Project 037 CLEEN II System Level Assessment

Georgia Institute of Technology

Project Lead Investigator

Dimitri Mavris (PI)
Regents Professor
School of Aerospace Engineering
Georgia Institute of Technology
Mail Stop 0150
Atlanta, GA 30332-0150
Phone: 404-894-1557
Email: dimitri.mavris@ae.gatech.edu

University Participants

Georgia Institute of Technology

P.I.(s): Dr. Dimitri Mavris (PI), Mr. Christopher Perullo (Co-PI), Dr. Jimmy Tai (Co-PI)
FAA Award Number: 13-C-AJFE-GIT-013
Period of Performance: August 31, 2016 – August 31, 2017

Project Funding Level

The project is funded at the following levels: Georgia Institute of Technology ($170,000).

The Georgia Institute of Technology has agreed to a total of $170,000 in matching funds. This total includes salaries for the project director, research engineers, graduate research assistants and computing, financial and administrative support, including meeting arrangements. The institute has also agreed to provide tuition remission for any students paid for by state funds.

Investigation Team

Georgia Institute of Technology
Principal Investigator: Dimitri Mavris
Co-Investigators: Christopher Perullo, Jimmy Tai
Fleet Modeling Technical Lead: Holger Pfaender
Noise Modeling Technical Lead: Greg Busch

Project Overview

The objective of this research project is to support the FAA by independently modeling and assessing the technologies that will be developed under the CLEEN II program. This will involve direct coordination and data sharing with companies developing technologies under CLEEN II, in order to accurately model the environmental benefits of these technologies at the vehicle and fleet levels.

Georgia Tech (GT) was previously selected to perform all of the system level assessments for the CLEEN program under PARTNER project 36 and ASCENT project 10. As a result, Georgia Tech has a unique position from both a technical and programmatic standpoint to continue the system level assessments for CLEEN II. From a technical perspective, GT has significantly enhanced the Environmental Design Space (EDS) over the last 5 years to incorporate advanced, adaptive, and operational technologies targeting fuel burn, noise, and emissions. EDS was successfully applied to all CLEEN I contractor technologies including: GE open rotor, TAPS II combustor, FMS-Engine and FMS-Airframe; Pratt & Whitney geared fan; Boeing adaptive trailing edge and CMC nozzle; Honeywell hot section cooling and materials; and Rolls-Royce turbine cooling technologies. GT also gained significant experience in communicating system level modeling requirements to industry engineers and translating the impacts to fleet level fuel burn, noise, and emissions assessments. This broad

technical knowledge base covering both detailed aircraft and engine design and high level benefits assessments puts GT in a unique position to assess CLEEN II technologies.

As the ultimate goal of this work is to conduct fleet level assessments for aircraft representative of future 'in-service' systems, GT will need to create system level EDS models using a combination of both CLEEN II and other public domain N+1 and N+2 technologies. The outcomes of the technology and fleet assumptions setting workshops conducted under ASCENT Project 10 will be heavily leveraged for this effort. Non-CLEEN II technologies for consideration along with potential future fleet scenarios will help to bound the impact of CLEEN II on future fleet fuel burn, emissions, and noise. In the first year, non-disclosure agreements have already been signed with all of the CLEEN II contractors.

Since the FAA will also be performing a portion of the EDS technology modeling work, EDS training has been provided to the FAA in 2016 under the ASCENT Project 10. The training has provided the requisite skill set required to use EDS.
In the prior year of this project, Georgia Tech began modeling activities with Aurora, Pratt and Whitney, and GE. This modeling process included validation of underlying EDS models, information and data exchange necessary to model the individual technologies, and related EDS modeling activities. In addition, Georgia Tech has assisted the FAA with in-house modeling of Delta/MDS and GE technologies. This process has increased the FAAs use of FAA personnel for EDS system level assessment modeling.

More specifically, this year has focused on modeling and assessment of Aurora, Delta/MDS, Pratt & Whitney, and GE technologies. Georgia Tech and the FAA have collaborated on the modeling and assessment of the GE FMS and Delta/MDS technologies. The GE FMS system improves vehicle performance through more intelligent operations and flight path planning. The Delta/MDS technology uses a coating to reduce erosion rates on the fan blade leading to improved performance retention. Both of these technologies have been modeled within EDS. The modeling work for Delta/MDS is complete and the modeling work for GE FMS is currently in iteration with GE. Erosion maps were implemented into the EDS software to simulate the degradation with and without the Delta / MDS fan blade coatings. The erosion maps were provided by a CFD analysis study that Delta had conducted in the spring of 2016. Direct changes of fan efficiency retention were modeled in EDS from the CFD data. The level of fuel burn benefit is dependent on other technology assumptions.

In addition, Georgia Tech has completed modeling assessments for Aurora on the D8 aircraft concept. Benefits have been shared with Aurora and the FAA. While specific benefits are proprietary under the terms of the nondisclosure agreement between GT and Aurora, the benefits predictions match to within 1.5% difference. Georgia Tech has is also in the middle of modeling and assumptions setting discussions for the GE MESTANG more electric aircraft power systems technology.

Major Accomplishments

- GT has signed non-disclosure agreements with all CLEEN II contractors
- Delta/MDS Modeling Complete
- Aurora Modeling Complete
- Pratt & Whitney modeling started
- Modeling and data exchange underway for GE FMS
- Modeling and data exchange underway for GE MESTANG
- Discussions on modeling process held with all contractors

Publications

None.

Outreach Efforts

None.

Awards

None

Student Involvement

Students will be involved later in the period of performance once specific modeling work begins.

Plans for Next Period

GT will continue to model and assess CLEEN II technologies. Specifically, EDS models will be created for the UTAS Integrated Nacelle including fuel burn, noise, and emissions sub-models where appropriate. GT will work with UTAS to verify EDS models before adding to the CLEEN II assessment. GT will also work with Boeing to model the Compact Nacelle technology including any fuel burn and acoustics impacts. Additional EDS modules developed under this effort will be made available to the FAA by GT in the event they are based on public domain information. Proprietary data developed by, or in collaboration with, CLEEN II contractors will need to be obtained by the FAA directly from the respective contractor. This work will also support attendance at CLEEN consortium meetings and contractor preliminary and detailed design reviews to identify any updates required to technology models developed in prior years.

References

None