Paper ID: 88072
oral
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IAF SPACE SYSTEMS SYMPOSIUM (D1)
Interactive Presentations - IAF SPACE SYSTEMS SYMPOSIUM (IPB)

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SATELLITE MDO PROBLEM FORMULATION USING DESIGN COUPLING INFORMATION

Abstract

Spacecraft are complex engineering systems involving multiple interconnected disciplines. Multidisciplinary Design Optimization (MDO) integrates the different disciplines that are part of engineering systems and enables their optimization. With finite computational resources, one important question when formulating the MDO problem is which design aspects should be chosen as design variables and which should be fixed problem parameters. While this decision can be made based on previous experience or expert intuition, we aim to make this a more systematic task. The goal is to, given system design goals, select the design variables that will make the most impact on the MDO problem in the context of limited computational resources.

In this work, we use quantitative design coupling information to support problem formulation decisions. Design coupling strength may be quantified by calculating how the optimal value of each design variable changes when another variable is perturbed. The use of design coupling information in MDO problem formulation is demonstrated using a satellite design optimization example. Several disciplines are involved, including thermal, communications payload, propulsion, power, ADCS, and structures. The objective is to minimize the satellite mass. Design coupling strength is quantified and then used to select the most relevant design variables, with the aim of achieving the lowest objective function value possible. Tradeoffs in formulation decisions and the effectiveness of design coupling metrics for formulation decision support are assessed based on study results.