Design of Experiments Mechanical Systems

Course leader: Jan Åkerström

Duration 1 day

Audience

This instructor-based course is for engineers and scientists who have completed some design of experiments training and who want to design and analyze experiments in mechanical systems.

Course Description
Real life mechanical systems typically deviate from the assumed system behaviour in design of experiments literature. The signal noise ratio can be more than 10 times larger than usually assumed in parts of the factor space while other parts are characterized by phenomena such as resonance, eutectic mixtures and other discontinuities in response surfaces leading to extreme dispersion effects and other complications.
The course is intended to give a practical view on how we with the support of traditional statistical methods plan experiments and perform analysis in mechanical systems.
Emphasis is put on extraction of information through graphical analysis of residuals with safeguards in the formal least square analysis with decisions based on β, α and p values generated by F and t distributions. The overall goal is – as usually - to build sound decision base through a synthesis of specialist system knowledge and information generated by experiments.
We will also discuss how to use the results when optimizing the design and production process based on the six sigma criteria.

Prerequisites

Before attending this course you should have a basic understanding of design methods based on statistical methods. Experienced designers of mechanical systems might also find the course interesting.

Course content
Recapitulation of standard statistical theory for design of experiments

- Statistical models and experiments
- Basic randomized two level designs
- Experiments for robust product design

Special characteristics of mechanical systems

- Choice of standard transformation
- Focus on extraction of information in residuals given physical system behaviour
- Planning and analysis considerations given system classification including assessed signal noise ratio category and system stability

Taguchi: History and ideas useful in classical analysis of experiments in mechanical systems

An introduction to residual based analysis with location and dispersion effects: Welding experiment

Real case 1: Design of exhaust gas heat exchanger – flow induced resonance

- Scenario
- Planning: factors and levels , design selection, engineering analysis including estimation of natural frequencies and Strouhal numbers
- Sequence of experiments: two steps – factor reduction to simplify response
- Analysis: residual analysis, dispersion and location effects, different behaviour in different subspaces

Real case 2: Reliability of threaded pipe joint exposed to accelerated user load spectrum

- Scenario
- Sequence of experiments: 5 steps
- Planning and analysis: factor selection (two sessions), assessment of variance structure, dispersion effect or outlier, unreplicated to replicated design, from block to block factor.
- Actions based on 6 sigma criteria including production process optimization for 6 sigma level production and SPC initiation