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# PLUG AND PLAY OPTIMIZATION FOR ADVANCED CONCEPTS MODELLING TOOLS

**Abstract**

Spacecraft conceptual design is considered a mixture of art and science, where most of the art consists in quickly coming up with designs that make sense, mixed with an intuition on how to iterate on the design to converge mass, power and size budget constraints. This process is a combination of parametrization of the concept, and performance analysis. At the conceptual stage, the analysis is done through a mix of advanced concepts modelling tools and simpler methods: back of the envelope calculations, spreadsheets, simple simulations in custom software, such as orbit or thermal analyses, and script evaluations. Evaluations allow the conceptual designers guide their iterative design, not only in the goal of converging on budgets, but improving performance related to main goal and first level requirements.

Multidisciplinary design optimization(MDO) is a method that can automate the evaluation process, and it has been widely used in the aircraft industry, but for later stages of the engineering life-cycle. MDO is therefore most often associated with optimization of high fidelity models but embedded in optimization-focused modelling environments. MDO at these later stages often requires optimization specific knowledge on how to tune the algorithms. As a result it can be seen as quite an involved process, one of the reasons it is not associated with earlier phases of the design.

MDO has been used in the literature for earlier stage modelling to automate the conceptual design iterative process, but in reality it is rarely used outside research environments, as it still requires a good understanding on optimization. Additionally, the optimization runtime can be significant(hundred of hours), which discourages the use of it during early stages. A paper presented during IAC 2017 on "Geometric programming for spacecraft conceptual design optimization" handles a lot of the optimization knowledge specifics, but it still requires the use of modelling in Python, a programming language used in many applications. This makes the tool intractable to many engineers who are not very experienced with programming.

Here we introduce a plug an play framework for optimization taking advantage of geometric programming. We show how it can be easily plugged and played into a newly developed web-based Systems Engineering Tool: Valispace, requiring no optimization background from the engineer. We present a case study for a conceptual satellite, showing how we can speed up the design process, and especially take away the burden of converging budgets in the current iterative procedure.