

# NATO AVT-297 DEVELOPMENT OF A FRAMEWORK FOR VALIDATION OF COMPUTATIONAL TOOLS FOR ANALYSIS OF AIR VEHICLES ICAS2022\_0933 [Presentation Only]



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# PROBLEM DEFINITION

# BACKGROUND

Drag Prediction  
Workshop



Juncture Flow



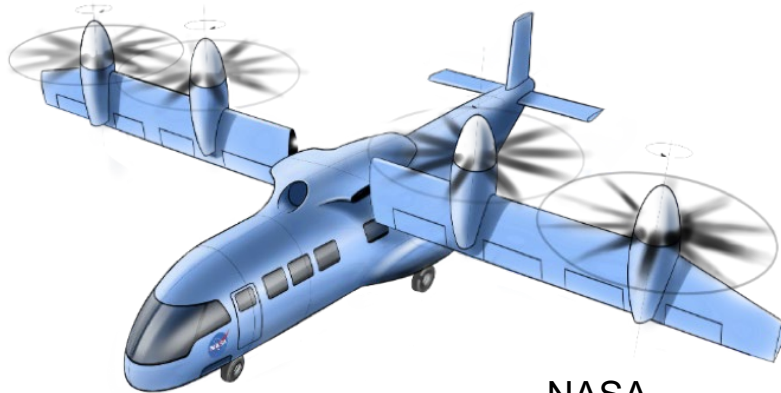
NASA

# THE PROBLEM

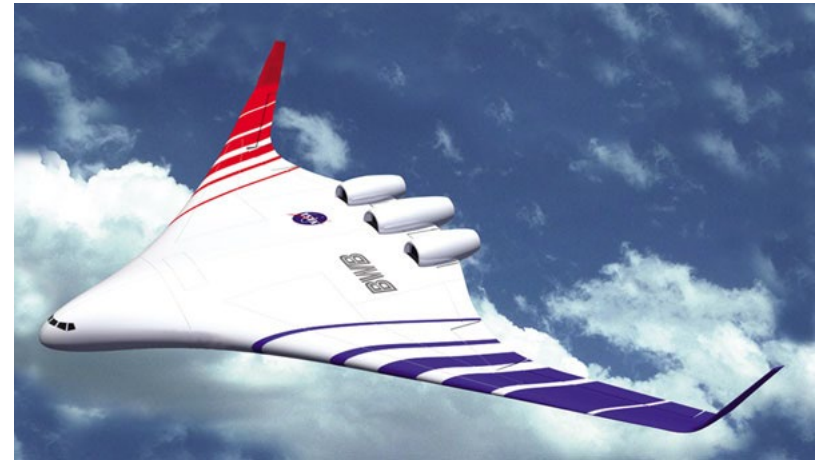
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- What experimental validation data is required to validate a computational code:
  - To enable Certification by Analysis?
  - To predict a new design with unknown physical phenomena?
  - To make validation investment decisions by connecting validation level data to vehicle platforms?

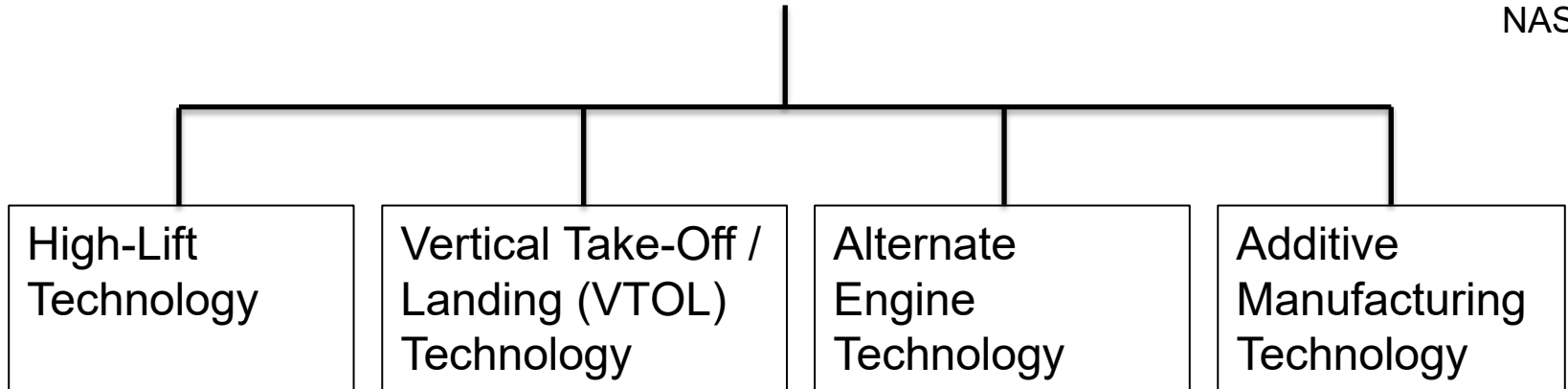
# DESIGNING A NEW CONFIGURATION WITH NEW TECHNOLOGIES



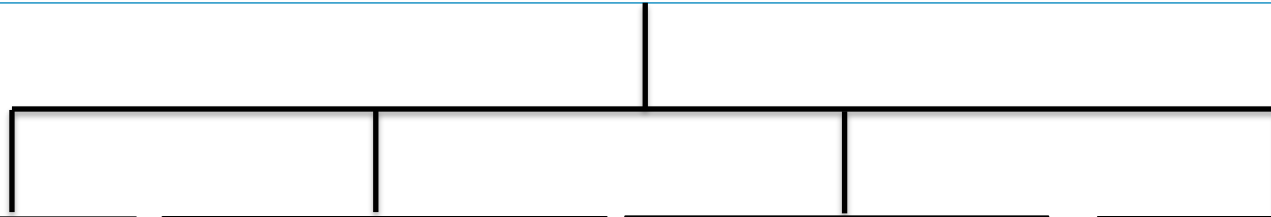
NASA



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# DESIGNING WITH NEW TECHNOLOGIES – HIGH LIFT

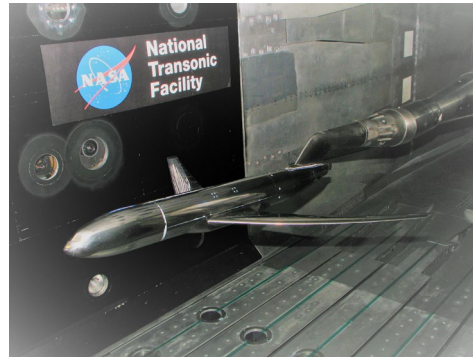
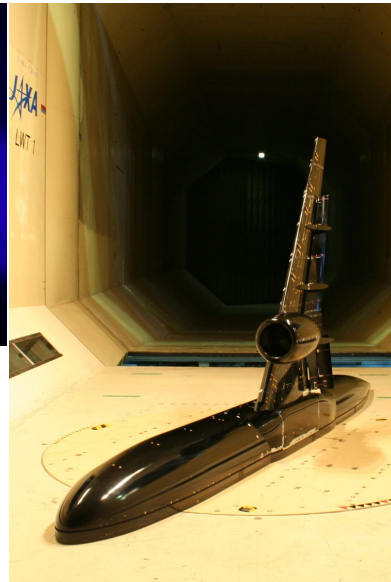


High Lift Prediction Workshop

High-Lift Common Research Model

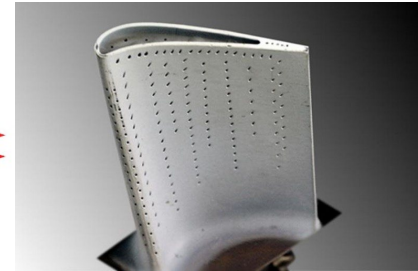
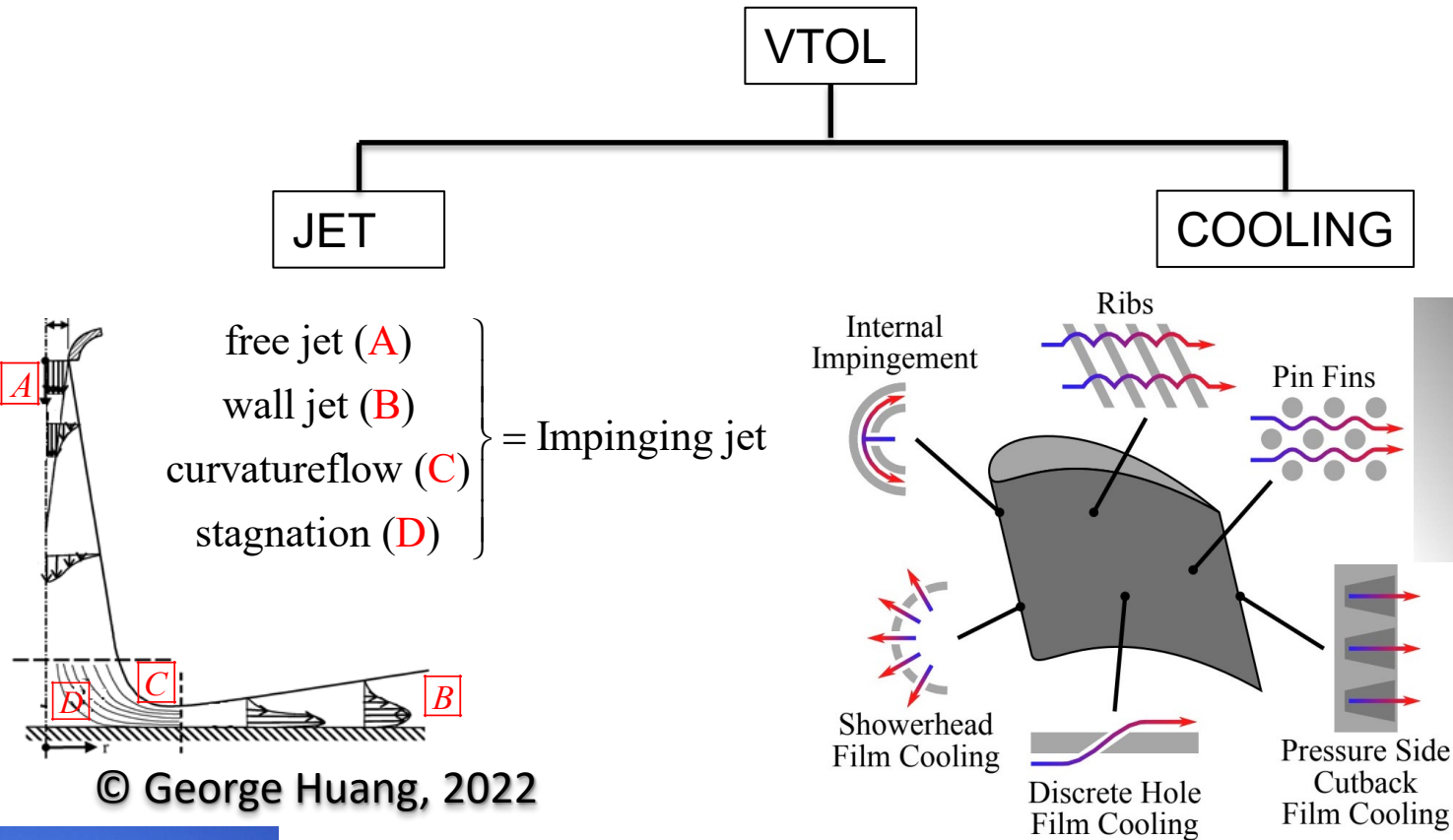
Drag Prediction Workshop

Juncture Flow



NASA

# DESIGNING WITH NEW TECHNOLOGIES – VTOL



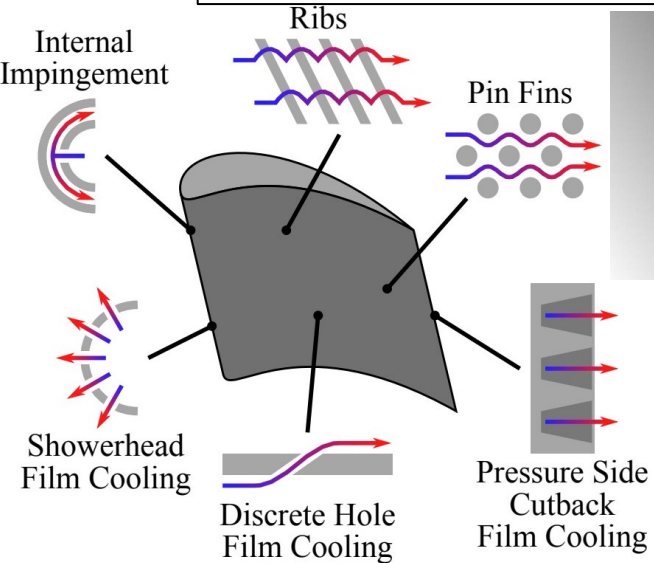
Banko, 2022

# DESIGNING WITH NEW TECHNOLOGIES – ALTERNATE ENGINE TECH.

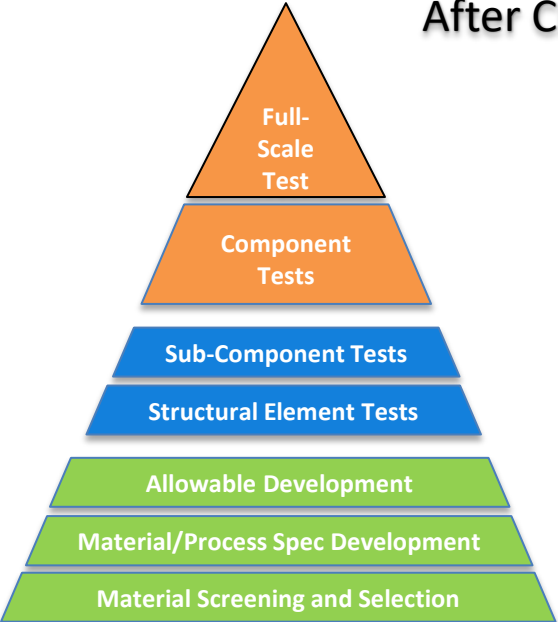
## ALTERNATE ENGINE TECHNOLOGY

### ALTERNATE FUEL

### MATERIALS



After Chisolm et al., 2019



Analysis Verification

Design Value Development

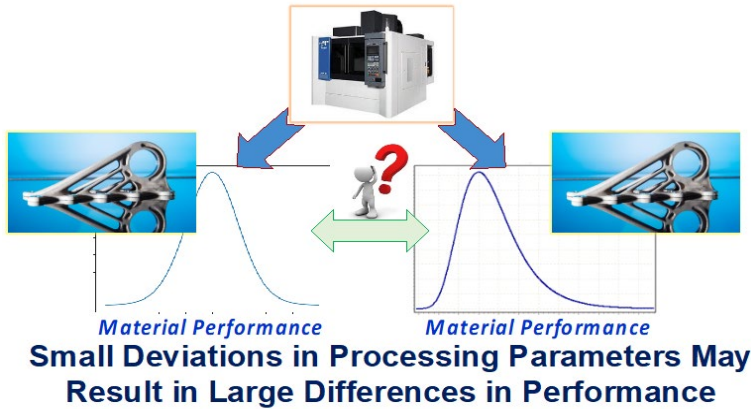
Material Property Evaluation<sup>8</sup>



# DESIGNING WITH NEW TECHNOLOGIES – ADDITIVE MANUFACTURING

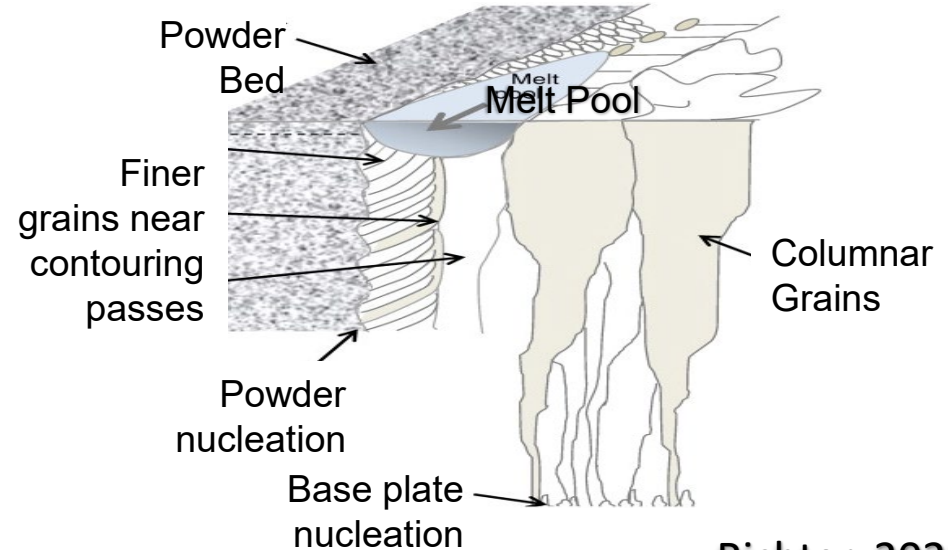
## ADDITIVE MANUFACTURING

### PROCESSING



Kitahara, 2022

### MELT POOL



Richter, 2022

# THREE QUESTIONS

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1. How do we demonstrate to Certification/Qualification authority that results of our analyses are equivalent to a flight test?
2. How do we ensure that our analyses don't miss any key system behavior and the actual system will respond like the simulation across full envelope?
  - E.g., emergent behavior from a complex system or key physics
3. How do we choose to apply resources – time, human, funding – to key tests to meet Objectives 1 and 2 when the systems, sub-systems, and disciplines have competing requirements?

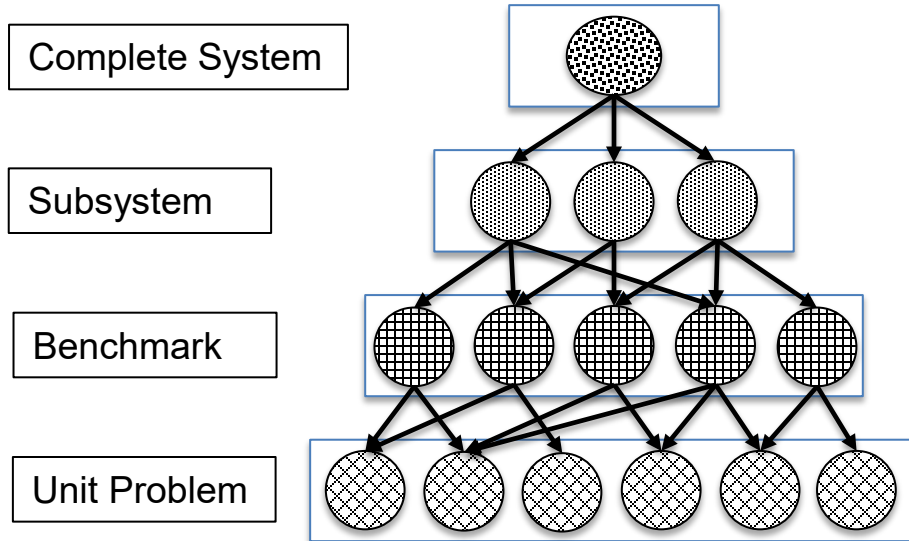


# APPROACH

33RD CONGRESS  
OF THE INTERNATIONAL COUNCIL  
OF THE AERONAUTICAL SCIENCES  
STOCKHOLM, SWEDEN, 4-9 SEPTEMBER, 2022

**ICAS**  
**2022**  
SWEDEN 

# THE APPROACH

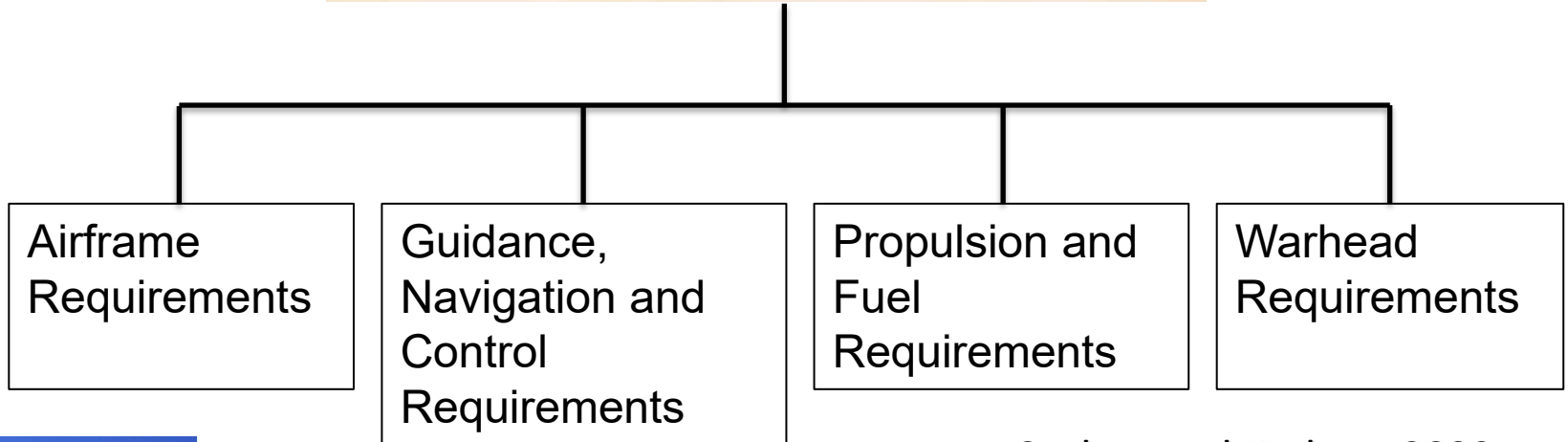
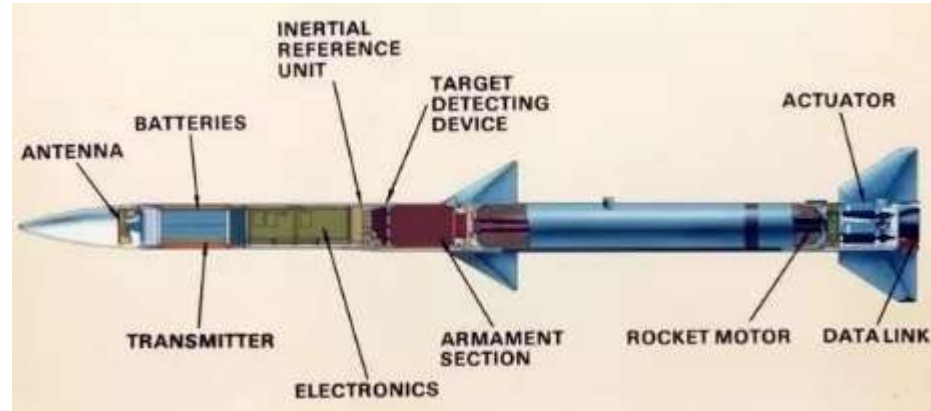


Concept for Validation Hierarchy

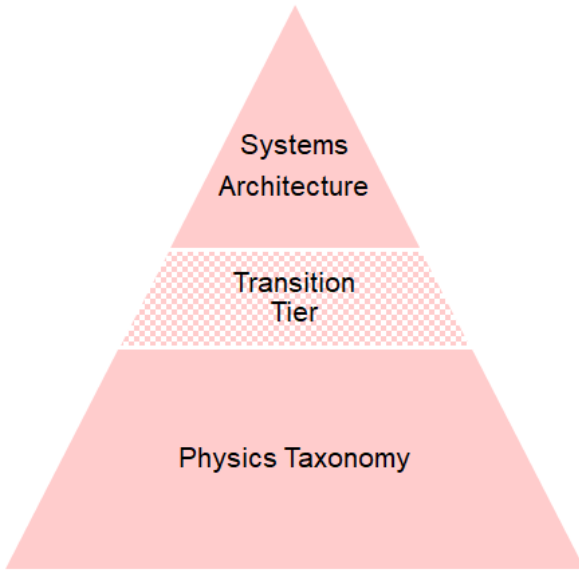
After AIAA, 1998

- Formed 4 Teams working **Interdisciplinary** Problems
  - Missile Team 1
  - Missile Team 2
    - Presentation 1.6.2
  - Mobility Team 1
  - Mobility Team 2
    - Presentation 1.6.3

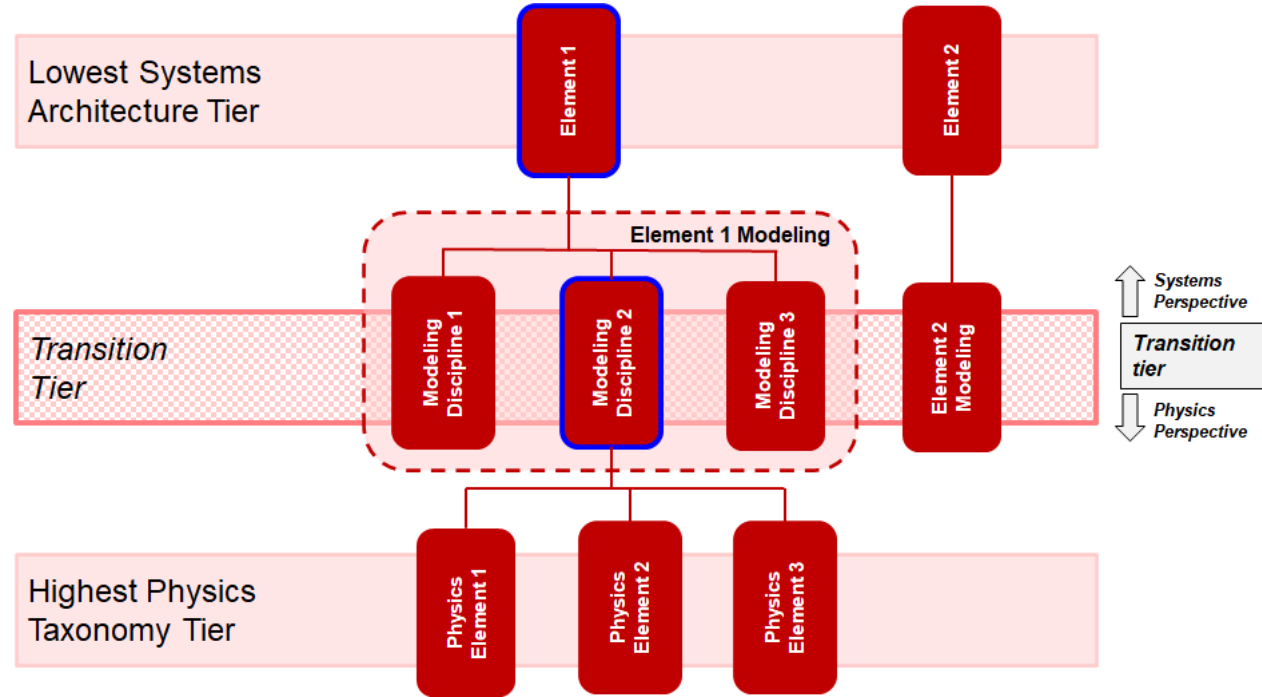
# MISSILE TEAM 1: FUNCTIONAL DECOMPOSITION



# MISSILE TEAM 2: SYSTEM AND PHYSICS VALIDATION HIERARCHY



Concept of Validation Hierarchy

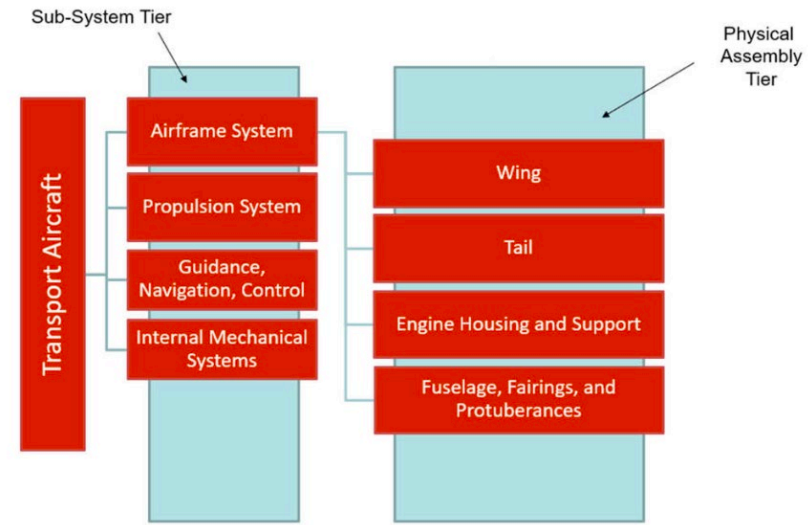
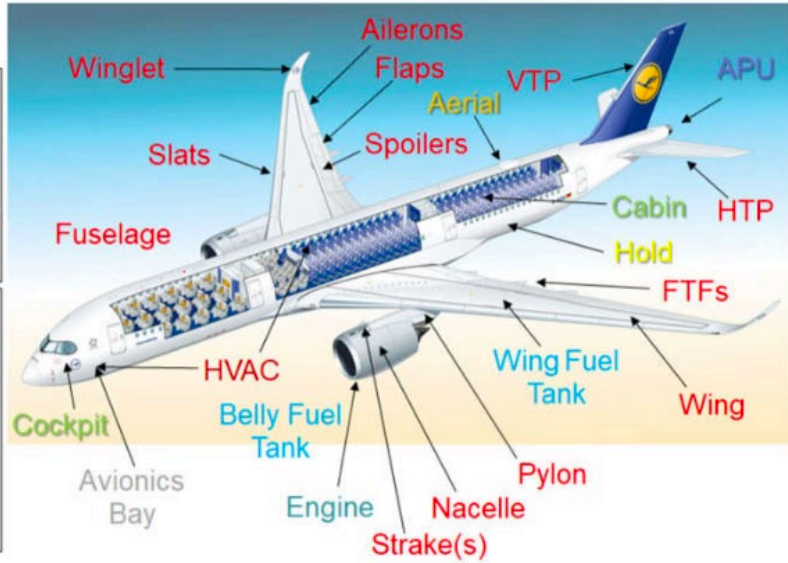


Example of Transition Tier of Validation Hierarchy

Luckring, Shaw, Oberkamp, and Graves, 2022

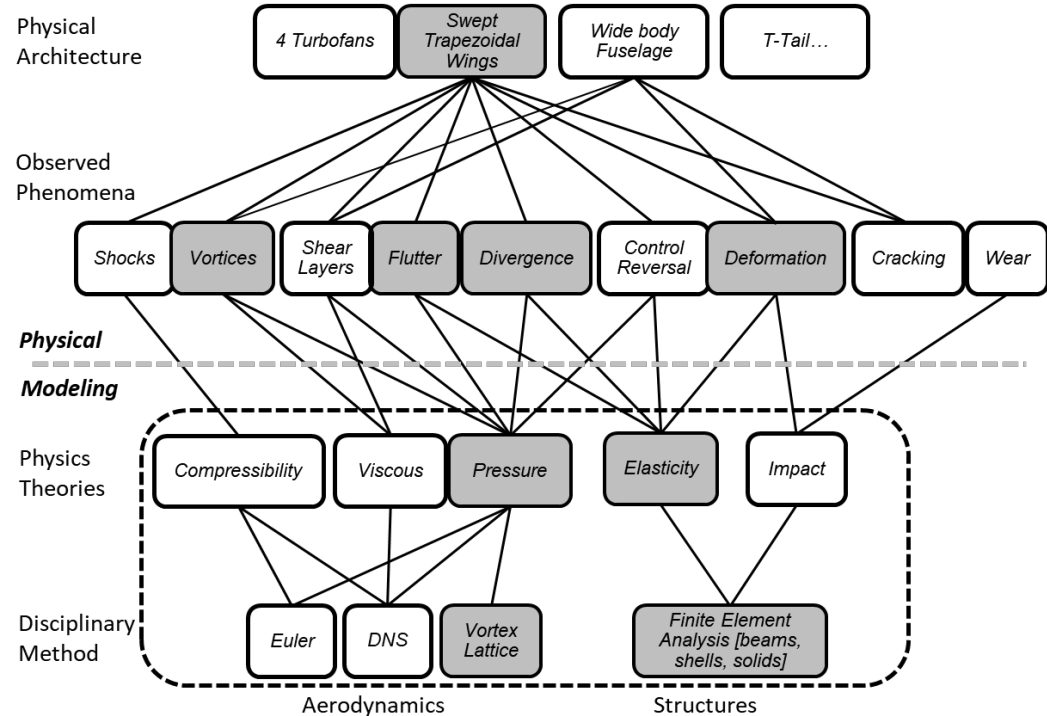
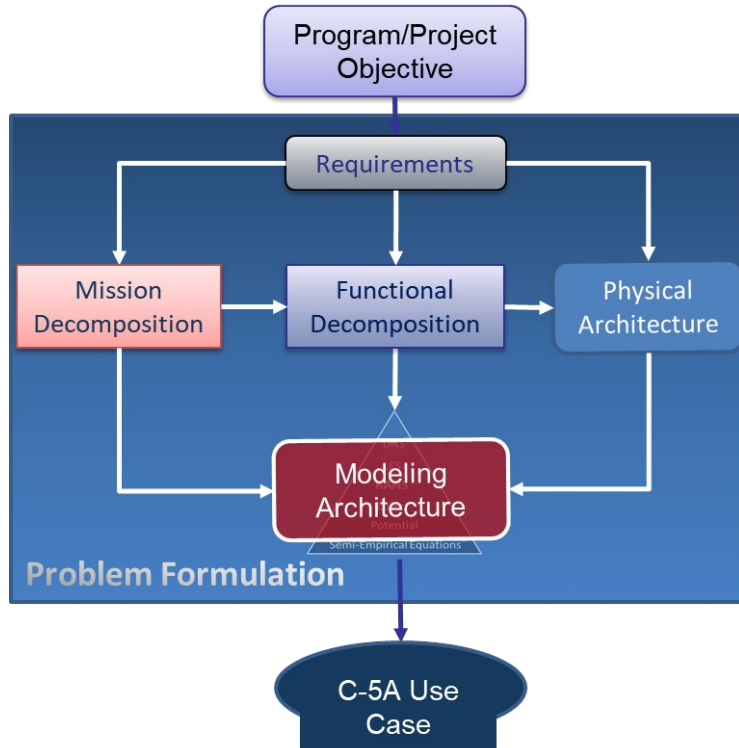
# MOBILITY TEAM 1: SYSTEM AND PHYSICS VALIDATION HIERARCHY

- Airframe
- Propulsion
- Communication
- Avionics
- Electrical Power
- Environmental Control
- ...
- Cockpit and Cabin
- Cargo/Luggage
- Fuel Systems
- Emergency Systems
- Landing Gear
- ...



Krumbein, 2022

# MOBILITY TEAM 2: FUNCTIONAL, PHYSICAL, AND MODELING FRAMEWORK



Mavris, Bagdatli, Yarbasi, and Taylor, 2022



## Session

1.6.2: A Model Validation Hierarchy for Connecting System Design and Simulation Capabilities

1.6.3: System Level Identification of Critical Uncertainties to Enable Validation Experiments

1.6.4: Open Panel Discussion