Aircraft interiors INTERNATIONAL

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Green light

TAKE THE SPIN OUT OF CIRCULARITY: HOW DATA-DRIVEN PROCESSES REDUCE THE COSTS AND RISKS OF INVESTING IN CABIN SUSTAINABILITY PROGRAMMES

Clear data FOR GREEN CHOICES

A DATA-DRIVEN APPROACH TO ASSESSING THE SUSTAINABILITY OF CABIN HARDWARE CAN ENABLE ACCURATE LIFE CYCLE ANALYSIS, AND REDUCE COST AND RISK WHEN INVESTING IN SUSTAINABLE CABIN PRODUCTS

Words by Ben Orson. Illustration by Sean Rodwell/Aeriform

Making the transition from a traditional industrial design or engineering background into designing for sustainability presents a steep learning curve. With so many cabin products marketed as being sustainable, it can be difficult to assess their true value to ensure you make the right investments.

However, the integration of analysis and design expertise unlocks synergies, and digital tools have been developed that can accelerate the gathering of cabin hardware inventory data and enable life cycle analysis (LCA) to be carried out with more speed and accuracy.

A data-driven approach can reduce the costs associated with introducing sustainable solutions, foster new business models, and drive enhancements in design, procurement, through-life maintenance, and end-of-life (EOL) management.

Going forwards, industry collaboration can bring together the required data, strategies and solutions to deliver a turnkey, full-life vision of persistent circular product lifecycles as a step towards creating more sustainable aircraft interiors.

In a positive stride towards this vision, Orson Associates has partnered with the IBA Group aviation intelligence and advisory company, and the Aircraft Interior Recycling Association (AIRA), to develop better ways to identify opportunities for how investors, lessors, airlines, MROs and manufacturers can further their sustainability goals.

The research collaboration, titled LUCID (Lifecycle Understanding for Circular Innovation & Design) – see p27 – aims to provide transparent and in-depth analytics of cabin lifecycle impacts across multiple levels, from the


greenrinsing
pledge
Eco-friendly
natural
ethical
vague claim
data spin
sustainababble
eco-babble
organic

> *"Weight reduction is deeply ingrained into the culture of aerospace engineering"*

Ben Orson will be speaking at the Passenger Experience Conference on 7th April, including a session titled 'Circularity in the Cabin'

global fleet, to specific operators, aircraft, and components.

The following set of key concepts, while being far from comprehensive, may provide a useful introduction to a new way of assessing sustainable options. A set of methodologies can then be set out to help organisations review the sustainability of their product portfolios and create effective sustainability strategies.

CRITICAL MASS

Few will be surprised to hear that the fundamental product characteristic that designers need to keep in mind for sustainable projects is weight. Global warming is commercial aviation's existential challenge, and the sector's contribution is overwhelmingly a function of engine emissions. More weight equals more emissions, and so weight's primacy as a decision driver is clear.

Even setting aside emissions, the total weight of any material used in the cabin is a fundamental factor in determining the impact attributed to that cabin's manufacturing or EOL lifecycle phases.

In addition to weight, other factors such as material choice become more critical when considering impact categories besides global warming (freshwater ecotoxicity or fossil resource scarcity, for example), looking specifically at the manufacturing or EOL lifecycle phases, or exploring opportunities for circularity.

On a positive note, weight reduction is deeply ingrained into the culture of aerospace engineering, and so it is an issue already receiving due attention. As the industry pursues novel and more sustainable materials and manufacturing techniques, or indeed any design innovations, their projected impact in terms of weight must be considered. The rule of thumb from a sustainability perspective is therefore that any change made in pursuit of a reduction in environmental impact must be weight-neutral – or ideally, weight reducing.

Industrial designers, CMF designers and production engineers tend to think in terms of products, but sustainability practitioners consider systems, and this distinction is vital. A cabin can be viewed as a set of systems providing passenger comfort and safety over the service life of the aircraft.

From this perspective for example, a dress cover is not just a designed object – it is a consumable in a living system. A system that makes, ships, installs, removes,

PROJECT LUCID

LUCID (Lifecycle Understanding for Circular Innovation & Design) is a research collaboration between Orson Associates, the IBA Group, and AIRA. The project combines each organisation's vision, expertise and data.

LUCID provides rigorous, transparent and in-depth analytics of cabin lifecycle impacts across multiple levels, from the global fleet, to specific operators, aircraft and components. Its data-driven approach can reduce the costs associated with sustainable solutions, foster new business models, and drive enhancements in design, procurement, through-life maintenance, and end-of-life management.

About the LUCID project partners:

- Orson Associates is a multidisciplinary strategy and design consultancy with over 20 years of experience in helping companies define how we travel today, and how we aspire to travel in the future. The company's capabilities span strategy, design, and production development, with every project informed by this breadth of expertise and perspective.

- IBA Group is a trusted advisor to the global aviation finance, airline and aerospace community, and provides fleet, flight, airline, appraisal and emissions information through its data platforms: IBA Insight, IBA NetZero, and IBA Airlines. IBA's services bring insights and key data to influence and inform investments for stakeholders across the aviation sector.

- Aircraft Interior Recycling Association (AIRA) is a materials processing company for the aircraft interiors sector. AIRA has put in the hard graft setting up the critical processes that categorise, standardise and certify incoming and outgoing recycled materials. AIRA's work enables recycled aircraft interior materials to enter the circular economy and closed-loop systems, and to be put back in aerospace-grade systems for cabin components.

RIGHT: THE TEAM AT ORSON ASSOCIATES USED THEIR DESIGN EXPERTISE TO CREATE CABIN CONCEPTS FOR THE FLYZERO PROJECT

Search the Aircraft Interiors International website for an in-depth feature on the FlyZero cabins

cleans, transports and disposes of perhaps thousands of dress covers every month, with each constituent operation impacting the environment in multiple ways.

Considering most items found in an aircraft cabin – particularly items that are frequently replaced, such as carpets, cushions and dress covers – environmental impact is primarily a function of weight, in-service durability, and the direct manufacturing and EOL impacts (closely related to material selection).

Weight drives emissions, durability determines the rate of consumption, and the direct impacts are incurred each time an item is installed or replaced. These factors are clearly linked, and so changes to products and the resultant impact on the systems they are part of must be considered simultaneously.

IMPACT ASSESSMENT

Any organisation looking to take control of its product portfolio's environmental footprint must determine which categories of impact they are most concerned with. Depending on the assessment method followed, there is a spread of around 15 standardised definitions, including the likes of global warming, ozone depletion, and human toxicity. Whilst organisations could consider all of these, a focused approach is advisable when resources are finite and industry-wide priorities are clear.

For cabins, global warming is a logical priority, but companies may have other environmental, social and governance (ESG) goals to consider. For example, operational waste reduction is important to many airlines.

Most design changes will raise environmental impacts in some categories and reduce them in others, so it is beneficial to have guidelines in place for weighting the effects to each category in order to enable consistent and transparent decision making.

The selection of system boundaries for any LCA-based analysis is a pivotal step in defining the scope and depth of activity. Typically, these boundaries are established based on environmental impacts across the lifecycle stages of a product, from raw material extraction to EOL. However, it is often appropriate to set these boundaries strategically to maintain a manageable scope and allow a focus on the most critical aspects for decision making.

In the initial stage of a multi-step LCA process for a complex product like an aircraft cabin, speed is more important than absolute accuracy. This first step reviews the entire product system to identify hotspots for the subsequent detailed LCA activity. At this stage, it is appropriate to refine system boundaries by focusing on essential factors such as the types of materials used and their interim origins. Using generic values from LCA databases like Ecoinvent to represent standard pre-processing impacts allows significant streamlining of the process, with only a minimal loss of accuracy.

This approach enables an effective preliminary evaluation, setting precise targets for a focused LCA, and enabling a broader range of evidence-based sustainable design choices in subsequent product development.

MAKING A START

Suppliers have responded with enthusiasm to the increased demand for sustainability from the public and airlines, leading to an abundance of offers from

The FlyZero project

Between 2021 and 2022, alongside companies including Airbus, Rolls-Royce and easyJet, and several universities, Orson Associates led cabin sustainability assessment and foresighting activities for an initiative named FlyZero. This research project investigated how to deliver a new generation of sustainable aircraft and shaped 'Destination Zero', the UK's current aerospace investment strategy.

In partnership with Cranfield University and leveraging established industry expertise and networks, a groundbreaking body of research was delivered, describing in detail the impacts that aircraft cabins have on the environment, key issues with today's approaches, and practical recommendations for positive change.

Levelling up

Orson Associates has developed several proprietary tools to accelerate the gathering of cabin hardware inventory data and carry out LCA with improved speed and accuracy. These tools have been instrumental in the company's work to date, and the team continues to prioritise their development, with improvements currently underway targeting extended functionality, enhanced usability and database integration, and potential formalisation as licencable tools for external parties in aviation and beyond. These tools continuously evolve through day-to-day projects and the team is seeking funding to enable more focused refinement.

As the next stage, the team also sees great value in collaboration to bring together the required data, strategies and solutions to deliver a turnkey, full-life vision of persistent circular product lifecycles that can enable the right choices for more sustainable aircraft interiors.

both new and established organisations, all emphasising the environmental credentials of their products. At the same time, airlines and manufacturers responsible for vast portfolios of legacy products often have a limited understanding of the environmental impacts of their products. This gap needs to be bridged, to enable companies to identify the right solutions.

Listening to industry, it is clear that any organisation serious about developing environmental impact mitigation strategies needs to have an understanding of its existing portfolio impact profile, sufficiently granular that it allows pain points to be clearly identified, and sufficiently quantified that it provides a baseline against which progress can be measured. Fortuitously, the modelling and data that provides this analysis allows organisations to precisely isolate and characterise the root causes of critical impacts, and so provides the basis of a mitigation strategy.

So, over four years, one PhD and a number of projects, our team has developed a flexible and streamlined methodology to help organisations review their product portfolios and create robust strategies for actively managing their environmental impacts. This approach, outlined below, has its roots in cross-sector decision support philosophy, but is tailored to the demands of the cabin sector and delivers a tangible step forward for organisations looking to make measurable, credible progress. It is data-driven and empirical, reflecting the backgrounds of its developers.

"A flexible and streamlined methodology to help review product portfolios"

STEP 1 – SET YOUR SCOPE

Of all the products you are responsible for, which do you need to analyse? For leasing companies, scope could be driven by certain agreements. Airlines may prioritise the sections of their fleet that are most representative of the future, or particular cabins or cabin products. Manufacturers may be interested in their best sellers, or products soon to come to market. Also, how deep do you dive into the supply chain to get the required result while keeping a project manageable?

By carefully evaluating the dissimilar opinions of the diverse stakeholders involved with the chosen products, and purposefully defining the system boundaries appropriately, this step delivers a manageable, valuable scope, and potentially provides the broad strokes of a comprehensive portfolio impact mitigation strategy.

STEP 2 – IDENTIFY THE HOT-SPOTS

Streamlined LCA allows rapid creation of a heatmap of items with the highest impact that warrant further investigation. Although methodologies serving this purpose exist, none have been optimal for addressing the cabin sector's unique challenges – so we have a bespoke version, developed in-house.

These methods provide a rapid, robust and transparent environmental impact analysis of the in-scope products, allowing prioritisation of items for immediate development, and setting of longer term goals.

STEP 3 – BRING FOCUS TO CRITICAL ITEMS

Taking the elements prioritised in Step 2, we can now apply a standardised ISO 14040/44 LCA, modelling the cabin lifecycles and refining understanding of their

environmental impacts to the greatest practical level of precision. This is a resource-intensive process, requiring significant interaction with the supply chain, but it provides the highest degree of confidence in the outcomes, and the quantified data enables measurable improvements.

This process reveals precisely how products affect the environment and to what degree, enabling cost-effective mitigation strategies and meaningful comparisons between current products and potential replacements.

STEP 4 – EXPLORE SOLUTIONS AND CREATE AN ACTION PLAN

The lifecycle models developed in Step 3 can now be used as a 'sandbox' environment to explore the pros and cons of diverse potential solutions, allowing the development of precise interventions that will lead to the most significant impact mitigations with minimised cost and disruption.

So why does this four-step approach work?

RESOURCE EFFICIENCY

The two-stage assessment is particularly powerful for organisations responsible for extensive product portfolios, where conducting individual ISO 14040/44 LCAs on each item would be impractical. It is therefore an ideal fit for airlines and cabin product manufacturers.

This methodology employs a streamlined LCA to quickly narrow the scope, followed by an in-depth LCA to reveal detailed insights for critical items. This is a great way to put to one side items in the original scope that are relatively benign. Excluding these from the subsequent work, available resources can be exploited extremely efficiently, containing the cost and time required for analysis.

STREAMLINED DATA GATHERING

The greatest challenge for LCA-based approaches in this sector seems to be the gathering of information. LCA catalogues inputs and outputs of materials and energy from every step in the relevant manufacturing, through-life and EOL processes. So, for a woollen carpet or dress cover for example, that could be everything from the impact of growing the sheep feed, to the electricity demand offset from eventually burning the fibres.

In more mainstream industries, commercial databases provide much of the necessary information, and suppliers routinely externalise the data relevant to their processes. In the aircraft cabin sector, however, many specialist materials are not represented in databases and – today at least – the supply chain is mostly willing but unprepared to provide the necessary information.

The approach advocated above, as a function of the multi-step management of the scope and boundaries described, effectively minimises the data requirement and therefore the time and effort required to achieve a high-quality outcome. Having collaborated now with around 30 cabin suppliers and catalogued hundreds of processes, we have also developed our own data-gathering tools and a specialist database. The challenge remains, but it can be strategically managed.

PRACTICAL, USABLE OUTCOMES

The outcomes of Step 2 are a comprehensive heatmap of the in-scope products, which provides an understanding of those items that should be prioritised and deprioritised for further development, based on agreed criteria.

The digital cabin lifecycle model created in Step 3 provides impact analysis over time for the cabin system, and baseline metrics against which future developments can be assessed.

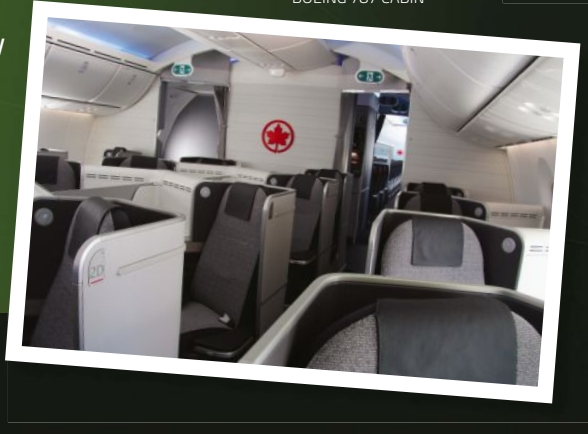
AIR CANADA CABIN ANALYSIS

In 2022 Air Canada selected Orson Associates to analyse and document the environmental impacts of the newest aircraft cabins from its B787 and A220 fleets, to establish a baseline that improvements could be measured against, identify priorities for change, and create proposals for how they could be realised.

Developing the multi-step LCA methodologies that formed part of the FlyZero work, and embedding its own people in the airline's HQ, in a matter of weeks Orson Associates was able to analyse 31 cabin products and identify those that contributed most to the impact categories prioritised by the airline.

A detailed LCA of these key products was then conducted, through speaking with 26 suppliers and analysing 179 different production processes, to quantify their impacts and pinpoint root causes. The team's familiarity with the cabin supply chain, and their experience in developing cabin products, was pivotal in accelerating the analysis and developing pragmatic solutions that aligned with the requirements of Air Canada, its passengers, and its supply chain partners.

BELOW: AN AIR CANADA BOEING 787 CABIN



> *"It is often possible to identify low-risk, low-effort solutions"*

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BELOW: A SUSTAINABLE IDEA AND A CRYSTAL CABIN AWARD WINNER. STARLIGHT BY COLLINS AEROSPACE IS A STRUCTURAL TECHNOLOGY THAT USES ADVANCED COMPOSITE DESIGNS, ROBOTIC MANUFACTURING, AND SUSTAINABLE MATERIALS TO REDUCE MANUFACTURING COSTS – AND WEIGHT

In Step 4, the findings revealed by this model, combined with an understanding of cabin product design, suggest tangible changes that should yield improvements.

FOSTER COLLABORATION

It is a great idea to involve all of the key stakeholders in the product portfolio throughout the process – in particular Steps 1 and 2, where objectives, parameters, scope and boundaries are established. In this way, the project direction and outcomes have greater value by better reflecting the collective priorities of all parties. Also, by giving everyone a degree of ownership of the defining parameters, this kind of collaboration breaks down interdepartmental silos and boosts the likelihood of outcomes ultimately being adopted by the broader group.

It also helps to think about how the different stakeholders can use the project outcomes independently and collectively. Often this is a function of dissecting the data in ways that suit the requirements of each team. Procurement teams seeking to purchase less environmentally impactful products need a quantified description of the impacts of the existing equivalents.

Product teams need material impact breakdowns to locate problematic materials within the products they are responsible for and to enable the strategic development of alternatives. Maintenance teams need to understand how alterations to their procedures drive environmental impacts. Framing the resultant data appropriately, teams are empowered to become sustainability champions together, or in their own right.

VIRTUAL SANDBOX

A key component is the creation of flexible digital models of customers' product portfolio lifecycles. These relatively simple digital twins serve two key purposes. Firstly, they serve as a framework to enable compiling and processing of data to describe existing products. Secondly, they enable digital trials of changes to materials, product types and maintenance operations, to see the resultant impact variations for very little cost, thereby supporting more confident decision making when it is time to act.

LOW-COST SOLUTIONS

Discussing projects with customers, concerns often arise around the disruption and cost of acting upon the findings. The reality is that once the nature of critical impacts has been precisely located within the product lifecycle, it is often possible to identify low-risk, low-effort solutions. Many of these solutions tend to fall into two groupings: either the selection of an alternative off-the-shelf product (often comparable in terms of cost), or an alteration to maintenance operations.

This is not to say that technically more ambitious routes are to be ignored, but rather that there can be significant 'low hanging fruit' offering low-cost, high impact and quick turnaround opportunities.

CONCLUSION

Since the 1970s, environmentalists have encouraged us to 'think globally, act locally' and it is heartening to see how courageous individuals in organisations across the cabin sector are taking this to heart and leaning into their capacity to effect change.

There is, however, a gap in the majority of organisations' abilities to understand the impacts of their product portfolios, and from this, the ability to identify, assess and integrate the solutions they need in order to make measurable improvements with real confidence. Reducing impact in the near term is the goal of aviation, and it is vital that the finite resources available are used in the most targeted and efficient way possible. This demands empirically grounded strategies that recognise the opportunities and limitations presented by suppliers.

We encourage lessors, airframers, airlines and suppliers to explore the ideas, methodologies and assessment frameworks discussed here and consider how they might be adapted to their specific needs and operational context.