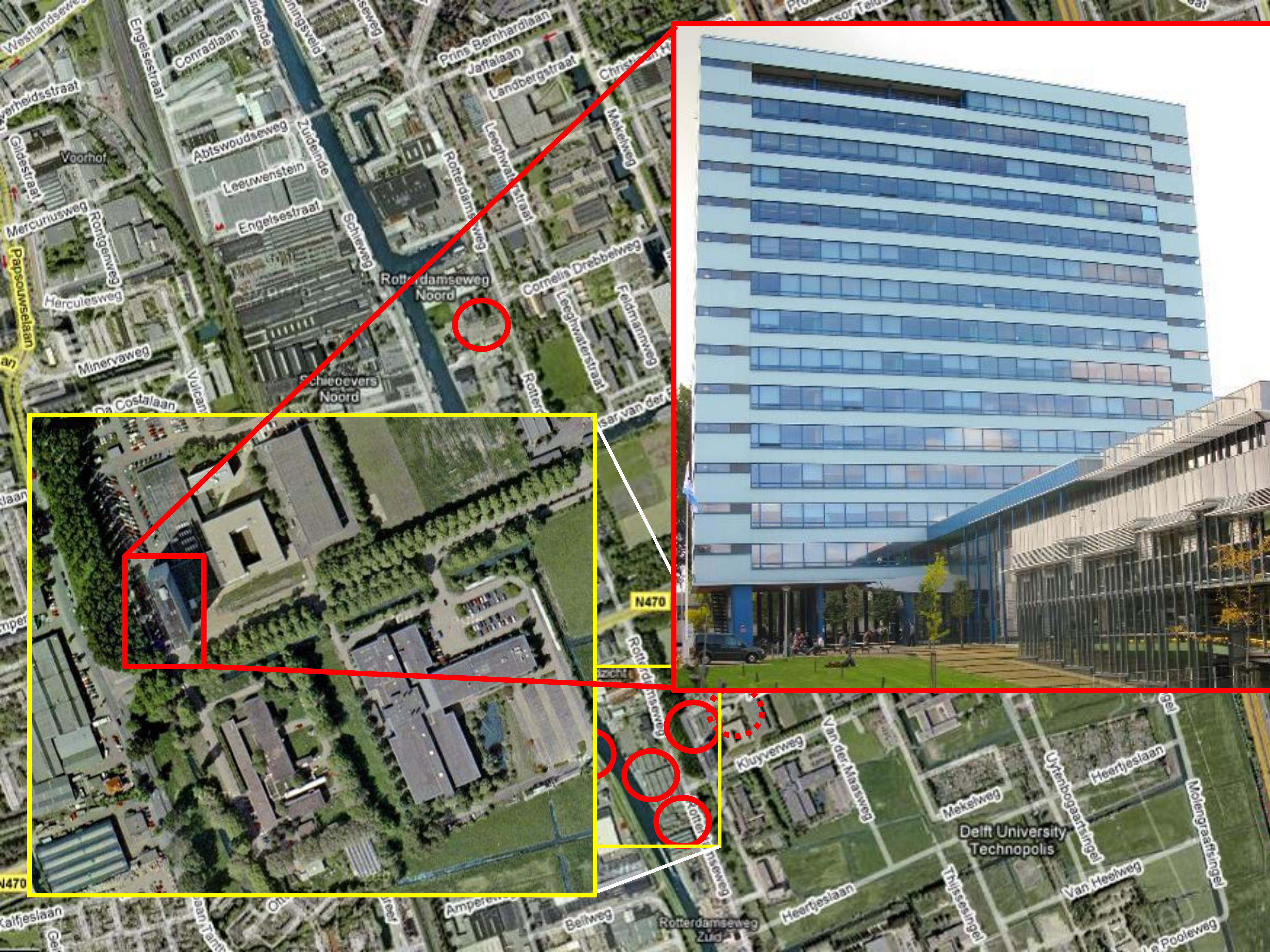
•Delft University of Technology

Faculty of Aerospace Engineering


EWADE 2011 - Gianfranco La Rocca (g.larocca@tudelft.nl)


Amsterdam
The Hague
Delft
Rotterdam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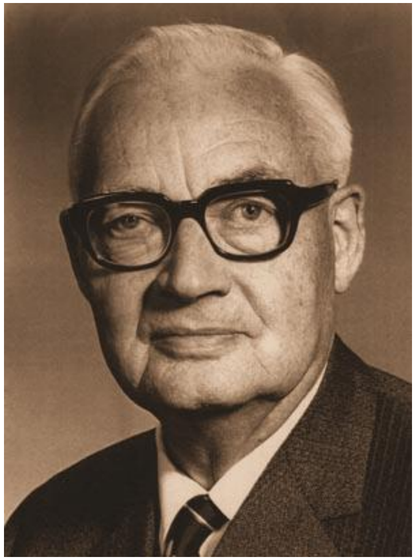
Engelsestraat
Conradiaan
Prins Bernhardlaan
Jaffalaan
Landbergstraat
Abtswoudseweg
Zuideinde
Voorhof
Gildestraat
Leeuwenstein
Engelsestraat
Rotterdamseweg
Leeghwaterstraat
Mekelweg
Mercuriusweg
Röntgenweg
Papsouwselaan
Schieweg
Herculesweg
Rotterdamseweg Noord
Cornelis Drebbelweg
Leeghwaterstraat
Feldmannweg
Minervaweg
Schieoevers Noord
Da Costalaan
N470
Kluyverweg
Van der Maasweg
Heertjeslaan
Mekelweg
Uytenbogaartsingel
Molengraaffsingel
Delft University Technopolis
Van Heelweg
Heertjeslaan
Thijssesingel
Bellweg
Rotterdamseweg Zuid
Kalfjeslaan
Poolseweg

Aerospace Engineering

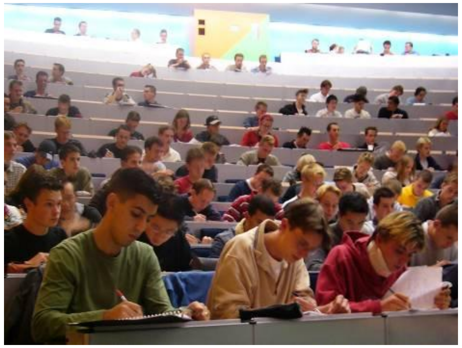
- 1842: TU Delft founded by King Willem II
- 1946: **Department** of Aeronautical Engineering founded by Prof. Van der Maas
- 1961: Start of Space technology
- 1975: **Faculty** of Aerospace Engineering



Aerospace Engineering

Complete

Research & education covering almost all areas of aerospace engineering, both with expertise and laboratory equipment



Largest aerospace engineering faculty in Western Europe

- International scientific reputation
- Unique facilities
- Large student body

Internationally oriented

- **Fully English taught programme**
- **34% International students**
- Member of IDEA League, PEGASUS university networks
- Bilateral international agreements
- Working in multinational research teams

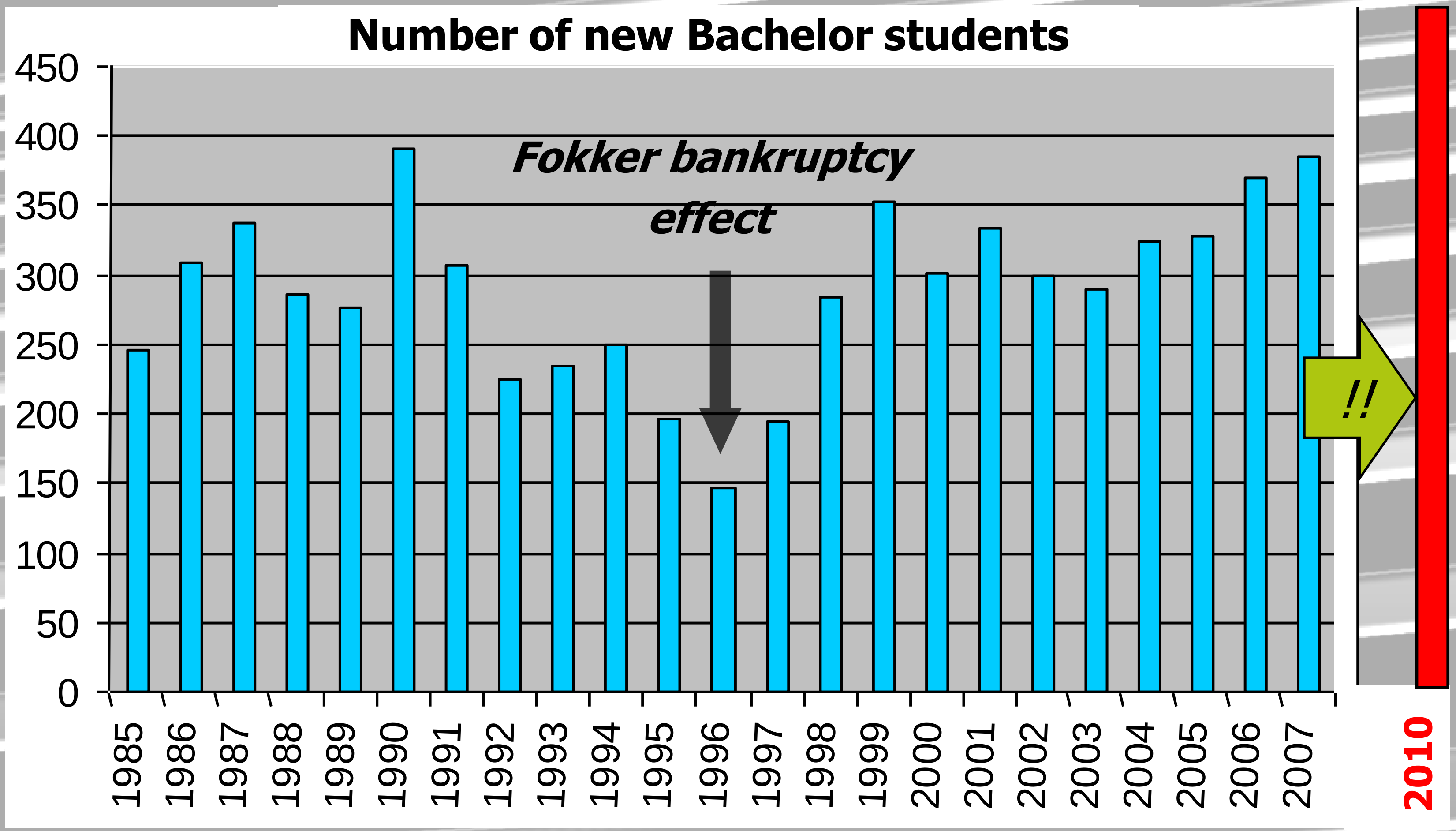
Aerospace Engineering

Number of staff:
- 59 support staff
- 228 academic staff
- 100 Ph.D. students

Number of students:
- 2000 students (BSc & MSc)
- 509 first year students

Funding:
- 22 M€ - Governmental funding
- 7 M€ - External funding

Aerospace Engineering



Aerospace Engineering

- **SIMONA**

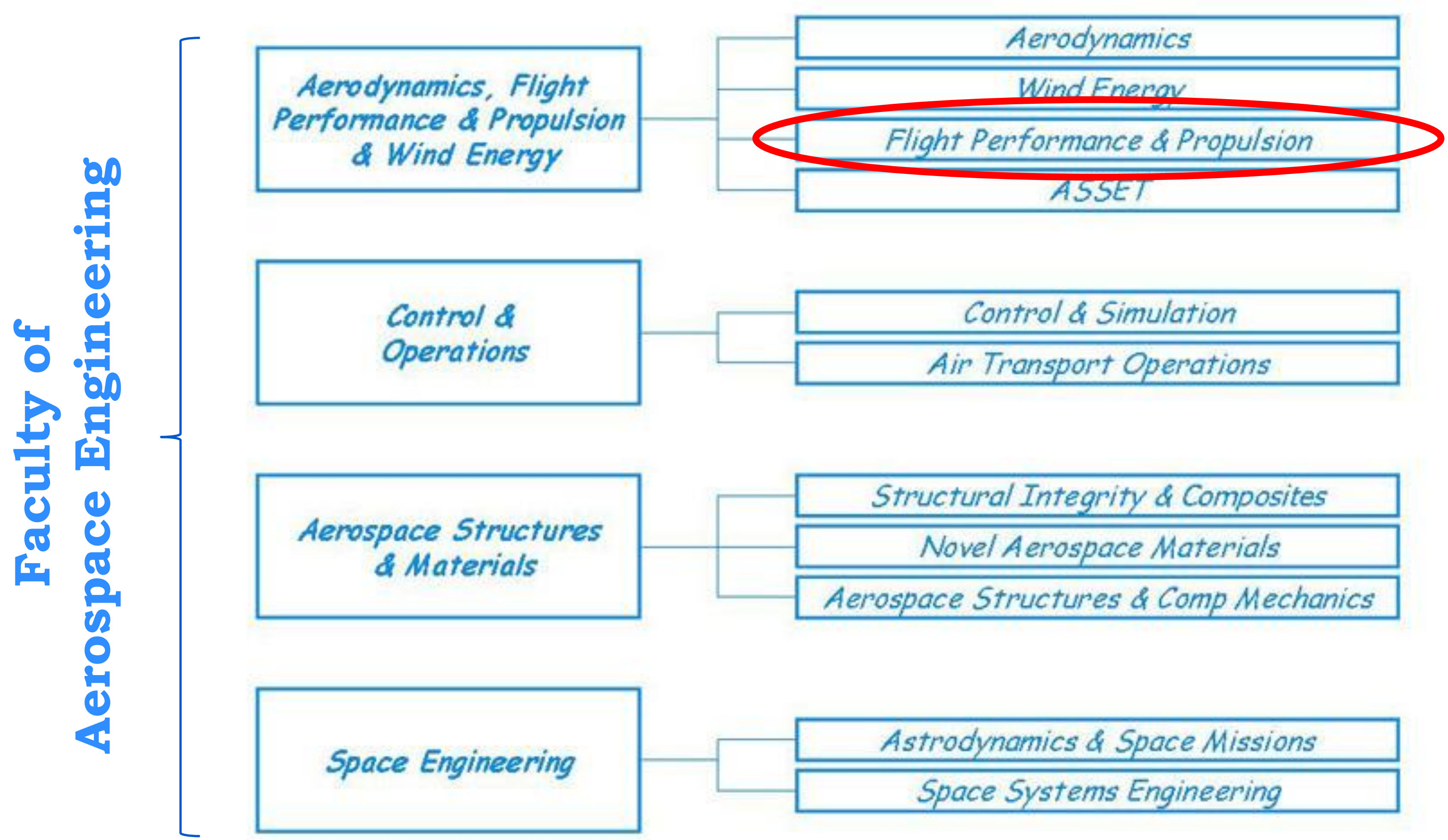
  Advanced moving base flight simulator
- **Cessna Citation II**

  Flying classroom research facility
- **Space certified satellite clean room**

  Class 100000 (ISO 8)
- **Wind tunnels**

  Subsonic, Transonic up to Hypersonic (M6.0-M11)
- **Laboratories for testing & manufacturing aerospace materials and aerospace structures**

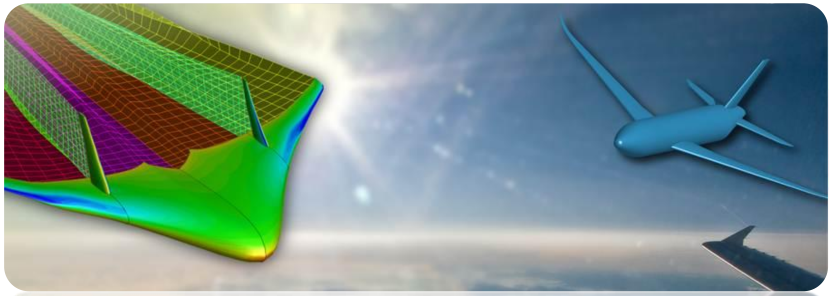
Aerospace Engineering



departments chairs

On the Flight Performance & Propulsion (FPP) chair

- Aircraft design related **education** (BSc & MSc courses)
- Focus, motivation and organization
- Aircraft design **research** programs
- A brief overview on the **design support systems** research area



FPP contribution to AE education*

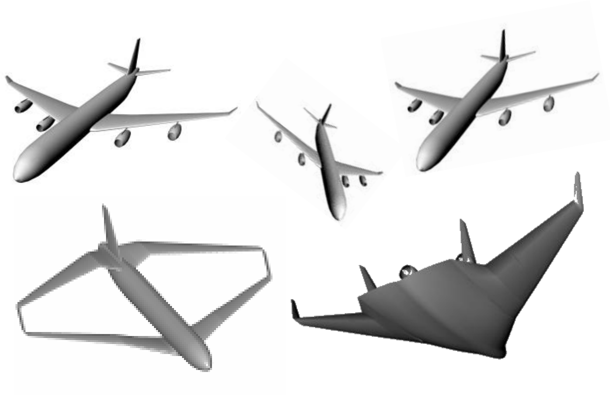
- BSc:
  1. Aerospace Design and Systems Engineering elements I - II
  2. Systems Engineering and Aerospace Design
  3. Flight Mechanics
  4. Aircraft Design (now redistributed across 3 BSc course)

- MSc:
  - Advanced Aircraft Design I
    - on the aerodynamic design of transport aircraft
  - Advanced Aircraft Design II
    - on the aerodynamic design and performance of combat aircraft
  - Advanced Design Methods
    - on Multidisciplinary Design Optimization and Knowledge Based Engineering

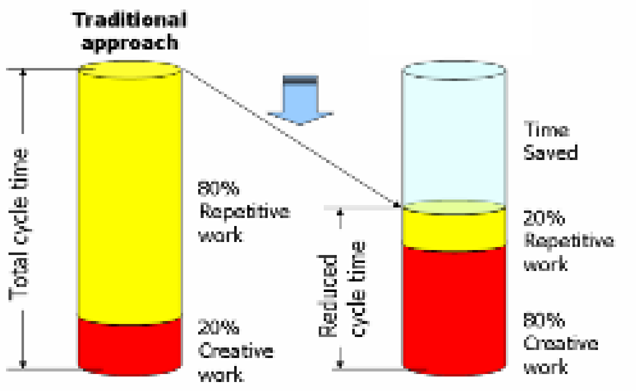
*Propulsion related courses not included here

Focus, motivation and organization

- **Products**: search for better aircraft and propulsion systems



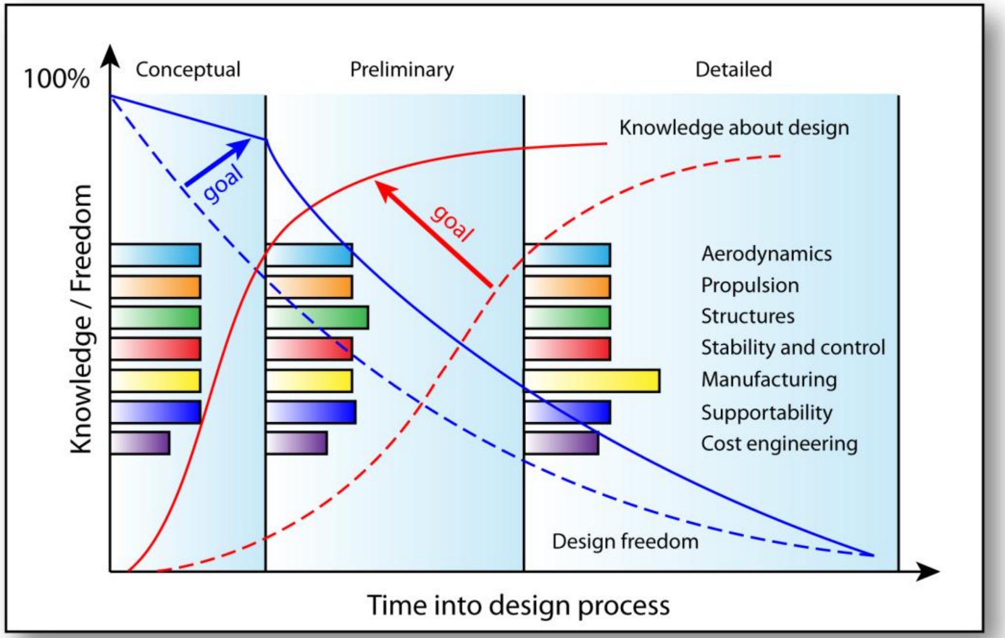
- **Methods & Tools**: Brain drains, higher complexity, too much repetitive vs. creative work in engineering (80% - 20%).
  How to improve designers productivity?



Focus, motivation and organization

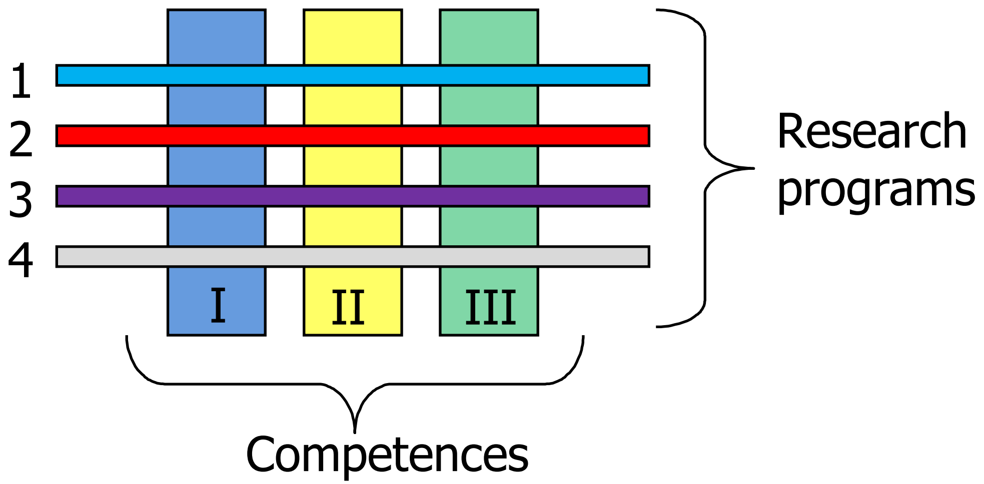
- **Methods & Tools (cont.)**: improvement of the design process by means of **multidisciplinary design optimization (MDO)**.

  → *Development of tools to enable and support the MDO approach*.



Focus, motivation and organization

The competences-research programs matrix



1. New air vehicle concepts
2. High fidelity modeling of complex aeromechanical systems
3. Design support frameworks
4. New and improved propulsion systems and engines

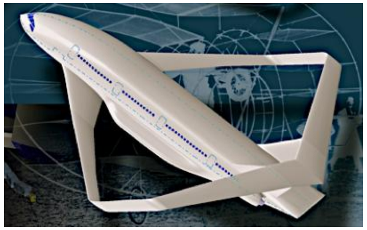
I. Propulsion
II. Flight mechanics
III. Aircraft Design & Design Methodologies

Research programs

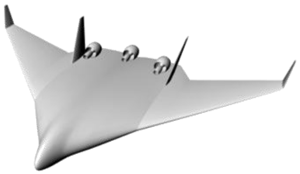
1. New air vehicle concepts

Objectives

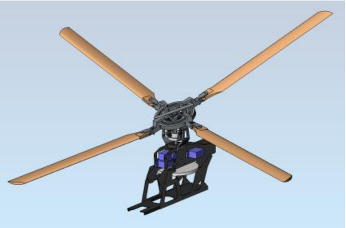
- Minimum induced drag
- Less noise
- Smaller span
- Less weight

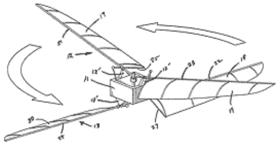


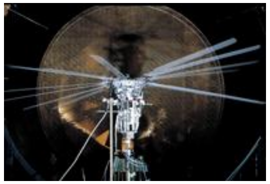
- Minimum friction drag
- Less weight
- More comfort
- Less noise



- Improved controllability
- Increased safety
- Less noise
- Less fuel consumption





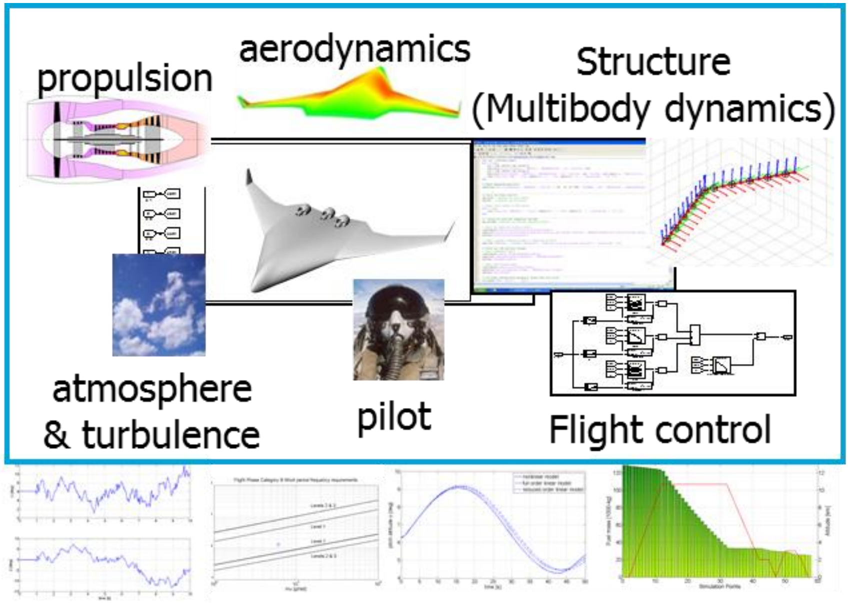


Research programs

2. High fidelity modeling of complex aeromechanical systems

Objectives

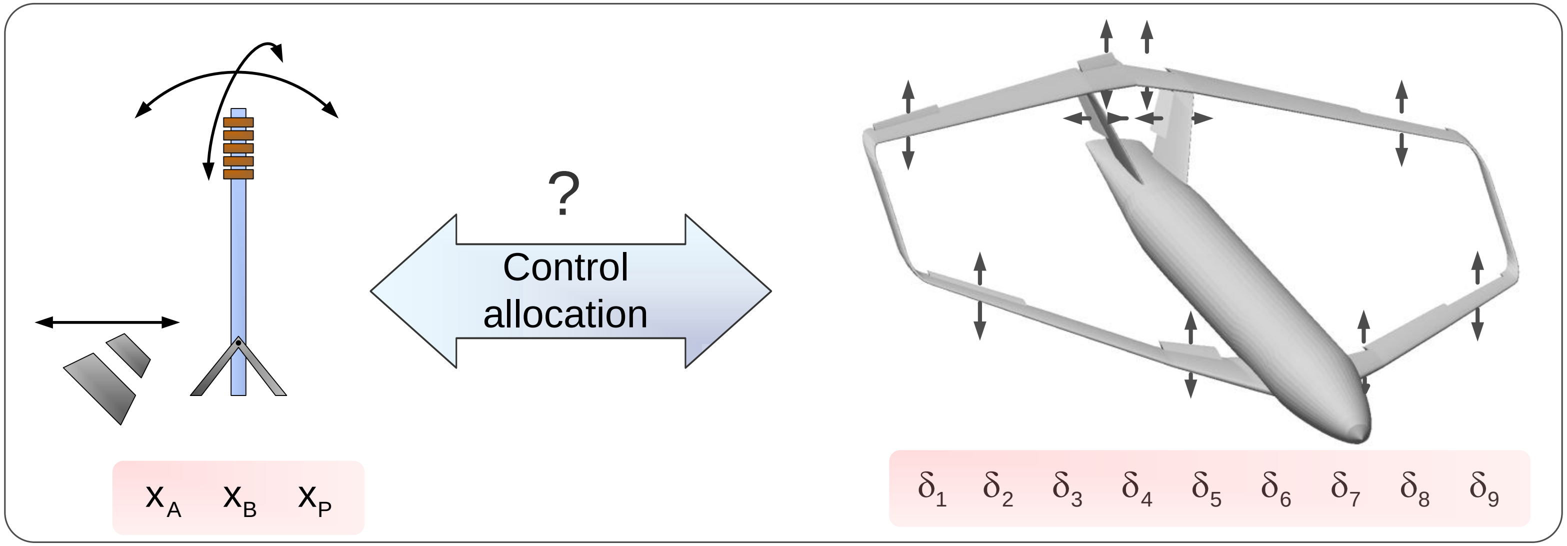
- New vehicle performance evaluation by development of a generic flight mechanics toolbox.
- Evaluation of systems that are complex to model



The Generic Flight Mechanics Toolbox

Research programs

2. High fidelity modeling of complex aeromechanical systems



Control surface sizing and allocation for novel configurations

Research programs

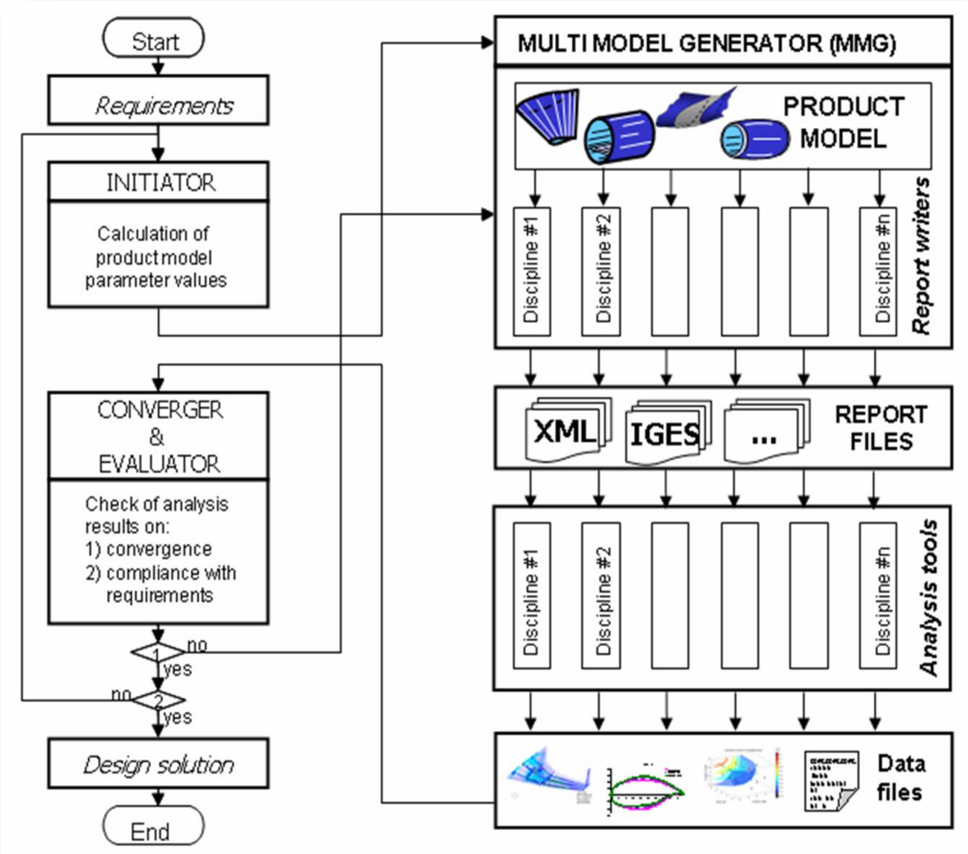
3. Design Support frameworks

Objectives

Development of a computational system (the DEE)

- to explore design domains
- to increase yield of current analysis tools potential
- to free designers' time for creative activities
- to reduce cost of engineering

Methods: KBE, MDO, Agents, Knowledge Bases

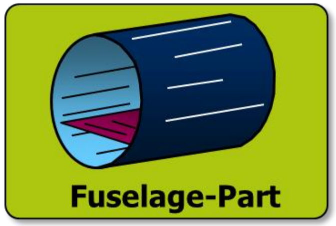


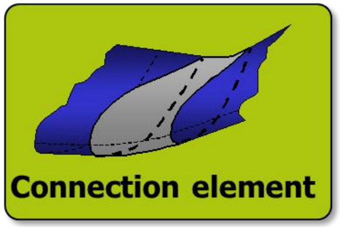
The Design and Engineering Engine

Research programs

3. Design Support frameworks

KBE tools for fast generation of aircraft configurations and variants





The parameters represent the "degrees of freedom" of the HLPs!

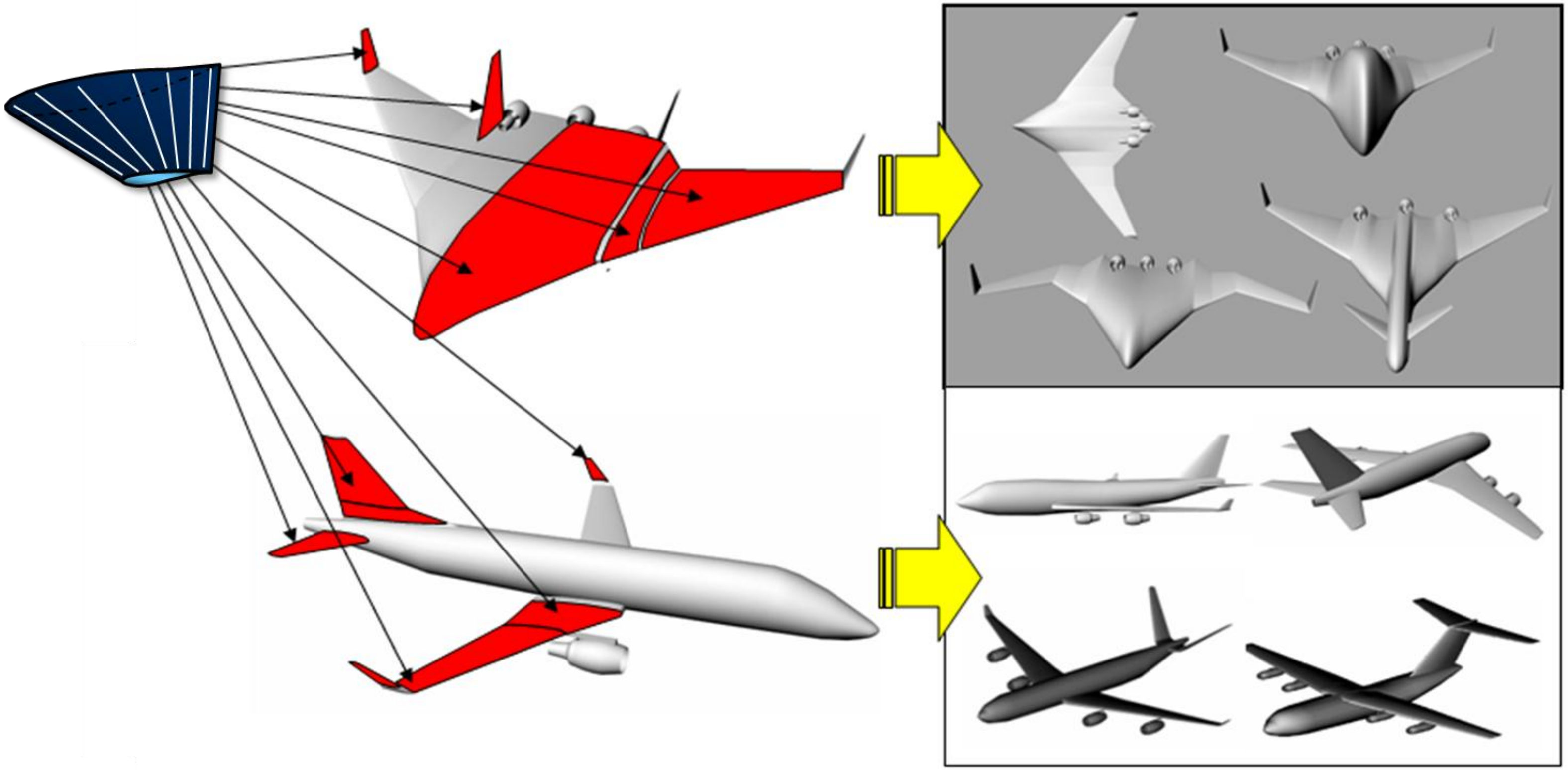
Wing-Part parameters

- Type of airfoil (from a library)
- Amount of airfoils
- Positioning of airfoils
- Thickness of airfoils
- Reference axes
- Chords' length
- Span
- Dihedral angle
- Sweep angle
- Twist angle
- ……

Research programs

3. Design Support frameworks

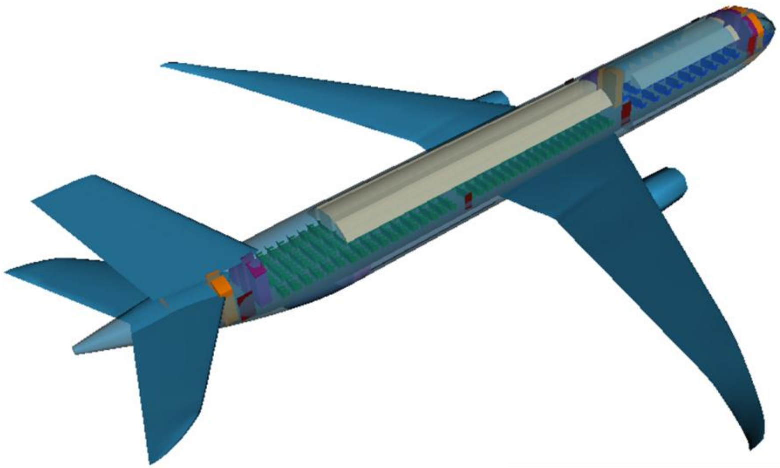
KBE tools for fast generation of aircraft configurations and variants

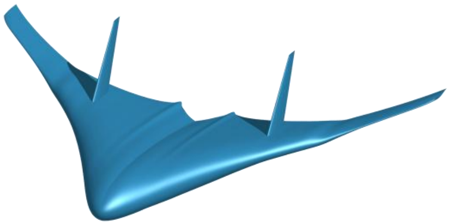


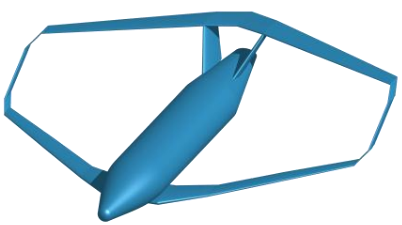
Research programs

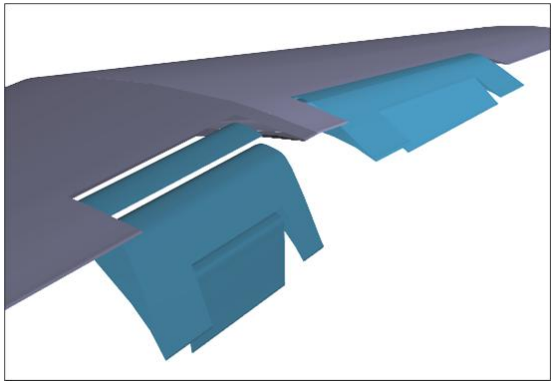
3. Design Support frameworks

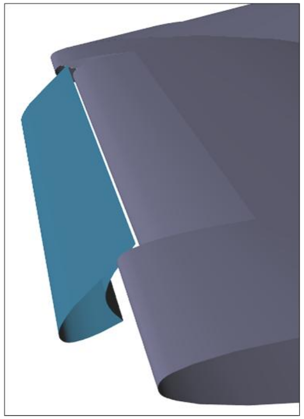
KBE tools for fast generation of aircraft configurations and variants







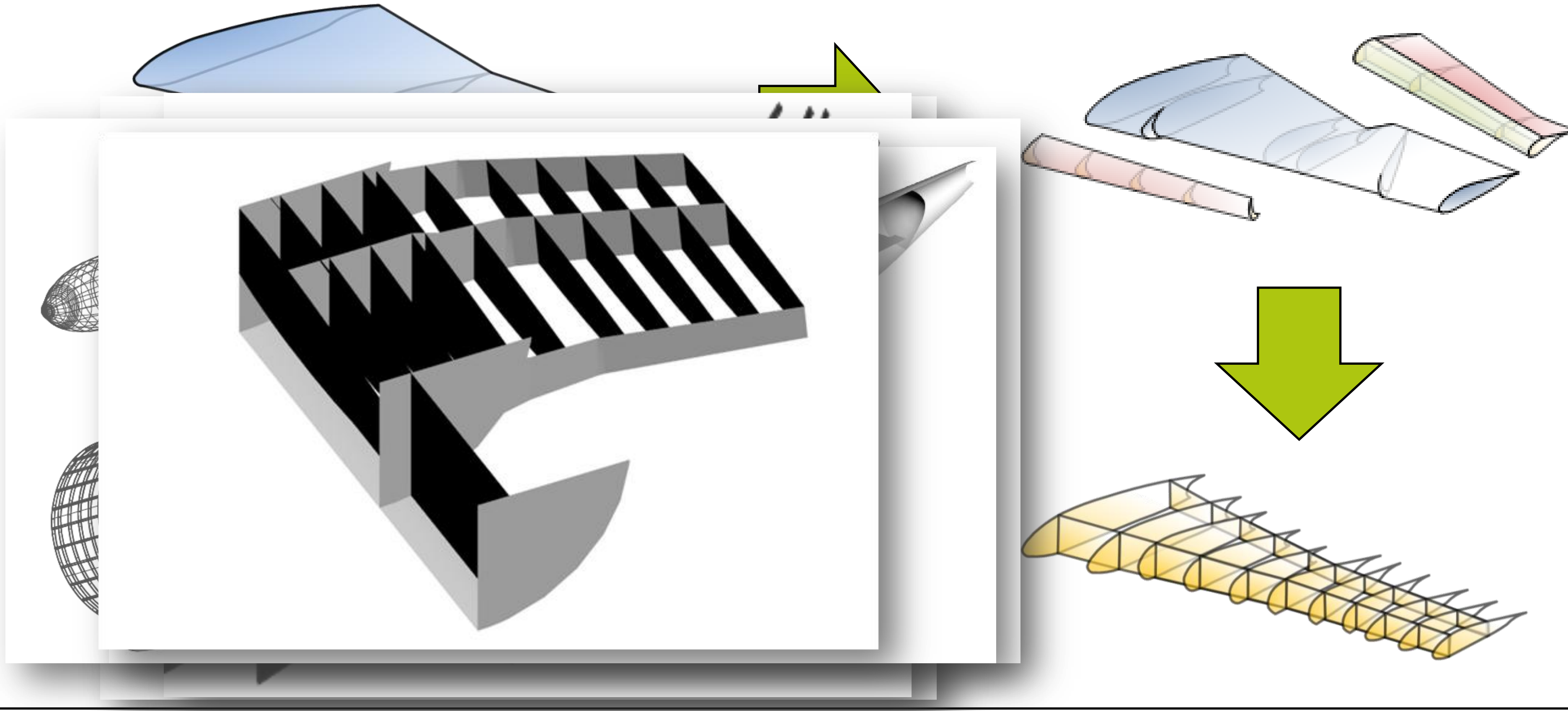




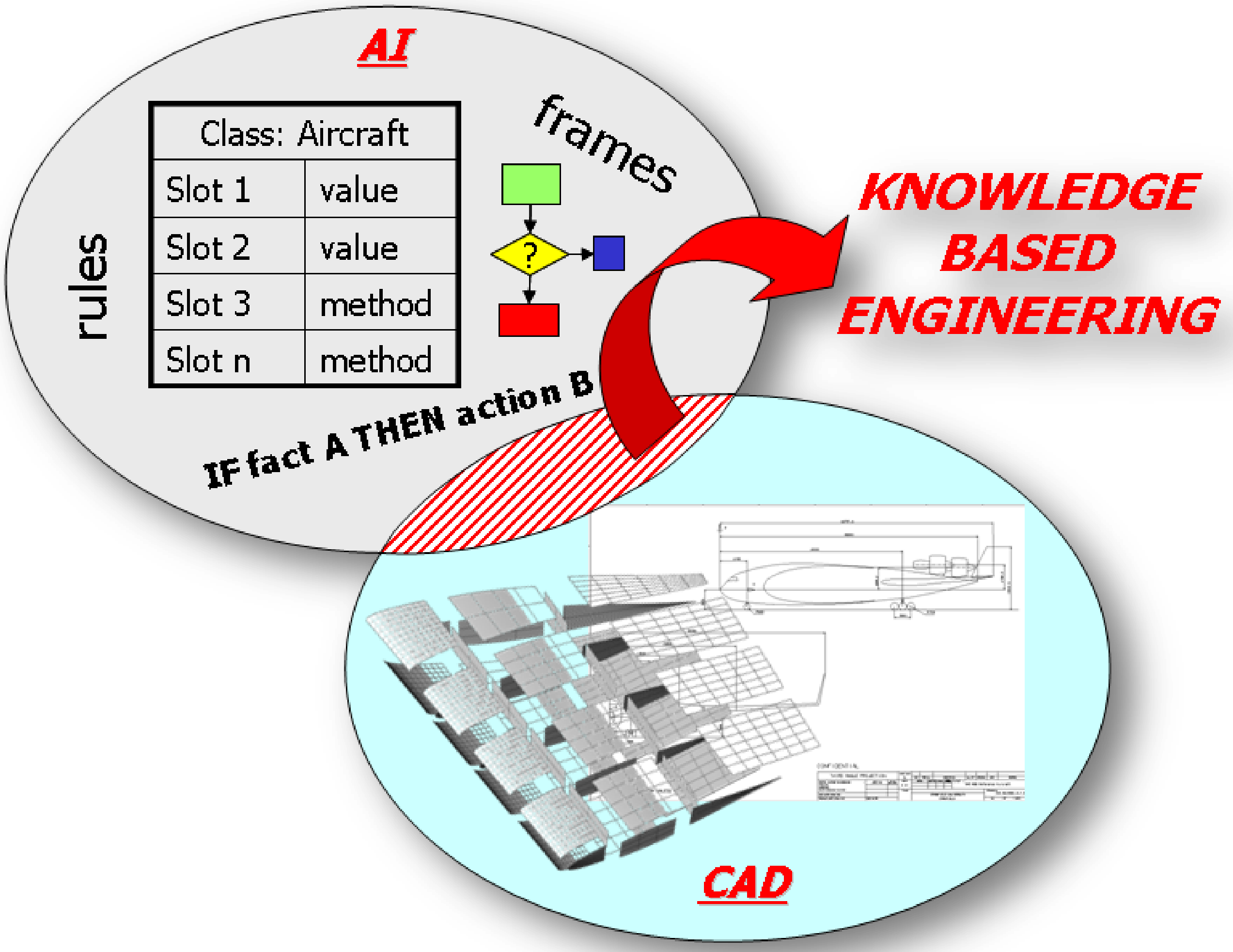
Research programs

3. Design Support frameworks

KBE tools for fast generation of aircraft configurations and variants



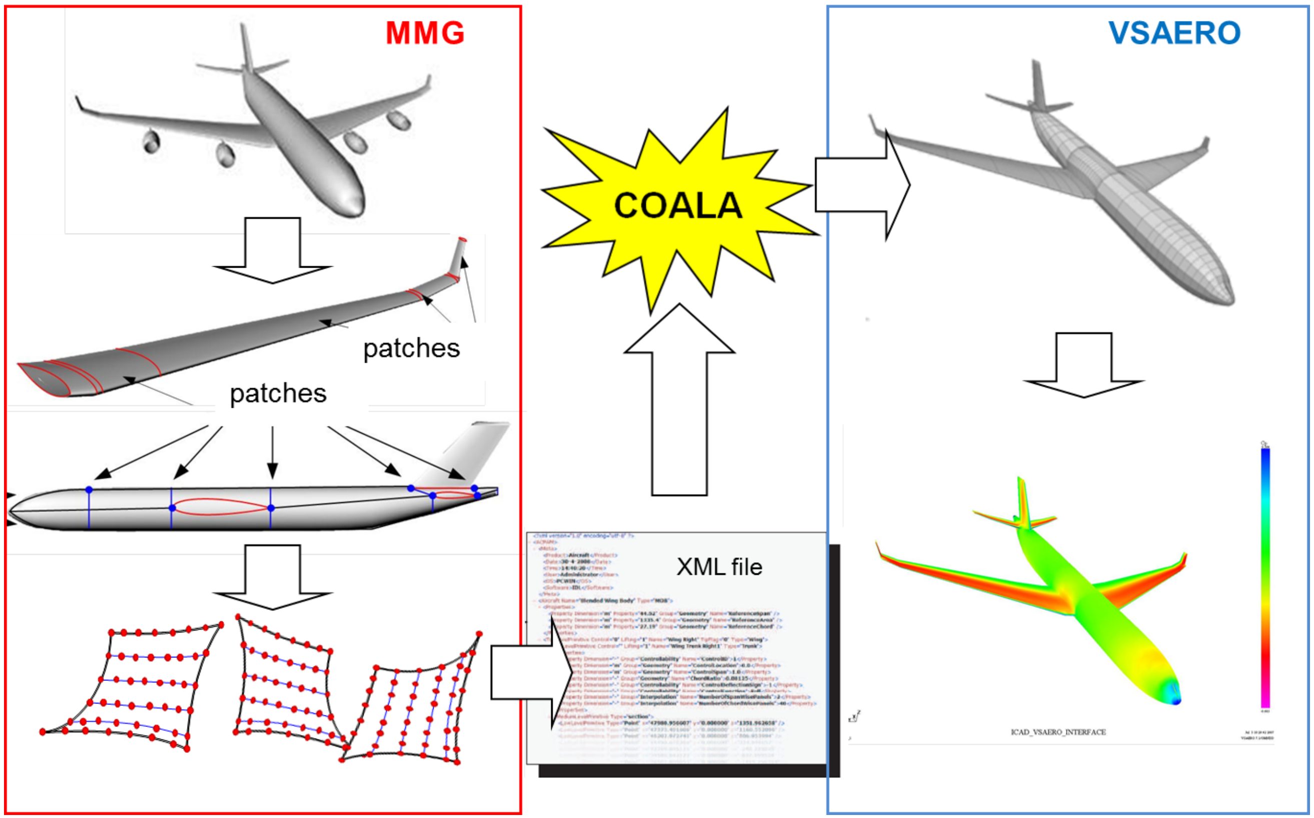
…but what is Knowledge Based Engineering (KBE) ?!?



Research programs

3. Design Support frameworks

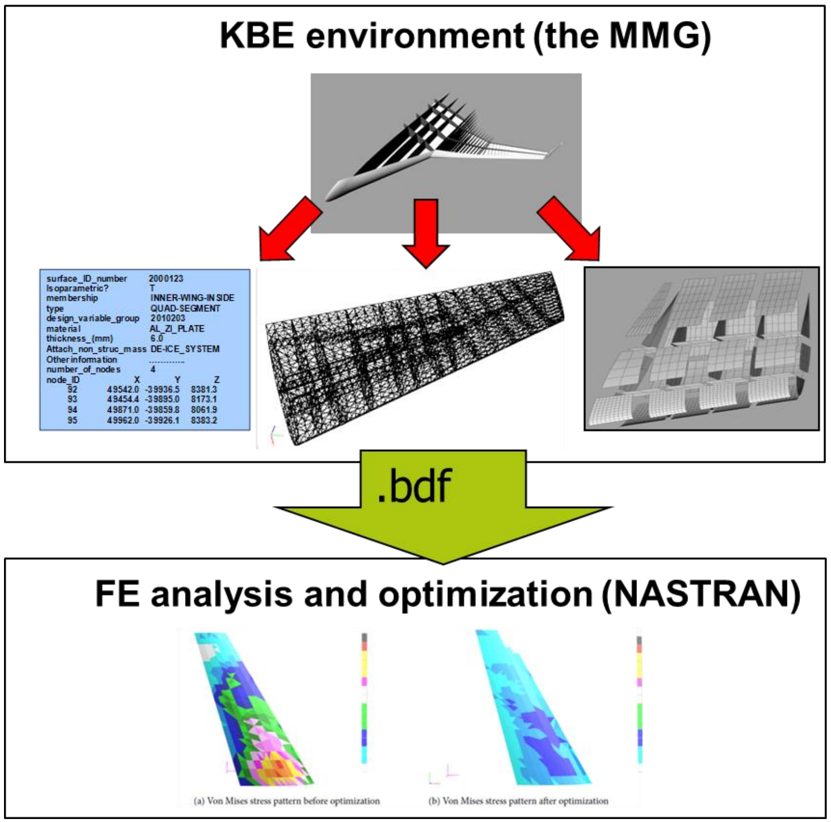
Automation of complex analysis cycles (example of aerodynamic analysis)



Research programs

3. Design Support frameworks

Automation of complex analysis cycles (example of FE analysis)



STEP 1: model instantiation

STEP 2: meshing (MMG)

STEP 3: properties assignments and mapping (MMG)

STEP 4: loads mapping (MMG)

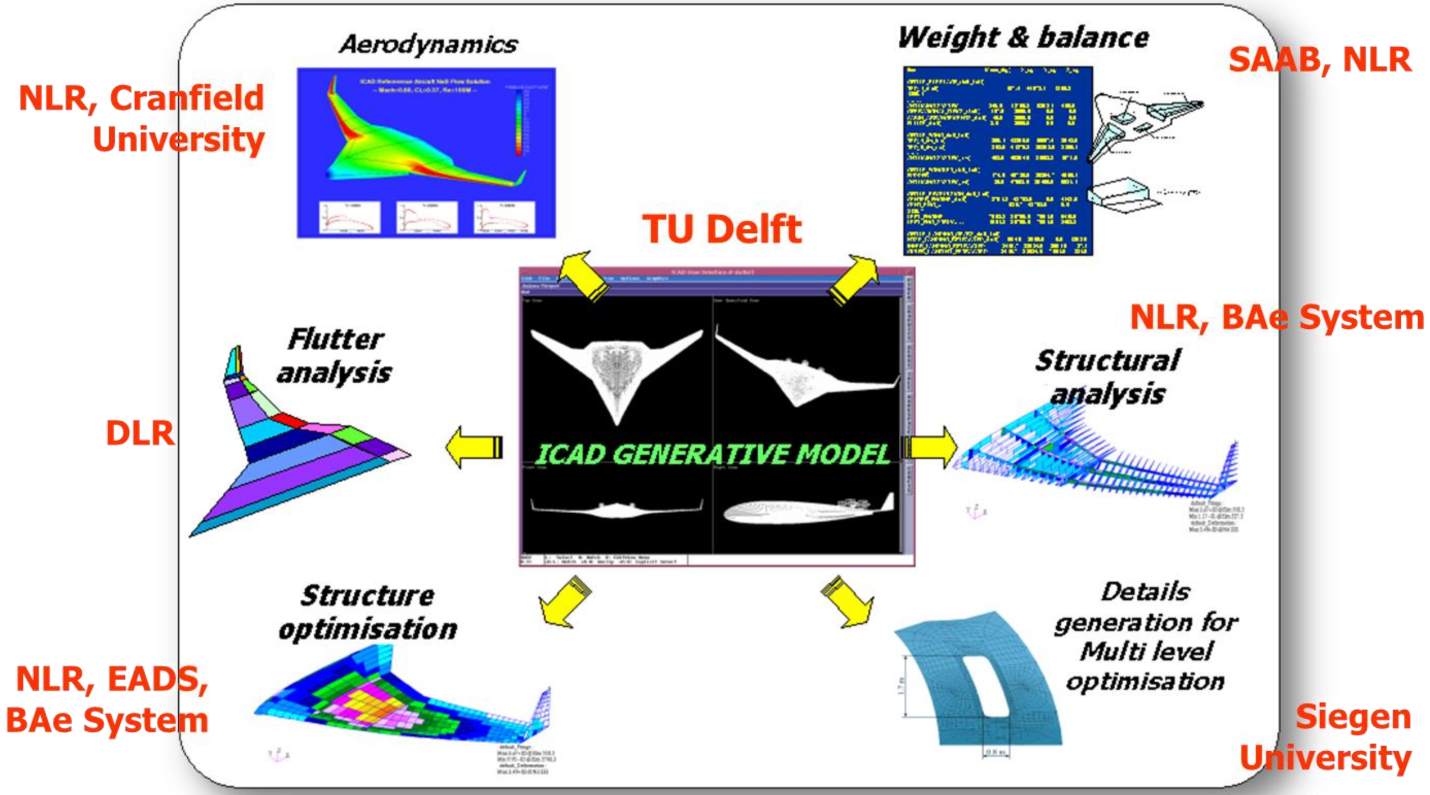
STEP 5: generation of the .bdf file, i.e., the Nastran Input file (MMG)

STEP 6: analysis & optimization (NASTRAN)

Research programs

3. Design Support frameworks for new vehicles development

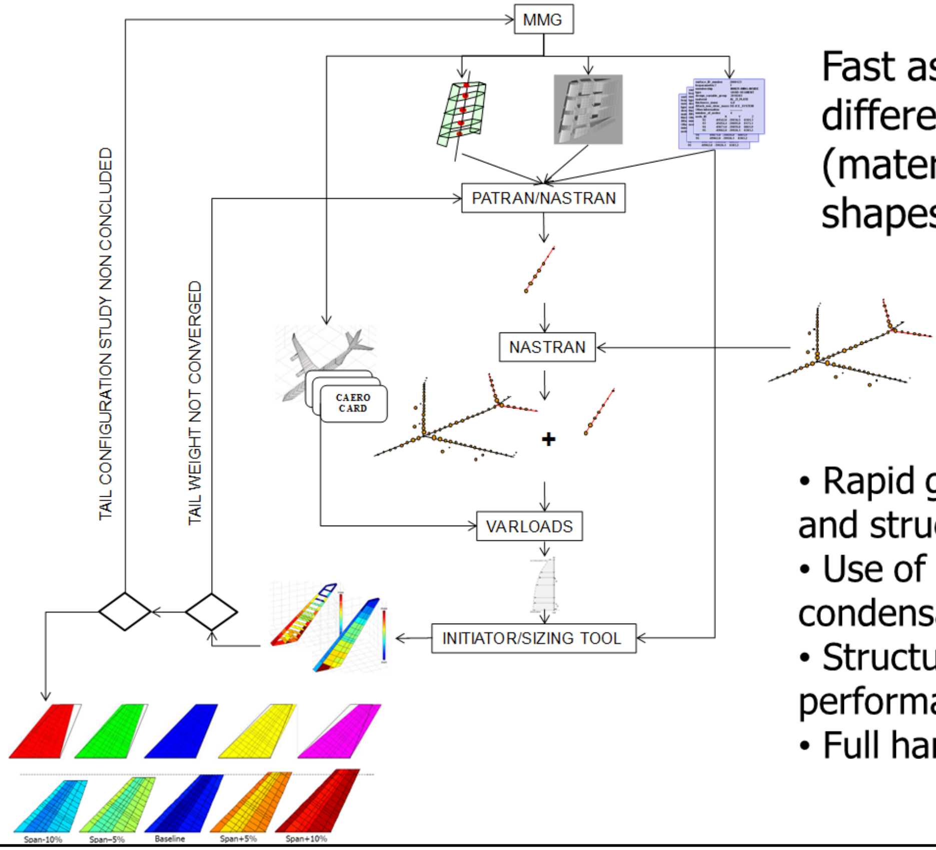
Distributed MDO of Blended Wing Body configurations (EC sponsored project)



Research programs

2. Design Support frameworks for A/C main systems design

Distributed computational engine for vertical tail redesign (TAILORMATE project with Airbus)



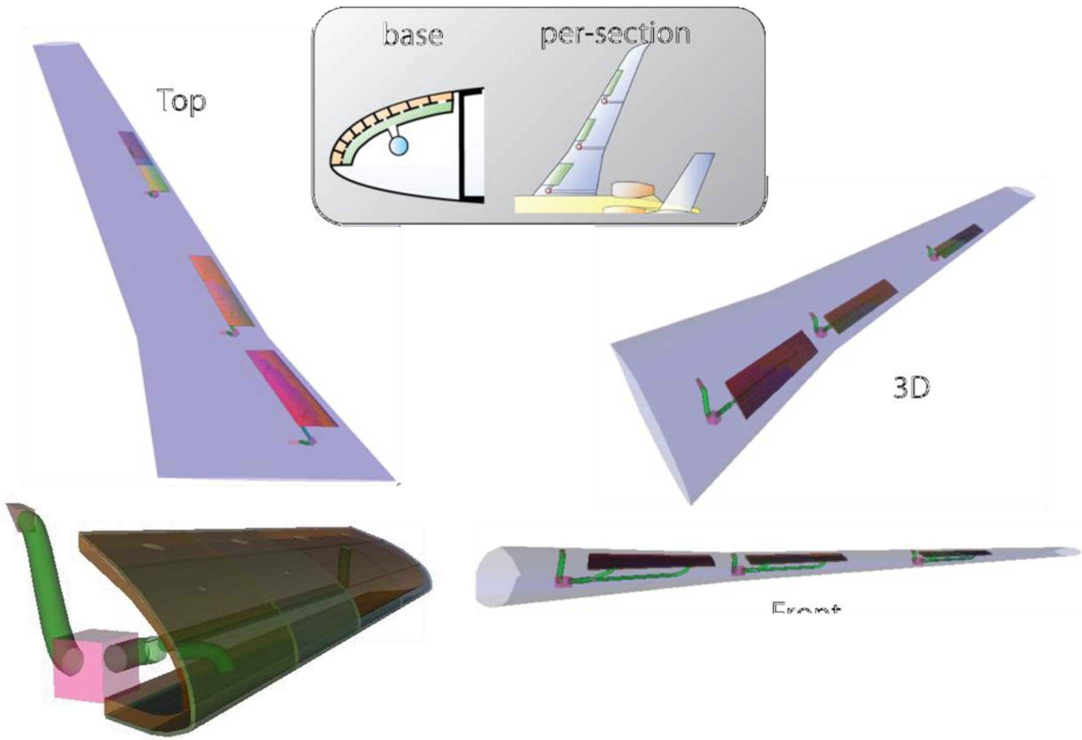
Fast assessment of different tail design options (material and planform shapes)

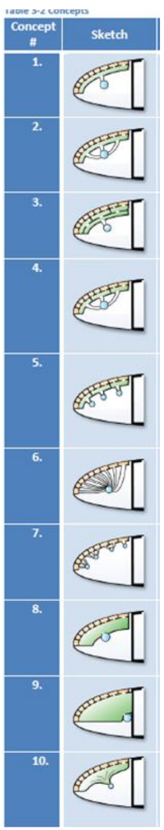
- Rapid generation of aeroelastic and structural models
- Use of reduced models (mass condensation methods)
- Structure, Aero and Flight performance involved
- Full hands-off MDO design

Research programs

2. Design Support frameworks for sub-systems integration and operation (EC sponsored project)

KBE modeling of wing internal systems for boundary layer suction, with weight, cost an power absorption analysis



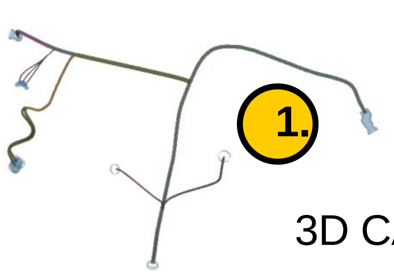


Research programs

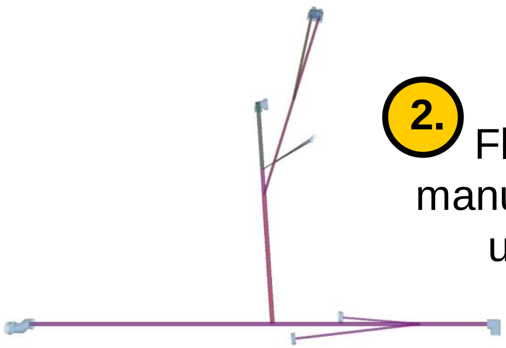
3. Design Support frameworks for sub-systems integration systems design, integration and production

EXAMPLE: Automatic signal-pin assignment to connectors at production breaks

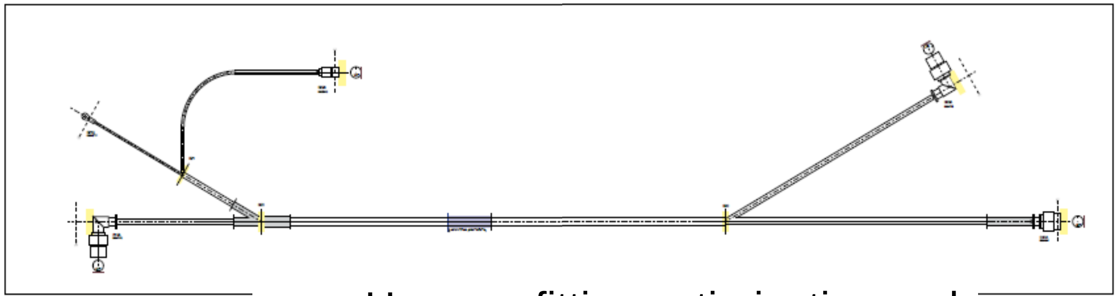
(FORMBOARD with Fokker Elmo)



1. 3D CAD model of the wiring harness



2. Flattening according to manufacturing constraints using KBE techniques



3. Harness fitting optimization and automated layout generation

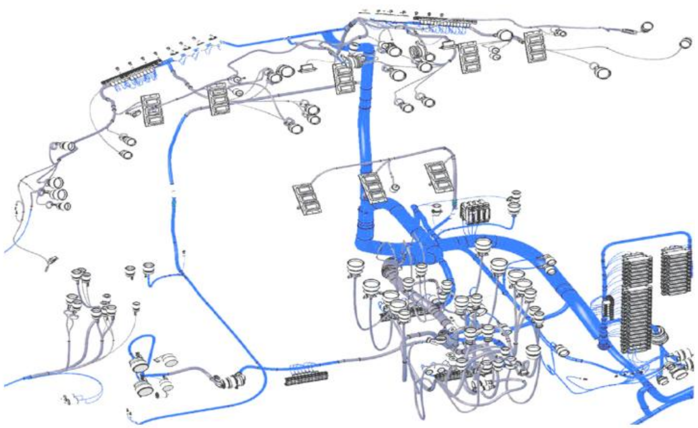
4. Printed drawing in wiring harness manufacturing

Research programs

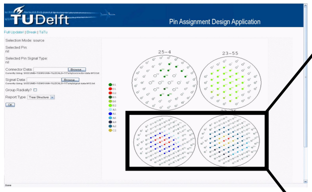
3. Design Support frameworks for electrical systems design, integration and production

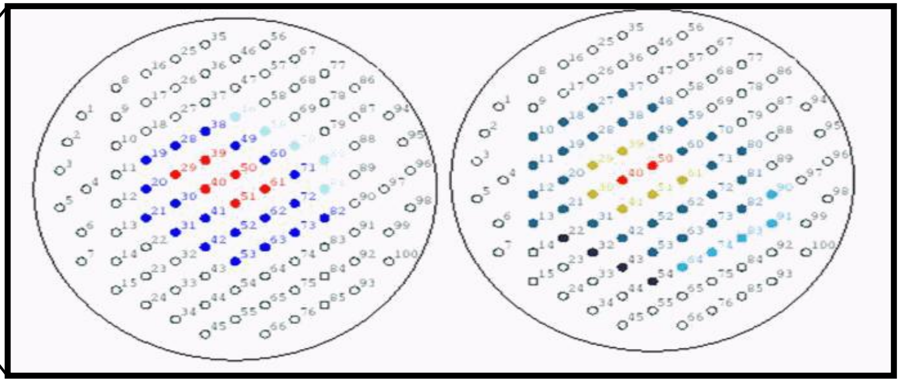
EXAMPLE: Automatic signal-pin assignment to connectors at production breaks

(AWARD project with Fokker ELMO)



Assigning 25000 signals to connectors at production breaks takes 100 hrs in the traditional approach, few seconds using KBE tools.






That's all Folks!