# Interdisciplinary Thesis Lab 2023-2024:

# Circulaerospace

## LDE CfS Industries-Hub

Universiteit Leiden

TU Delft

Erasmus University Rotterdam

AIRBUS

## Colofon

This document includes the challenge and explanation of the thesis lab ‘Circulaerospace’.

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The 26th of September 2023

Logo: Centre for Sustainability

# Centre for Sustainability

Leiden-Delft-Erasmus Universities



## Thesis assignments

# Introduction

The lab program 'Circulaerospace' runs from the beginning of February until the end of June 2024. It is a biweekly program were students participating in the lab come together to follow in-depth lectures and workshops related to their sustainability challenge formulated together with this year's partner Airbus.

This Thesis Lab will focus on all aspects around future technologies, digital innovations and business models for a decarbonised aviation scenario. The entire product life cycle will be considered. In the lab we examine how bio-based materials can be used in aircraft components and what consequences these materials have for the supply chain, both in production and end-of-use of the parts. Furthermore, we will examine how digital technologies can contribute to the development of new materials, production techniques and supply chain monitoring.

For the implementation of such innovations, we will examine how uncertainties in various simulations propagate during the development process. But also what the role is of alternative business models and how such innovations find acceptance in the organisation.

To evaluate the effects of changes in design, materials and business models, a real-time LCA model for aircraft is sought, as well as circularity indicators and KPIs to use in guiding management decisions and business models.

Make sure to check the website.

## Interested in joining the Thesis Lab?

**Get in touch with or submit your application online**
**Registration opens on the 27th of September 2023**

**Esther van der Ent**
Coordinator of Thesis Lab
Education Coordinator LDE Honours; Sustainability & Practice CML
LDE_Cfs@cml.leidenuniv.nl

**Jelle Joustra**
Academic coordinator of the Thesis Lab

For more information on enrolment and selection procedure, **click here.**

## Partner

**Airbus**
Airbus is a leader in designing, manufacturing and delivering aerospace products, services and solutions to costumers on a worldwide scale. As the largest aeronautics and space company in Europe, Airbus designs, produces and delivers innovative solutions with the aim to create a better-connected, safer and more prosperous world.

# #1 EOL Management of Cabin Material

**EOL management of cabin material: What is the future supply chain going to look like focus in on coherent recycling and integration of bio materials for a bio based cabin?**

### Problem statement:

Today's airplane cabins are unfortunately ending up at the landfill because of a low level of recyclability. The sustainable cabin doesn't exist yet since EOL (end of life) aspects were in the past not part of design aspects - functionality, weight and costs were the main focus. Today's customers are requesting solutions that avoid this and to bring green EOL of relevant materials into the cabin.

### Research question(s):

- **How change supply chains in this context?!**
- **What materials are already investigated that could play a role in the sustainable cabin?**
- **What kind of recycling processes would be relevant?**
- **How can EASA (European Union Aviation Safety Agency) and FAA (Federal Aviation Administration) support the transition to these new materials?**
- **What research is already conducted on this topic?**

**What role can NL industry play when it comes to the sustainable cabin that includes EOL needs?**

### Expected type of work

Relevant is to analyse what the involved stakeholders are interested in, what is in the pipelines in industry and academia that can enter the market soon to transform the cabin into a green system. Interviews can be executed and also product designs be put forward. A scenario should be displayed how a fully green cabin could look like within the coming years and the related supply chains.

### Available data/reports or other relevant information sources for the assignment

- https://www.iata.org/en/programs/environment/cabin-waste/
- https://www.ati.org.uk/wp-content/uploads/2022/03/FZO-AIR-POS-0039-Sustainable-Cabin-Design.pdf
- https://www.flightglobal.com/air-transport/airbus-unveils-new-cabin-concepts-as-sustainability shapes-2035-vision/153487.article
- https://www.sciencedirect.com/science/article/abs/pii/S0956053X19304489
- www.iata.org/contentassets/c81222d96c9a4e0bb4ff6ced0126f0bb/annual-review-2023.pdf
- https://nag.aero/nag/special-interest-groups/aircraft-interiors-cluster/

### Commissioner details

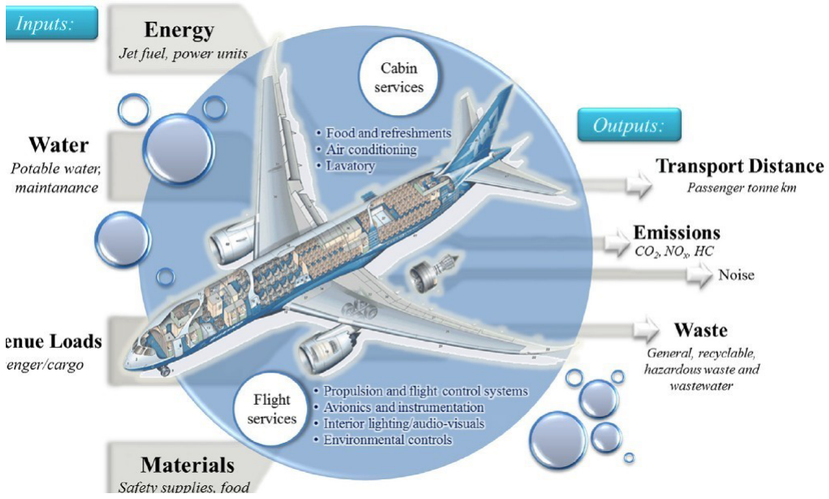
- Department: Strategy & Innovation

# #2 Real-time Assessment of the Aircraft Metabolism

**Real-time assessment of the Aircraft Metabolism via (onboard) data and its potential environmental impacts**

### Problem statement:

The use phase of civil aircraft is by far the most impactful in most impact categories of Life Cycle Assessments (LCA). Currently, LCA are just considering one snapshot in time and require high manual efforts in data gathering. This makes it difficult to measure the effectiveness of actions taken to lower the environmental impact in aircraft design and operations. Therefore, the real-world effect of a design change by an aircraft manufacturer or in maintenance cannot be consistently monitored and proven. Neither can improvements by airlines, e.g., in reducing catering or by using lighter seats.




Airbus Engineering could directly influence the data availability for Airbus aircraft. This could be by developing sensor solutions or by making real-time flight data available to other systems. Identifying which data is important, how it can be gathered automatically, and how to connect it to existing concepts from sustainability science is an important challenge. This thesis project aims at linking the concepts of Aircraft Metabolism (Kılkış & Kılkış (2017)), real-time (live) Life Cycle Assessments (e.g., Hagen, et al. (2020)), as well as existing work on detailed aircraft Life Cycle Assessments (e.g., Rahn et al. (2022)). This should be accomplished by the development of a demonstrator. Additionally, a critical angle analysing the undesired environmental impacts of implementing such real-time assessments itself is highly desired.

### Literature Overview:

The Aircraft Metabolism concept proposed by Kılkış and Kılkış (2017) draws inspiration from the biological metabolism of living organisms. It regards aircraft as "mobile micro-communities" with "varying levels of performance". This way, the concept defines the aircraft as a system boundary for impact assessment. The approach is to capture the inflows and outflows of materials, revenue loads, water, and energy that pass these boundaries. The analogy to biology makes it easy to grasp for decision makers and other actors across the entire value chain, even if not acquainted with other concepts of impact assessments. However, the final assessment carried out by Kılkış and Kılkış (2017) does not use any standardised indicators and is largely based on literature only.

The work by Rahn et al. (2022) follows a computational approach and considers the complexity of an aircraft lifecycle using discrete-event simulation. They carry out an LCA for each event or event category over the life cycle considering the details of the event and aggregate the impact of these single assessments. This allows, for example, for a more holistic analysis or forecast of the impact of operational changes, but still does not include any real data allowing verifiable proofs towards customers or potential regulators.

Several publications such as from Filippone et al. (2021) and Clarke et al. (2022) already implemented the concept of combining ADS-B flight data (as available e.g., on Flightradar24) and emissions models to estimate aircraft emissions nearly in real-time. This may suffice in assessing the impact of flight route changes, but the approach is still not suitable to measure the impact of individual changes to the aircraft or to airline processes as mentioned above.
This brief literature overview emphasises that there is a potential gap of collecting real-time environmental data, processing it in a scientifically sound manner, and presenting it using easily understandable concepts.

### Research question(s):

**What could a centralised platform for real-time environmental assessment based on the Aircraft Metabolism concept look like?**

**■ 1.)What are current gaps in understanding the environmental impact of aircraft operations and which data points that the aircraft can provide in real-time would help overcome them?**

a. What are possible decisions that could be made based on real-time environmental data?
b. Which data is already available?
c. Are additional onboard sensors required?
d. Which data can be provided by existing models?
e. Which data should be gathered on ground before entering the aircraft?

**■ 2.) How can a parameterized model be built based on the identified data inputs?**

a. Which modelling concept is reasonable to use?
b. Are some of the indicators of the concept by Kılkış & Kılkış (2017) reasonable to use, or would it make sense to adopt, e.g., some common LCA impact categories instead?

### Expected type of work

There will be the necessary freedom to steer the project deliverables in a direction the student finds most impact-and purposeful and to define a reasonable amount of work.

Firstly, the project should assess the value real-time environmental assessments of each aircraft in a fleet could provide. Therefore, a literature-based analysis of existing real-time optimization potential in existing aircraft can mark the beginning of the research. The A320 family in a just-fly configuration (e.g., as used at low-cost carriers) can be used as the baseline in order to make sure the research is widely applicable.

Conducting interviews with experts at Airbus to verify assumptions will be possible over the course of the research.

As a next step, the development of a concept demonstrator of a real-time Aircraft Metabolism platform would be very valuable. Common Python libraries for rapid prototyping of graphical user interfaces such as Streamlit or Dash may be used. The prototype development includes the identification of necessary data points, a (draft) definition of a simple data format (e.g., based on JSON or XML) to integrate environmental data, and possibly the integration of existing models (e.g., the CeRAS dataset, or pycontrails). Integrating aspects of cabin operations would be a great addition.

**Available data/reports or other relevant information sources for the assignment**

- Shapiro, M., Engberg, Z., Teoh, R., Stettler, M., & Dean, T. (2023). pycontrails: Python library for modeling aviation climate impacts (v0.47.1). Zenodo. https://doi.org/10.5281/ZENODO.8329793

- Rahn, A., Wicke, K., & Wende, G. (2022). Using Discrete-Event Simulation for a Holistic Aircraft Life Cycle Assessment. Sustainability, 14(17), 10598. MDPI AG. http://dx.doi.org/10.3390/su141710598

- Clarke, D., et al. (2022). CO2 Emissions from air transport: A near-real-time global database for policy analysis. OECD Statistics Working Papers. No. 2022/04. OECD Publishing, Paris. https://doi.org/10.1787/ecc9f16b-en

- Filippone, A., Parkes, B., Bojdo, N., & Kelly, T. (2021). Prediction of aircraft engine emissions using ADS-B flight data. In The Aeronautical Journal (Vol. 125, Issue 1288, pp. 988–1012). Cambridge University Press (CUP). https://doi.org/10.1017/aer.2021.2

- Manz, O., Meyer, S., & Baumgartner, C. (2021). Life cycle assessment of an Internet of Things product: Environmental impact of an intelligent smoke detector. In Proceedings of the 11th International Conference on the Internet of Things. IoT '21: 11th International Conference on the Internet of Things. ACM. https://doi.org/10.1145/3494322.3494332

- Hagen, J., Büth, L., Haupt, J., Cerdas, F., & Herrmann, C. (2020). Live LCA in learning factories: real time assessment of product life cycles environmental impacts. In Procedia Manufacturing (Vol. 45, pp. 128–133). Elsevier BV. https://doi.org/10.1016/j.promfg.2020.04.083

- Kılkış, Ş., & Kılkış, Ş. (2017). Benchmarking aircraft metabolism based on a Sustainable Airline Index. In Journal of Cleaner Production (Vol. 167, pp. 1068–1083). Elsevier BV. https://doi.org/10.1016/j.jclepro.2017.03.183

- Risse, K., Schäfer, K., Schültke, F., & Stumpf, E. (2015). Central Reference Aircraft data System (CeRAS) for research community. In CEAS Aeronautical Journal (Vol. 7, Issue 1, pp. 121–133). Springer Science and Business Media LLC. https://doi.org/10.1007/s13272-015-0177-9

- https://pace.txtgroup.com/products/flight-operations/pacelab-flight-profile-optimizer/ https://blog.google/technology/ai/ai-airlines-contrails-climate-change/


**Other remarks**

For the demonstrator development, skills in a suitable programming language for data analysis and presentation (e.g., Python) is highly desired. This will allow to put developed concepts directly into practice and eases the final presentation to other stakeholders. A passion for design or graphical user interfaces could also help, but is not mandatory. Furthermore, some knowledge on methodologies for environmental impact assessments and a vision for the future would be great!

**Commissioner details**

- Department: Airbus Operations GmbH / 1CDC6

# #3 Aerospace Meets Biotech

**Aerospace meets biotech: Designing bio-sourced materials towards functionality for aerospace (mycelium, enzymes, etc.)**

**Problem statement:**

Bio-sourced raw materials are emerging materials that are made from renewable resources e.g. agricultural wastes, sugars or fungi feedstock. Their versatile properties make bio-sourced products promising for a wide range of applications. Biotechnology has been applied as a valuable tool to produce useful bio-sourced products. Bio-sourced materials and biotechnology have shown a huge potential to replace conventional petroleum-based materials towards a more sustainable and circular economy. Furthermore, biomaterials are manufactured using low-energy processes from agricultural by-products or wastes. Currently the main applications are packaging, automotive and building materials. First studies showed that bio-sourced materials are also promising alternatives for aerospace applications, e.g. in aircraft secondary structures and interiors. However their application is still limited and some key challenges have to be solved to implement biotechnology and bio-sourced materials in the aerospace industry.

**Research question(s):**

**Today, although there are some promising opportunities, bio-sourced products are produced at a small scale. What are the challenges to mature and upscale the technology and make these products the materials of choice for our tomorrow's aerospace applications?**

**Design of new class of materials:**

How to answer the demanding aerospace requirements, e.g. high mechanical performance or flame, smoke and toxicity properties, while improving the environmental impacts of the products.

**Market Analysis:**

- What are the aerospace needs? e.g. how many biomaterials/biotechnology factories do we need for our aircraft.
- How to set-up this new biomaterial supply chain? Challenges and Opportunities, e.g. viable biobased feedstocks and waste streams identification and if other industries are also interested.
- Are there any economies of scale benefits?
- How to scale-up biological manufacturing processes?

**Life Cycle Assessment:**

- How to up-scale the data from the lab scale?
- How to compare the environmental impact of low maturity materials and technologies, and drive the future developments?

**Expected type of work**

Interviews, material flow analysis, stakeholder analysis, life cycle assessment

**Available data/reports or other relevant information sources for the assignment**


- E. Ramon et al., Aerospace 2018, 5(4), 110; https://doi.org/10.3390/aerospace5040110
- S. Bitting et al., Biomimetics 2022 7(2), 44. https://doi.org/10.3390/biomimetics7020044
- M. Chaudhury, Master thesis, Delft University of Technology "Designing Circular Applications of Mycelium-Based Materials for Aircraft Cabins" 2023


**Commissioner details**

- Department: Airbus Central Research & Development, Materials Domain

# #4 The Use of Quantum Computing for Simulation of Bio-Species

**Problem statement:**
Bio-species (e.g. enzymes, bacteria, fungi, algae) gain more and more importance for processing and manufacturing. A low environmental impact as well as a high selectivity for specific biochemical processes contribute to the increasing interest for bio-species-based products and technologies that enable recycling and circularity of resources.

While the technology for (large scale) production of bio-species is usually available, the identification of the right species is challenging. A large number of time-consuming test procedures is necessary to analyse the properties of the macromolecular structure and assess their catalytic capabilities, leading to long development cycles. Therefore, computational methods are an essential backbone of biological science, allowing the simulation and prediction of properties and capabilities of bio-species. However, computational methods face increasing challenges when it comes to complexity and scale of simulated problems. Atomistic approaches (e.g. DFT, MD) quickly reach their limitations in number of atoms and molecules that are simultaneously simulated while continuum approaches (e.g. FEM) cannot adequately reflect the relevant atomistic processes.

Quantum computing can contribute to overcome some limitations of classical methods by providing more computational power and new approaches to solve even the most complex problems. Therefore, quantum computing is highly interesting for the simulation of the complex macromolecular structure of bio-species and the resulting catalytic properties.

Research question(s):
**Today, the first quantum hardware is already available. However, the step from classical simulation approaches to the implementation via quantum computing is a new field with lots of open questions: What are the main challenges to realise the transition towards quantum computing approaches and what is necessary to implement these approaches for industrial use, and more specifically for the simulation and prediction of properties and capabilities of bio-species?**

**Expected type of work**
**Quantum computing implementation:**
- What is needed to make use of quantum computing (hardware, algorithms, expertise)?
- What are the specific needs of industry regarding quantum computing (e.g. hardware specifications, software requirements) to benefit compared to classical supercomputers/ clusters?

**Estimation of Quantum Advantages (using the example of bio-species):**
- What new approaches to perform complex simulations will be provided by quantum computing compared to classical methods?
- What are the computational benefits (in terms of computational limitations) of quantum computing (classical simulation approaches vs. quantum or quantum/hybrid approaches)?

**Market Analysis**
- How to access quantum computing hardware/software (e.g. suppliers of hardware/ software, rental/computing hours models)?

**Available data/reports or other relevant information sources for the assignment**

- Prashant S. Emani et al., Nature Methods 2021, 18, 701-709; DOI 10.1038/s41592-020-01004-3
- Martin J. Field, J. Comp. Chem. 2001, 23(1), 48-58; DOI 10.1002/jcc.1156
- Johan Åqvist et al., Chem. Rev. 1993, 93(7),


**Commissioner details**

- Department: Airbus Central Research & Development, Materials Domain

# #5 Key Performance Indicators for Circular Business Models

**Problem statement:**
For decades, businesses have operated mainly with a model of profit-primacy: putting profits first, sometimes to the detriment of people and planet. At Airbus, we are committed to pioneer sustainable aerospace for a safe and united world. This means not only looking at the financial impact of our decisions, products, etc, but beyond that. In this assignment, we challenge you to create a decision framework for Airbus to evaluate whether to invest in certain new initiatives or not - based on both financial and 'alternative' key performance indicators. How to decide whether new ideas and innovations can truly be considered as circular business models, yet still fit the company's economic circumstances?

**Research question(s):**
**Which key performance indicators to use as Airbus when evaluating whether a new business proposition is truly 'circular'?**

- **What is the definition of a circular business model?**
- **Which frameworks / criteria / KPIs exist (best practices) to use to evaluate whether a new idea or innovation fulfills the requirements of a circular business model?**
- **Which of these frameworks would fit Airbus?**
- **Which challenges might Airbus face as an organization when implementing such a framework?**

**Tentative focus areas for this assignment could include circular business model KPI's for:**
- The use of disposable plastics in-flight
- The effect of carbon offsetting programs of airlines
- The perception of Airbus engineers regarding implementation of biobased or recycled materials

**Expected type of work**
Literature study, expert interviews with external stakeholders on best practices, interviews with Airbus colleagues, decision framework and process design, change management

**Available data/reports or other relevant information sources for the assignment:**
- https://lutpub.lut.fi/handle/10024/160340
- https://impacteconomyfoundation.org/wp-content/uploads/2023/03/IWAF-Summary-Impact-Eco nomy-Foundation.pdf
- https://impacteconomyfoundation.org/wp-content/uploads/2023/01/Principles-for-True-Pricing.pdf

**Commissioner details:**
- Department: Airbus Netherlands Technology & Innovation



# #6 Neural Style Transfer for Novel Materials Generation

**Problem statement:**
New materials and chemicals must fulfil a range of requirements, including desired properties for their application, and their safety profile for people and the environment. The search for materials that fulfil all requirements is often a time consuming and costly process. Artificial Intelligence and specifically newly emerging generative models have the potential to disrupt and revolutionise the materials design process, which could pave the way for faster development of functional, safe, and environmentally friendly compounds.

**Research question**
**Generative models can be used to create new data samples by combining or transferring properties of different data points. A typical example is a model that generates an image of a painting in the style of another artist. An open research question is how applicable this concept is to the domain of material science, where new molecules could be created as the result of a style transfer from one set of molecules to another.**

**A possible application is the generation of non-toxic materials. Specifically: Given a material with desirable properties for industrial application, but an undesirable toxicity profile, can the 'style' of non-toxic materials be transferred to create a new material that has all desired qualities?**

**Expected type of work**
Review of the state of the art in image style transfer and investigation of the applicability of these methods in the domain of material science.

Research of molecular generation through property transfer on at least one use case, e.g. toxicity, and evaluation of newly created molecules.

**Available data/reports or other relevant information sources for the assignment**
Some relevant publications in image style transfer and molecular generation:
- Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks: https://arxiv.org/pdf/1703.10593.pdf
- StyleDiffusion: Controllable Disentangled Style Transfer via Diffusion Models https://arxiv.org/pdf/2308.07863.pdf
- Mol-CycleGAN: a generative model for molecular optimization: https://jcheminf.biomedcentral.com/articles/10.1186/s13321-019-0404-1
- Equivariant Diffusion for Molecule Generation in 3D https://arxiv.org/abs/2203.17003

**Other remarks**
We look for expertise on: Chemistry, Cheminformatics. Computer Science, Machine learning, Material Science

**Commissioner details**
- Names: Tim Brockmeyer , Christian Keimel

# #7 Digitalisation to Push Manufacturing Sustainability

**How can digitalisation help to approach manufacturing chains in a holistic way to lower environmental impact in production - how can design, digitalisation and circularity approaches be measured to improve environmental indicators.**

### Problem statement:
The question is about how to apply digital tools to optimise the environmental impact of the production phase (relevant emissions, energy, ...). Can these results already be used during the design and product definition phase? The research will focus on a concrete study case of e.g. the production of carbon fibre reinforced plastics. Key drivers of the production process will be identified as well as options for defining alternative pathways with lower environmental impact. What are today's technology blockers?

### Research question
**The result of this study will be an assessment report of existing methods for environmental impact assessment and analysis, visualisation methods for impact analysis results and potentials for low environmental footprint process chains for aerostructure production. The results will be presented for a specific use case. A guidance and methodology will be proposed to connect design with production optimization having environmental impact in mind.**

### Expected type of work
The result of this study will be an assessment report of the status quo. Options for impact assessment and analysis. Impact analysis visualisation plus. Potentials for low environmental footprint process chains for aerostructure production will be investigated along a specific use case. A guidance and methodology will be proposed to connect part design with product optimization having environmental impact in mind.

### Available data/reports or other relevant information sources for the assignment
https://www.airbus.com/en/newsroom/stories/2021-04-this-new-class-of-materials-could-trans form-aircraft-design

### Suggested academic background:
- Manufacturing & Automation
- Materials Informatics
- Global business and sustainability
- Aerospace engineering

### Commissioner details
- Department: 1XR

# #8 Metric for the Measurement of the Propagation of Uncertainties Across Coupled simulation models

**Development of a metric for the measurement of the propagation of uncertainties across coupled simulation models with different level of details**

### Problem statement:
Modelling and simulation of complex systems (e.g. system-of-systems) often use coupled simulation models as different disciplines are involved using dedicated solvers for these disciplines. The different simulation models may have different levels of detail or granularity, quality of input parameters and their associated uncertainty leading to output quantities that are difficult to assess. For the evaluation of the quality of the overall result of the analyses and their uncertainties, a metric is required that, starting from the individual uncertainties, makes the overall quality of the result assessable. Within the thesis a metric for the assessment of industrial system models (using discrete-event-simulation) that are coupled to economic market models (using system dynamics based simulation) has to be developed.

The thesis could be based on an eFuel supply chain model involving a high amount of epistemic uncertainty, and coupled to an industrial model of AC production (product dependent on availability and price of eFuel). The industrial model would entail a lower amount of epistemic uncertainty but would also need to deliver a higher level of fidelity in order to support meaningful decisions.

### Research question(s):
- **How is the uncertainty of different simulation models propagated through the loosely coupled system-of-systems model?**
- **Do we need to differentiate between different types of uncertainty?**
- **Is it possible to define a metric that assesses the overall predictive capability of the coupled model in a quantitative fashion?**
- **If not, is it possible to quantitatively assess single sub-models or can the complete model be assessed in a qualitative manner?**

### Available data/reports or other relevant information sources for the assignment

- Oberkampf, William Louis, Trucano, Timothy Guy, and Pilch, Martin M. 2007. "Predictive Capability Maturity Model for computational modeling and simulation.". United States. https://doi.org/10.2172/976951.
- A.D. Kiureghian et al. "Aleatory or epistemic? Does it matter?" Structural Safety (2009)
- Romero, Vicente. (2023). Advantages of the Real-Space Model Validation Approach vs. the ASME VV10 and VV20 Validation Approaches. 10.2514/6.2023-1483.


### Commissioner details
- Department: Airbus Central R&T /1XRV

# #9 Digitalization of the Supply Chain Sustainability monitoring

**Technologies assessment for the digitalization of the supply chain sustainability monitoring**

### Problem statement
In light of new legislation (Corporate Sustainability Due Diligence Directive - CSDDD), proof of the sustainability of a product also requires complete transparency about the sustainability of the supply chain. Monitoring and documentation along complex, global, multi-level supply chains can be achieved with the help of new, digital technologies such as blockchain. The thesis aims to identify requirements, possible technologies and their potential for the digitalisation of supply chain sustainability monitoring and to provide recommendations for action.

The study case will be the integration of new suppliers into the next industrial system from northern Africa or Asia (low cost / best price countries). With the aim to track the sustainability of raw materials for components in major component assemblies by e.g. block chain. Tracking should include information & certificates about sustainability such as CO2 emission, human workforce wellbeing, clean water/ environment protection and more.

### Research questions:
- **Which sustainability requirements are added to the supply chain monitoring?**
- **Which digital technologies can help the monitoring of sustainability requirements across the supply chain and how?**
- **How can a concept look like to implement those technologies for the supply chain?**

### Expected type of work
Technology assessment, concept development

### Available data/reports or other relevant information sources for the assignment
EU legal framework: https://commission.europa.eu/business-economy-euro/doing-business-eu/corporate-sustainability-due-diligence_en

### Other remarks
We look for expertise on: economics, supply chain management

### Commissioner details
- Department: Airbus Central R&T / 1XRV



# #10 Modelling and Simulating Aircraft Program Strategies within a Competitive eFuel Market

**Decrease driving with disposables: the impact of disposables on board of ambulances**

### Problem statement
Future sustainable aircraft programs (i.e. aircraft model) will use CO2 neutral fuels (eFuels such as H2, methanol, ammonium or similar). In a future eFuel market, these aircraft programs will compete with other means of transport or consumers of eFuels or CO2-neutral energy (e.g. maritime, land transport). The competitive situation of such a future eFuel market as well as different market strategies from the perspective of the aircraft manufacturer are to be modelled and simulated in a suitable modelling approach (e.g. System Dynamics) in order to be able to evaluate aircraft programs with regard to possible future market scenarios.

### Research questions
- **How to model the market for eFuels and which future scenarios can be identified?**
- **How does the eFuel market and the competition of different eFuel consumers affect the optimal program strategy of an aircraft manufacturer?**

### Expected type of work
Modelling and simulation of the eFuel market and its participants using System Dynamics method

### Available data/reports or other relevant information sources for the assignment
- https://blog.oxfordcollegeofmarketing.com/2018/02/25/evaluating-strategic-options-usi ng-saf-strategy-model/
- https://skynrg.com/a-market-outlook-on-sustainable-aviation-fuel/

### Other remarks
We look for expertise on: industrial management, economics and supply chain management

### Commissioner details
- Department: Airbus Central R&T / 1XRV

# #11 Estimation of the Human Fatigue State by use of Bio Markers Measurements

**Get a grip on chest pain: assessment of environmental impact of acute ambulance care**

### Problem statement:
Cabin crew and assembly workers are exposed to a) both high physical and mental loads in their daily work causing fatigue as well as b) disruptions to their circadian rhythms due to jet lag and irregular shift work. Monitoring and management of fatigue has the potential to improve performance and sustainability by a) reducing the minimum number of crew required and thereby the overall weight of flight operations and b) reducing waste produced in assembly thanks to increases in quality and decreases of human error risk.

Knowledge of the fatigue state of people in the course of their work activity can be used to better manage workload distribution in teams or/and offer support if necessary. The determination of the fatigue state could be done via physiological parameters such as Heart Rate Variability (HRV), breath rate or body temperature. The aim of the thesis is to investigate whether those bio markers are suitable for determining the fatigue state of humans.

### Research question
**How can human operators' individual level of fatigue be most unobtrusively and most reliably assessed in operations?**

### Expected type of work
Literature review, empirical research

### Available data/reports or other relevant information sources for the assignment
- Matthews, G., & Hancock, P. A. (2017). The handbook of operator fatigue. CRC Press.
- Bendak, S., & Rashid, H. S. (2020). Fatigue in aviation: A systematic review of the literature.
- International Journal of Industrial Ergonomics, 76, 102928.
- Aryal, A., Ghahramani, A., & Becerik-Gerber, B. (2017). Monitoring fatigue in construction workers using physiological measurements. Automation in Construction, 82, 154-165.

**Other remarks**
We look for expertise on: human factors

### Commissioner details
- Department: Airbus Central R&T /1XRV



# #12 Digital Design Automation for Sustainable Additive Manufacturing

### Problem statement:
The current laser powder bed fusion additive manufacturing (L-PBF AM) process has limited co-design capability which limits the scalability of the process and results in high workload. Moreover, the full potential of reduced material use associated to additive manufacturing is not achieved, limiting the gain on weight and therefore leading to undesired fuel/energy costs. Material waste is also not optimal. The project aims to enable integration and automation of workflows over the entire end to end (E2E) process in order to optimize that process and move towards a more sustainable additive manufacturing.

### Research question
- **How to achieve design tool integration?**
- **How to achieve workflow automations?**
- **How to collect and structure data for further analysis (eg. developing machine learning models)?**

### Expected type of work
- Review of existing workflow and design tools
- Tools integration and workflow automation
- 'As-is' vs 'to-be' Figures of Merits

### Available data/reports or other relevant information sources for the assignment
M. Biedermann, P. Beutler, M. Meboldt, Automated design of additive manufactured flow components with consideration of overhang constraint, Additive Manufacturing 46 (2021) 102119c, https://doi.org/10.1002/cite.202100209.

**Other remarks**
Desired competencies: Mechanical Design, Data Science, Software Development.

### Commissioner details
- Departments: Chamber of Reference for Metal Additive Manufacturing (1ACP), IM Technology and Product Innovation (DGYX)

# Excited?
# Please contact us or register online