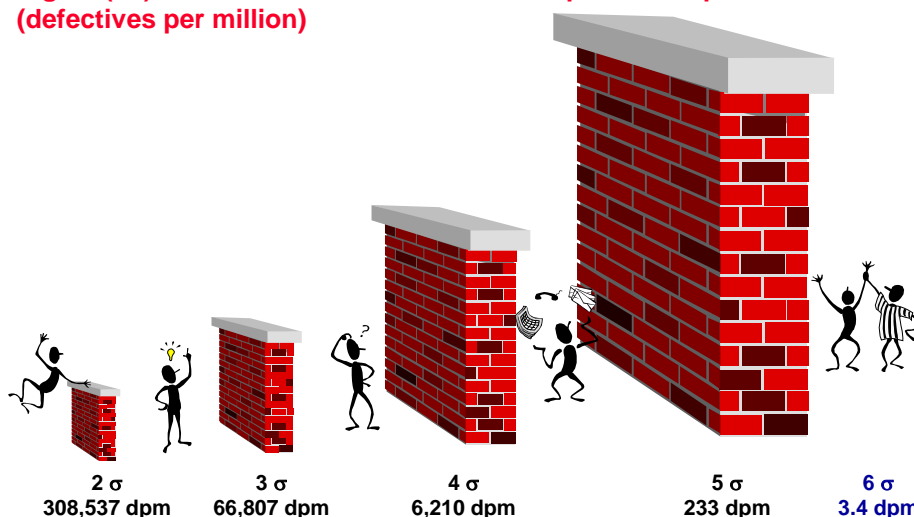
PEUSS 2011/2012

Design for Six Sigma

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What is six sigma performance ?

Sigma (σ) is a statistical metric that corresponds to dpm (defectives per million)

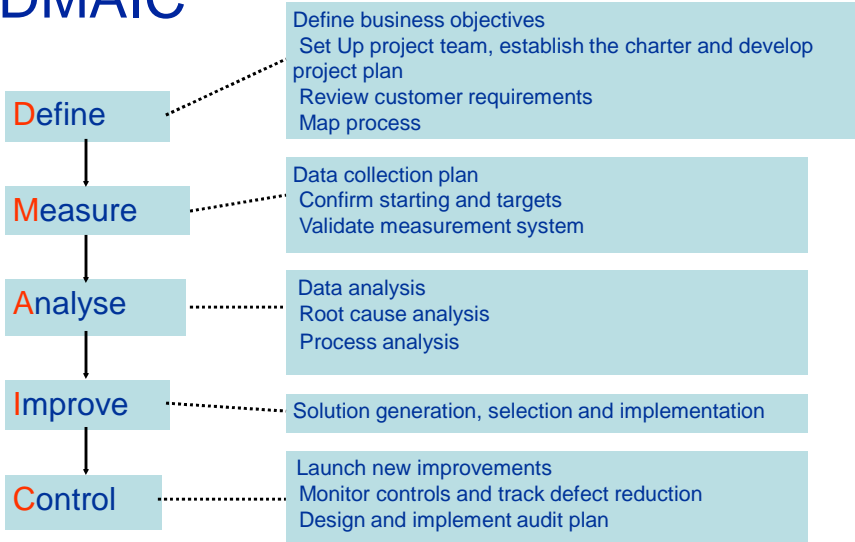


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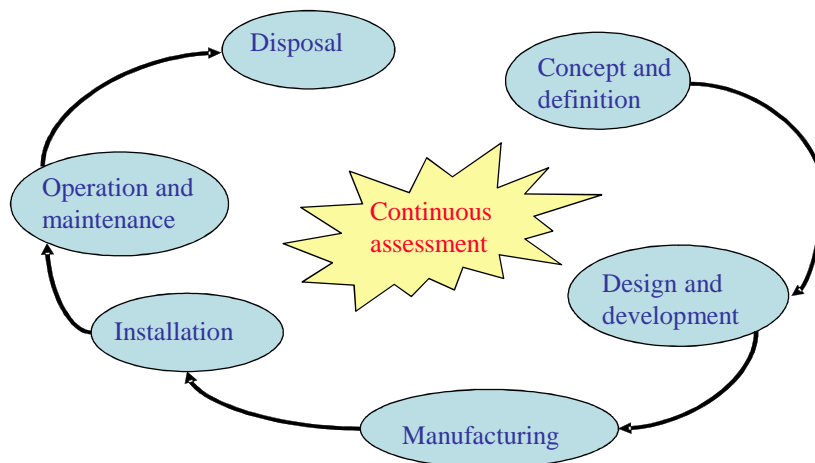
Design for Six Sigma

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DMAIC



Product life cycle



Introduction to DFSS



- Systematic methodology for designing or redesigning products or services according to customer requirements and expectations.
- Optimises design process to achieve six sigma performance
- Get it 'right first time'

What is Design For Six Sigma?



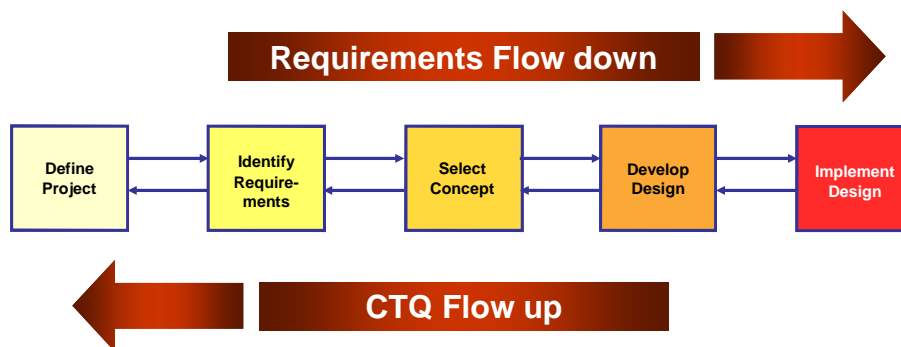
- Companies who had seen the success of Six Sigma for problem solving using DMAIC wanted to apply data driven tools and techniques to the design of new products, processes & services
- Typically, after 2 years of DMAIC, Design For Six Sigma programmes were launched
- Applied in both Manufacturing and Service industries in technical and non-technical environments
- **Used to define and/or supplement the 'design' process**

When to Use DFSS

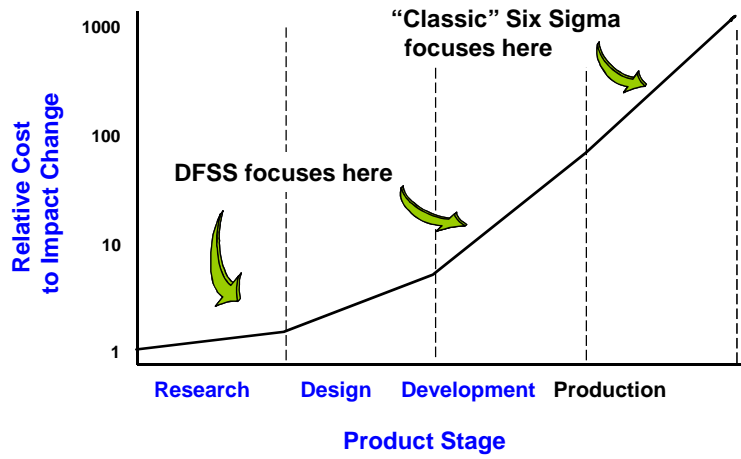


- Creating a new product, process, or service
- Incremental improvement cannot close the gap between the current process capability and customer requirements
- Should spend time understanding the faults of existing systems before you embark on a a redesign methodology

Generic 'Design' Process

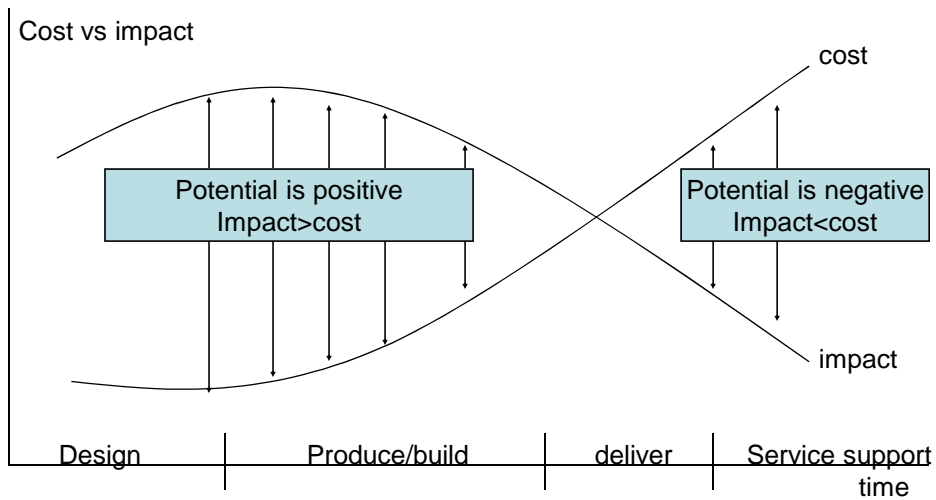


The DFSS Opportunity



"Design in" quality when costs are lowest

Effect of design phases on life cycle



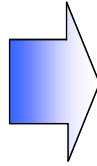
The Vision of DFSS



From

- Evolving design requirements
- Extensive design rework
- Product performance assessed by “build and test”
- Performance and producibility problems fixed after product in use

- Quality “tested in”



To

- Disciplined CTQ flow-down through requirements management
- Controlled design parameters
- Confidence in product performance
- Designed for robust performance and manufacture

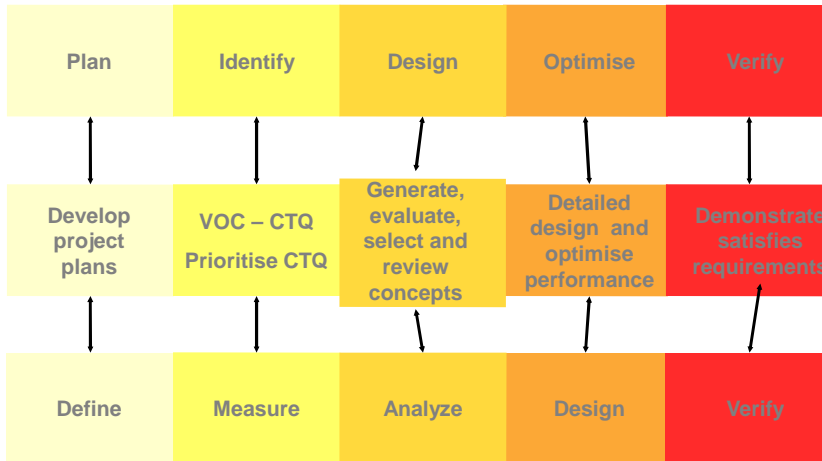
- Quality “designed in”

DFSS Methodology



- **DMADV**
 - **D**efine, **M**easure, **A**nalyse, **D**esign and **V**erify
- **PIDOV**
 - **P**lan, **I**dentify, **D**esign, **O**ptimise and **V**alidate.

DFSS Process



Process for DFSS - DMADV



Tollgates and phases



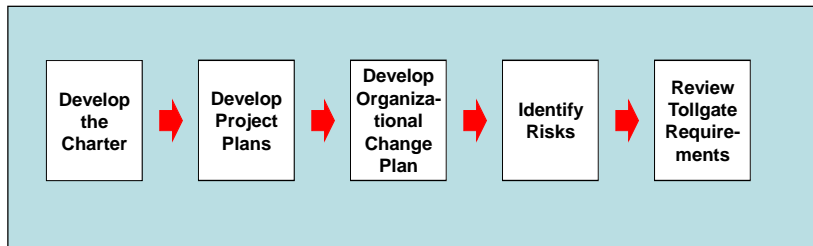
- Stopping point within the flow of phases
 - A thorough assessment of deliverables
 - A thorough review of the project management plans for the next phase
- Checklists
 - Summary statements of tools and best practices required to fulfil gate deliverable
- Scorecards
 - Summary statements from specific application of tools and best practice

DMADV



Define

DMADV - Define



Elements of a Charter



- Problem Statement
- Opportunity Statement
- Importance
- Expectations/Deliverables
- Scope
- Schedule
- Team Resources



Develop Project Plans

- **Project schedule and milestones**
- **Organizational change plan**
- **Risk management plan**
- **Review schedule**



Risk Management Plan

- **Design projects face a number of risks**
- **The team's job is to anticipate where the key risks of failure are and to develop a plan to address those risks**
- **In Define, the team should:**
 - **Identify known and potential risks for the project**
 - **Indicate when and how the risks will be addressed**

Project Reviews



- **Regular reviews are key for successful projects and should be included in the project schedule**
- **There are several levels of review:**
 - Milestone or tollgate reviews; weekly reviews; daily reviews
- **In addition, design projects have three unique reviews:**
 - Concept review; High-level design review; Detailed design review

Key Outputs of DEFINE Phase



- Project team
- Project business case
- Project objective
- Project plan (GANNT chart)
- Document control systems
- Risk reduction plan

Measure

DMADV - Measure

- **Goals:**
 - Collect Voice of the Customer data
 - Translate VOC into design requirements (CTQs)
 - Identify the most important CTQs
 - Develop the measurement system for each CTQ
 - Develop a design scorecard
 - Revise project objective if necessary

- **Output:**
 - Prioritized CTQs

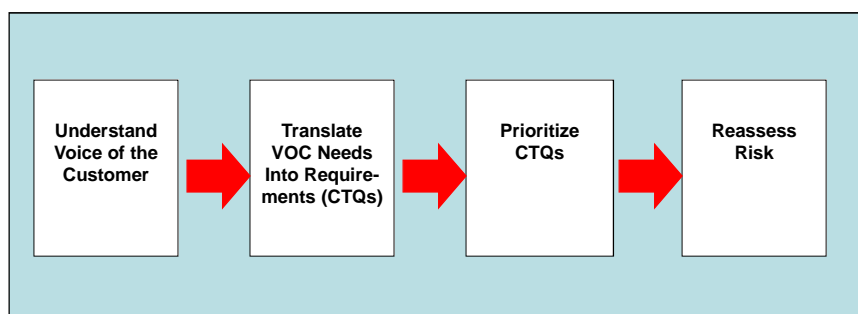


Measure: Tools

- **Data collection plan**
- **Customer segmentation**
- **Customer research**
- **Voice of Customer table**
- **Kano model**
- **Affinity diagram**
- **Benchmarking**
- **QFD (Quality Function Deployment)**



Measure: Key Activities



What is the Voice of the Customer?



- The term Voice of the Customer (VOC) is used to describe customers' needs and their perceptions of your product or service
- It includes all forms of interaction between customers and your organization



Use of Kano analysis

Critical to Quality Characteristics



- A quality characteristic that specifies how the customer need will be met by the product/service to be designed
- A quantitative measure for the performance of the quality characteristic
- A target value that represents the desired level of performance that the characteristic should meet
- Specification limits that define the performance limits that will be tolerated by customers
- Several CTQs will exist for each need.
- Use QFD to transfer VOC data into CTQs

Develop and Validate a measurement system



- Review data requirements
- Review how to capture data
- Review applicable analysis methods
 - e.g. compare voice of the process with voice of the customer – SPC and capability analysis
- Decision criteria to determine acceptance
- Establish validity of the measurement system

Develop a design scorecard



Used to help the team to:

- Establish nominal values and specification limits for each CTQ
- Predict output of the voice of the process with respect to stability (SPC)
- Highlight problems and risks of CTQs
- Track CTQs throughout the entire life of the product

Generic design scorecard



Scorecard Part A (Voice of the customer)					Scorecard Part B (Predicted Voice of the process)					
CTQ	Target	LSL	USL	Sigma target	Stable (Y/N)	Shape	Mean	Standard Deviation	DPU	Predicted Process Sigma

Reassess Scope and Risk



- How difficult do we predict it will be to meet all the target values of the most important CTQs?
- Is it necessary to adopt a phased approach to meet the target?
- What are the risks associated with not meeting the CTQs now?
- What are the risks associated with dropping some of the less important CTQs from consideration?

Measure: Tollgate Review



- This tollgate review focuses on
 - Customer segmentation strategy
 - Top 10-15 customer needs
 - Top 8-10 CTQs and targets
 - Summarized benchmark information
 - Platform management matrix
 - CTQ achievement matrix
- The review can lead to the following steps:
 - Proceed to **Analyse**
 - Redo parts **Measure**
 - Stop the project

DMADV



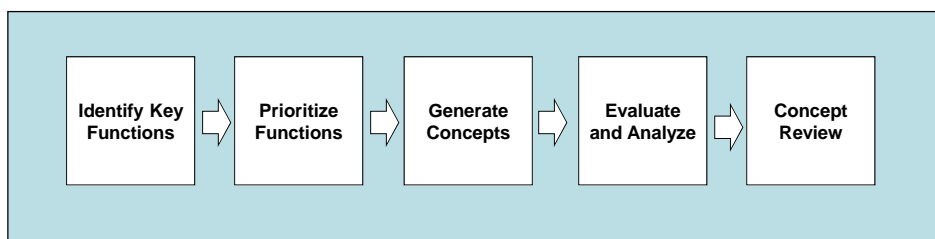
Analyse

DMADV - Analyse: Key questions

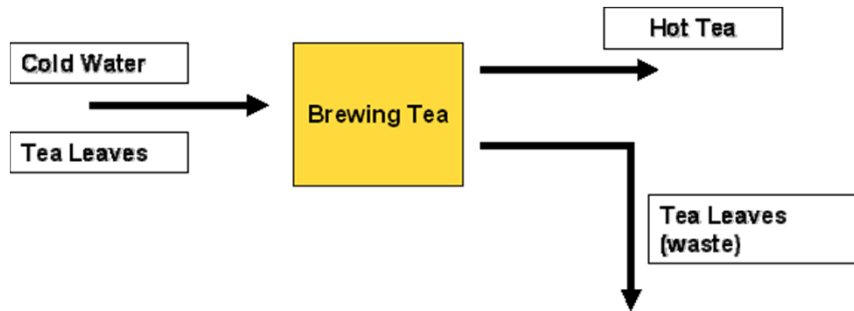


- Important processes/functions that must be designed to meet the design requirements?
- Key inputs and outputs of each process?
- Processes for which innovative new designs are required to maintain a competitive advantage?
- Different solutions available for designing each process?
- What criteria do we use to evaluate these design alternatives?
- Collect information on these criteria for evaluation?

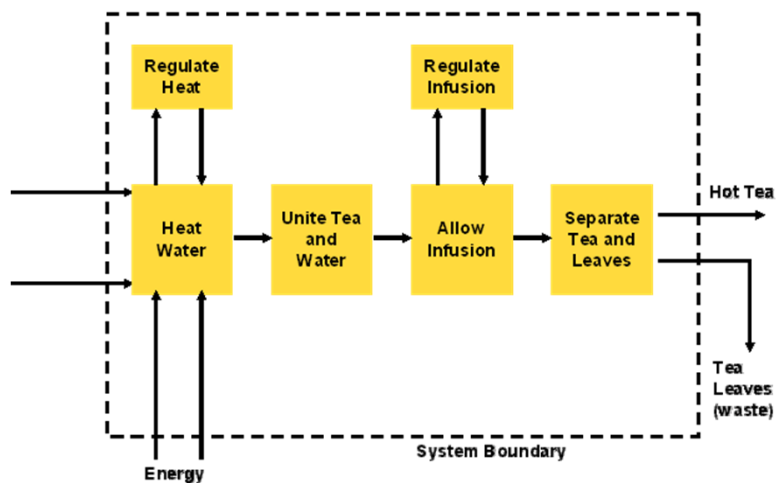
DMADV - Analyse



Identify Key Functions



Identify Key Functions



Generate Concepts



- Concepts are generated using two approaches:
- Creative idea-generation techniques that focus on analogy, connections, extrapolations and creative visualization to develop new ideas
- Benchmarking techniques that study similar designs in competing and non-competing businesses

Design Review



- Process for objectively evaluating the quality of a design at various stages of the design process
- Opportunity for voices external to the design team to provide feedback on the design, as the product and service is being developed
- Helps to ensure that the design will satisfy customers, and that the design process will function effectively to produce a high quality product or service

When to conduct a design review



- **Concept Review:** Conducted after two to three key concepts have been identified and their feasibility has been determined.
- **High Level Design Review:** Conducted after a selected concept has been designed to some level of detail and tested, and before detailed design begins.
- **Pre-pilot Design Review:** Conducted when the detailed design is complete and the product/service is ready to be piloted.

Design for X



- Design for manufacture
- Design for assembly
- Design for reliability
- Design for testability
- Design for service
- Design for quality
- Design for reusability
- Design for environment

Analyse: Tollgate Review



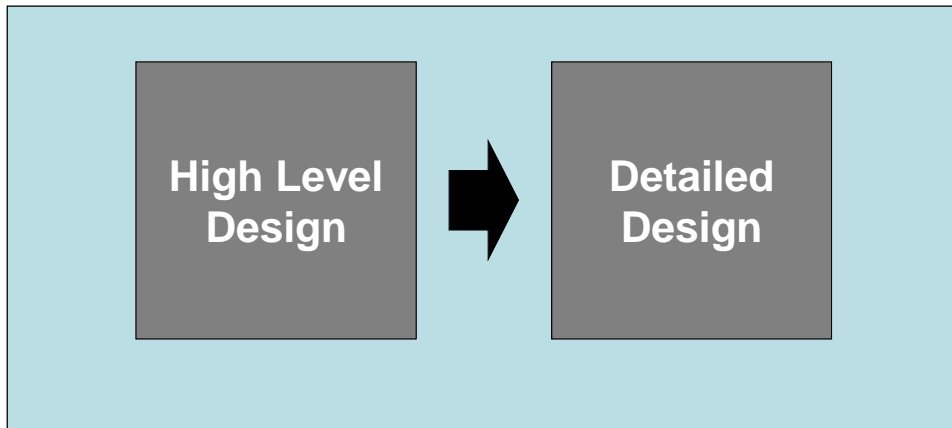
- This tollgate review focuses on:
 - List of key functions
 - List of top concepts
 - Pugh Matrix
 - Concept review outputs
 - Risk analysis update
- This review can lead to the following steps:
 - Proceed to High Level Design
 - Redo work on concepts, concept review and tollgate review
 - Stop the project

DMADV

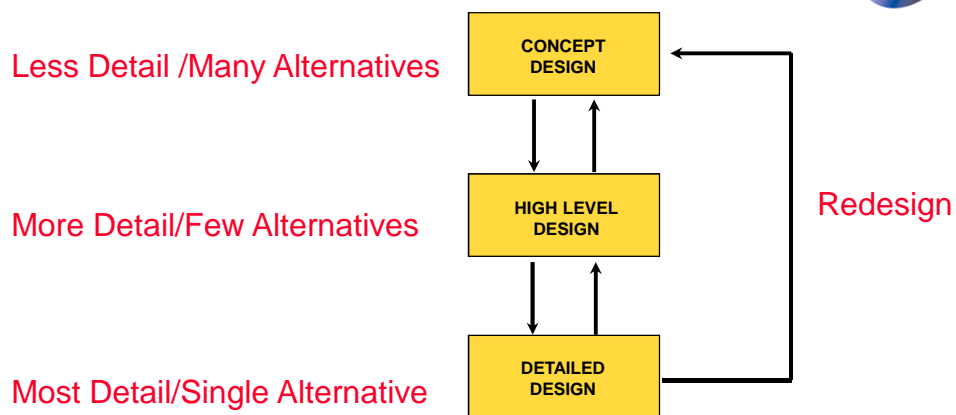


Design

DMADV - Design



From Concept to Design



Design: Goals and Outputs



- **Goals:**
 - Develop high level and detailed design
 - Test design components
 - Prepare for pilot and full scale deployment
- **Outputs:**
 - Tested high level design
 - Tested detailed design
 - Plans for process control
 - Completed design reviews

Design: Tools



- QFD
- Simulation
- Rapid prototyping
- Weibull analysis
- SPC and process capability
- Detailed design scorecards
- FMEA
- Reliability testing and qualification testing
- Design reviews

Tollgate review



The pre-pilot detailed design tollgate review focuses on:

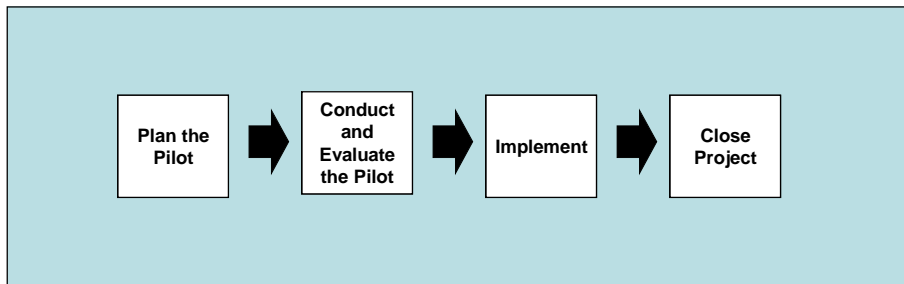
- Developed design
- Completed FMEA/simulation analysis
- Design solutions for vulnerable elements
- Organizational Change Plan updates
- Process management system variables
- Process management system details

DMADV



Verify

DMADV - Verify



Steps in the Verify phase



- Build a prototype
- Pilot test the prototype
- conduct design reviews using design scorecards
- Decide if the process is meeting business objectives
- Close DMADV project
- Transfer lessons learned from the project

Verify: Goals and Outputs



- **Goals:**
 - 'Stress-testing' and de-bugging of prototype
 - Implementation and team closure
- **Outputs:**
 - Working prototype with documentation
 - Plans for full implementation
 - Process owners using control plans to measure, monitor and maintain process capability
 - Project closure and documentation completed
 - Ownership transition from sponsor to operations management, and from design team to process management team(s)
 - Lessons learned

Completion Checklist



- Completed project documentation that summarizes results and learnings
- Recommendations (supported by updated information, if possible) for the next generation of this design
- Plans for (or results from) communicating your achievements to the rest of the organization
- Plans for celebrating your success

Advantages of DFSS



- Provide structure to development process
- Anticipate problems and avoid them
- Reduce life cycle cost
- Improve product quality, reliability and durability
- Cultural change
- Minimise design changes
- Improve communication between functions

Difference between SS and DFSS



DMAIC	DFSS
reactionary	proactive
detecting and resolving problems	preventing problems
Existing products or services	Design of new products, services or processes;
Financial benefits quantified quickly	Financial benefits long-term
Mainly manufacturing processes	Marketing R&D and design
	DFSS team cross-functional

DFSS Summary



- Rigorous approach to design
- Primarily used for new product design
- Structured approach
- DMADV and PIDOV
- Tailored for each company
- In conjunction with product introduction
- Pushes key issues up front – design for reliability and design for manufacture