

Visitor Research Report

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Area of Research: Design System for Three-dimensional Inlet
Compression Systems

Period of Visit: August 13, 2008 - July 31, 2009
Period of Report: August 13, 2008 - December 31, 2008

Goal:

My part in this project is to build a tool which can be used to design a general class of three-dimensional shape-transitioning inlets for hypersonic airbreathing engines.

A further goal is incorporate this design tool into an automated gridding technology to produce structure grids for further flow analysis. With the capability to rapidly generate structured grids for these complex three-dimensional inlets, it will be possible to use high-fidelity analysis early on in the design stage.

Strategy:

The strategy is summarized by the list of research activities that appear as Exhibit A in my Visiting Researcher Agreement (C08-2628-RJG). That list is repeated here:

1. *Integrate 3-D methods*

The 3-D methods developed at the University of Queensland (UQ) by the researcher will be brought into the NASA Langley design and analysis system to produce parameterized geometry for the Rectangular-to-Elliptical Shape Transition (REST) inlet. The researcher will work with NASA to modify grid topologies for use with this class of inlet.

2. *Produce Baseline Inlet Design*

After the methods from UQ have been integrated into the NASA system, a baseline inlet design and computational solution, including inlet performance figures of merit, will be produced. The computational solution will be done with VULCAN (a CFD solver for the compressible Navier-Stokes equations).

3. *Implement and Improve Morphing Rules and Algorithms*

Once a baseline design has been developed, the rules and algorithms for how the shape will need to change in order to improve the figures of merit will be defined and incorporated into the system.

4. *Document Methods and Tools*

This research will involve technically challenging methods so the methods and tools used in the system will require detailed documentation.

5. *Apply Optimization Process*

Once the system has been developed, it must be exercised on alternative designs to identify errors and limitations.

Accomplishments:

As of December 31, 2009, progress has been made in a number of areas which address the above items. The accomplishments with regards to specific items are listed here.

1. The methods and tools I brought from UQ have been integrated into the NASA Langley design system. The tools give output of the inlet geometry in a parametric form ready for direct incorporation as input into the design system.
2. Some example baseline designs have been generated with the tools. This work is continuing.
3. The user guide for the tools has largely been completed. It will require updates as the tools/methods are refined.

Future Work:

The future work is listed as it pertains to the items above.

2. Further baseline designs will be produced which probe the extremes of the design space, in order to test the limitations of the tool.
3. In collaboration with the other members of the team, we plan to define an exact set of figures of merit and then select an appropriate optimization method.
4. While the user guide is mostly complete, I wish to document the internal code for the tools also.
5. As part of 2. in this list, we plan to exercise the design tool at the extremes of the design space for this class of inlet.

Pending Publications:

None as yet.

Seminar Presented:

Not as yet, at this developmental stage of the project.