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LCC Analysis for the Replacement of the Dutch F-16

Mr. R.C.T. de Haas, Mr. M.C. Smit
en Kol. Ir. M. de Zeeuw
Postbus 96864
2509 Den Haag
The Netherlands

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Abstract:

In the presentation we will first describe the way LCC-analysis are performed in the Netherlands in a general way. In the Netherlands LCC-studies are mainly used in the acquisition process of new military equipment. Inside the armed forces a project team is responsible for the acquisition process and thus also for the execution of an LCC-study. TNO is also regularly involved for a number of reasons. The most important reason is that TNO is independent. Besides that TNO-FEL has developed a step by step approach for performing LCC-analyses inside the Defence Organisation, called FELSALDO. The FELSALDO method consists of five steps: planning, definition, development, analysis and report. We will show a common cost tree for the acquisition costs, the exploitation costs and the disposal costs. When the elements of the cost tree have been determined, these cost elements are estimated. There are different ways of estimating a cost element. After estimating the cost elements the total LCC can be calculated.

After this introduction we will focus on the project: Replacement F-16. We will show how the FELSALDO method was applied during the LCC-analysis in this project. First we will give a little background of the F-16 replacement project. We will indicate that LCC is only one of seven main decision criteria. After that we will give a detailed description of the LCC process, from planning to report using the five steps of the FELSALDO methodology. The LCC analysis in this project was done thoroughly and extensively. A lot of effort was put into gathering the right data from the vendors and a lot of interaction with the vendors was necessary in order to make sure that the data used was the right one and that the vendors data was used in an appropriate manner. Finally we will give the current status of the project, describe what the next LCC related problems will be and share the lessons learned of the F-16 replacement project.

Introduction

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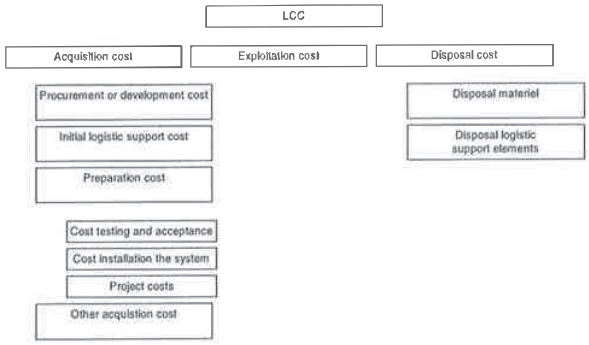
   Very often a number of candidate suppliers have to be compared in the acquisition phase. It is also possible that one candidate supplier offers a number of options to fulfil the requirements. The different candidate suppliers and the different options can be compared on cost issues, when a common cost tree is used.
   It is also possible to use LCC-analyses to calculate, evaluate and compare several support alternatives for the equipment. For instance a comparison of the concept of four levels of maintenance with the concept of two levels.
3. Determine important factors of influence / cost-drivers
   Cost-drivers are closely related with the main factors of influence. Based on the results of the study, cost-drivers can be analysed and studies can be performed trying to lower the total life cycle costs.
4. Sensitivity analyses on important factors of influence or uncertain cost elements
   When the important factors of influence are known, analyses can be performed on the sensitivity of these factors to determine their impact on the total life cycle cost. This type of sensitivity analyses can also be done on uncertain cost elements. On how to deal with uncertainty in cost I will come back later.

FELSALDO
TNO-FEL has developed a step-by-step methodology for executing an LCC-study. The FELSALDO method consists of five steps: planning, definition, development, analysis and report. The first two steps determine the objective and scope of the LCC analysis. The most important steps are the third and the fourth in which the LCC are calculated. Finally a report is written.

Here is an example of a common cost tree for the acquisition and disposal costs.



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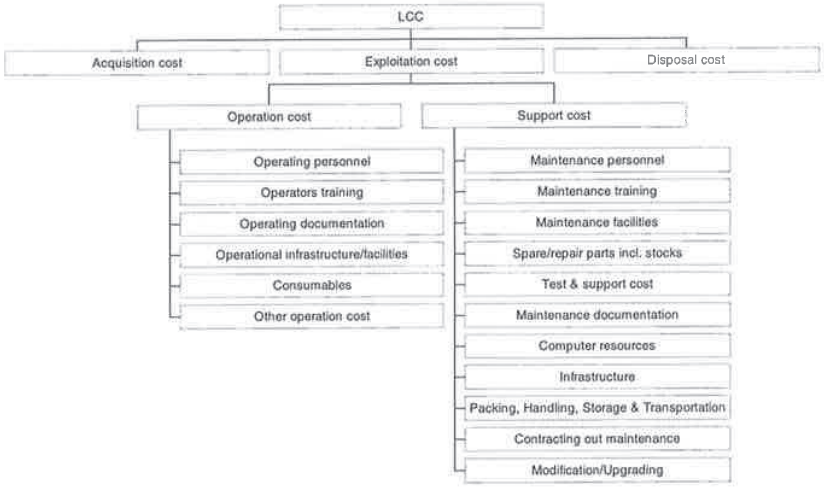

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To be able to calculate the total Life Cycle Cost, cost elements have to be estimated. There are different ways of estimating a cost element. In one LCC-study different ways of estimating the cost will be used. The more detailed data is available the more accurate the costs can be estimated.

- For the analytical method mathematical expressions are used. This method requires a lot of information from the system considered. We try to use this method as much as possible in our studies.
- The parametric method is used when common CERs (Cost Estimating Relationship) are available using large historical databases. Only generic information on the system is required to calculate the costs.
- The method of analogy can be used if the cost of the new system can not be calculated, but when the cost of a similar system is known. Based on the cost of that similar system

the costs of the new system can be estimated, using characteristic parameters, technology factors and add-on factors.
- Three other methods can be used if even less information is available for the new system: expert opinions or rules of thumb may then help in estimating the cost. The method of simulation can be used if the real height of one or more cost elements is uncertain. Statistical methods (e.g. Monte Carlo simulation) can be used to produce confidence intervals for the total costs.

After estimating the cost elements, the total LCC can be calculated.

LCC in replacement F-16

Background of the project
The Royal Netherlands Airforce has the F-16 in service since 1979. Currently the RNLAF operates 138 AC form three main operating bases, Leeuwarden, Volkel and Twenthe. The F-16's have undergone a Mid-Life Update that is almost completed for the entire fleet. Around 2010 the aircraft has reached its operational and technical limits. The replacement of the F-16 is expected to take place in a time frame of 15 years (2010 –2025). The replacement of the F-16 is biggest NL material project ever, estimated at 10-12 billion guilders. For the acquitsition of material the Defence Material Procurement Process (DMP) is used. This process consist of five phases:
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- DMP-D: acquisition preparation phase
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For the replacement of the F-16 the B and C phase are combined and this phase is almost completed. The reason that the B/C phase is done now, 10 years before introduction, is that experience learns that it takes 10 to 15 years to develop a new aircraft and that the RNLAF and the Dutch government is very interested in participating in the development of the replacement of the F-16 (this was also the case with the F-16).

The following timetable gives a broad overview of the replacement F-16 project:

Mid 1998:	Masterplan for project
End 1998:	Start of project
Beginning 1999:	Develop evaluation structure
Beginning 1999:	Formulating Request For Information (RFI) Sent out May 1999 Answers due October 1999
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End 2000:	B/C document formulated by RNLAF and presented to MOD and government (still not presented to parliament for approval)

For the replacement of the F-16 there are 7 main decision criteria of which LCC is one. Other main criteria are, for example, system effectiveness, risk and industrial participation. The following candidates were identified (through WEAG publication):
- Eurofighter Typhoon (EUR)
- Boeing F-18 E/F (USA)
- Saab Gripen (SW) (No LCC data)
- JSF (USA)
- Dassault Rafale (FR)
- Lockheed Martin F-16+ (USA)

Besides these candidates there were other considerations that were taken into account by the RNLAF:

- UAV's
- End-Life Update of the current F-16
- Continue flying with the current F-16

LCC was not used as a decision criteria for these alternatives.

LCC in the project replacement F-16

As stated earlier LCC was one of the main decision criteria. Expect for Gripen (no data supplied) an LCC analysis was performed for each of the candidates. Again we would like to stress that the focus is on the process and not on the results as they are still not made public.

First step of FEL-SALDO: Planning

Before the project started a masterplan for the whole project was formulated. The planning for the LCC analysis was part of this plan. The main purpose of the LCC analysis was to make a ranking for the main decision criteria LCC between the different candidates for the replacement of the F-16. It was also decided to make an estimation and evaluation of the exploitation costs (not investment costs) of the current F-16 in order to have a baseline for the comparison of the candidates.

Second step of FEL-SALDO: Definition

In the definition phase the system, its use and maintenance are described. The results of this phase were used as starting points and assumptions for the LCC-analysis. And this information was also included in the RFI.

Step three of FEL-SALDO: Development

The third and fourth step are the most important in the FEL-SALDO approach. The first step in the development phase is making a cost tree. Using the generic cost tree, a specific cost tree for the replacement of the F-16 was developed. Basically this meant that a few extra costs that were expected to be important such as simulator costs and costs for mission planning (systems) were added to the generic cost tree. The cost tree was used to determine who had to provide the cost information: industry or the RNLAF. For the cost elements that had to be provided by the industry detailed questions and definitions were formulated. LCC was a separate chapter in the RFI. The questions and definitions, together with the main assumptions such as number of flight hours, number of aircraft, personnel skills, etc, were included in the RFI.

After formulating the RFI a LCC analysis of the current F-16 was performed. Here only the exploitation costs were taken into account. These results were used as a baseline for comparison of the different candidates. The results were also used as the basis for the cost elements for which the RNLAF had to provide the information.

Step four of FEL-SALDO: Analysis

The answers to the RFI were due in october 99. The answers were first checked on completeness (were all questions answered) followed by a more thorough check of the contents. Points of attention were:

- Consistency with LCC assumptions
- Consistency with answers on logistics aspects
- Similarities and differences between candidates
- Similarities and differences with the current F-16

When answers were not clear additional questions were formulated and clarifications were given by industry. In some cases multiple question and answer sessions were necessary in order to get the right cost information. Also during this period formal presentations to the RNLAF were given by industry.

In this process a lot of information on the different cost elements was gathered. This information was used to determine the values of different cost elements. For a number of cost elements other experts were also consulted. The cost of fuel, based on flight hours and average fuel consumption per flight hour, for example were reviewed by experts on aircraft and jet engines. In a small number of cases information provided by industry were corrected or adjusted by the RNLAF. After filling in all the cost elements, the LCC of the different candidates were calculated.

In the whole process it became clear that the RNLAF and the various industries quite often used or interpreted the definitions of cost elements and information/data in a different way. The question and answer cycles reduced the misinterpretation a lot. To reduce misinterpretations as much as possible a final "verification" round was executed. The LCC project team visited the different industries to verify the LCC analysis. In this verification round the following things were done:

1. Check on the documents provided by industry
2. Show how the information on LCC was used in the LCC analysis
3. Show where and when adjustments were made
4. And finally show the results of the LCC analysis (the specific RNLAF information was excluded form this LCC analysis)

Also during this verification round the consistency between the configuration of the aircraft as presented in the operational/technical information and the LCC information was checked. The main reason for this was to make sure that the operational analysis and the LCC analysis were performed for the same aircraft.

As a result of this verification round a few minor adjustments were made the final determination of the LCC was done.

Step five of FEL-SALDO: Report
With the final analysis of the LCC ready it was time for the last step to make a report. The results of the LCC analysis were used by the RNLAF in their evaluation of the different candidates for the replacement of the F-16.

Current status replacement F-16 project
At the end of last year the RNLAF wrote the DMP B/C document, containing their evaluation of the different candidates for the replacement of the F-16. Early 2001 this document was presented to the MOD and the government. The MOD performed a formal validation of the evaluation and its results. So far the replacement of the F-16 has not yet been presented to parliament for approval.

Lessons learned
In such a big project there were obviously a lot of lessons learned. There is however one big lesson that we would like to emphasize: You have to make sure that, in big and complex projects like this, that the LCC projectteam and industry have to make sure they are talking the same (LCC) language. Using definitions and assumptions on LCC in general and on specific cost elements helped only partially in achieving this. The things that helped most to establish a clear understanding between the different parties were the formal presentations, the question and answer sessions and the verification round. This interaction between the RNLAF and industry created an atmosphere were mutual understanding on each others approach to LCC was achieved.

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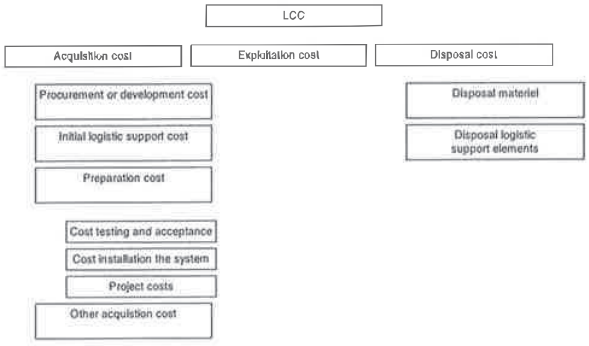

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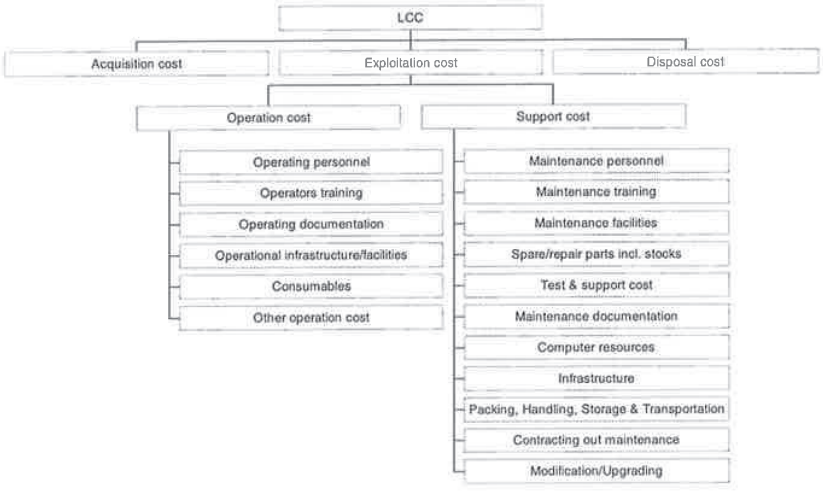

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