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GENERIC EUROPEAN LIFE CYCLE COST NOMENCLATURE AND STRUCTURE

by

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Abstract

This document proposes a European structured Life Cycle Cost nomenclature. It aims to be applicable to aeronautical engine - or engine parts - manufacturers. Three levels of LCC structure are presented. This work is the first step for an engine LCC modeling.

You will find :

Ø A three levels distribution of engine costs in its different life cycle phases.

Ø The definitions of these costs in each level.

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TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This document presents the work done by WP2.2 members within the context of 2.2.1 Task "Life Cycle Cost Nomenclature & - Structure". It is the first from the two deliverables of this task.

LCC is used by engine manufacturers to know all costs linked to all life phases of an engine.

Within the Vivace project context, WP2.2 aim is to model these costs in order to reduce engine development time and cost. Its first task (T.2.2.1) is to define generic European LCC nomenclature and structure in order to provide a European standard and to identify all cost elements which have to be taken into account.

After a clarification work on the different LCC existing notions, internal surveys have been conducted among people working on costs in different engine life phases. It has been done in each company taking part in WP2.2. The final step has been the homogenization of this information to reach a common LCC structure and nomenclature.

LCC structure is here presented on three levels.

LCC nomenclature defines each term of LCC structure.

The next deliverable will present the fourth level of the LCC structure with the corresponding nomenclature.

2. DEFINITIONS

In this type of work a common agreement on the used notions definitions is fundamental.

There are many definitions for LCC. The most precise ones are referenced below and are also used within this work .

Life Cycle Cost definitions :

- *LCC* is the sum total of the direct, indirect, recurring, non-recurring, and other related costs expended, or estimated to be expended in the design, Research and Development (R&D), investment, operation, maintenance, and support of a product over its life cycle, i.e., anticipated useful life span. It is the total cost of the R&D, investment, Operating & Support and, where applicable, disposal phases of the life cycle. All relevant costs should be included regardless of funding source or management control.

  (Aerospace Information Report 1939, SAE, December 1986)

- *LCC* is defined as the sum of all monies expended, attributed directly and indirectly to a defined system from its inception to its dissolution : encompassing the acquisition, ownership and disposal phases of a program.

  (Aerospace Recommended Practice 4294, SAE, 1992-02-14)

- Cost related to the whole life of a product for a specific use.

  (NF X 50-150 ; "Coût global" definition, "LCC" translation in French)

Here is the definition we chose for Nomenclature:

Nomenclature : set of technical terms of a science or of an art.

3. WORK CONTEXT

3.1. GENERAL POINTS ABOUT LIFE CYCLE COST

As it appears in §2.definitions, many different LCC definitions exist. Our aim was not to create a new one. We accepted definitions presented above because they are close to each other and describe the same notion from different angles. Some are more precise than others.

LCC notion appeared in the United States in the sixties, at first in some assessments provided by the Department of Defense. This notion arrived in Europe in the seventies, used by companies which wanted to answer to international invitations to tenders, especially in aeronautical industry.

Nowadays all invitation to tenders include an LCC part.

Working on LCC brings many benefits :

- Commercial arguments support;
- Product positioning in competition;
- Maintenance policy preparation;
- Technical choices orientation;
- Life cycle budget forecast.

3.2. PRESENTATION OF WP 2.2 AND TASK 2.2.1

§ WP2.2

Two Vivace objectives are 30% reduction in the lead time and 50% reduction in development costs for a new or derivative gas turbine.

One of the way to approach these objectives is to model the LCC of an engine. That's the aim of WP2.2 "Life Cycle Cost Modeling within the virtual Engine Enterprise".

LCC modeling will help to make right design choices early in the development phase, and on the way to reduce the development time and costs.

In VIVACE context, the creation of a unique nomenclature and a unique structure of LCC used by European aeronautical industries will help the understanding of major parameters and their impact on the product. This the intent of WP3.3 platform. The result is to obtain the best compromise in order to have the optimised final product at the A/C level. It will reduce the number of LCC model iterations between A/C and engine.

So engine development time and costs will be reduced.

§ Task 2.2.1

To reach these objectives, the first step is to define a common LCC nomenclature which will be used in all European aeronautical companies.

That is the first task of WP2.2 : “Life Cycle Cost Nomenclature and Structure”. (Task 2.2.1) These LCC nomenclature and structure standards will allow notably to reduce cost in product development by reducing travel expenditures and meeting times needed to synthesize different LCC terms and structure.

3.3. TASK WORK PROCESS

The aim of the task work is to find a common nomenclature. Then, WP2.2 members proceeded as below.

Work process had three steps :

- LCC notions clarification;
- Internal surveys;
- Homogenization of information.

The first step was to collect information about LCC and to choose a common agreement on definitions. This information comes from different sources, which are representative of different views about LCC. Consequently, customers, engine manufacturers and supply chain points of view are taken into account.

Secondly, internal surveys were made in each WP2.2 member’s company. For different phases of engine life, a person responsible for cost was interviewed about the way costs are structured. LCC nomenclatures of each participants’ company were presented. All partners explained how they produced Life Cycle Cost.

After that, the terms were compared. Differences in wording, meaning and procedures were discussed.

Proposals to harmonize LCC structures and definitions have been made and were discussed internally in companies.

After having had internal agreements, final discussions took place to homogenize the final LCC structure and nomenclature. All WP members reached agreement.

4. STRUCTURE OF AN ENGINE LIFE CYCLE COST

The structure of an engine life cycle is presented below.

LCC Structure

Level 1	Level 2	Level 3
Development Cost	**Pre-development cost**	Engineering
		Hardware
		Testing
	Detailed development Cost	Engineering
		Hardware
		Testing
	Post-development Cost	Engineering
		Hardware
		Testing
Industrialisation cost		Engineering
		Production tools
Production cost	**Purchase and manufacturing**	Purchase
		Manufacturing
	Programme management	Engineering support
		Financial and commercial
Operating and Support Cost	**Initial cost**	Spares investments
		Ground support equipment
		Logistic Support Analysis
		Training
		Technical Publication
		Facilities
	Recurrent cost	Maintenance labour Cost
		Maintenance Material Cost
		Customer Support
		Fuel, oil
		Operational Taxes
Life Termination Cost		Administration Cost
		Recycling Cost
		Scrapping Cost

Although LCC has been structured on four levels at the document dissemination date, it is presented on three levels in this document. The fourth level aims to define precisely terms of third level. This lower level will be presented in next deliverable after that a fifth level would have been established to define it precisely.

Level 1 corresponds to engine life cycle phases : development, industrialisation, production, operating and termination.

Levels 2 and 3 are linked to cost distribution.

At a same level, one find cost elements of same “dimension”. Consequently, one find same cost element at level 1 and 2, such as “industrialisation cost” and “life termination cost”.

5. NOMENCLATURE

In this part all terms used in the LCC structure are defined.

Development cost

All the costs linked to design and validation activities.

Pre-development cost

All the costs linked to all the activities for preliminary design of an engine : need analyses, general requirements, global definition and preliminary tests.

Engineering

All engineering activities for preliminary design : drawings, studies, instrumentation and project management activities.

Hardware

Hardware needed for pre-development : components for rig testing, test rig adaptation and tools.

Testing

All activities to test the concepts of engine preliminary design, including instrumentation and results analyses.

Detailed development cost

All the costs linked to all the activities for detailed design of an engine : studies and tests.

Engineering

All engineering activities for detailed design : drawings, studies, instrumentation and project management activities, engineering support to product support.

Hardware

Hardware needed for detailed development : components for rig and engine testing, test rig adaptation and tools.

Testing

All activities for rig testing and engine testing in detailed development phase : modules and engines assembly/disassembly, instrumentation, rig and engine tests and results analyses.

Post-development cost

All the costs linked to all post-certification activities to complete the engine development.

Engineering

All engineering post-certification activities: modification and updating assessments, project management ; instrumentation, engineering support to product support and certification documents update.

Hardware

Hardware needed for post-certification activities : components for rig and engine testing, test rig adaptation and tools.

Testing

All activities for rig testing and engine testing in post-development phase : modules and engine assembly / disassembly, instrumentation, rig and engine tests, and results analyses.

Industrialisation cost

All the costs linked to the activities that prepare the production of engines.

Engineering

All engineering industrialisation activities : production process definition, suppliers' validation and machine programming.

Production tools

All activities to design, buy, manufacture or maintain production tools.

Production cost

All the costs linked to all the activities that allow production of engines.

Purchase and manufacturing

All the costs directly linked to all activities for engines manufacturing.

Purchase

What the engine manufacturer buys to manufacture engine. It includes raw materials, components and equipment purchase. Reception quality control is added.

Manufacturing

What the engine manufacturer pays to transform purchase into the final engine. It includes components and equipment manufacturing, assembly, quality control, and tests.

Programme management

All the costs linked to the programme management to support production.

Engineering support

Purchase, production and system management.

Financial and commercial

Financial and commercial activities during production phase : sales contracts, insurance, patents and licences, commercial programme activities.

Operating and support cost

All the costs incurred from the initial engine deployment through to the end of engine operations. Includes all costs of operating, maintaining, and supporting the engine.

Initial cost

All the costs incurred at the initial engine deployment to allow the engines support.

Spares investments

Investments in spare accessories, modules and engines for supporting the fleet.

Ground support equipment

Equipment to support engines : tools, test equipment and transportation containers.

Logistic support analysis

All activities to organize engines support : level of repair analysis, spares modelling and maintenance analysis.

Training

Employees training and line operating courses for engine support.

Technical publication

All publications such as illustrated part catalogues, aircraft and components maintenance publication and maintenance plan to help engine support.

Facilities

Costs linked to modification of facilities and fulfilment of technical and environmental requirements.

Recurrent cost

All the costs that occur during the engine operational life.

Maintenance labour cost

All labour costs to maintain the engine during its operational life.

Maintenance material cost

All costs linked to components, LLP and materials needed to maintain the engine during its operational life.

Customer support

All support activities provided by the engine manufacturer for the customer, except maintenance. These activities are programme management, configuration control, engineering support, field service, and ground support equipment maintenance.

Fuel, Oil

Costs linked to engine fuel and oil consumption.

Operational taxes

Taxes related to noise and gas emissions paid by the company.

Life termination cost

All the costs that occur at the end of engine operational life. Includes all costs linked with the scrap or the reuse of whole engine, engine components or spares.

Administration cost

Costs linked to the management of the termination phase.

Recycling cost

Costs linked to all recycling activities from dismantle to sale of reusable engine components or from removal to sale of a whole engine.

Scrapping cost

Costs linked to all scrapping activities from dismantle to scrap of a whole engine or of no reusable engine components.

6. CONCLUSION

This deliverable has presented the work achieved in the first part of Task 2.2.1. This three levels LCC nomenclature has reached an agreement between partners, and so corresponds to LCC structure view of the three participating companies. A next complementary deliverable (D.2.2.1_2) whose publication is foreseen for December 2005 will present a deeper fourth level. Some abbreviations for each term will be added to this enlarged nomenclature.

These LCC nomenclature and structure are a first step for preparing LCC modelling. They clarify all LCC notions and identify all LCC cost elements.

7. GLOSSARY

LCC	Life Cycle Cost	VAC	Volvo Aero Corporation
O&S	Operating and Support	VMC	Vivace Management Committee
R&D	Research and Development	WP	Work Package