

COURSE DESCRIPTION

"Design of Experiments Basics", & "Quality by Design - DoE"

In practice, the "COST principle" "Change One Setting at a Time" is often used for development, running-in, trouble-shooting and the optimization of technical processes.

As a rule, this has several disadvantages and means that the project plan, budget and resources cannot be reasonably planned, while one cannot describe the processes in sufficient quality.

A structured approach and high data quality are required for a scientifically and reliable assessment of process quality. "Design of Experiments" is the most effective approach to achieve these goals. In comparatively few experiments, cause and effect of processes are defined and visualized. Parameters and factors are weighted in their influence and the quality of the measurement method is evaluated. In addition, the influence of "uncontrollable" parameters on the process result can be recorded and analyzed to some degree.

Current software packages such as "Modde pro" support guided, structured evaluation and interpretation of individual designed test plans. After modelling the data, it can be checked if the pre-set targets can be fulfilled. If a technical solution is feasible in principle, the software can be used to calculate and display robust and maximized tolerances ranges for a large number of target parameters. The software-based approach can help to find out whether a process objective can be achieved in the predefined investigation space.

COURSE OBJECTIVE: The course empowers the participants as follows:

- Introduction to technical problem formulation.
- Setup of efficient experimental designs depending on the task.
- Analyze of experimental data with validated statistical methods.
- Improvement and optimization of products and processes.
- Robustness testing, qualification and validation of processes / products.
- Interpreting test results and generating knowledge.
- Better assessment of process or product risks.
- Preparing reports including graphs and diagrams.

WHO SHOULD PARTICIPATE?

- The course is designed for technicians, laboratory staff, auditors, scientists and engineers from all areas of industry and science.
- Typical applications include product development, process optimization, validation and quality control.
- Previous statistical knowledge is not required.

COURSE CONTENTS

- Understanding the DOE concept incl. problem formulation
- Data modelling and diagnostics
- Creation of a solid basis for further decisions
- Interpretation and derivation of optimal process settings and limits e.g. feasibility study
- Qualitative evaluation of process robustness
- Introduction to the "Design Space Validation" or "Robust Set-Point" definition according to the "Quality by Design" concept
- Practical application

COURSE AGENDA

Presentation "Where" and "How" Design of Experiments is used



- Integration of the DoE method into the "Design for Six Sigma" and "Quality by Design" context
- Introduction of the methods, models and limits of the DoE-approach
- Presentation of efficient designs to reduce the amount of experiments
- Problem formulation: Presentation of methods and tools
- Definition of goals, factors, desired functions, model types and designs
- Building and analysis of complete factorial designs
- Evaluation and evaluation of raw data
- Regression analysis, interpretation of models incl. interactions.
- Exercises with subsequent discussion

Focus on screening and optimization



- Analyze of Screening designs, which factors dominate the process and what are their optimal settings / workspace. (*Pareto 80/20 rule*)
- Advanced interpretation of data and models with clarification what to do at which level of the investigation incl. troubleshooting, and complementing of designs due to findings of none-linear effects.
- Introduction to RSM designs, for optimization and none linear-effects.
- Introduction to the concept of "Design Space Validation" with the QBD-approach
- Software supported multi size optimization with efficient algorithms.
- Assessment and evaluation of (set-point) results and process capabilities.
- Exercises with subsequent discussion (*also own examples are possible*)
- Reflection & Lessons Learned

Concentration on optimization, robustness and process capability



- Introduction to the "Design Space Validation" with robust set-point (based on an integrated *Monte Carlo simulation*).
- Concept of process capability based on process probabilities.
- Definition of safe limits, tolerances and settings of processes and products with help of incorporated *Manhattan distance algorithms*.
- Software based calculation of the safest and broadest possible tolerance bands in the multidimensional test space. (*Proven acceptable Region*)
- Setting up concepts for robustness testing and process validation.
- Exercises with subsequent discussion (also own examples are possible)
- Reflection / Lessons Learned
- Summary based on a visual DoE recipe (*Flowchart*)
https://stefan-moser.com/files/Cooking_recipe_V05.pdf



- Courses with more than 12 participants are not didactically useful, for larger groups I recommend splitting groups or a supporting second trainer.

Course planning / training room / requirement



- Course language: German or English
- Documents: English



- projector / Beamer
- flipchart / whiteboard
- Power supply (distributor) for all Laptops



- More current standard PC or Laptop
 - Please perform a software compatibility check with the participants' computers prior to the course.
- Resolution min. 1024x768
- Windows 8 or 10
- Min. one computer per two participants



- Licenses of the software will be provided by the trainer
- Software Modde per V.12+ (Umetrics / Sartorius Stedim)



- Catering during the course will be provided by the client

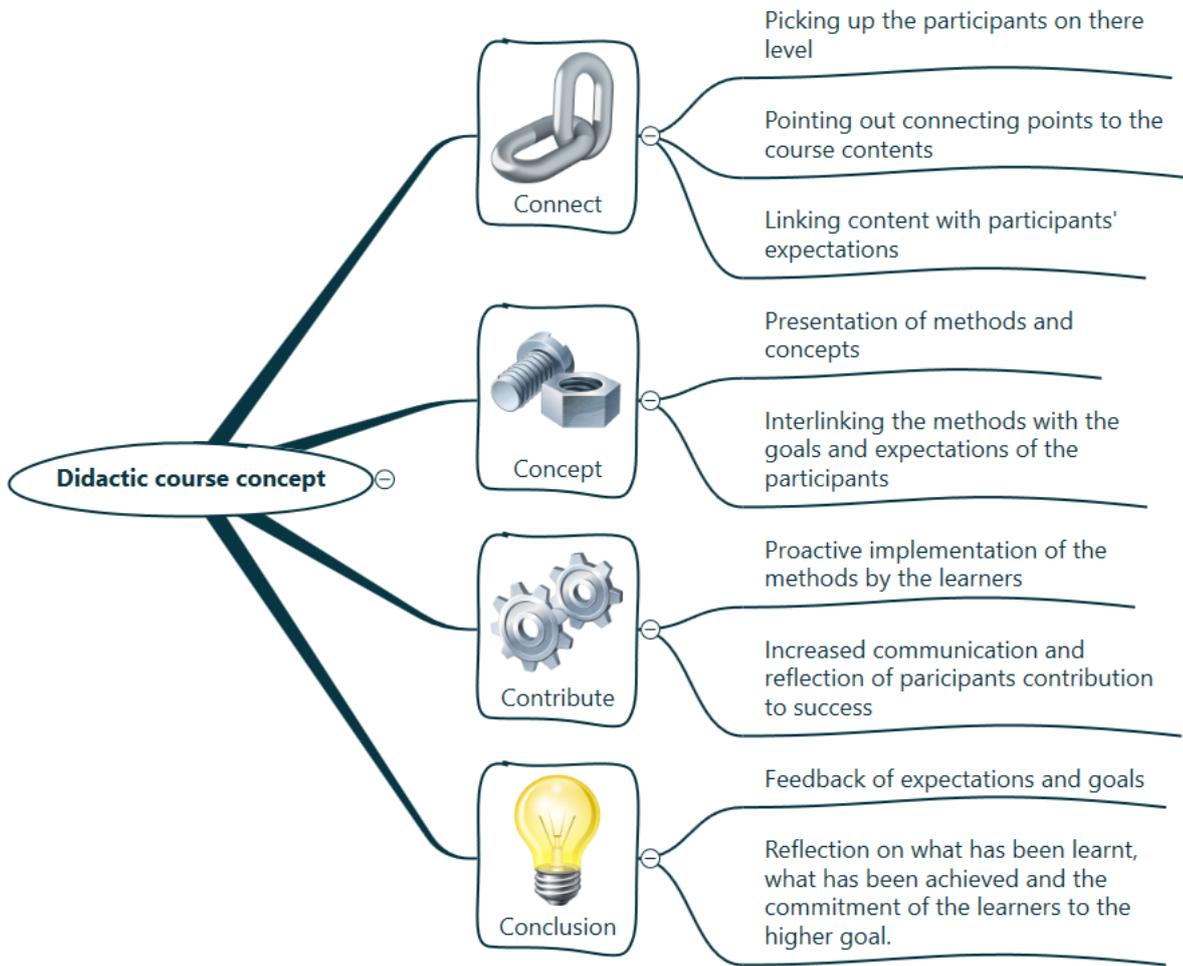


- In order to deepen the contents of the course in a sustainable way, practical "hands on" examples *can be integrated optional* in addition to the theoretical examples.
- One option could be, to bring my wooden catapults with me. If you have own ideas please let me know, I am open to discuss it.



- Please contact me if you have any questions, suggestions or to plan your individual training.

Didactic structure of the course:



Possible accompaniment and assistance with first applications in the form of:

- Coaching / support during the initial phase (online/offline), "training on the job
- Coordination of DoE activities and processes as well as analyses
- Support in the problem formulation phase: e.g. DFSS, DMAIC, DMADV - Workshops with
 - SIPOC, Ishikawa, Morphological Box (Zwicky Box), Pugh Matrix
 - Multivariate evaluation of existing data to set up a DoE
 - consistent matrix, methods for Priorities, QFD, decision trees
 - Determination of measuring equipment capabilities according to V1, V2, V3
 - Correlation of attributive, subjective results with possible numerical evaluations.
- See suggestions e.g.



Optional

<https://stefan-moser.com/files/ProjektManagement.pdf>