

Noise Certification Streamlining

Georgia Institute of Technology

PI: Dimitri Mavris, Michael Balchanos

PM: Sandy Liu

Cost Share Partners: Boeing, Bell, Gulfstream, Rolls-Royce

Industry Partners: Boeing, Bell, Gulfstream, Rolls-Royce, Embraer, Cessna/Textron, De Havilland Canada

Objective:

Examine current noise certification procedures and identify opportunities to streamline the noise certification process in addition to recommending methodologies for building the needed flexibility to accommodate all air vehicle types

Project Goal and Benefits:

Recommendations towards a more efficient, streamlined, and flexible aircraft noise certification:

- Proposition of equivalent procedures, supported by latest technologies and hardware
- Evaluation of alternative practices through a Model-Based Systems Engineering (MBSE) model of the noise certification process (in SysML)
- Analysis techniques to support certification of future air vehicles types

Research Approach

Task 1: Interview Industrial Partners on Current Noise Certification Process

- Task 1.1: FAA Noise Certification Regulation Review
- Task 1.2: Industrial Partner Interviews via Workshops

Task 2: Develop a Streamlined Noise Certification Procedure for Existing Aircraft

- Task 2.1: Current Process Assessment
- Task 2.2: Streamlined Process Definition

Task 3: Develop a Flexible Noise Certification Procedure for New Aircraft

- Task 3.1: Flexibility Assessment of Streamlined Process

Task 4: Simulate Streamlined and Flexible Noise Certification Procedure

- Task 4.1: Identify Modeling Approach
- Task 4.2: Noise Certification Process Metric Definition

Major Accomplishments (to date):

- Benchmarking of current practices in certification flight testing and identification of improvement opportunities
- Baseline certification representation in SysML through requirements verification model
- Simple certification process simulation model
- Community outreach and collection of feedback to improve model accuracy and capability
- Exploration of lateral microphone equipment options

Future Work / Schedule (Year 2 Tasks):

- Improvements on the SysML certification process model
- Use of sample noise measurement to perform validation of the requirements verification model
- Exploration of probabilistic approaches for certification process model
- Use case to demonstrate benefits of streamlined certification through use of equivalent procedures

Overview of ASCENT 61 Progress: Noise Certification Streamlining

Research Approach:

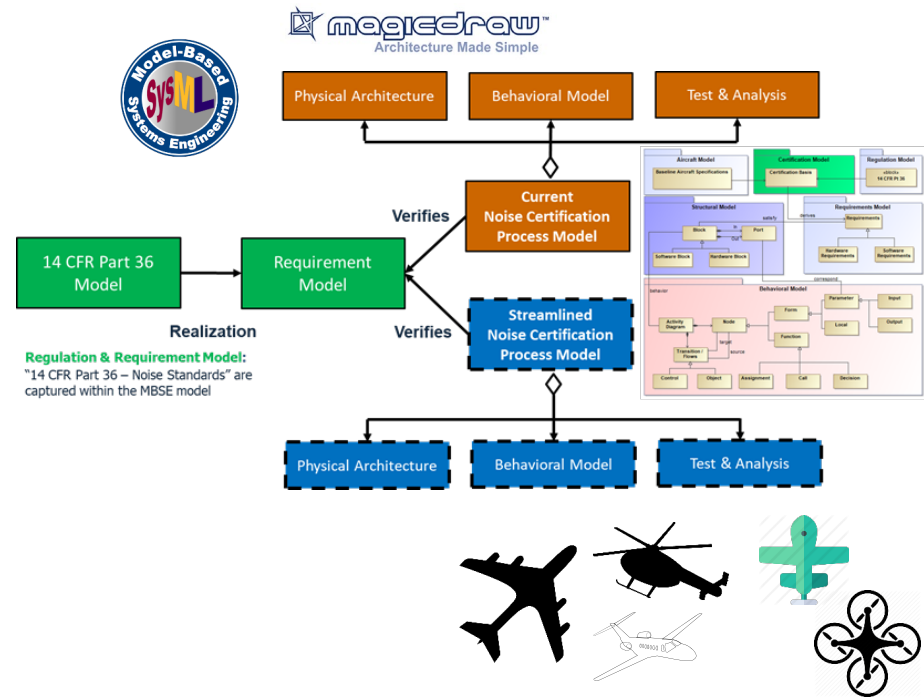
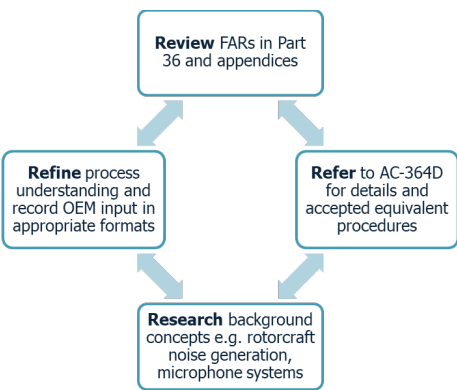
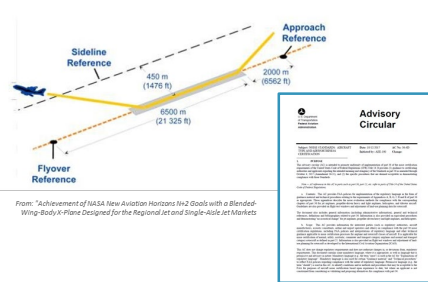


Review Title 14 CFR parts, mainly Part 36, (plus Advisory Circulars) to understand current regulatory framework for aircraft noise certification

Interview Industrial Partners (through a series of Workshops) on applied noise certification procedures for transport, rotorcraft and small propeller-driven aircraft types, with focus on certification flight testing

Develop an MBSE-enabled noise certification model for current noise certification procedures

Formulate, simulate and evaluate a more streamlined noise certification procedure for existing and new aircraft types



End Goal: Provide recommendations to the FAA, in the form of equivalent procedures, supported by latest technologies/hardware, as well as analysis techniques to support certification of future air vehicles types

Noise Certification Regulation Review (Tasks 1.1, 1.2)

Task Objective:

- To gain an understanding of the current regulatory framework for aircraft noise certification, as required by FAA regulations and followed by OEMs to demonstrate compliances

Progress and Methods:

Conducted a thorough literature review of relevant 14 CFR parts (mainly Part 36), plus associated documents where relevant, e.g., Advisory Circulars

Phase 0: Environmental Assessment

Check wind velocity & abnormal weather conditions

Phase 1: Testing Site Preparation

Obtain and set-up microphones, and any other flight test equipment

Phase 2: Flight Testing

Pilot executes takeoff, flyover and approach runs according to test plan

Phase 3: Analysis and Data Validation

Apply necessary corrections & validate test data

Phase 4: Test Data Reporting

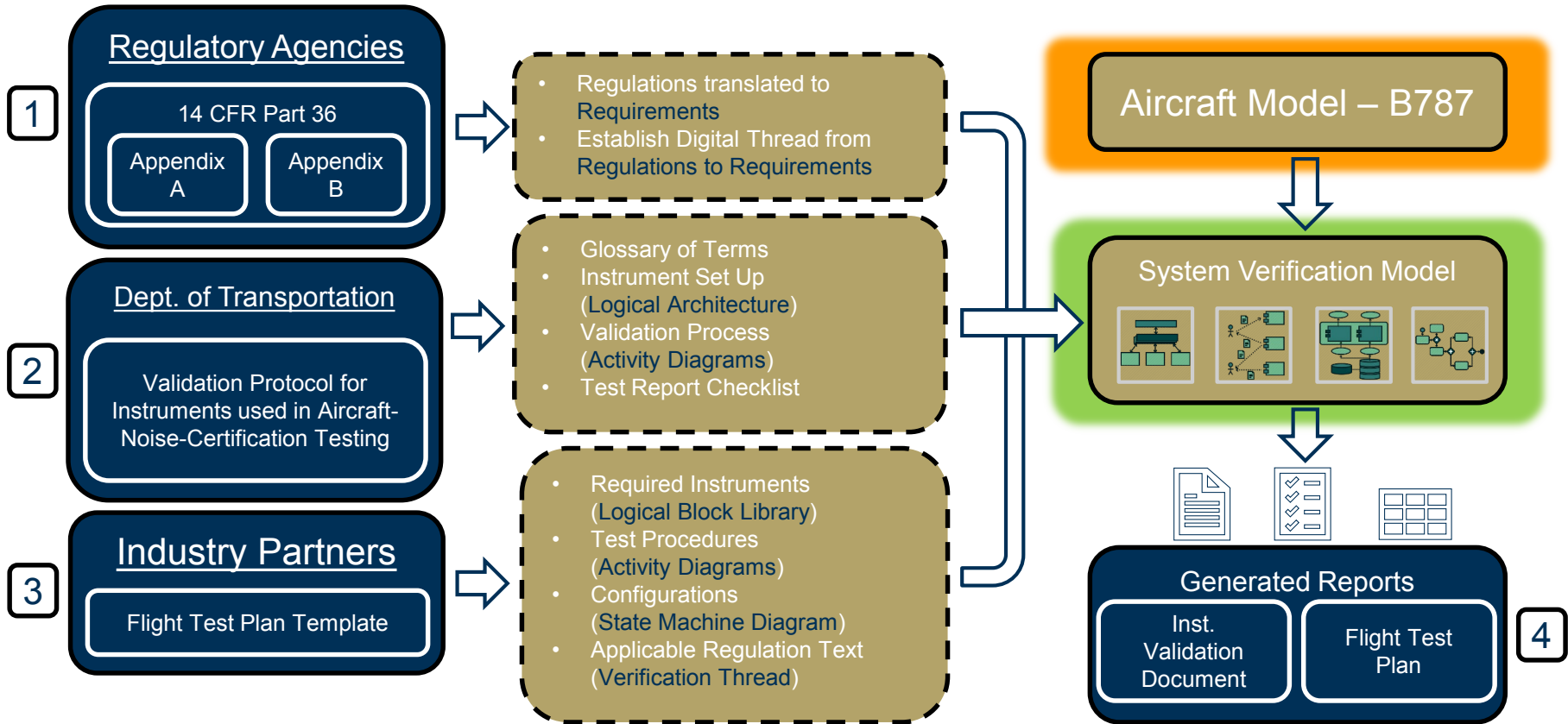
Report all values, adjustments and required aircraft information to the FAA as instructed

Key Takeaways from OEM interviews

- **Acoustical changes** (AC's/NAC's) challenging to navigate without standardized approval procedures – more detailed feedback would be useful for OEMs to propose suitable solutions
- **Test site selection** normally restricted by sound measurement technology and requirements (e.g., the lateral microphone component), and by weather window options
- **Delays in flight testing** are primarily weather-induced, and occasionally due to communication disruptions
- **Conformity** discussions can be significantly time/effort consuming – especially in cases where there is a need to justify changes that are unrelated to acoustics
- **Interactions between Part 36 and Part 25/23:** Discontinuity between environmental and design standards, often leaving little space to apply acoustic improvements
- **Calculating EPNL values from noise data** collected during flight testing: No single standardized software, each OEM's methodology and code is different

Task 1 has been completed and findings have been instrumental for the formulation of the model-based approach to represent current noise certification procedures for transport category

Verification Model Development (Task 2.1): An Overview



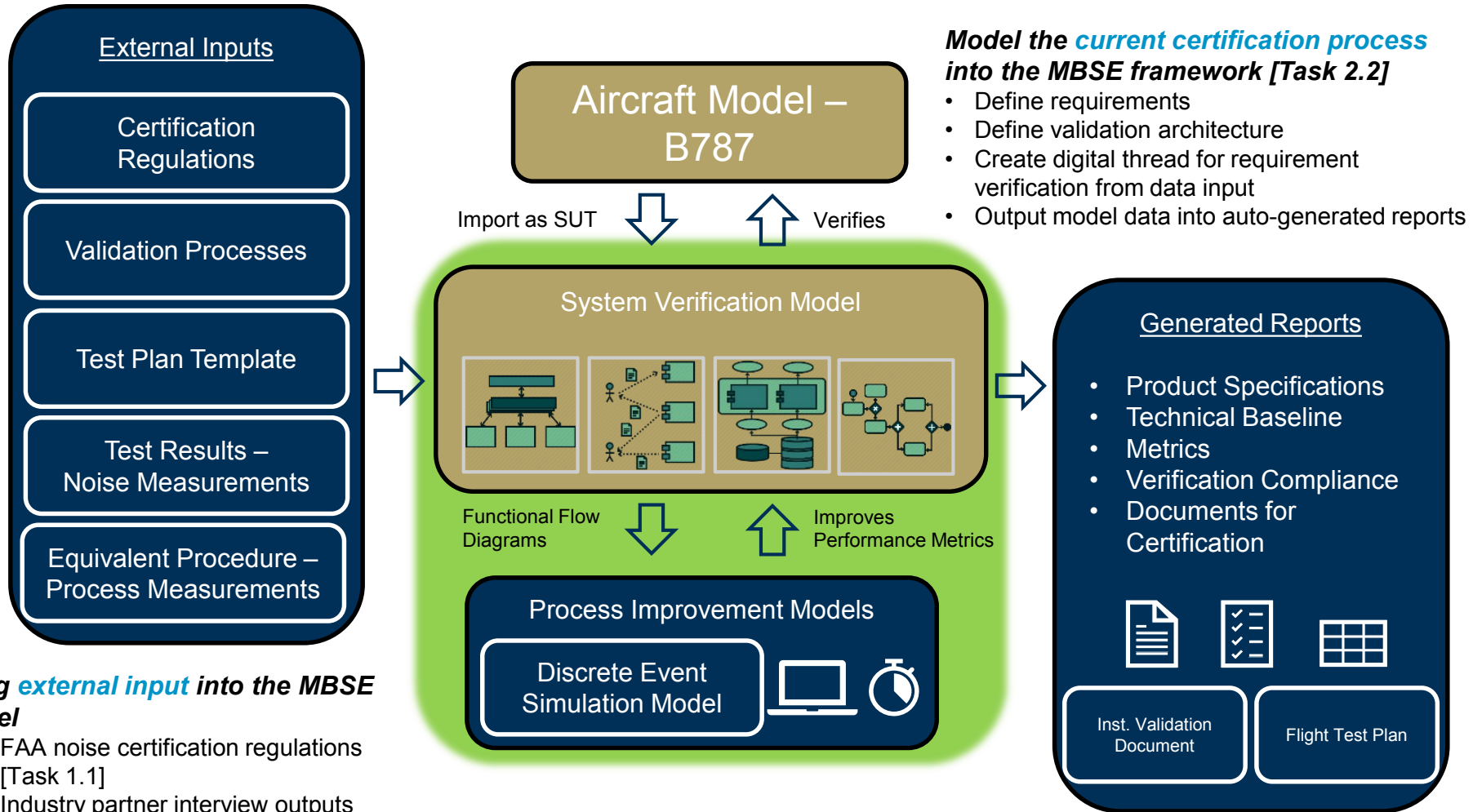
Regulation & Requirement Model:

- “14 CFR Part 36 – Noise Standards” are captured within the MBSE model to build a **verification thread** from the certification model to the regulation it is certifying

Current Noise Certification Model:

- The regulatory documents and industrial partner interviews help to capture an accurate MBSE model of the noise certification process
- Focus is around **the Flight Test Demonstration**

Verification Model with Process Improvement: Summary of Current SySML Model



Model the current certification process into the MBSE framework [Task 2.2]

- Define requirements
- Define validation architecture
- Create digital thread for requirement verification from data input
- Output model data into auto-generated reports

Bring external input into the MBSE model

- FAA noise certification regulations [Task 1.1]
- Industry partner interview outputs [Task 1.2]
- Current processes (e.g., VOLPE instrument validation) [Task 2.1]
- Import base aircraft model into MBSE

Develop process improvement DES model

- Build a modeling approach [Task 4.1]
- Define metrics [Task 4.2]
- Integrate DES model to MBSE model

Conclusion: Year 1 Recap



Recap of Year 1 Activities

- Completed documentation of current noise certification regulatory framework (14 CFR Part 36 , AC 36-4D) with input from literature and partner interviews/workshops
- Hosted workshops/interviews with Industry Partners for transport category aircraft (jet & turboprop)
- Benchmarking of current practices in certification flight testing and identification of key technical challenges and improvement opportunities
- Working version for process model on current noise certification procedures in SySML, made possible with input and guidance by OEM participation in interviews
- Established connection with VOLPE and planning for regular status checks, model reviews and auditing of findings
- Broader outreach of A61 to the aviation community on noise certification
 - ASCENT Fall/Spring Meetings
 - Presentation to Flight Test Harmonization Working Group (FTHWG)
- Annual and quarterly reports available to KSN
- Contributions and new technical capabilities to be published in conferences and peer-reviewed journal articles

Next Steps

- Continue development and improve accuracy of MBSE noise certification process model
 - Obtain data for a specific application of a known test article in order to verify requirements
 - Define interfaces between instruments and the MBSE model
 - Determine equivalent procedures to showcase and develop appropriate metrics
 - Develop probabilistic simulation (e.g., Markov Chain Monte Carlo) for process evaluation
- Assess the effects of identified certification testing challenges and represent quantitative impact through use of the certification process model and process performance indicators and metrics
- Formulate alternatives with proposed equivalent procedures utilizing modern technology (e.g., microphone technology)
- Formulate a demonstration use case for the certification problem, where the current baseline will be the basis for comparing to streamlined alternatives.