Hochschule für Angewandte Wissenschaften Hamburg
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Green Freighter

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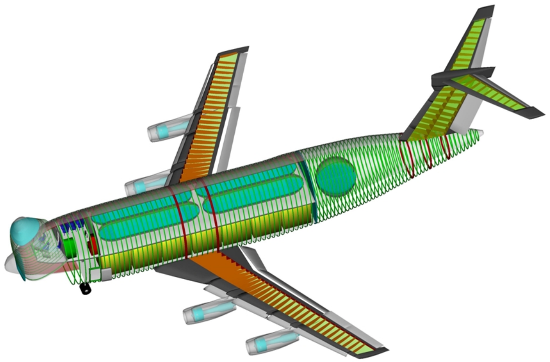


Project partners

- **Hamburg University of Applied Sciences (HAW) (Project leader)**
- **Airbus Deutschland GmbH, Future Projects Office (FPO)**
- **Institute of Aircraft Design and Lightweight Structures (IFL) of the Technical University of Braunschweig**
- **Bishop GmbH**

Basic facts about the GF-Project

- **Partly funded by the German Federal Ministry of Education and Research (243,000 €)**
- **Initial time schedule: Sep. 2006 – Aug. 2009**
- **Kick-off: Dec. 2006**
- **Total volume: 646,000 €**
- **Tentative entry-into-service: 2025**

Aim of the project

- **Investigations on <u>environmentally friendly</u> and cost effective freighter aircraft configurations**

- **"Environmentally friendly" due to:**
  - **Low fuel consumption**
  - **Low emissions (CO_2, NO_x)**
  - **Future fuels (Liquid hydrogen – LH_2, Synfuel, Biofuel)**
  - **Low noise level**

Aim of the project

- Investigations on environmentally friendly and <u>cost effective</u> freighter aircraft configurations

- "Cost effective" = low operating costs due to:
  - Low fuel consumption
  - Low emissions (emissions related taxes)
  - Low noise level (nighttime operation)
  - Zero-pilot operation (crew costs, no / reduced environmental control system)

Why freighter aircraft?

- Greater freedom in design
  - Greater psychological acceptance of zero-pilot operation
  - No or at least largely reduced environmental control system (ECS)
  - Less problems with flying wing and blended wing-body configurations (cabin pressurization, accelerations during flight maneuvers, no outside-view, evacuation, ...)

Methods and tools

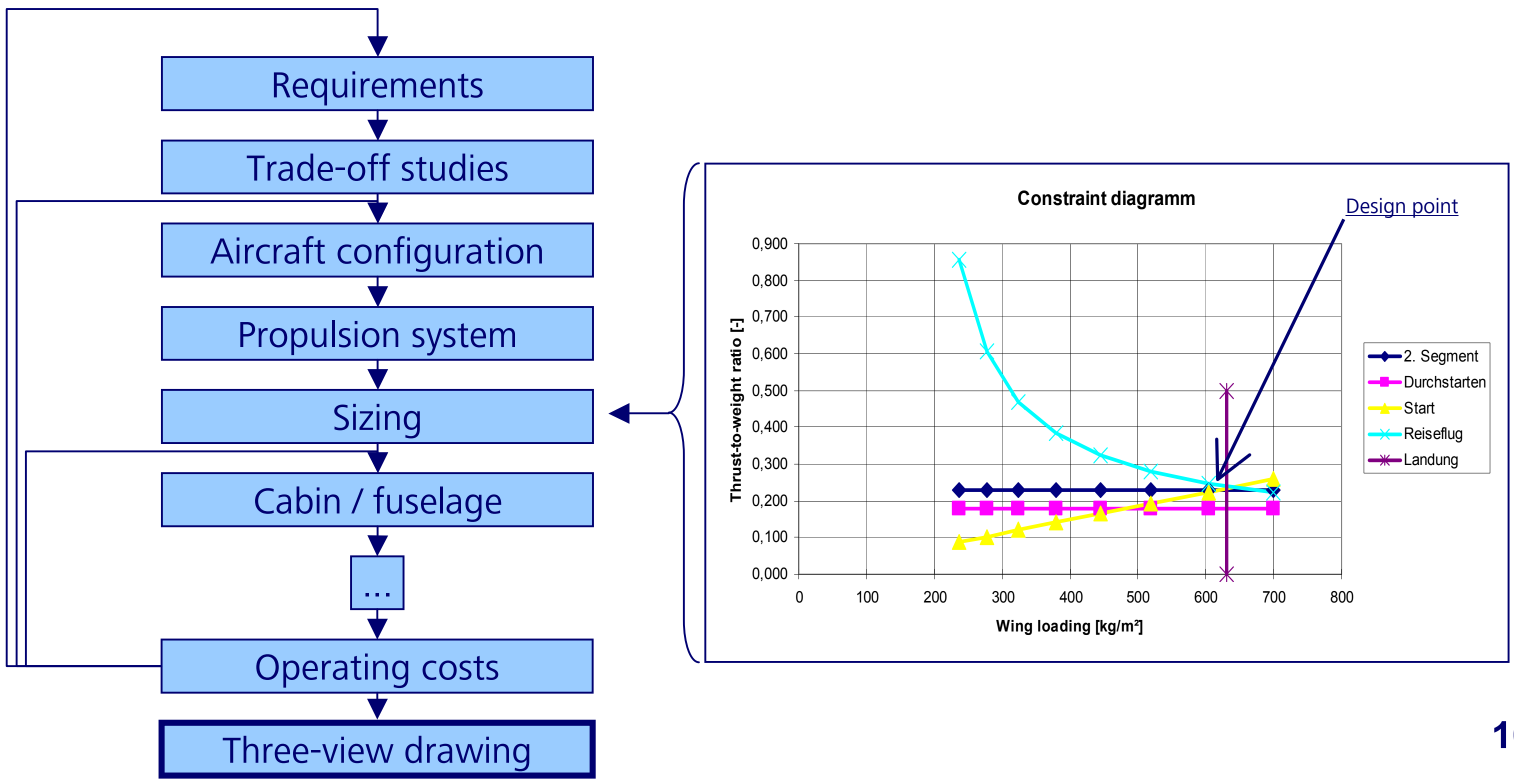
- **Aircraft preliminary sizing:**
  - Excel spreadsheets from HAW and the University of Linköping, Sweden
  - Only conventional aircraft configurations possible
  - Fast and easy but rough, many estimations

Methods and tools

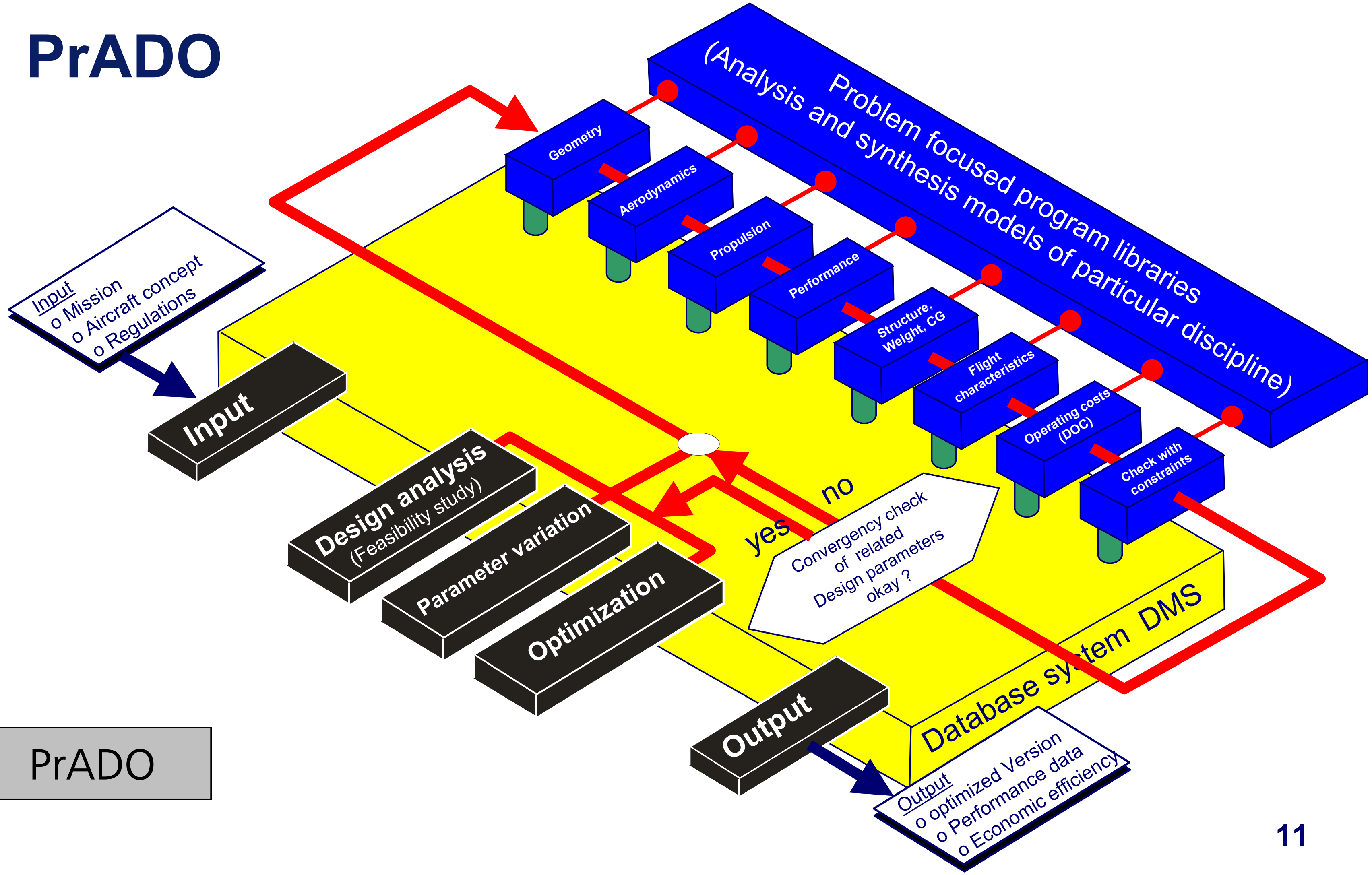
- **Detailed design, analysis and optimization:**
  - PrADO (Preliminary Aircraft Design and Optimization program) from IFL
  - Today, only jet propulsion and kerosene possible
  - ➢ Task: modification for propeller and LH_2-powered aircraft
  - Very sophisticated (including aerodynamics and finite elements analysis) but bulky

Aircraft preliminary sizing

- **Basic design process**



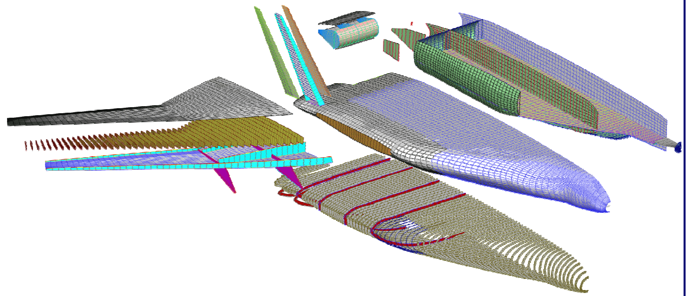
PrADO


Problem focused program libraries
(Analysis and synthesis models of particular discipline)
Geometry
Aerodynamics
Propulsion
Performance
Structure, Weight, CG
Flight characteristics
Operating costs (DOC)
Check with constraints
Input
o Mission
o Aircraft concept
o Regulations
Input
Design analysis
(Feasibility study)
Parameter variation
Optimization
no
yes
Convergency check of related Design parameters okay ?
Database system DMS
Output
Output
o optimized Version
o Performance data
o Economic efficiency

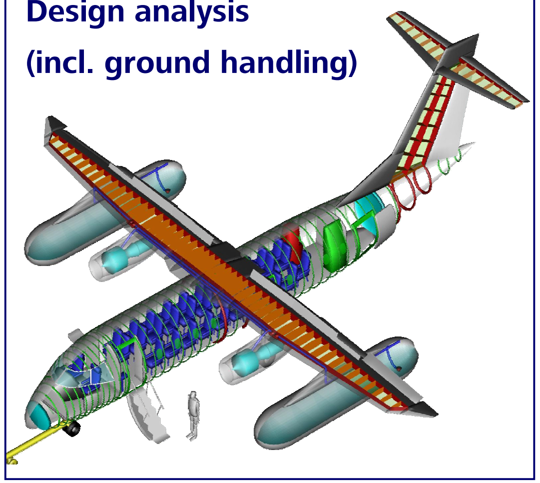
PrADO

PrADO

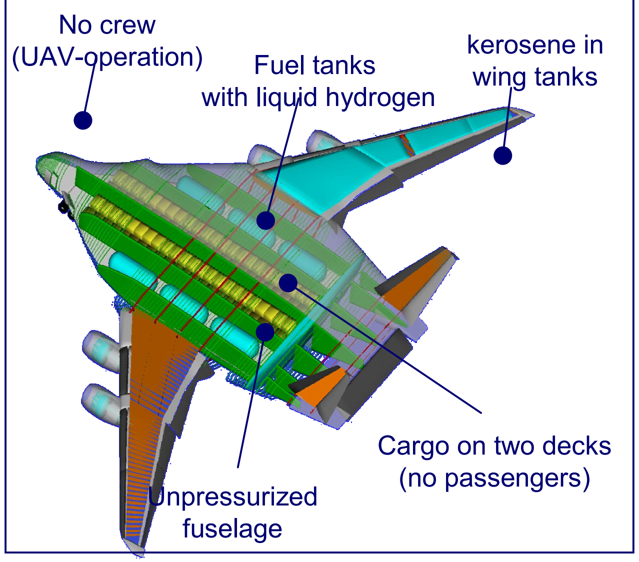
Structural breakdown



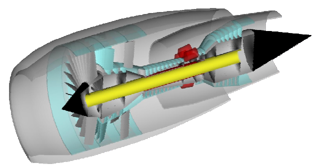
Design analysis
(incl. ground handling)



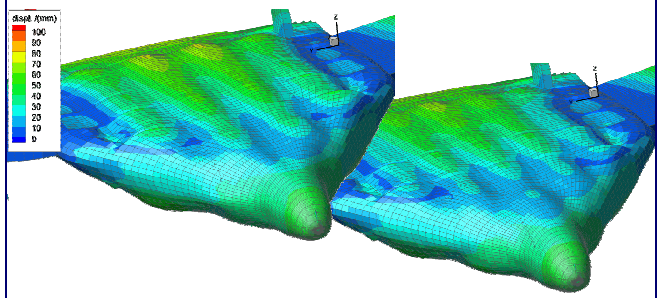
Design analysis



Jet engine model



FE analysis

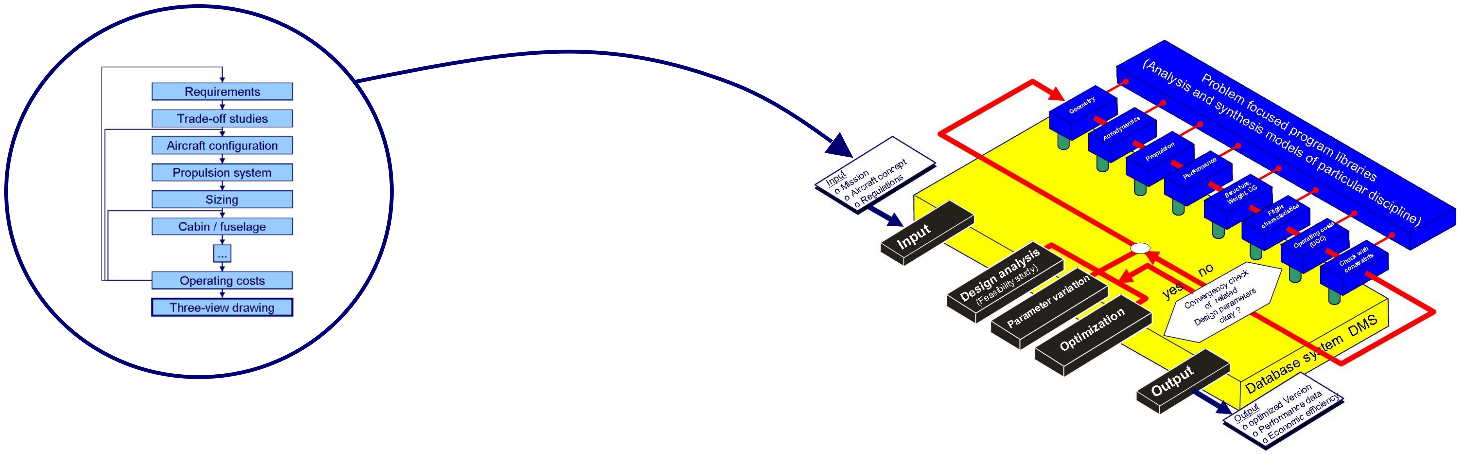


Methods and tools

Aim: Combination of Excel spreadsheet and PrADO

– ‘Feeding’ PrADO with Excel-generated design parameters

→ Reduced effort to run PrADO



Current state

- **Two reference aircraft of different size**
  - **ATR-72 and B-777F**

- **Top level aircraft requirements (TLARs) being defined, e.g.:**
  - **Payload: 108 t (B-777F)**
  - **Configurations to be compared:**
    - **Conventional jet: M_{cr} = 0,84**
    - **Blended wing-body: propeller vs. jet driven**
      LH_2 vs. kerosene powered
      M_{cr} as a result
  - **Cargo compartment large enough for cross section of standard ship container (TEU)**

Current state

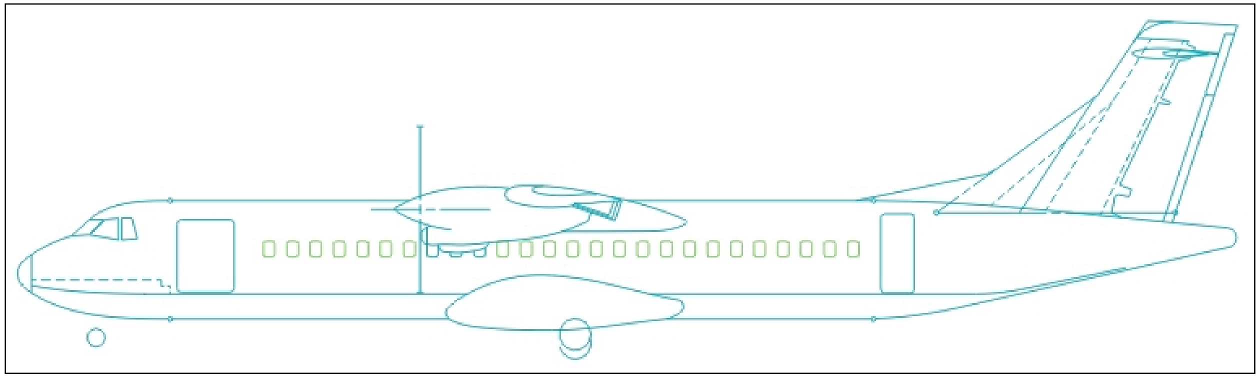
- HAW
  - Use and structure of PrADO
  - Cargo chain, cargo handling
  - Environmental effects of air transport
  - Propeller efficiency, engine data
  - Adaptation of HAW preliminary sizing tool

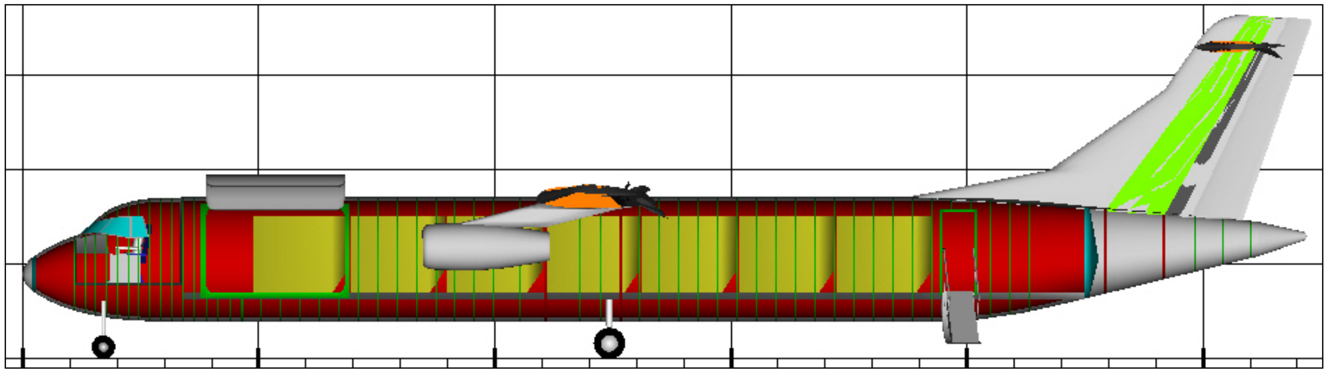
- IFL: modification of PrADO
  - New databases for different fuel tank geometries
  - New engine characteristics
  - New mass estimations

Current state

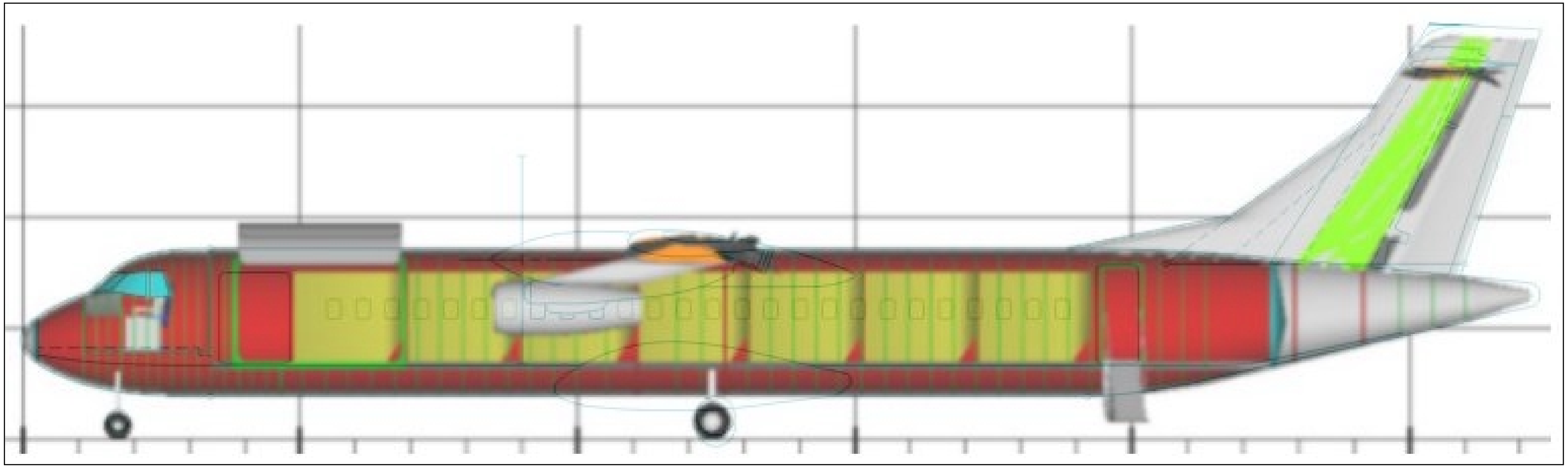
- Bishop
  - Benefits / penalties resulting from no / reduced environmental control system (ECS)
  - Hydrogen handling issues
  - Propeller efficiency

Current state





Current state



Current state