Dedicated to innovation in aerospace

Centre for Sustainability
Leiden-Delft-Erasmus Universities

Circular Aviation

ASSIGNMENT	PAGE NUMBER

Assignment 1a and 1b

The material requirements of electrifying aviation

Problem statement

Electrification of aviation requires specific materials, most of them classified as critical raw materials by EU regulations. In order for electric aviation to scale-up, it is necessary to examine the environmental, regulatory and economic implications of this increased demand for critical materials.

Research question(s)

1. What critical raw materials are used and what quantities are needed for a full electrification of aviation? What is the environmental impact of this transition?
2. Circularity could ensure the necessary material supply by supplementing primary materials with secondary raw materials. But what regulations and business models are needed for this to happen?

Suggested academic backgrounds

- Industrial Ecology (TUD/Leiden)
- Aerospace engineering (TUD)
- Management of Innovation (EUR)
- Global Business & Sustainability (EUR)
- Engineering and Policy Analysis (TUD)

Expected type of work

For RQ1, material inventorying and flow analysis. For RQ2, study of the legislation, business-case and availability for retrieving these required materials as secondary materials. Two different students can take each RQ.

Assignment 2

The challenges and opportunities to achieving circularity: an analysis of end-of-life best-practice guidelines

Problem statement

Aircraft decommissioning and recycling is a complex process, with environmental, operational, safety, legal and economic aspects, and related challenges. Therefore, it is important that all involved stakeholders in the aviation sector act together to develop and implement best practices in this area. The *AFRA Best Management Practice for Management of Used Aircraft Parts and Assemblies and for Recycling of Aircraft Materials* (BMP) is a document that represents a collection of recommendations concerning best practices for the management of parts that are removed from an aircraft, engine or other asset during the disassembly of the asset at the end of its service life, and for the recycling of parts and materials that are recovered from an aircraft, engine or other asset during the recycling of the asset at the end of its service life. If AFRA aircraft end-of-life best-practice guidelines are followed, 90% of the weight of current decommissioned aircraft can be reused or recycled. However, they have not yet been implemented widely.

Research question(s)

What are the obstacles towards widely achieving circularity (e.g. as outlined in AFRA aircraft end-of-life best-practice guidelines) and how can they be overcome in the present situation and in the future?

Suggested academic backgrounds

- Governance of Sustainability (Leiden)
- Aerospace engineering (TUD)
- Management of Innovation (EUR)
- Urban, Port and Transport Economics (EUR)
- Global Business & Sustainability (EUR)
- Industrial Design (TUD)

Expected type of work

Can be a technical study (evaluation of the implications of AFRA guidelines on a case study) or qualitative study (based on interviews with manufacturers and recyclers of the legislative, societal, economic implications).

Assignment 3 and 4

Cross-industry knowledge transfer for a circular economy: what can the aviation sector teach, and what can it learn?

Problem statement

The aviation industry already makes extensive use of repairing and re-manufacturing, which are crucial components of circular economy systems. How can repair and re-manufacturing procedures used in aviation be adapted and transferred to other industries? On the other hand, circular design frameworks, approaches and practices have been developed in other industries. How can lessons learned in other industries be adapted and transferred to the aviation industry?

Research question(s)

1. How can circular design frameworks, approaches and practices have been developed in other industries be adapted and transferred to the aviation industry?
2. How can repair and re-manufacturing procedures used in aviation be adapted and transferred to other industries? Are there areas in which the aviation sector a frontrunner when it comes to sustainability?

Suggested academic backgrounds

- Industrial Design (TUD)
- Industrial Ecology (TUD/Leiden)

- Aerospace engineering (TUD)
- Management of Innovation (EUR)
- Urban, Port and Transport Economics (EUR)
- Global Business & Sustainability (EUR)

- Philosophy and Economics (EUR)

Expected type of work

This research assignment can be developed by designers, engineers, natural or social scientists.

Assignment 5

The costs and benefits of airframe weight reduction

Problem statement

Airframe design pushes weight-saving to the extremes. The last few decades have seen a steady rise in the amount of 'composite' materials used in the airframe of aircraft. These have added strength but lowered the overall weight of the aircraft. The use of composites in one new aircraft has generated a weight saving of 20% over traditional aluminium alloys. There are monetary, environmental and material trade-offs in the choices of airframe design. Circular design may add weight instead of reducing it. But how much? And in view of a full life-cycle, what is better? How much weight can be added to achieve a circular aircraft?

Research question(s)

- What are the monetary, environmental and material trade-offs in the choices for airframe weight reduction?

Suggested academic backgrounds

- Aerospace engineering (TUD)
- Industrial Design (TUD)
- Industrial Ecology (TUD/Leiden)

Expected type of work

Technical assessment

Assignment 6

Facilitating cooperation across organizations in the aviation industry

Problem statement

Circularity advocates the interaction among different industries and sectors to reach its full impact. One of the aspects is to integrate the airlines' solutions with the airports' solutions and infrastructures, and then favour the integration of the airports' infrastructures with the local community infrastructures, in order to ensure that local communities shall benefit from the developed circular solutions. The transition of airlines and airports to circular aviation should translate in new job and business opportunities, from which local communities shall have a direct, long term benefit, without negative impact on the community's quality of life. The challenge is having individual aviation stakeholders cooperate as a cohesive system.

Research question(s)

- What is preventing individual aviation stakeholders to cooperate as a cohesive system?
- What non-technical solutions can be proposed to facilitate cooperation across organizations and the aviation supply chain towards sustainable aviation?
- What would be the impact (societal, economic, environmental, etc.) of those solutions?

Suggested academic backgrounds

- Governance of Sustainability (Leiden)
- Management of Innovation (EUR)
- Global Business & Sustainability (EUR)
- Philosophy and Economics (EUR)
- Development Studies (EUR)
- Law (Leiden/EUR)
- Behavioural Economics (EUR)
- Engineering and Policy Analysis (TUD)
- Economic and Consumer Psychology (Leiden)

Expected type of work

Business model development, etc.

Assignment 7

Shifting mindsets: drivers and barriers in aerospace engineering education and mindsets for sustainable aviation

Problem statement

Engineering education plays and important role, and faces a significant challenge, in providing the mindset and practical tools for transitions towards sustainability.

Research question(s)

- What obstacles exist within the aerospace engineering/technical mindset that prevent the implementation of more sustainable or circular practices?
- How could the education of engineers be developed?

Suggested academic backgrounds

- Governance of Sustainability (Leiden)
- Management of Innovation (EUR)
- Global Business & Sustainability (EUR)
- Philosophy and Economics (EUR)
- Development Studies (EUR)
- Law (Leiden/EUR)
- Behavioural Economics (EUR)
- Economic and Consumer Psychology (Leiden)

Expected type of work

Explorative study from behavioural sciences perspective

Assignment 8

Tensions and synergies between net zero-emissions and circularity for aviation

Problem statement

Till now, sustainability in aviation mainly referred to reducing polluting emissions from operations; therefore, the focus has been on high efficiency gas engines, lightweight solutions, alternative fuels and (hybrid-) electric solutions. Though useful, this approach only covers part of the lifecycle of an aircraft, and only a limited amount of the overall energy consumption and pollution emissions related to aviation. Now, increasing environmental awareness is challenging the aviation sector to intensify its efforts towards a greener, cleaner and more sustainable aviation, by reducing its environmental impact in terms on consumption, waste and emissions connected to all aviation activities and operations. The principles of circularity, or circular economy, provide a framework to re-evaluate the complete, cradle-to-cradle, life cycle of each aspect of aviation, enabling the transition to circular aviation.

Research question(s)

- What new perspectives does focusing on circularity bring to the aviation sector?
- Where are the tensions between net zero-emissions and circularity?
- To what extent is circularity a solution towards net zero-emission aviation?

Suggested academic backgrounds

- Governance of Sustainability (Leiden)
- Aerospace engineering (TUD)
- Management of Innovation (EUR)
- Urban, Port and Transport Economics (EUR)
- Global Business & Sustainability (EUR)
- Industrial Design (TUD)
- Philosophy and Economics (EUR)
- Development Studies (EUR)
- Law (Leiden/EUR)
- Behavioural Economics (EUR)
- Industrial Ecology (TUD/Leiden)
- Engineering and Policy Analysis (TUD)
- Economic and Consumer Psychology (Leiden)

Expected type of work

Explorative study, legislative, design, economic, social, environmental, ethical implications can all be studied.