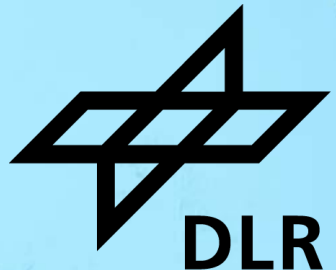# REQUIREMENT-BASED COMPONENT PLACEMENT FOR AIRCRAFT DESIGN

Authors: **Brigitte Boden, Tim Burschyk**
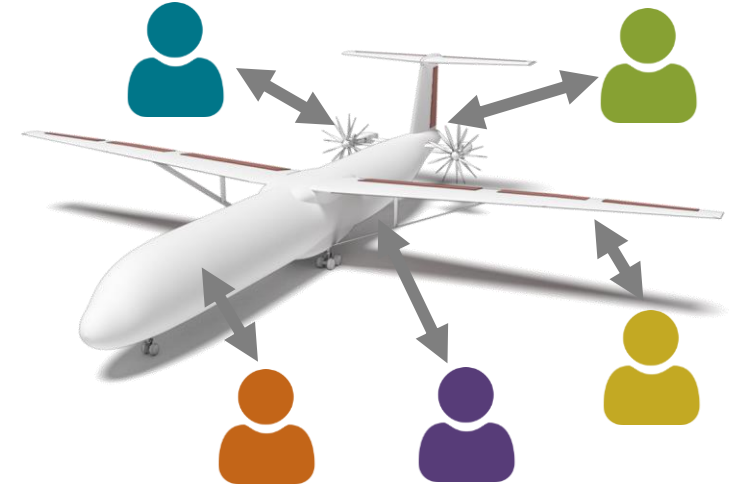
Institute of System Architectures in Aeronautics, DLR Hamburg

DLR

Geometric Challenges in Aircraft Design

- Many stakeholders designing different components

- Rapid changes in early design stages

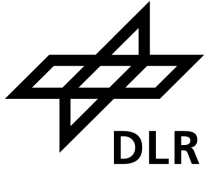- All components have to "fit" together in design space

Our approach:

- Geometry modelling using semantic web technologies

- Formalize and evaluate geometric requirements

- Geometric integration of subsystems at early design stages

Problem statement

- Manual placement of components leads to errors and inefficiencies

- Lack of automation in geometric design tasks increases design time and cost

- Integration of multiple domains and requirements is difficult
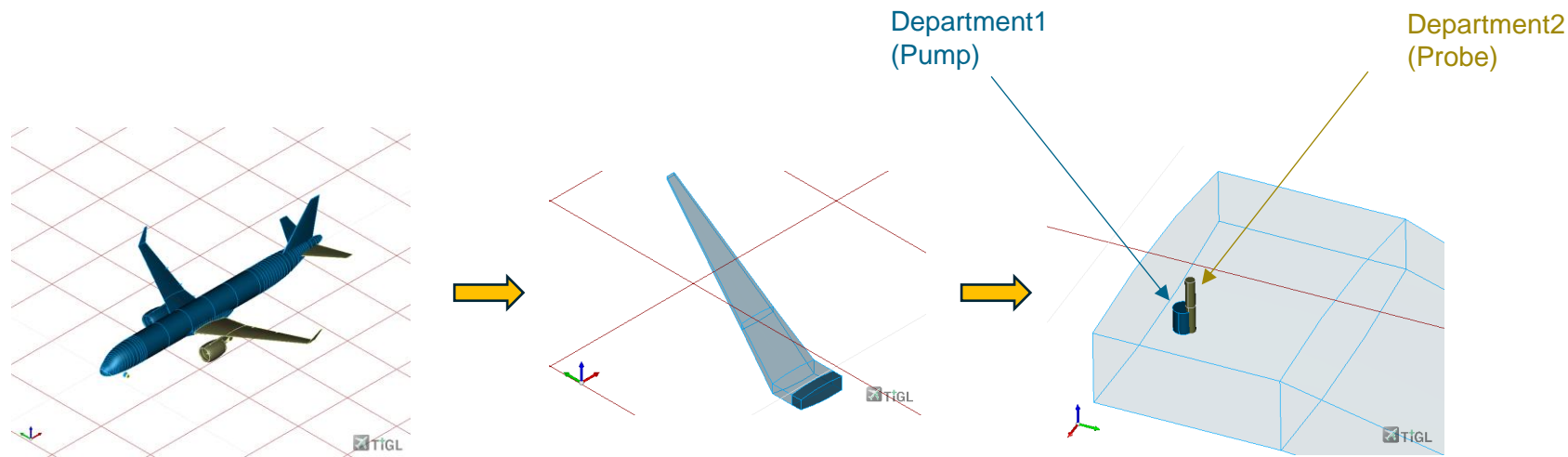
The Codex platform: Overview of codex-geometry

- Codex (COllaborative DEsign and eXploration) Platform

- Semantic Web Technologies for domain-neutral knowledge formalization and data integration

- Reduces manual effort and increases design efficiency

- Automatic evaluation of geometric requirements and suggestions for improved component placements

The Codex Platform: Semantic Knowledge-Based-Engineering

Framework for the sustainable development of tools for complex system analysis
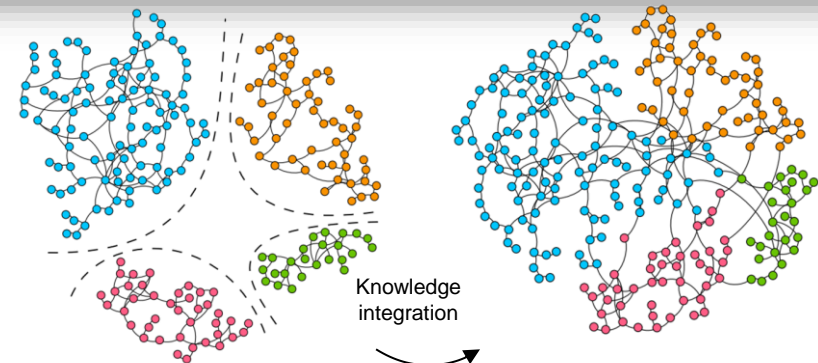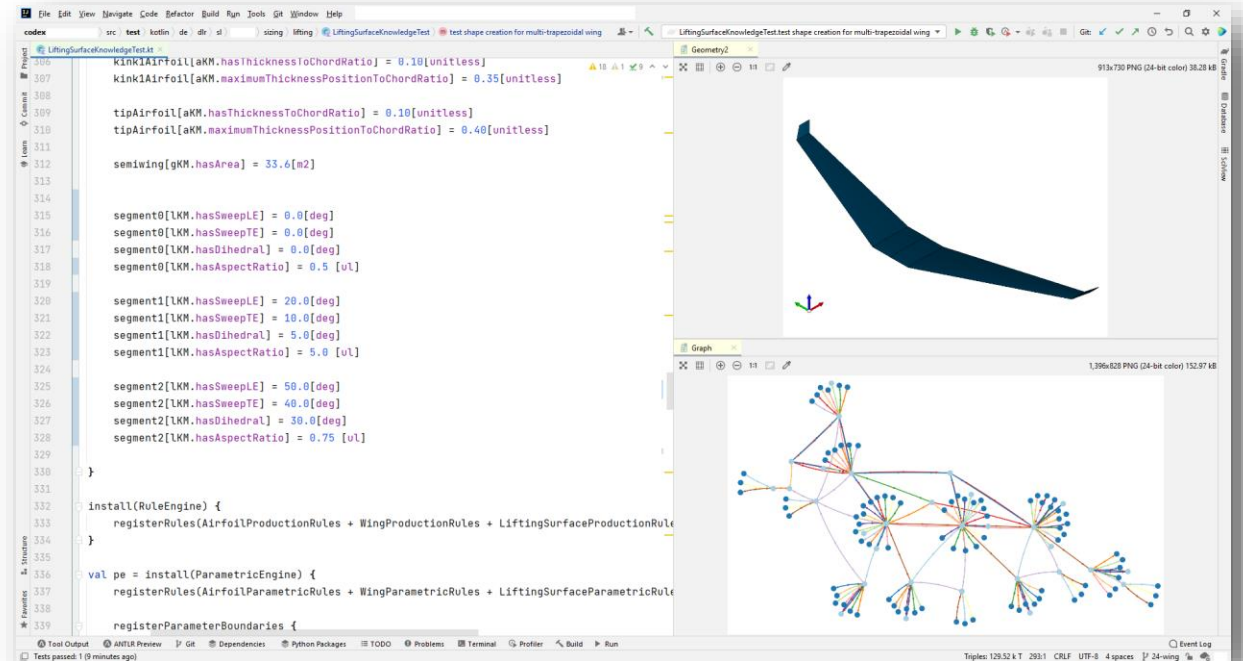
Dynamic modeling environment for effective knowledge digitization, combination and execution

Enables effective sharing and re-use of knowledge in multiple tools, no "re-invention of wheels" occurs

link knowledge between domains to enable data continuity across the digital thread

Knowledge integration

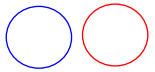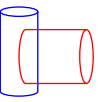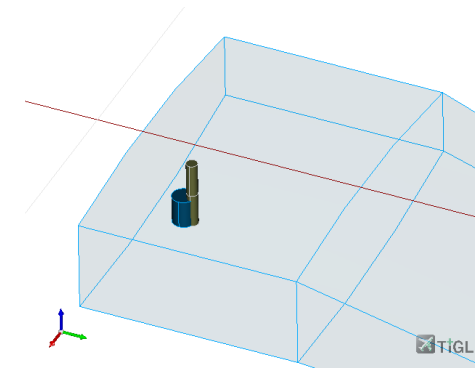# Codex-geometry: Defining geometric requirements

Example requirements :

- "Pumps, probes should be contained in design space (wing box)"
- "Fuel lines shall not pass through other components"

➡ Automatically checked by codex-geometry

Simple geometric checks:

- „contained in"
- „no overlap"
- „connected to"
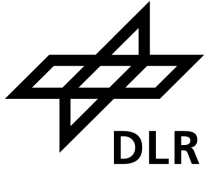- „minimum distance"

Rule-based Placement Suggestions

- Integrating geometric data from different sources
- Requirements: - „Pump contained in feeder compartment " ✔
                  - „Probe contained in feeder compartment " ✔
                  - „Min. distance between pump and probe: 10cm" ✘ ✔

Department1
(Pump)

Department2
(Probe)

codex-geometry
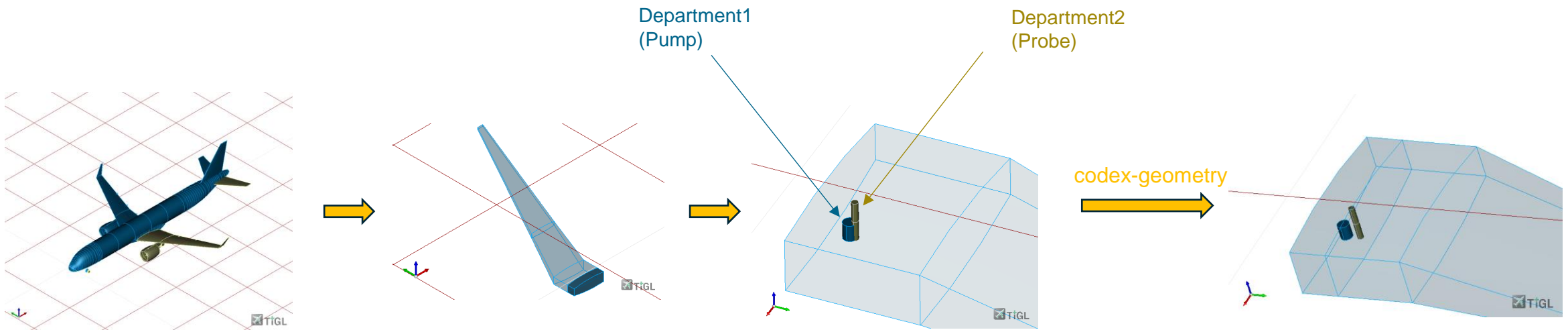
Improving component placement based on requirements

If requirement is not met -> suggest improved placement for component

- Components can be marked as "Movable"

- Only suggest translations for the given components. Size and orientation of a shape may not be altered!

- Define maximum number of allowed movements per shape

- Rules may throw exception if the requirement cannot be fulfilled

- Rules return a suggested translation for the component

Application Case: Uncontained Rotor Burst

- Minimizing hazards due to engine burst

- Modeling expected trajectories of possible fragments using engine disk geometry and spread angle

- Critical components should be located outside debris impact zones or duplicated for redundancy
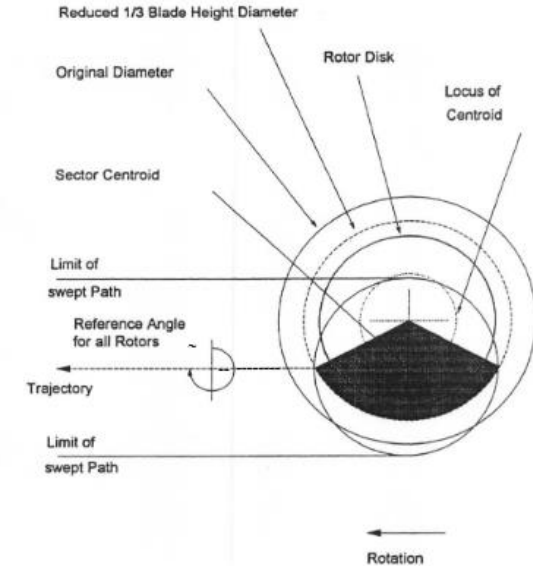

AC 20-128A
Appendix 1   3/25/97

Reduced 1/3 Blade Height Diameter

Original Diameter

Rotor Disk

Locus of Centroid

Sector Centroid

Limit of swept Path

Reference Angle for all Rotors

Trajectory

Limit of swept Path

Rotation

FIGURE 3

TRI-SECTOR ROTOR BURST

Source:
https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_20-128A.pdf

- Requirement: „Redundant components should be placed in „safe" compartments of the wing box"
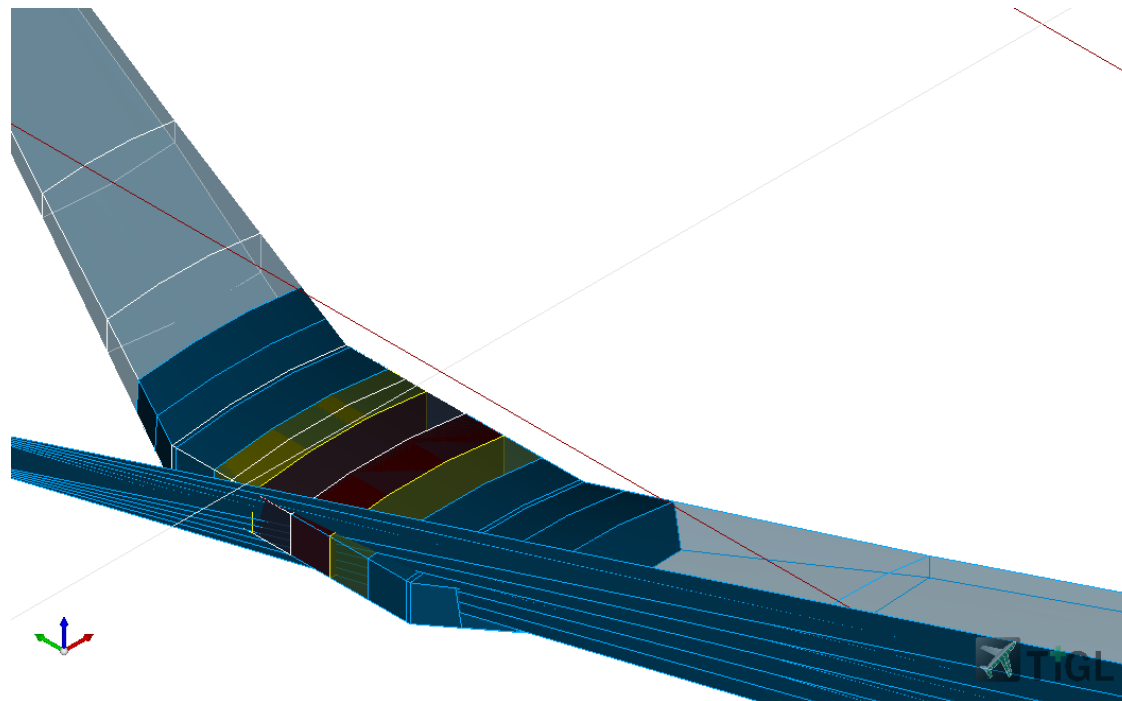
Compartment 1: High Risk
Compartment 2: High Risk
Compartment 3-5: Lower Risk

Future work
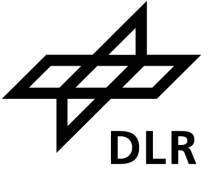
- Automatically suggest placements for sets of components that comply with all requirements

- Extend methodology to accommodate more complex geometries and subsystems

- Create a comprehensive and integrated design process

Imprint

Topic: **Requirement-based component placement for aircraft design**

Date: 2025-10-14

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Institute: Institute of System Architectures in Aeronautics

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