Research and Development of Aircraft Design DX

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Abstract

This project is in response to NEDO's proposal for the "Key and Advanced Technology R&D through Cross Community. Collaboration Program/Development and Demonstration of Advanced Technologies for Developing and Manufacturing Processes Using Digital Technologies for Designing, Manufacturing, and Certifying Aircraft" (hereinafter referred to as "K-Pro"). Currently, a domestic heavy industry manufacturer and JAXA are jointly making this proposal. In the period from FY2023 to FY2027, K-Pro is required to implement four major items, one of which is the design DX of this project. The theme of design DX is the innovation of the conceptual design flow, and the aim is to reduce the rework period by 30% by introducing MBSE-MBD linkage in the design process from the aircraft level to the component level. JAXA will be mainly responsible for the MBD part of aircraft and engines, and will contribute to the achievement of the above goals by improving the fidelity of aerodynamic analysis and other aspects at an early stage of design. Specifically, the goal is to complete the evaluation of the required aerodynamic performance of aircraft design candidates (up to 10,000 individuals) provided by heavy industries within the specified period through CFD analysis, etc., and to create a database of compressor analysis results that will contribute to the design of engines.

Reasons and benefits of using JAXA Supercomputer System

In this project, it is necessary to evaluate various aerodynamic performance by CFD analysis for a very large number of design candidates and design conditions provided by heavy industry manufacturers. In order to do so, it is necessary to have computing resources that can evaluate a very large number of candidates by numerical analysis at the necessary timing, while ensuring security recognized by heavy industry manufacturers. There is no other company that can meet these conditions, except for JSS.

Achievements of the Year

Regarding the contribution to the conceptual design flow for the entire aircraft, a reduced order model (ROM) is constructed based on the CFD analysis results in order to evaluate the shape of up to 10,000 individuals. After narrowing down the number of individuals based on the evaluation results from ROM, CFD analyses are conducted for better design individuals. In the previous fiscal year, in order to carry out the above, the entire work was automatized, i.e., generating a large number of aircraft shapes, constructing a grid, and performing CFD analysis was automated by linking JSS and the other computers (the main role of JSS was to perform CFD analysis and its pre- and post-processing.) In this fiscal year, some trials of the above automation flow were conducted, resulting in sufficient evaluation results of ROM and CFD.

We made a flow field database as reference data for improving the accuracy of RANS analysis targeting engine compressors, utilizing detailed analysis with Zonal DES. Analysis was conducted on a three-dimensional compressor rotor including chip clearance, and we were able to make a flow field database that met the target accuracy.

This achievement was obtained as a result of a commissioned work by the New Energy and Industrial Technology Development Organization (NEDO) (JPNP23012).

Publications

- Oral Presentations

Yokoyama et al., Aircraft Conceptual Design with System Descriptive Model and Analytical Model, 62nd Aircraft Symposium (in Japan)

Nambu et.al., Detailed Analysis of Tip Clearance Flow of an Axial Compressor for Turbulence Model Parameter Tuning, 38th CFD symposium (in Japan)

Usage of JSS

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	480 - 2880
Elapsed Time per Case	2 Hour(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 5.11

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	128,518,795.89	5.88
TOKI-ST	1,235,556.02	1.27
TOKI-GP	42.42	0.00
TOKI-XM	110,691.55	53.88
TOKI-LM	36,350.95	2.62
TOKI-TST	73.15	0.00
TOKI-TGP	0.00	0.00
TOKI-TLM	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	4,913.19	3.31
/data and /data2	430,684.24	2.06
/ssd	69,025.78	3.70

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	19.79	0.06

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

- **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[*2] (%)
ISV Software Licenses (Total)	5,496.21	3.75

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.