UNIVERSITY OF Southampton

Engineering and the Environment

Aeronautics, Astronautics and Computational Engineering

Prometheus: Embedding Knowledge & Best Practice Within CAD for Combustor Design Optimisation

UTC for Computational Engineering

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Prometheus project overview

The main goal of Prometheus, as part of the **EN**gine **T**echnologies for **A**ircraft **P**ersistence and **S**urvivability (**ENTAPS**) research program, is to develop an efficient and effective multi-disciplinary combustor design system . This system aims to facilitate complex geometry changes while automatically pre-processing geometry and generating the required scripts for a variety of operations using embedded engineering knowledge and best practice. Figure 1, below, illustrates the positioning of Prometheus within the framework of system and sub-system level design processes.

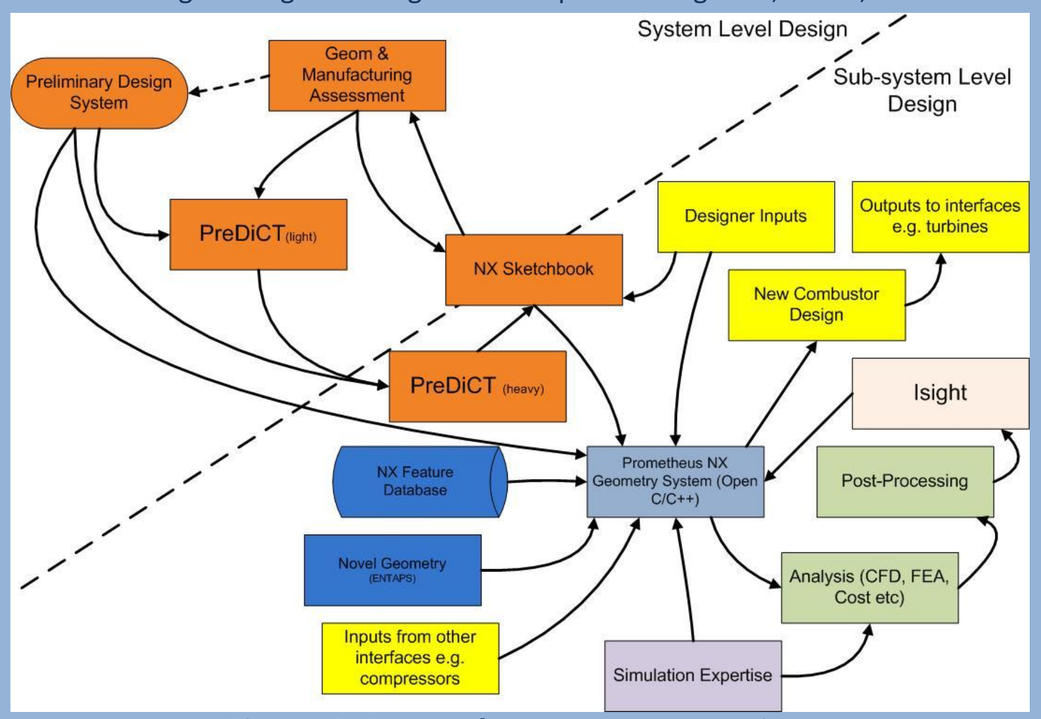

Figure 1: Prometheus system overview

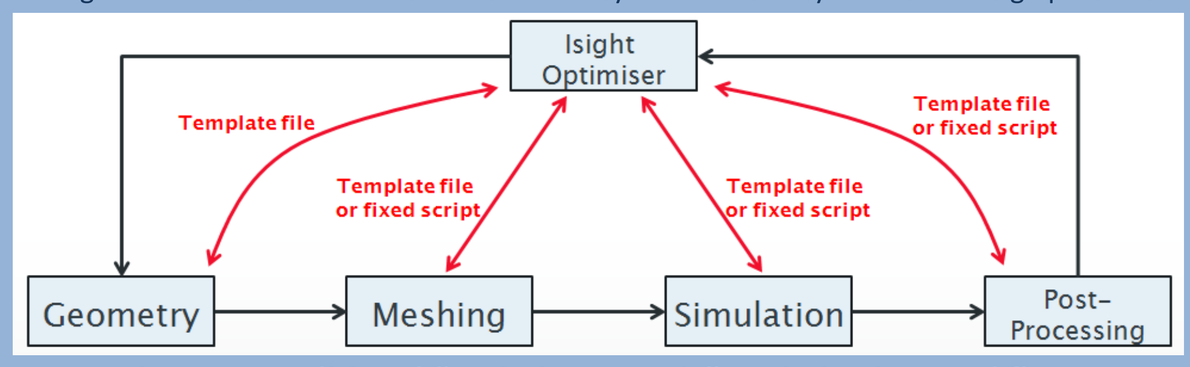

Figure 2: Traditional "optimiser centric" optimisation workflow

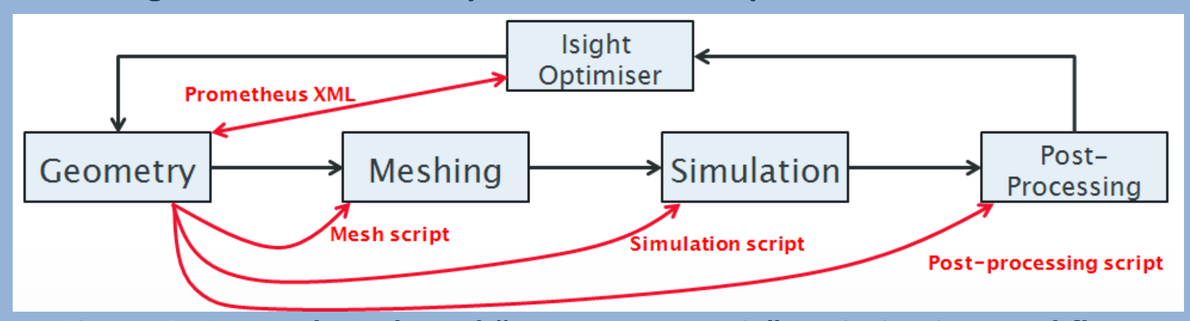

Figure 3: Prometheus based "geometry centric" optimisation workflow

Potential pitfalls of the typical approach to optimisation workflow creation

A typical optimisation workflow, Figure 2, usually requires the optimisation program to manage the generation of input files to each of the workflow's components. The generation of new geometry, for example, can be controlled using a template input file within which the magnitude of the design variables are updated as required. Similarly, scripts controlling meshing, simulation and post-processing operations may be either updated from a template or fixed.

While this approach may be acceptable, significant topological changes made to the geometry within a design study can invalidate the remaining scripts. Take, as a simple example, the case where an additional port has been included within a combustor design. This port may require a mesh refinement zone around it to accurately capture the flow features, however, the meshing script from a previous design study will not apply a refinement zone in this location and must be either updated manually or a code must be implemented to generate a new script. This requires considerable effort up front or some degree of rework for each new design study and may actually limit the ability to consider particular topological changes within an optimisation.

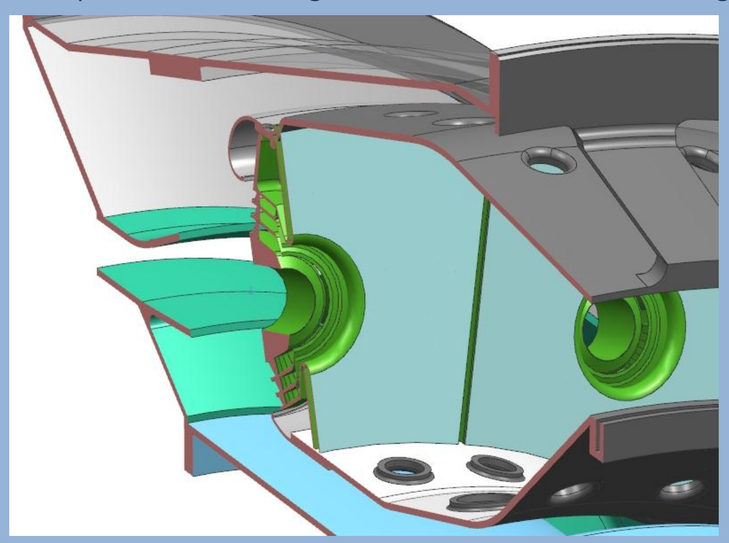

Figure 4: ENTAPS combustor sketchbook

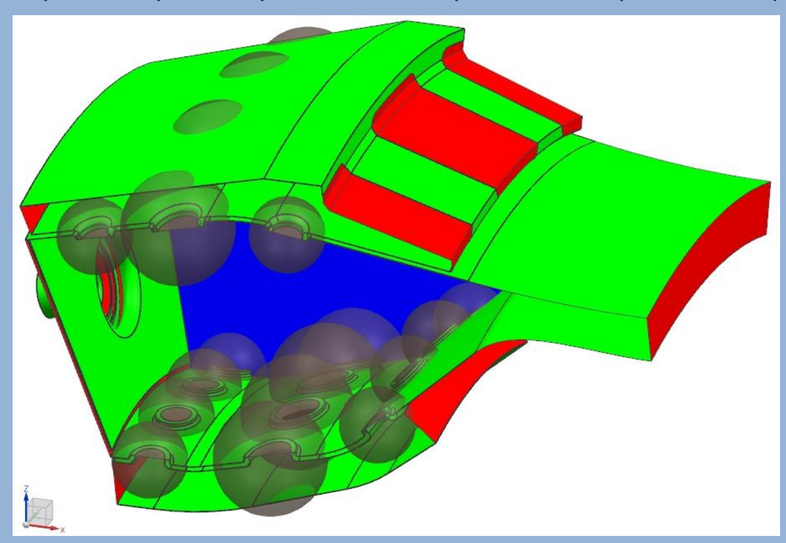

Figure 5: Prometheus generated fluid volume with port mesh refinement zones indentified

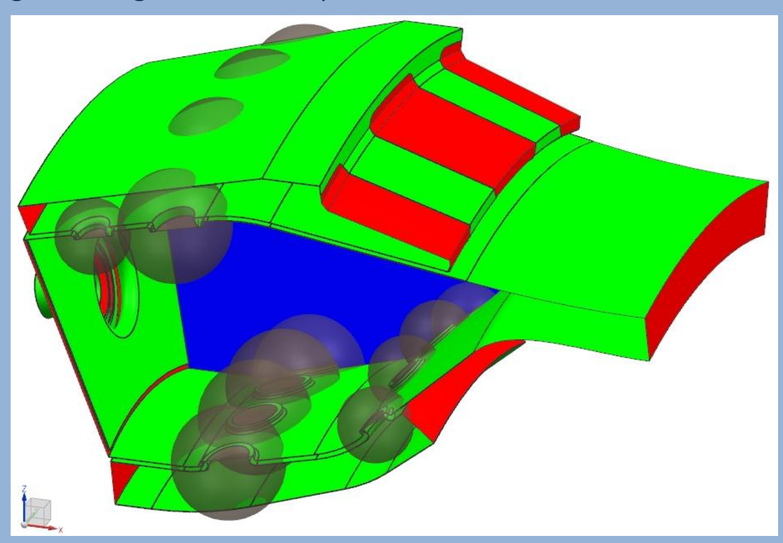

Figure 6: Mesh refinement zones indentified after modifications to the position and number of ports

Prometheus' "geometry centric" approach to optimisation workflows

Prometheus aims to reduce both the level of workflow complexity and rework by taking a more "geometry centric" approach to optimisation, Figure 3. All of the information required to generate the appropriate scripts is already present within the computer aided design (CAD) part why not use this to create them automatically when pre-processing the geometry?

Figures 4 illustrates the current version of the ENTAPS combustor sketchbook. Given this sketchbook and a few lines of Extensible Markup Language (XML) identifying the necessary parts and the required axial positions of the annuli inlet and outlet planes, Prometheus will create a fluid volume of the combustor, Figure 5. Simultaneously all of the ports are identified and their positions and sizes used to define mesh refinement zones and post-processing planes, illustrated, respectively, by the transparent spheres and planes in Figure 5. Any changes to the geometry, for example, the movement or removal or a row of ports is then matched in the fluid volume and corresponding meshing and post-processing scripts.

Current & future work

Currently Prometheus combines optimisation friendly geometry manipulation, combustor fluid volume generation and meshing script generation routines, with embedded designer best practice, for the ENTAPS combustor. However, work is ongoing to extend its capabilities to alternative combustor designs and additional simulation disciplines.

Acknowledgements

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