

# ACADEMY

AIRBUS CORPORATE ANSWER TO DISSEMINATE ENVIRONMENTAL MANAGEMENT SYSTEM

## Streamlined Life Cycle Assessment

ECO-EFFICIENCY AND SUSTAINABILITY - G1 - ISSUE 1



GIFAS



# Streamlined Life Cycle Assessment

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# I. Introduction

Life cycle thinking reflects the consideration of cradle to grave implications of any actions, and guides the overall approach to dealing with environmental and sustainability issues. The concept has been considered in decision-making in the public and industrial sectors in the USA and Europe. It has been embedded in European Commission Directives on industrial environmental management such as IPPC (Integrated Pollution Prevention Control), and has strongly influenced regulations aimed at the minimisation of consumer product environmental impacts, especially in the electronics sector with the WEEE/ROHS (Directive 2002/96/EC; Directive 2002/95/EC). Voluntary schemes such as the EU Eco-labelling scheme (Regulation 1980/2000/ec) also integrate life cycle considerations in the definition of criteria used in the eco-label award procedure.

Within the scope of sustainable production and consumption, IPP (Integrated Product Policy) advocates “life-cycle thinking”, which means that when pollution reduction measures are identified, consideration is given to the entire life cycle of a product, from design to end of life. In this way, appropriate and efficient action can be taken in advance of the problem stages in the life-cycle.

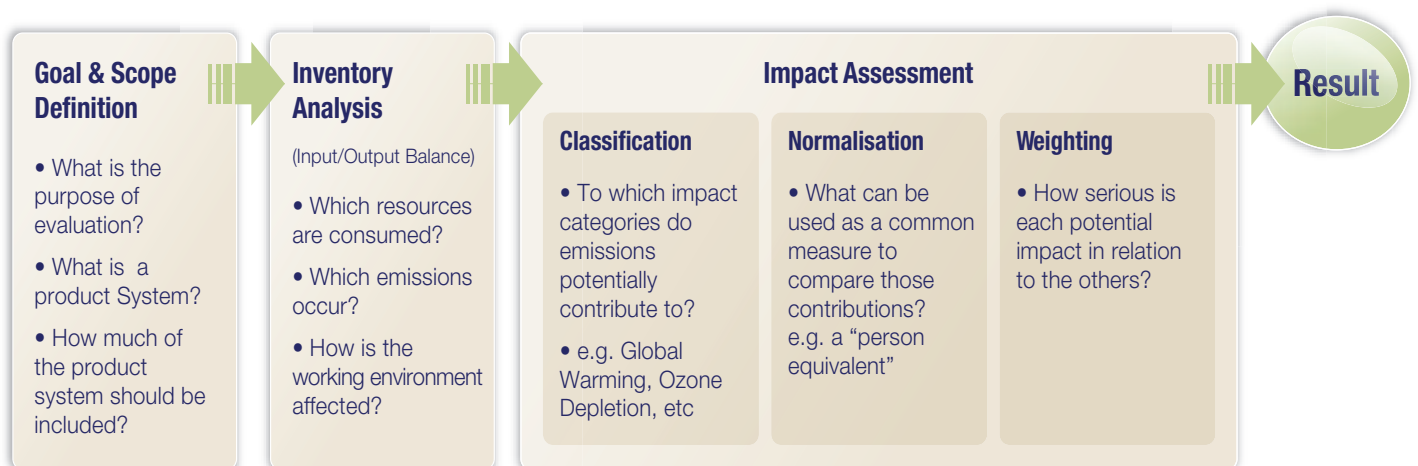
The application of the concept to a product, such as aerospace products, should provide in-depth analysis of the precursors to the product, the production processes and the application and retirement aspects. This comprehensive review of the complete value chain provides a tool for making decisions based on a life cycle view that embeds the driving forces for change. The design phase of most products is decisive for their environmental life-cycle performance, and the majority of a product’s environmental impacts will be determined during this phase.

The main tool supporting the life-cycle thinking concept is Life Cycle Assessment, whose principal aim is to specify the environmental consequences of products and services from cradle to grave. The principles, procedures and methods of LCA are based on the terminology and structure of the ISO Environmental Management Systems, tools and standards on LCA (ISO 14040) and other guidelines published by SETAC or ISO.



Typically, a Life Cycle Assessment study should follow the requirements of ISO14040 series and include the following four phases:

- Goal and Scope Definition
- Inventory Analysis
- Impact Assessment
- Interpretation



## Streamlining LCA

Depending on the complexity of the object of the study, a full Life Cycle Assessment can be a very complex, long and difficult exercise. Streamlining LCA is a practice which has been widely adopted to make this type of exercise more manageable.

Streamlining LCA can be achieved in a number of ways, including:

- Limiting the scope: for example, eliminating life cycle phases deemed not significant, or processes with negligible effect on the environment
- Use of qualitative information
- Removal of upstream and/or downstream components
- Use of specific impact category

In this methodology, the simplification lies in the consideration of a limited scope and the fact that it is based on a combination of qualitative and quantitative approaches to evaluate impacts. Both or only one of the two approaches can be used to determine significant environmental impacts.

## II. Basic principles

### Scope

Defining the scope of the study is a crucial first step. Scoping involves defining boundaries for the study that are relevant to its purpose. The functional unit, fundamental to the credibility of an LCA, provides a basis for comparative studies.

When considering manufactured products, important aspects limiting the scope include the elimination of life cycle steps, parts or processes with negligible impact on the environment.

Important parameters to be defined in the scoping exercise are detailed below:

#### 1. Life Cycle Steps

For example, these can include:

- Raw material including energy production and fuel refining (even fuel used during the operation phase)
- Manufacturing and Assembly
- Transport (of parts and assemblies)
- Operation, including maintenance
- End of Life

#### 2. Mapping of Relevant Processes

For example, processes such as core metal extraction, electricity production can be part of the raw materials phase, machining, drilling, painting, curing, etc. are typical processes used in manufacturing and assembly. The geographical location of manufacturing and assembly processes will determine transport requirements, and the inclusion of transport in life cycle mapping according to its environmental significance. During the operational life of the product, the main use process linked to the mission of the product and key maintenance processes such as paint stripping, cleaning and degreasing should be taken into account.

#### 3. Product Mission

The product mission represents the service the product will deliver during its typical operational life. In the case of an aircraft, this is defined by the number of flight hours, range and payload the aircraft is designed for. The environmental impacts during the use phase of the product will therefore be based on these design parameters. This mission is also called the functional unit of the product.

## Exercise

### Scoping Study

To illustrate the methodology, each step will be applied to an example as a guide.

Aerospace products can be very complex, and as highlighted earlier, focus on specific components may be necessary to simplify the Life Cycle Assessment and make it more manageable. In particular, it can be very useful to apply the methodology to one particular technology and compare it to different design options.

For example, we could compare a fuselage panel to a composite panel used in a specific aircraft. In this case, the scope will include only one component, and its life cycle will be considered using the aircraft mission as its functional unit.

#### Scope:

Product: Fuselage Panel - Long range Aircraft

Design options: Aluminium - Al

Composite - CFRP

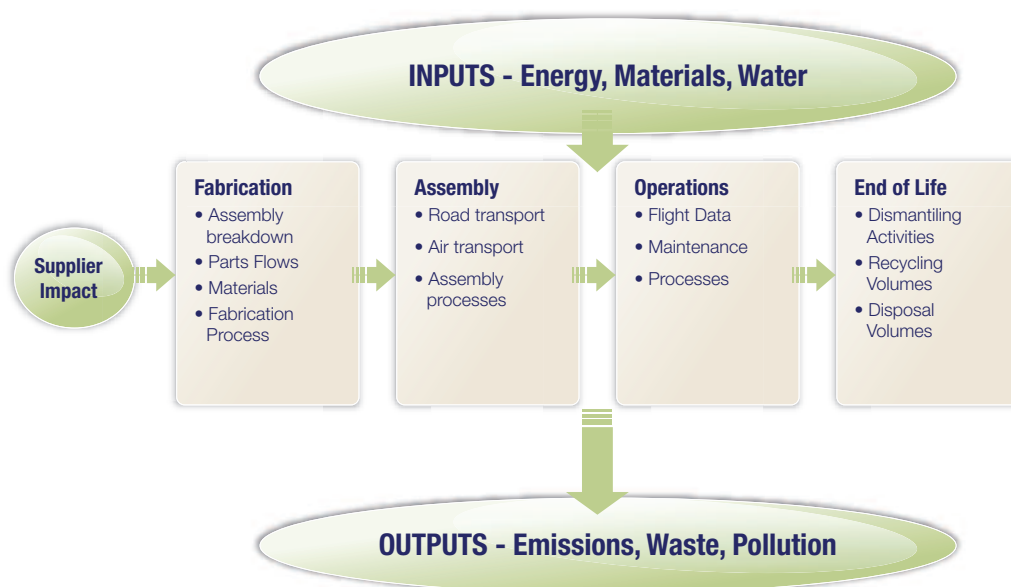
#### Life Cycle Steps:

1. Raw Materials - Aluminium extraction for the metallic panel and CFRP production
2. Manufacturing Processes
  - a. Metallic Option: Machining
  - b. Composite Option
3. Operation - Weighting will be applied to compare the reduction of environmental impacts based on weight savings over the aircraft mission
4. End of life - Aluminium recycling and composite incineration.

### III. Inventory Analysis

The objective of the inventory phase is to quantify the environmental burdens associated with the life cycle of the product or object under study.

For each phase of the product life cycle, the following environmental aspects (Inputs and Outputs of the system) shall be evaluated:



#### INPUT - Examples

**Energy consumption:** electricity, oil, fuel, gas etc. used in a unit process.

**Water usage** in a unit process.

**Primary aircraft materials:** raw materials used in a unit process and that will remain on the aircraft.

**Secondary materials:** materials used in a unit process but not found on the aircraft, such as coolant, etc.

**Hazardous materials:** materials used in the unit process with a hazardous potential.

*High Altitude*

**Fuel consumption** is in the same category as primary aircraft material.

#### OUTPUT - Examples

**Air emissions** including at minimum carbon dioxide CO<sub>2</sub>, carbon monoxide CO, nitrogen oxides NO<sub>x</sub>, sulphur oxides SO<sub>x</sub>, Volatil Organic Compound (VOC), ozone depleting substances and particles.

**Water release** of a unit process.

**Waste** (hazardous and general): any material output to be disposed of.

**Noise:** nuisance due to the unit process.

**Land use:** soil occupation by the unit process.

*High Altitude*

**Cabin exposure**

(low pressure, low humidity, air quality, DVT etc).

**Radiation exposure** and other as far as necessary...



## Exercise

### Inventory Analysis of Inputs/Outputs

For each process used in the life cycle of the fuselage panel, the next step is to build an inventory of the environmental inputs and outputs. These data can be collected and gathered from a number of sources, including site environmental data and published databases on common processes.

Obviously, data collected on the site where processes are performed will be the most accurate. This is especially the case for manufacturing/fabrication processes, which are usually specific to each company. However, this exercise can prove to be very time consuming and difficult, as specific data for each process is not always readily available. In many cases, estimation and approximations are necessary to work out a full set of data for each process. However, it is recommended that validation of data be conducted during the data collection process in order to improve the overall data quality. Systematic data validation may point out areas where data quality must be improved or data must be found in similar processes or unit processes. For other common processes used in raw materials production or end of life for example, generally outside the boundaries of the product manufacturer, published literature or external database are available to compile relevant inputs and outputs.

Data was compiled for 80 raw materials and manufacturing processes commonly used in aerospace, and 18 End of Life processes have been performed. These are given per kg of component.

*Note: In this approach, the link between output/input per bag of produced component is crucial. At this stage, reliability of the data shall be ensured only if the company has set up an Environmental Management System.*

In our example, the following environmental inputs and outputs will be compiled with for all the processes listed previously according to this database.

Unit per kg of fuselage	Machining Process 1	Other process Process 2	Process...
Energy usage	10 KWh	—	—
Water Usage	Negligible	—	—
Materials usage (primary/secondary)	70% scraps	—	—
Hazardous Materials	No	—	—
Air emissions (CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> , VOC, ODS)	No	—	—
Water emissions	Low	—	—
Waste (hazardous/non hazardous)	50% alloys	—	—





## Evaluate Environmental Aspects

The main criticism of LCA studies is the amount of time and effort required to collect the quantitative data relative to energy, materials, emissions and waste for the product or process under consideration. However, despite uncertainties and lack of information, engineering decisions still have to be made. In an effort to overcome this issue, a number of organizations have developed life cycle based tools in the form of matrices requiring only qualitative evaluation of the important environmental concerns for the product and organization considered.

### Qualitative Approach

In this methodology and for complex products, we recommend the use of a qualitative approach. This approach consists in determining the scoring of environmental impacts for each relevant aspect on a qualitative basis, for each phase of the life cycle independently. The preferred format for the presentation of Environmental Impacts is a matrix, which illustrates the environmental impact scores for the main impact categories, for each life cycle phase.

The quotation table allows a score to be assigned, based on a defined scoring system, to each input/output according to the criteria and threshold. The score assigned to each activity or process analysed represents a qualitative evaluation of the environmental impact of this activity or process.

The criteria and thresholds are established according to existing quantitative or qualitative data collected for the field of activities under evaluation:

- The industrial processes quotation rules should be based on existing data for activities under evaluation, during raw material, manufacturing, maintenance, end of life phases
- The transport quotation rules should be based on the combination of several means of transport, including: truck, ship, aircraft, and railway
- The operation quotation rules should be based on a table of successive generation of civil aircraft

This quotation table used is based on the following scoring system - other scoring systems can also be used:

- 0 = No environmental load
- 1 = Low environmental load
- 2 = Intermediate environmental load
- 3 = Medium environmental load
- 4 = High environmental load

This qualitative assessment is carried out for each input and output flow per a/c phase.

The quotation tables detail the thresholds for the defined scoring system per kg of element (parts/assembly) or, if necessary, per other relevant unit (notably for the operation phase).

### Example of quotation tables are given below

Once the quotation for each process is completed, the environmental load can be calculated. The environmental load per aspect and per phase is determined using the following rule:

$$\text{Environmental load (per aspect, per phase)} = S (\text{Environmental aspects quotation}) \times \text{weighting}$$

Weighting shall be consistent with the quotation table format.

## Exercise

### Qualitative Evaluation of Aspects

In our example, we defined in the previous step the relevant input/output for the processes concerned in life cycle stages included in the scope of the study - Raw Materials, Manufacturing and End of Life. The next step is to allocate for each I/O a score based on the Quotation Tables given as an example below. This scoring exercise then leads to the qualitative evaluation of the environmental load.

In this case, the weighting factor used is the mass of the part - 107 kg for the metallic option.  
The following table illustrates the environmental loads for each step of the life cycle for the two designs.

	Raw Materials		Manufacturing		End of life	
	Aluminium Extraction	Composite Production	Metallic Panel Production	CRFP Panel Production	Aluminium Recycling	CRFP Incineration
Energy usage	1000	500	2400	1800	200	—
Water Usage	600	200	2500	300	200	—
Materials usage (primary/secondary)	1300	200	500	200	100	—
Hazardous Materials	600	100	1600	400	400	—
Air emissions (CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> )	600	400	0	0	0	—
VOC	600	100	400	200	100	—
Water emissions	1000	400	2100	200	0	—
Non-hazardous waste	1300	300	500	450	100	—
Hazardous waste	300	200	2800	450	100	—

## Quantitative Approach

As explained earlier, the objective of this qualitative approach is to identify the significant environmental impacts in each phase of the life cycle. The main weakness of the approach is that there is no possibility of drawing comparisons between life cycle phases. Each phase is assessed independently.

In order to overcome this problem, a complementary approach can be used based on semi-quantitative values. It consists in compiling quantitative values for key environmental indicators (e.g. CO<sub>2</sub>) representing the main impacts of the product during its life cycle (table 4). This approach serves to identify the life cycle phases (raw material, manufacturing, operation...) that have the most impact for the selected indicators, and to compare the relative dominance of each phase.

It is suggested to use this method as a complement to the qualitative approach, focussing on key environmental impacts identified in this first approach. The collection of quantitative data, even for simple indicators for all processes related to the product's life, can be extremely time-consuming. Before embarking on this type of exercise, the choice of indicators and the availability of associated data is therefore essential to ensure its viability.

For example, if global warming is considered as a key impact, CO<sub>2</sub> emission can be selected as an indicator. Other typical examples are given in the table below.

Environmental impact	Key Indicator
Global Warming	CO <sub>2</sub> emissions in Tonnes
Resource consumption	Energy Consumption in KWh Primary Material Consumption in Tonnes
Tropospheric O <sub>3</sub> (photochemical oxidant formation)	VOC emissions
Acidification	SO <sub>2</sub> emissions

## Exercise

### Semi Quantitative Evaluation of Aspects

In our example, we have selected four key indicators, which represent significant environmental impacts for the fuselage panel and for which quantitative data is available for the selected life cycle phases.

CO<sub>2</sub> emission

VOC emissions

Primary materials consumption

Energy Consumption

The compilation for the above indicators for the two design options (Metallic versus Composite) is summarised below

	Raw Materials		Manufacturing		End of Life	
	Aluminium Extraction	Composite Production	Metallic Panel Production	CRFP Panel Production	Aluminium Recycling	CRFP Incineration
CO <sub>2</sub> emission (kg)	2200	1300	0	0	0	200
VOC emissions (g)	200	0	0	0	5	300
Primary materials consumption (kg)	2100	300	600	100	0	100
Energy Consumption (kWh)	5100	6500	11200	9700	300	0



**A350, Futur aircraft Composite built**



## IV. Impact Assessment

These environmental burdens calculated in the analysis are translated into environmental impacts during the Impact Assessment phase of LCA. Impact assessment is the third phase in a life cycle assessment, and it contains the following main stages:

- Category definition
- Classification
- Characterisation
- Valuation/weighting

### Category Definition

The environmental impact categories selected for the application of this methodology include:

**Abiotic/biotic resources:** diminishing of resources of biological origin (e.g. wood) or non-biological origin (metal, oil etc.).

**Land use:** refers to land used by the plant or unit studied.

**Global warming:** changes in the surface-air temperature, referred to an increase of global temperature brought by the greenhouse effect which includes the emission of greenhouse gases into the air.

**Stratospheric ozone depletion:** destruction of the ozone layer, which protects all living things from harmful ultraviolet solar radiation. The main chemicals that are depleting stratospheric ozone are chlorofluorocarbons and halons.

**Hazardous properties:** elements that can cause effects on the environment, such as toxicity or ecotoxicity.

**Photochemical oxidant formation:** air pollution containing ozone and other reactive chemical compounds formed by the action of sunlight on nitrogen oxides and hydrocarbons.

**Acidification:** process whereby air pollution - mainly ammonia, sulphur dioxide and nitrogen oxides - is converted into acid substances.

**Eutrophication:** excessive enrichment of water with nutrients, and the associated adverse biological effects.

**Noise (ground level):** harmful or unwanted sounds in the environment at ground level.

## Classification and Characterisation Steps

During these phases, the relative contributions of each input and output to the selected impact categories are determined.

In this step, the associated burden for each aspect (input/output) is allocated to these relevant impact categories.

The allocation tables should be based on the latest scientific and academic references on environmental impacts, including uncertainties, and reviewed regularly. The table below describes the key links between Input/Outputs and the Environmental Impacts.

The table on page 10 contains an example of the allocation table, illustrating the contribution of each input/output to the defined environmental impacts.

Aspects	Description
Resource Use	Material usage of biological origin (e.g. wood, which can be grown) or non-biological origin (metal, oil)
Land Use	Refers to land use by factories
	Excludes land taken for roads, airports, ports
Global Warming	Emissions (during operations) of CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>x</sub> , VOC (HC), contrails, particulates and Other Chemicals, e.g. CO all contribute to Global Warming
Ozone Depletion	Ozone-depleting chemicals are now banned, but some may still be in use until replacements, satisfying the strict needs of air transport certification, have been found
Hazardous Materials	Refers to 'poisonous' effects on plants, humans and other animals
Photochemical Oxidant Formation	Formation of oxidants (namely Ozone) by the actions of sunlight and chemistry
Acidification	Acidification is caused by three main pollutants: sulphur dioxide (SO <sub>2</sub> ), nitrogen oxides (NO <sub>x</sub> ), and ammonia (NH <sub>3</sub> )
Eutrophication	Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth often called an algal bloom. Dissolved oxygen in the water is reduced and causes other organisms to die
Noise	Exposure of the general public to noise

«By default, the allocation value is set to one each time an environmental aspect contributes mainly to an environment impact.  
It is set to zero if it does not contribute or if does not contribute significantly comparing to other environmental aspect».

## Exercise

### Classification-Characterisation

	Composite Fuselage	Metallic Fuselage
Resource Use	1	1
Land Use	0	1
Ozone Depletion	0	0
Hazardous Materials	1	1
Photochemical Oxidant Formation	0	0
Acidification	0	0
Eutrophication	1	1
Noise	1	1

### Impact Assessment - Qualitative Approach

In this step, the environmental load compiled for each Input/Output needs to be allocated to one or more impact categories according to an allocation table. For certain environmental impact categories there is some consensus about the equivalency factors to be used when estimating the total impact (e.g. global warming potentials, ozone depletion potentials, etc.), whereas equivalency factors for other environmental impacts are not available at consensus level (e.g. biotic resources, land use, etc.). The weighted burdens within each impact category are then added to give scores for the different categories.

In this qualitative approach, in order to simplify the exercise and avoid the use of equivalency or characterisation factors, the allocation value could be either 1 or 0 to account for a contribution of the aspect (I/O) to the impact or not. However, weighting may need to be applied to take into account the relative contribution of each Input/Output to the various impact categories. Indeed, in many cases the aspect (I/O) will contribute to several impact categories but not to the same extent. For one impact category, the contribution of one I/O may be the dominant factor to be accounted for. This would avoid overloading impact categories to which many identified aspects contribute.

For each environmental impact category, the associated score will be the sum of all the Input/Output contributions.

$$\text{Environmental Impact Score} = \text{Allocation Value (or equivalency factors)} \times \text{qualitative environmental load (per phase, per aspect)}$$

## Impact Assessment - Quantitative Approach

The environmental impact associated with the indicators should be determined according to published characterisation factors associated with recognized LCA impact assessment methods:

$$\text{Environmental impact} = \text{Characterisation Factor} \times \text{Indicators}$$

Characterization factors are available in the Airbus literature referenced in AP 2199 Form 1 (allocation table references).

Characterisation results in a quantitative statement on different impact categories, e.g. global warming, stratospheric ozone depletion and ecotoxicological effects. Comparison of these categories is not immediately possible. Therefore, the life cycle impact assessment includes a fourth element of valuation/weighting of the impact categories against each other (ISO Standard 14042, 1997). This is a step which cannot be entirely based on traditional sciences and, as a result, includes political, ethical and administrative considerations. Since people and societies have different political and ethical values, it can be expected that different people will come to different conclusions based on the same data.



## Weighting

Following compilation of the score for each impact category, the significant impacts per life cycle phase or process/activity can be identified through the use of a ranking system. For example, an arbitrary rule such as “the impacts representing two thirds of the overall score” can be defined.



## V. Interpretation of Results

Interpretation is the fourth phase in LCA and contains the following main issues (ISO Standard 14043, 1997b):

- Identification of significant environmental issues
- Evaluation
- Conclusions and recommendations

Interpretation is performed jointly with the three other phases of the life cycle assessment. If the results of the inventory analysis or the impact assessment are found not to fulfil the requirements defined in the goal and scoping phase, the inventory analysis must be improved, for example by revising the system boundaries or by further data collection followed by an improved impact assessment.

The final step of interpretation is more or less similar to the traditional conclusions and recommendations part of a scientific and technical assessment. This step is important to improve the reporting and transparency of the study.

The use of this methodology should lead to the following results:

- Identification of environmental loads for all relevant aspects identified in the life cycle phase of the products under study
- Comparison of these environmental loads between different design options
- Determination of a qualitative or quantitative statement on selected environmental impact categories
- Identification of the significant environmental impact for each phase of the life cycle, and comparison for different design options
- Determination of the relative dominance of each phase of the life cycle in terms of its contribution to specific environmental impacts through key indicators, and comparison for different design options

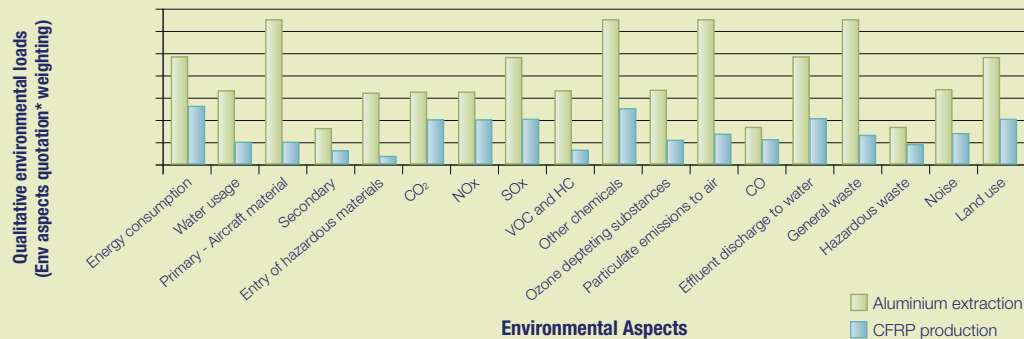
**Caution:** Careful attention shall be paid to the results. Most of the available data have been derived from "static" databases or inventory. Major improvements should be made in incorporating this analysis with the Environmental Management System to regularly allows an update of the data in a dynamic mode.

## Exercise

### Interpretation of Results

Comparison of Qualitative Environmental Loads in the Raw Materials Phase between the two selected design options for the fuselage panel.

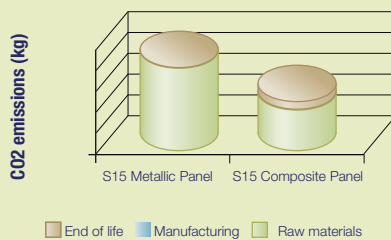
**Qualitative environmental loads for the Raw materials phase**



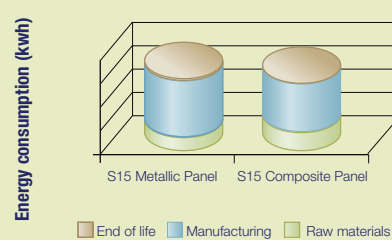
The chart clearly shows that for all environmental aspects, the environmental load is higher for aluminum extraction. This is particularly due to the large quantity of aluminum to be extracted compared to the quantity of composite to be produced.

Comparison of the relative dominance of life cycle phases for key environmental impact of the two selected design options for the fuselage panel.

**Comparison of emissions (kg)**



**Comparison of energy consumption (kwh)**



The energy consumption for the composite panel is 3 % less than for the metallic panel, so with the uncertainty of the values, we can consider that there is no significant environmental improvement. However, a gain is obtained in the manufacturing phase. This could be explained by the quantity of matter to be machined in the manufacturing phase for the aluminum panel compared to the composite part with nearly no loss.

34 % less CO<sub>2</sub> emissions are determined on the life cycle of the composite panel compared to the metallic panel. This is due to the raw materials phase because of the quantity of bauxite to be extracted, and the extraction process emits CO<sub>2</sub>. The gain in CO<sub>2</sub> emissions obtained by the metallic part in the end of life process i.e. recycling compared to composite incineration does not balance the result.

### Conclusion

#### Environmental Comparison of Two Design options for the fuselage Panel

The study shows that the composite panel presents a great number of advantages for the environment. This is mainly due to minimum materials loss during the manufacture of the composite panel (10%) compared to the aluminum panel (nearly 85% with laser cutting and chemical milling).

Furthermore, in the operation phase, every 1% of mass saving will imply, with regards to today's environmental issues, 0.6% fuel saving and 0.6% less CO<sub>2</sub> emissions, the composite solution seems to contribute more to environmental protection than the other materials with regard to the assumption made for consumption in the operations phases.

This methodology is an analysis tool. Analytical tools vary according to the subject, type and depth of the environmental evaluation undertaken, and cover a different range of environmental parameters. Ideally, the results can be taken into account during decision-making in the design process. However, the successful application of such a tool as an effective design support relies on suitable integration with the design team and process, which require suitable consideration of the designer's needs and working environment; in particular, the type of environmental information supplied by the tool needs to match the requirements of the specific decision-making context.

For successful implementation, potential tool users require proper understanding of the tool objectives and methods, as well as adequate environmental knowledge, particularly of the organization's policy and strategy and of legislative influences in the matter.

Finally, the development of this methodology has highlighted the following important points concerning its use on aerospace products.

The most relevant functional unit for the product is likely to be the mission, defining the number of km travelled with a specific payload over its operational life, which corresponds to the service provided by the aircraft.

In the manufacturing phase, due to the multitude of components to be considered (produced all over the world by a very large supply chain), some parts will need to be excluded, based on weight and data availability. The limited availability of Life Cycle Inventory data for aerospace components in commercial databases is an added difficulty.

Considering the complexity of some products, and the uncertainties associated with long life cycles, simplified analytical methods using a semi-quantitative approach and simple metrics for key parameters are likely to be preferred when comparing design options for use in specific design phases.

## VI. Glossary

**EMS** - Environmental Management System.

**Environmental aspect** - an element of an organization's activities, products or services that can interact with the environment.

**Environmental impact** - any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services.

**Scope** - description of the areas of business covered by the EMS.

**ISO 14001** - International Organization of Standardization environmental management standard.

**Operational Control** - steps implemented to reduce/control an environmental impact.

**ETS** - Emissions Trading Scheme. An EU trading scheme allowing companies to emit CO<sub>2</sub> to an agreed level.

**EMP** - Environmental Management Programme. A central management process of an organization's objectives and targets.

**CFRP** - Carbon Fiber Reinforced Plastics.

**VOC** - Volatile Organic Compounds.

**SO<sub>x</sub>** - Sulfur Oxides.

**HC** - Hydrocarbon.

**kWh** - kilowatt hour.

**LCA** - Life Cycle Assessment.

**SLCA** - Streamlined Life Cycle Assessment.

**WEEE** - Waste of Electrical and Electronic Equipment.

**RoHS** - Restriction of Hazardous Substances.



## SPOEMS

(**S**ITE AND **P**RODUCT **O**RIENTED **E**NVIRONMENTAL **M**ANAGEMENT **S**YSTEM)

Investing in research to  
**design**  
cleaner aircraft



Inventing new best practices  
to disassemble and recycle  
**end-of-life**



Managing the  
**supply chain**  
for a shared vision of  
environmental responsibility




## SPOEMS

Mitigating the impact of  
**manufacturing**  
on the environment thanks to  
cleaner technologies and process



Optimising  
**aircraft operations**  
transport and maintenance for enhanced  
environmental performance





This document aims to provide guidance to help implementing Environmental Management System.

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