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Role of Design for Six Sigma in Total Product Development

Presentation Outline

- Introduction to Six Sigma
- DMAIC Approach
- Benefits and Limitations of DMAIC
- Introduction to Design For Six Sigma (DFSS)
- DMAIC VS DFSS
- Steps in DFSS
- Case Studies
- Deploying DFSS

What Is Six Sigma?

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- Philosophy
- Vision
- Initiative
- Goal
- Method
- Tool
- A means to stretch our thinking with respect to quality.

6σ

Six Sigma Is Different From Past Quality Programs In That It…

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- Changes business measurements
- Changes the role of finance
- Monitors projects to closure
- Sustains the gains
- Results in demonstrable success
- Improves competitiveness

…and is bottom line-focused and led by executives.

Six Sigma Benefits

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- Enables success in a world of intensified competition and declining margins
- Ensures quality necessary to satisfy increasingly demanding customers
- Provides means to become the best in the world
- Establishes standard language and approach across all functions and lines of business
- Helps develop next generation of leaders

Results directly linked with business objectives.

Premise Of Six Sigma

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- The basic premise of Six Sigma is that sources of variation can be:
  - Identified
  - Quantified
  - Eliminated or controlled
- Focused on strategic or core processes
- Data driven
  - Measurements focused on right things

Variation is the enemy!

Getting To Six Sigma

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Process Capability σ_{st}	Defects per Million Opportunities$_{lt}$	Long Term Yield
2	308,537	69.15%
3	66,807	93.32%
4	6,210	99.38%
5	233	99.98%
GOAL → 6	3.4	99.99966%

DMAIC Approach for Problem Solving

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Measure

Practical Problem

Analyze

Statistical Problem

$$y = f(x_1, x_2, \ldots, x_k)$$

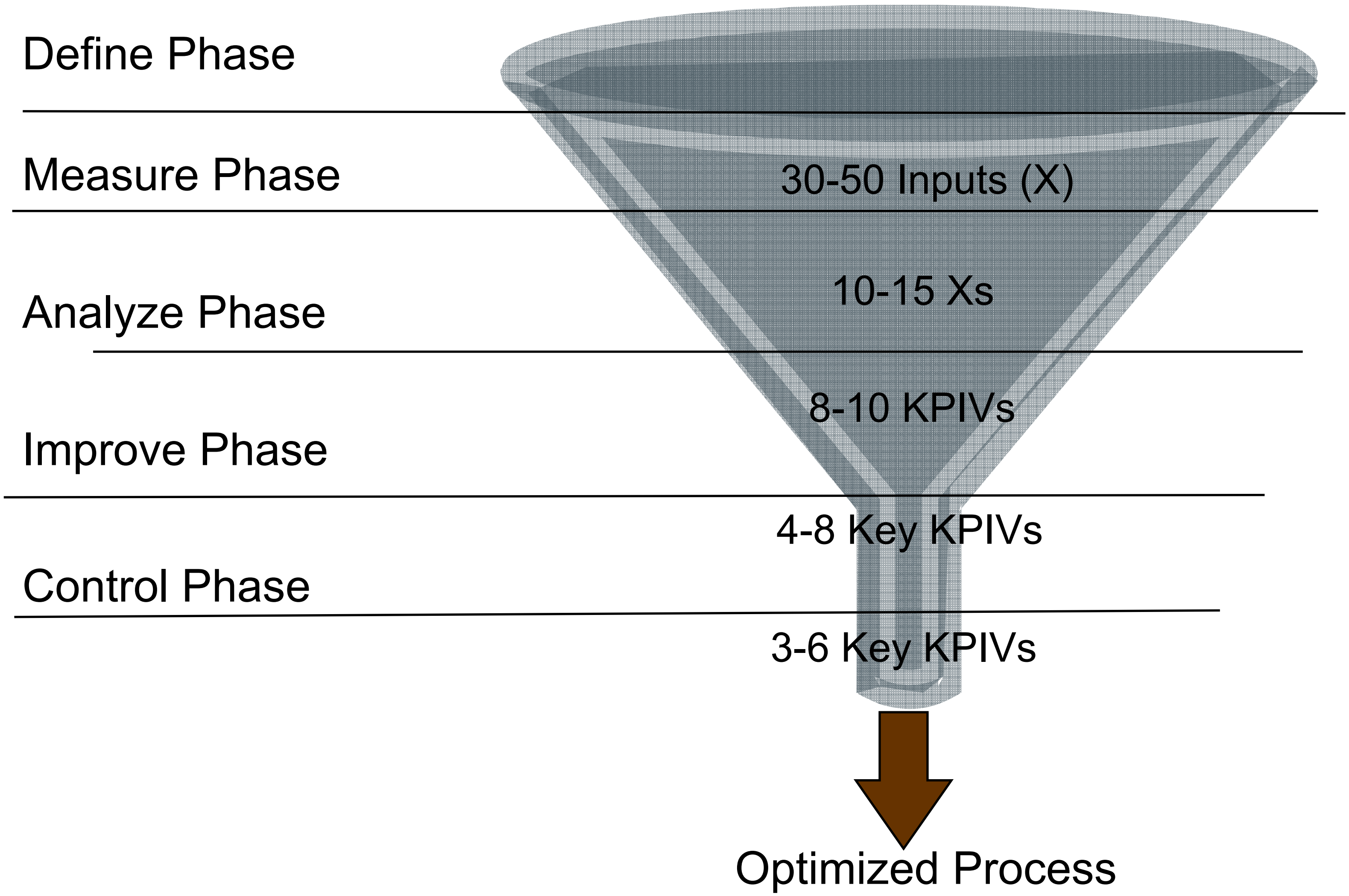
Practical Solution

Control

Statistical Solution

Improve

Dynamics Of Execution Strategy
The Funnel Effect



12 Steps in DMAIC Approach

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1. Select Output Characteristic
2. Define Performance Standards
3. Validate Measurement System
4. Establish Baseline Process Capability
5. Define Performance Objectives
6. Identify Variation Sources
7. Screen Potential Causes
8. Discover Variable Relationships
9. Establish Operating Tolerances – Implement Improvements
10. Validate Measurement System
11. Determine Final Process Capability
12. Implement Process Controls

Limitation of DMAIC Approach

The DMAIC approach can improve existing products and services to a level which they are capable of, but the overall product or service performance may be limited by design.

In order to overcome this limitation, Design for Six Sigma (DFSS) approach is recommended as it covers a full range of product and service design starting with the voice of the customer (VOC) and ending with product or service launch.

The Impact of DFSS

- By integrating DFSS methods and tools within their design organizations, companies have experienced the following benefits:
  - Shorter development cycles from idea-to-sale
  - Reduction is design process complexity
  - Reduced warranty cost after launch
  - Reduced early-life failures
  - Increase initial customer satisfaction
  - Greater efficiency in design resource utilization
  - Less post-pilot design changes
  - Easier integration of geographically separated design groups

How The Impact of DFSS Is Seen

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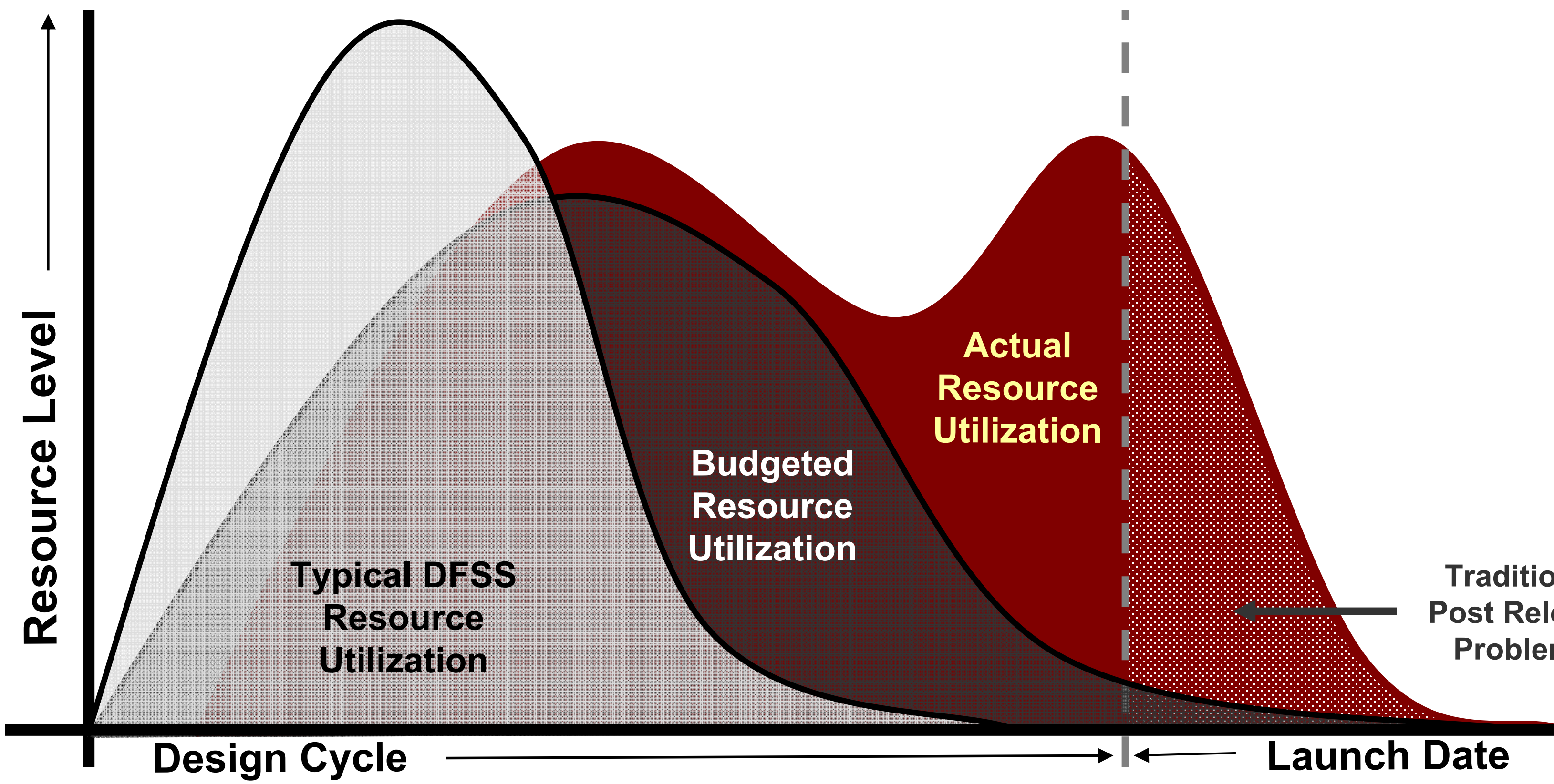
DFSS requires more resources early, but offers more effective utilization and less overall resource use during the design cycle.



DFSS (IDOV) Methodology

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- The DFSS (IDOV) process consists of eight phases which align to the following main steps:
  - Identify: Identify customer needs and strategic intent.
  - Design: Deliver the detailed design by evaluating various design alternatives.
  - Optimize: Optimize the design from a productivity (business requirements) and quality point of view (customer requirements), and realize it
  - Validate: Pilot the design, update as needed and prepare to launch the new design.

The IDOV Roadmap

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Identify → Design → Optimize → Validate

Identify

- Find customer wants and needs
- Conduct Feasibility Study | Assess Technology
- Validate Business Case

Design

- Identify Operational Noise
- Identify Inner Noise
- Convert Wants and Needs to CTSs
- Apply Noise Strategy
- Flow Down Requirements
- Create Design Concepts
- Evaluate design solutions
- Develop Transfer Functions
- Predict Design Capability

Optimize

- Identify Inner Noise
- Apply Noise Strategy
- Flow Down Requirements
- Develop Transfer Functions
- Predict Design Capability
- Optimize design and value
- Plan test for functionality
- Conduct Test for functionality
- Develop control plans
- Build confirmation pilot
- Verify process & measurement capabilities
- Implement Design

Validate

- Measurement & Process Controls
- Leverage to other applications

The Roadmap for DFSS Designs

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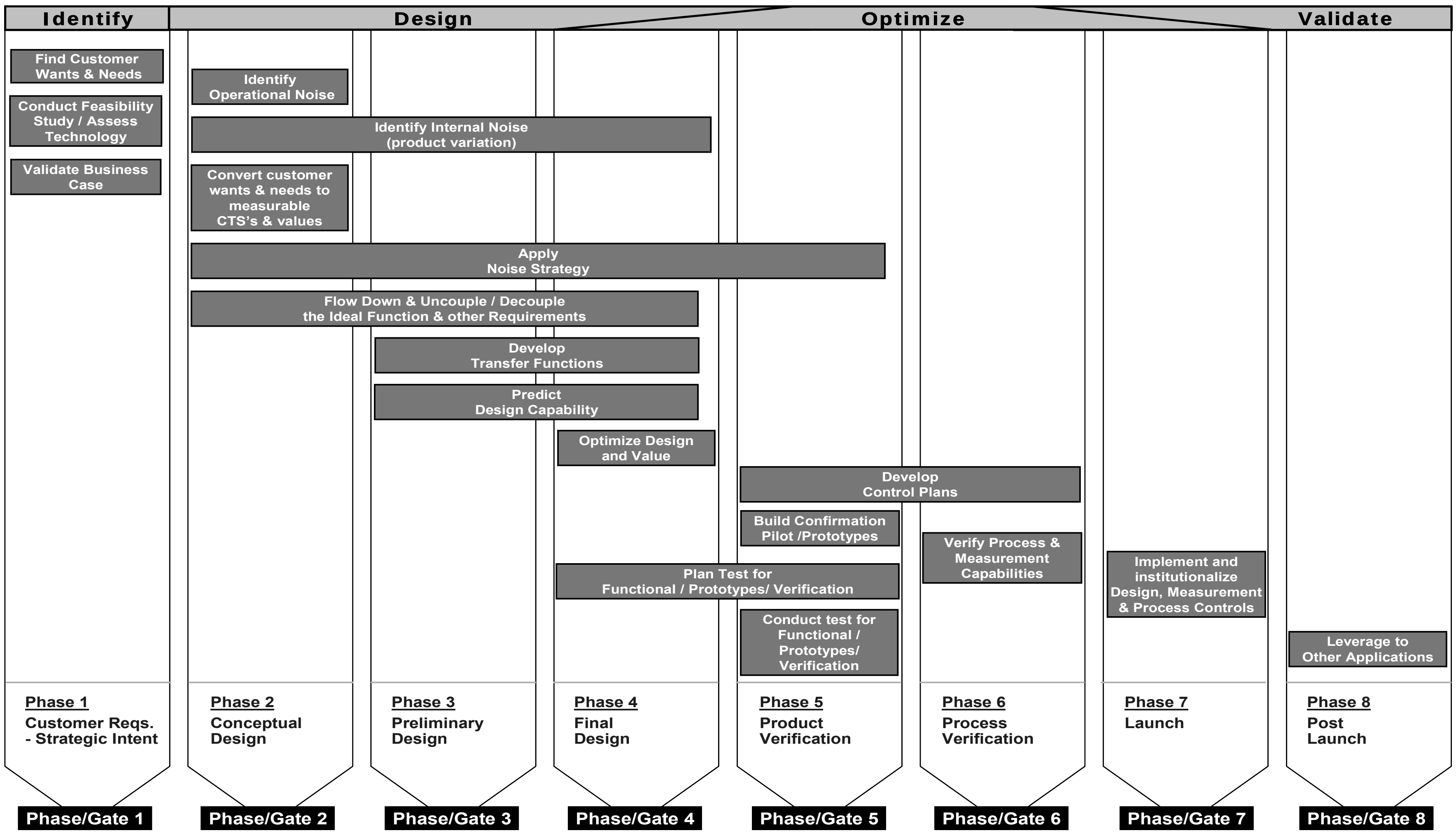
The Design For Six Sigma roadmap (IDOV) ensures design accountability



The Knowledge Base & Tool Set

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DFSS design teams apply advanced design methods and tools throughout the phases of a rigorous product, service, or process design roadmap to ensures proper design discipline and superior results.

DFSS Curriculum, Tools & Methods

	Phase	Curriculum Topics	Tools & Methods
Identify	**P1 - Customer Requirements / Strategic Intent**	Find Customer Wants and Needs Conduct Feasability Study Assess Technology Validate Businsess Case	Listening to the Customer Voice Kano Method QFD
Design	**P2 - Conceptual Design**	Identify Operational Noise Identify Inner noise Convert customer wants/needs to measurable CTS's Apply noise strategy Flow-down requiremnets (uncouple/decouple) Create design concepts Evaluate design soutions	QFD SIPOC Processing Mapping Design Concepts Pugh TRIZ
	P3 - Preliminary Design	Identify Inner noise Apply noise strategy Flow-down requiremnets (uncouple/decouple) Develop transfer functions Predict Design Capability	Robust Design QFD Axiomatic Design Zigzag Process Design Scorecards Process Mapping FMEA
Optimize	**P4 - Final Design**	Identify Inner noise Apply noise strategy Flow-down requiremnets (uncouple/decouple) Develop transfer functions Predict design capability Optimize design and value Plan test for functional/prototypes/verification	Robust Design Axiomatic Design Zigzag Process Simulations Capability analysis Lean techniques,TRIZ
	P5 - Product Verification	Apply noise strategy Develop control plans Build confirmation pilot/prototypes Plan test for functional/prototypes/verification Conduct test for functional/prototypes/verification	Robust Design Control Plans SPC Prototyping & Piloting
	P6 - Process Verification	Develop control plans Verify process/measurement capabilities	Control Plans, SPC SPC Capability Analyisis
	P7 - Launch	Implement and Institutionalize Design,	SPC MSA Pre-Launch and Launch
Validate	**P8 - Post Launch**	Measurement & Process Controls Leverage to other applications	

Example DFSS Projects

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Industry: **Financial Services firm**

Problem: **A Call Center at this Financial Services firm found that 18% of inbound customer calls required subsequent research and an outbound follow-up call to resolve the issue. Combined solutions resulting from this DMAIC project produced savings of $2.5 million and a 97% reduction in defects (issues not handled on first-call). This DMAIC project made minor improvements, and was successful in eliminating some processing defects, but the cycle time DPMO was reduced by only 9%. One result of the DMAIC analysis was the determination that only a redesign of the process could accomplish the desired breakthrough improvement in quality and meet customer needs.**

Problem Solving Methodology: **Management agreed on the need for redesign, and a design team has been formed to accomplish this task. Management has stated that the redesign should address existing customer satisfaction issues, add no additional staff, and minimize capital investment. The team followed systematic IDOV process to redesign of the process.**

Benefits: **After applying steps in DFSS (following IDOV process), the following benefits have been realized.**

Benefits due to reduction of average cycle time from 70 to 47.5:

- **32% reduction –Savings of = $1.944 million**

Benefits due to increase in Yield from 0.81 to 0.96:

- **19% increase-Savings of = $ 1.507million**
- **One time cost of design changes revised upward to = $1.530 million**

Overall Net Benefit (Year 1) = $1.921 million | Recurring Annual Benefit = $3.451million

Example DFSS Projects

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<u>Industry:</u> Telecommunication Equipment Manufacturer

<u>Problem:</u> To design a robust key pad for the cell phone by reducing contact problems and by increasing click ratio.

<u>Problem Solving Methodology:</u> The DFSS team identified all CTS's by obtaining VOC. The team followed DFSS steps by breaking down the requirements at all levels by developing transfer functions and identifying noise factors and utilizing techniques like robust design.

<u>Results:</u> After following DFSS road map, the team had achieved the following:

- **Time frame: Target 4 months, achieved in 3 months**
- **Generic contact problem: Target < 0.5%, reduced to almost 0**
- **Reduce total cost of the system: Target > 50%, reduced by > 75%**
- **Increase the click ratio (feeling): Target > 25%, achieved > 40%**
- **Savings due to achieved results > 3 Million Euro**
- **Cycle Time reduction for the next product generation**

Example DFSS Projects

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Industry: **PCB Manufacturing (Electronics)**

Problem: **Electro Plating is an important process step in PCB manufacturing. In the electro plating process, the circuitry will be plated with copper, The copper deposition rates were observed to be varying by a great extent. The adverse effects of improper plating are poor solderability, low ductility and low mechanical strength. These properties are required for the repeated component replacements and long PCB life. The specifications for plating thickness are 25 to 35 microns. The existing process performance was not satisfactory with high levels of mean (32 microns) and standard deviations (8 microns). Because there were many customer returns and rejections**

Problem Solving Methodology: **A team was formed with a task of improving the existing level of performance by redesigning plating process. The team followed the steps in the DFSS methodology. To identify and examine the nature and sources of plating thickness variations, data was collected and analyzed through Nested Analysis of Variance. After the analysis, it was concluded that variations due to stages and tanks were not significant but, variation between positions of panels (PCBs) was significant. After performing steps in IDOV process, changes in design of clamps and position of anodes were recommended.**

Benefits: **The DFSS solution gave a standard deviation of 2.5-3.0 microns and an average of 29 to 30 microns.. This has resulted in the savings of $ 300,000 per year.**

Example DFSS Projects

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Industry: **Telecommunication Equipment Manufacturer**

Problem: **To design a call center product supporter service by reducing non defined fault rate and its variation due to software updates**

Problem Solving Methodology: **After obtaining the VOC, the DFSS team followed IDOV methodology by using tools like axiomatic design and Pugh concept selection approach.**

Results: Following results were achieved through this DFSS project:

- **Project Savings > € 400,000**
- **Increase in Call Solution Rate > 15%**
- **Reduction in Non Defined Fault Rate: Reduction by > 35%**
- **Reduction in Non Defined Fault Rate Variation : Reduction by > 40 %**

How Will You Implement DFSS

- The following considerations can help you determine the most effective and efficient deployment approach for your organization:
  - How mature is your Lean and/or Six Sigma DMAIC deployment?
  - How sophisticated are your current design practices?
  - What data is available regarding how well your design process performs to plan and expectations?
  - Do you have a design cycle plan?
  - At what level do you envision the application of DFSS to your product and process design (component, sub-system, system or super-system)?
  - What are your strategic objectives for implementing DFSS?
  - Are there other factors that might influence the acceptance of DFSS methods, tools and practices?

Deployment Approaches

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	DFSS Deployment Models		
	Open Enrollment	**Process | Sub-System**	**System Level**
PARAMETER	• Single Seat or Small Team Training • Simple Sub-system • Typical project is a redesign effort	• Design Team Training - full classroom • Single System • Redesign and New Design efforts	• Organization-wide • Multiple Design Teams • Multiple Systems • New Designs
BUDGET	• Per Designer Tuition • Individual Travel Expenses	• Per Wave Fees • Travel Expenses for Instructor • Classroom Facilities (3 weeks per wave)	• Structured Investment Options • Deployment Team Travel Expenses • Facilities - Ongoing
ADVANTAGES	• Exposes Design Organization to DFSS • Lower initial cost • Lower initial people commitment • Can serve as a Proof of Concept • Basic DFSS Software included for individual	• Creates a Center of Design Excellence • Better discrete product or process • 3 Weeks of training scheduled to your needs • Training delivered at your location • On-site support by training class	• Generates transformational change • Implements growth strategies • Promotes better overall development process • Flexible training schedule and increments • Can align to development cycles • Easier to implement in non-Six Sigma companies
CONSIDERATIONS	• Creates a island of expertise • Training provided based on standing schedule • Requires self-sustaining climate	• Only touches part of the organization • Could be view as a pocket of deign excellence • Subject to cultural resistance • May require a separate software investment • Requires self-sustaining climate	• Can generate organizational stress • Requires strong leadership commitment • Requires design operational metrics • May require enterprise software investment • May require additional customer design input

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