Smallpeice Enterprises
a division of GP Strategies Limited

Design for Six Sigma
Green Belt Programme

In-company training

Accreditation pathway

Practitioner toolkit

train@smallpeice.com

DFSS Green Belt

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Design for Six Sigma (DFSS) is a methodology that focuses on reducing risks (and therefore unbudgeted costs) during product (and process) development. It does this with three main aims: firstly getting the requirements capture right, then by ensuring that the design will deliver to expectations and finally by choosing manufacturing and assembly processes that are capable of delivering components to drawing.

This modular programme will not only increase the effectiveness of technical practitioners but also provide invaluable insight to managers that want to be confident that development work is on track to deliver acceptable results at product launch. The programme is available for group training delivered on your company site.

To be certified as a DFSS Green Belt, participants must: complete all of the training and pass the end of course multiple choice exam (75 questions, 2 hour duration).
A portfolio of evidence must also be submitted to demonstrate practical application of a range of the tools.

Please note that certain modules within the programme use Minitab statistical software.

12-Day Programme (see following pages for detailed module descriptions)

Day 1
Introduction to Design for Six Sigma
See page 3

Day 2
Quality Function Deployment
See page 4

Day 3
Concept Generation & Selection
See page 5

Day 4
Design FMEA
See page 6

Day 5
Process Capability
See page 7

Day 6
Design for Assembly
See page 8

Day 7
Value Engineering
See page 9

Days 8 to 10
Design of Experiments
See page 10

Day 11
Variation & Tolerance Analysis
see page 11

Day 12
Process FMEA, Poka Yoke & Control Plans
see page 12

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Core Module dfss

Introduction to DFSS

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DFSS Green Belt
12-day programme

- Introduction to Design for Six Sigma
- Quality Function Deployment
- Concept Generation & Selection
- Design FMEA
- Process Capability
- Design for Assembly
- Value Engineering
- Design of Experiments
- Variation & Tolerance Analysis
- PFMEA, Poka Yoke & Control Plans

Design for Six Sigma (DFSS) enables companies to deliver competitor-beating products to market in less time and at lower cost. DFSS presents a new product development approach which combines the most powerful tools and methods known today to enable optimised product designs to be produced and verified. The DFSS method is intended to be used to support the front-end design of complex systems and to complement the existing new product development processes within a company. DFSS not only enables faster and higher quality product development but also helps teams to identify stronger, more innovative solutions to important customer needs. This course aims to introduce product developers to the DFSS tools and approach through a series of interactive hands-on workshops.

Programme of content

Introduction to DFSS
- Why Design for Six Sigma?
  - The time-to-market challenge
  - Why variation is the real enemy
- What is DFSS?
  - The right tool at the right time
  - Overview of the DFSS steps - DMADV

Define & Measure
- The DFSS project charter
- Capturing the Voice of the Customer
- Prioritising Customer Requirements
- Defining good measures

Analyse
- Basic brainstorming rules
- Framing the problem
- Pugh Convergent Design
- Risk Assessment using FMEA

Design
- Removing outliers through mistake proofing
- Simplifying the design
- Experimenting to optimise performance and reduce variation

Verify
- Fundamentals of verification
- Design margins and robustness
- Process Stability and Capability

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Core Module dfss

Quality Function Deployment

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- Introduction to Design for Six Sigma
- **Quality Function Deployment**
- Concept Generation & Selection
- Design FMEA
- Process Capability
- Design for Assembly
- Value Engineering
- Design of Experiments
- Variation & Tolerance Analysis
- PFMEA, Poka Yoke & Control Plans

QFD is a powerful development technique that ensures customer requirements drive the new product introduction process. Simple matrices are used to capture & analyse information, & delegates progress through the key stages of prioritising customer requirements & technical characteristics, selecting concepts, design deployment & production control, & managing the overall QFD process.

- Understand what makes a good product requirements specification
- How the Voice of the Customer is captured and translated into a product performance specification
- Practice the keys tools of the QFD technique
- Understand the links between engineering specifications

Programme of content

Introduction to QFD
- QFD purpose & structure
- The benefits of QFD within NPD
- Overview of the QFD rooms

Customer Focus
- Capturing & reviewing the VOC
- Categorising & prioritising customer needs
  - KANO model
  - Using Paired Comparison
- Needs Assessment
  - comparing current products against needs
  - product strategy using SWOT

Product Focus
- Defining product purpose using Functional Analysis
- Identifying performance characteristics
- Using correlation & relationship matrix
- Performance prioritization & targets
- Performance assessment

Further QFD Phases
- The specification cascade
- Linking DFSS tools to the cascade

Case Study Exercise
- Checking understanding, and practicing the tools in the various QFD phases

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Core Module dfss

Concept Generation & Selection

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- Design FMEA
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The tools of Concept Selection can be used to help take the best concept forward for refinement in the detail design part of the process. Using a structured approach avoids weak concepts and project delays and disruption occurring.

- Show how relevant creativity tools support the Design & Development Process
- Understand how to create an environment for new ideas
- Generate the triggers for alternative solutions using Functional Analysis
- Practice key creativity tools
- An overview of the TRIZ technique
- Practice a number of different concept selection tools and understand their differences

Programme of content

Introduction to Creativity
- Why develop alternative solutions?
- What is creativity?
- Thinking types
- The use of stimuli

Creativity Tools
- Brain storming
- Mind mapping
- Analogy & related words
- Lateral thinking
- TRIZ

Concept Selection
- The benefits of effective and timely concept selection
- Concept examples generation
- The set of evaluation criteria and their priority

Selection Tools
- Basic classification
- Paired comparison
- Bubble chart
- Radar chart
- Basic evaluation
- Controlled convergence
- Tools strengths & weaknesses

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Design FMEA

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Design FMEA is an early development 'gateway' module to identify & assess the key design risks facing a project team. These are then assessed to determine what actions are necessary to address them. The FMEA method is fully described and practiced, showing delegates what a good Design FMEA looks like. Also, at what level of design detail should it be applied.

- How to correctly scope a DFMEA
- Understand and practise the DFMEA method
- Be aware of the common mistakes
- Understand how DFMEA links with other NPD tools

Programme of content

Introduction to Design FMEA
- The importance of risk management
- The DFMEA method & language

Failure Modes, Effects & Severity
- Scoping the DFMEA & specifying failure modes
- Potential effects of the failure mode & grading effects
- Giving failure modes a status

Causes & Occurrence
- Identifying potential causes of the failure mode
- What cause prevention control is in place ?
- Grading the causes for occurrence

Control & Detection & Risk Review
- Evaluating the design & grading detection controls
- Risk review & identification of weaknesses
- Mitigating future risk & avoiding the pitfalls
- DFMEA governance & maturity

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Process Capability

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This training workshop is an module that delivers tools that enables and then ultimately provides an understanding of capability – how well the system performs, in terms of how comfortably the output results are within the limits of acceptability for that system. Although there are alternatives, Minitab is one of the most popular choices of software for the purpose of graphical and statistical analysis. This modules aims to provide the following:

- Achieve a working familiarity with Minitab
- Review the principles of basic statistics and common probability distributions
- Understand how to use Minitab to obtain a graphical summary of sample data
- Understand how to use Minitab to run capability studies for both Normal and non-Normal data

Programme of content

Assessing Process Control

- Understanding different types of process variation
- Understanding process control
- Anatomy & use of control charts
- Applications of SPC charts

Applied Statistics

- Basic statistics:
- The 3 measures of central tendency: Mean, median, mode
- The 4 measures of variability
- Probability distributions:
- The Normal distribution
- The Binomial distribution

Understanding Process Capability

- Understanding process capability
- Interpreting the common capability metrics: Cp, Cpk, Pp, Ppk and sigma level
- Testing for and dealing with non-Normality:
- Some simple checks to consider
- Individual distribution identification

Assessing Process Capability

- Calculating process capability for continuous and attribute data
- Selecting appropriate capability metrics & indices

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Core Module dfss

Design for Assembly

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One of the most powerful techniques for reducing production costs, DFMA forces designs to be analysed for assembly ease and shows how to re-design to reduce time-to-market, and increase production efficiency.

- Show how DFA supports the deliverables of design
- Recognise the links to other design tools
- Using DFA tools to assess a design and identify improvement opportunities

Programme of content

Introduction to Design for Assembly
- The influence & impact of design on assembly
- The DFA analysis method
- The consequences of poor DFA practice

Analysis Method
- Set up; scoping; difficulty analysis
- Review each product part for DFA difficulties
- Minimum part count & challenging part existence

DFA Design Index
- How good is the current design?
- Redesign & improvement; redesign analysis
- How good can a new design be?

Method Review & Application
- The strengths of the DFA method
- How DFA is normally applied

Also available . . .

Design for Manufacture & Assembly

This additional module can be added to the core DFA training.

- Linking Design for Assembly to Design for Manufacture
- Identifying potential manufacturing problems early in the cycle
- DFM process steps to a robust, cost effective part design
  - Scope interfaces
  - Functional description
  - Interface performance values
  - Part feature specification
  - Prioritise part features
  - Understand process variability and cost
  - Review process capability and cost
  - Re-design and/or re-specify process

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Core Module dfss

Value Engineering

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- Design FMEA
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- **Value Engineering**
- Design of Experiments
- Variation & Tolerance Analysis
- PFMEA, Poka Yoke & Control Plans

This training workshop is a gateway module to identify the value and cost issues facing a design team. These are then assessed to determine what actions are necessary to address them. The VE method is fully described and practiced, showing delegates how to assess any product design to optimise its value to the customer.

- Appreciate how value optimisation can help to optimise a product's design
- Explain the benefits of applying the value analysis method & show where it should be used
- Apply the value analysis method to identify areas of a design that give poor value
- To highlight where the cost is high compared with the function priority
- Identify potential improvements in the value of a product or service

Programme of content

Introduction to Value Engineering
- The concept of value
- Understanding the different types of value
- The value engineering method

Identify
- Defining the analysis subject
- What information is required?
- Product functionality

Assess
- The product / design relationship
- Functional cost analysis
- Functional worth analysis

Control
- Value optimisation
- Change implementation

Method Review & Application
- The strengths and weaknesses of the VE method
- How is VE is normally applied

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Core Module dfss

Design of Experiments

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Poor understanding of the interactions between key inputs & their effect on customer-critical outputs often leads to under-performance of products/ processes. This course navigates through the myriad of approaches available, providing guidance on best practice & application. It is suitable for anyone tasked with increasing product or process quality - or reducing costs within design, engineering or manufacturing

- To provide logical steps confirming what is required to conduct a Design of Experiment
- To enable assessments and alternative options when an experiment becomes large and uneconomic to perform
- To provide a step-by-step analysis of each type of experiment plus the use of Minitab Statistical Analysis

1-day introduction

Introduction to Design of Experiments (DoE)
- The application and benefits of DoE
- Stages of experimentation

Planning an Experiment
- Factors and levels

Designing an Experiment
- Design options
- Replication & Randomisation

Analysis Refinement and Optimisation
- Analysing results
- Visualising results
- Optimisation of confirmation

Signposting Additional Techniques
- Fractional factorials designs
- Response surface techniques

Additional 2-days of advanced techniques

Advanced (Taguchi) Design of Experiments
- Benefits & limitations of Factorial DoE techniques
- Taguchi loss function and how it can be used
- Explanations of signal and noise as used in Taguchi DoE
- Determining levels and design selection
- Generating main effects plots
- Using the results of a Taguchi experiment

Advanced (Response Surface) Design of Experiments
- Why use response surface methodologies
- Assessing the correct design space
- Adding axial (star) points and quadratic terms to the DoE
- Reading contour and surface plots
- Setting goals, limits and desired output response from the experiment

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Core Module dfss

Variation & Tolerance Analysis

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- **Variation & Tolerance Analysis**
- PFMEA, Poka Yoke & Control Plans

Understanding the effect of input variation on output performance via tolerancing has been traditionally been done via 'worst case' or statistical (RSS) approaches. Now that Monte Carlo Analysis can be performed via Minitab, we showcase the use of this powerful and flexible tool. We also turn to the progression from the critical to design measures (CTDs) and the processes that will create them and their critical to process measures (CTPs). Finally, we look at effective piloting of new processes.

- Review traditional tolerancing methods
- See the benefits of using Monte Carlo Analysis to predict capability and manage tolerances
- Understand of the 3rd House of Quality works
- Use Minitab's Response Optimiser to meet conflicting output targets
- Understand how careful planning can increase the benefits achieved when piloting new processes

Programme of content

Understanding Variation

- Sensitivity analysis: using a worked example to predict the variation in the output
- Monte Carlo analysis) to predict output variation
- How to manage input tolerances

Confirming Process CTPs and Optimisation

- The 3rd House of Quality
- Confirming the Critical to Process (CTP) factors
- Using Minitab's Response Optimiser to achieve multi-objective (i.e. multi-goal) optimisation

Piloting new processes & Reliability

- Effective pilot planning
- Conducting the pilot
- Declaring success

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Core Module dfss

Process FMEA, Poka Yoke & Control Plans

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- **PFMEA, Poka Yoke & Control Plans**

Process FMEAs & associated Control Plans are a mandatory requirement for most companies and they also provide a framework to drive continuous improvement activities. This training workshop is a gateway module to identify the process risks facing a NPD/manufacturing team, which are then assessed using the FMEA method. The controls identified to best reduce process risk are those that are summarised in the Control Plan. This document, created and used properly, will refer to suitable corrective actions that will, when carried out, correct a process that is going off track.

- Introduce a structured approach to Process FMEA that maximises benefits and reduces risk
- Link the Process FMEA to product design requirements
- Link the Process FMEA to current controls and the quality plan

Programme of content

Introduction to Process FMEA
- The importance of risk management
- Medical device FMEA types
- Links with QFD
- The PFMEA method
- What does a good PFMEA look like?

Identify
- Scoping the PFMEA
- Defining "success"
- Specifying Failure Modes

Assess
- Failure effects identification and grading for severity
- Failure causes and grading for occurrence

Assess (continued)
- Prevention Control, Poka Yoke
- Detection control and grading
- Risk review

Control
- Action plan development, delivery and impact
- Robust Control Plans

Quality Management
- Common PFMEA mistakes and how to avoid them
- Governance
- Team working
- PFMEA maturity/maintenance

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