

Strategies for Multi-criterion Optimization and Robust Design

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In industrial product development, design decisions are mostly based on intensive parameter studies combined with expert knowledge, where in case of complex technical systems typically several experts from different departments have to be involved. However, such a human driven design process has several drawbacks. Firstly, making design improving parameter changes requires either fundamental experience on the influence of specific parameters or time intensive design explorations to find out about sensitivities; secondly, humans are only able to cope with very few of the potential design variables at a time; and thirdly, even if an expert would be able to find the optimum for his specific subtask, the overall design would not exploit the overall optimization potential. To overcome these problems, automated design evaluation and process integration in a common optimization environment may be applied. Key drivers are optimization-oriented design parameterization, expert-driven problem formulation and use of multi-criterion optimization concepts to rise acceptance in industry. The tutorial will show the major difference in tackling design problems as classical nonlinear programming problems or using a multi-criterion optimization concept. Various solution strategies will be demonstrated and discussed with respect to solution quality and efficiency.

Especially if global optimization algorithms are involved, the number of design evaluations and evaluation effort may raise unacceptably querying the usage of such kind of design strategies. However, application of response surfaces may account for this kind of problems. Different approximation concepts will be discussed and their applicability will be demonstrated in the context of complex design problems. Response surfaces may be also used in the context of robust design requiring statistical estimates on mean behavior and variances in the presences of uncertain parameters or uncertain environmental conditions acting on the system to be designed. The tutorial will show a concept to tackle robust design problems and discuss the different quality of both kind of solutions.