



technology opportunity

Optimization Tool Integrates Software to Automate Design Process

Leveraging existing analysis codes to streamline optimization tasks



An optimization tool developed at NASA's Armstrong Flight Research Center is the framework for a multidisciplinary design analysis and optimization (MDAO) solution that automates the design and analysis process for a wide variety of engineering tasks. The object-oriented optimization (O^3) tool leverages existing commercial and in-house analysis tools, enabling integration of state-of-the-art software early in the design process. A key component of the O^3 tool is the central executive module, which integrates disparate software packages in a cross-platform network environment so as to quickly streamline optimization and design tasks. Developed for use in the aerospace industry, the MDAO tool can be applied to other engineering fields.

Benefits

- **Efficient:** Automates the design process by enabling optimization using multiple commercial codes and/or in-house executable and source codes
- **Economical:** Leverages existing tools and practices to save development time and resources
- **Effective:** Enables multidisciplinary optimization early in the design process
- **Customizable:** Allows for easy integration and adoption of new state-of-the-art software
- **Convenient:** Provides a single user interface for software that resides on a user's PC, a remote workstation, or computational cluster
- **Versatile:** Integrates analysis codes for multiple disciplines, rather than relying on one code to perform analysis for all disciplines
- **Simple:** Runs using just three basic commands, allowing users to choose optimization methodologies and input design variables

Applications

The O³ tool can be used for engineering tasks in the following industries:

- Aerospace
- Shipbuilding
- Automotive
- Sporting equipment
- Packaging
- Engineering services

Commercial Opportunity

This technology is part of NASA's Innovative Partnerships Office, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Object-Oriented Optimization Tool (DRC-010-013).

Technology Details

Modern engineering projects require designers to consider both conventional engineering parameters and other key factors such as cost, safety, and environmental impact. All of these elements must be considered equally and simultaneously in order to exploit their interactions, though this significantly increases project complexity. Innovators at Armstrong have developed software that automates this task based on user-defined parameters. Rather than a single engineer using one program to optimize one parameter, this tool provides the framework for multiple engineers to use multiple programs to globally optimize a model.

How It Works

The Armstrong-developed O³ tool leverages existing commercial computer programs such as NASTRAN, ZAERO, and Abaqus as well as in-house computer programs (including Cart3D, CAPTSDv, CFL3D, FUN3D, and MOMAT codes) to enable multidisciplinary optimization in the preliminary design of subsonic, transonic, supersonic, and hypersonic aircraft. Designers can use either the built-in pre- and post-processor to convert design variables to structural parameters and generate objective functions or use their own analyzer for the optimization analysis.

The heart of the framework is the central executive module, which designers use to choose input/output files and solution modules, determine the status of tasks, and select modules for output viewing and filtering. The object-oriented framework integrates the analysis codes for multiple disciplines, instead of relying on one code to perform the analysis for all disciplines. Optimization can then take place within each individual tool, or in a loop between the executive and the tool, or both.

With just three basic commands, users choose an optimization methodology, provide starting and side constraints for continuous and discrete design variables, and set external file names for interface variables that communicate between the central executive module and each analysis module. Incorporated into the tool are modules that calculate structural weight, stress, deflection, buckling, and flutter and divergence speeds. A graphical user interface will provide a single point of control for applications that run on a user's own PC, or for code that may reside on remote workstations or a computational cluster.

Most of the code is written in standard Fortran programming language, so it is easy to upgrade and incorporate new optimization technologies.

Why It Is Better

Current commercial design and optimization tools are limited to specific sets of disciplines and are largely based on a single fidelity approach. Aircraft designs are predominantly developed using a manual trial-and-error approach, which slows down the design process considerably. The Armstrong-developed tool greatly increases the speed of optimization by calculating the effects of parameter variation and displaying the optimal parameter. The tool also allows for multiple engineers to input constraints and parameters at the same time, reducing the need to alternately optimize two disciplines separately. Finally, the tool allows engineers to test a large number of unbiased parameters, leading to solutions they may not typically consider.

For more information about this technology, please contact:

Technology Transfer Office
NASA's Armstrong Flight Research Center
Phone: (661) 276-5743
E-mail: DFRC-TTO@mail.nasa.gov
Web: www.nasa.gov/offices/ipp/centers/dfrc/