Upcycling of Aeronautical Structures

I2M – Arts et Métiers Bordeaux – France

Context

This topic is part of the project **"Circularity 4.0 for the Aerospace Industry: High-Value Reuse of Aircraft Structures through Second-Life Use and Design"**, involving TU Delft (project lead), INRIA Côte d'Azur, and Arts et Métiers. The initiative is co-financed by Air France-KLM and the French Embassy in the Netherlands.

The project also includes two industrial partners: **AC Dismantling** and **Optima Aero**, both working on end-of-life aeronautical structures and developing more circular solutions.

- **Optima Aero** specializes in the reuse and refurbishment of helicopter components.
- **AC Dismantling** is a start-up focused on dismantling light aircraft (under 30 tons). They supply refurbished and certified parts, components, and engines to service centers and OEMs worldwide. Their goal is to implement a circular economy approach for end-of-life aircraft structures, maximizing value through recovery and fine sorting for improved recycling.

At the **Arts et Métiers Bordeaux campus**, the **I2M laboratory** is conducting R&D to support **Circular Economy 4.0**, which involves applying Industry 4.0 technologies—such as XR, robotics, and image recognition—to the end-of-life management of complex products. The aim is to recover modules and components through a multi-step process: **identification, diagnosis, dismantling, and requalification**, prioritizing reuse before recycling.

The **SDC2 platform (Smart Disassembly Cell for Circularity)** is dedicated to research in this area.

Analysis of Upcycling Potential – Collaboration with TU Delft

The objective is to support the **upcycling** (functional recovery) of aircraft structural components. TU Delft is exploring circular design concepts, such as outdoor furniture made from repurposed wind turbine blades.

Based on these design potentials, INRIA is developing 3D surface analysis tools tailored to design requirements and existing products.

Beyond geometric considerations, the project also addresses:

- Mechanical strength constraints
- Connection interfaces
- Identification and characterization of the existing product (referred to as the "deposit")

These tasks are carried out by **Arts et Métiers (ENSAM)**.

We currently have a **PIPER Navajo PA-31** aircraft structure as the basis for our studies, and have recently received an **EC135 helicopter structure**.

Planned Activities

(Documents and reports will be produced in English)

- Collect case information and materials:
    - Process aircraft documentation

- Perform 3D scanning of the fuselage
- Analyze aircraft KARDEX
- Create an annotated 3D model of the fuselage
- Define material composition of fuselage components
- Acquire a second aircraft structure via AC Dismantling

Key Questions and Challenges

- How can we digitize structures to enable annotation, analysis, and traceability of recoverable parts?
- How do we identify various components (structures, wiring, connectors) and their materials?
- What are the manual and automated/robotic disassembly solutions? What are the associated timeframes, tools, and performance metrics?
- How do we construct operational workflows and measure both individual and total process times?
- What is the theoretical recycling rate of a complete aircraft cell?

Tasks to Be Completed

- Implement XR technologies for scanning and annotating both the exterior and interior of the aircraft cell
- Develop extraction sequences for parts
- Catalog components and build a material repository
- Test dismantling solutions and assess operator/site safety requirements (PPE, waste management, tooling constraints)

Industrial Relevance

This project is directly aligned with industrial needs and will be conducted in collaboration with partner companies. It will involve ongoing discussions with industry stakeholders to refine analysis requirements and present methodologies and results.

Contact

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The candidate will have some contacts with RU Delft, INRIA Nice, Optima Aero and AC Dismantling, and the members of the SDC2 team in Bordeaux.

Working conditions

The student will be paid according to french regulation on internship.
The work will be done in Bordeaux Arts et Métiers Campus.