UNIFE-UNILIFE AND UNIFE-UNIDATA -THE FIRST EUROPEAN LIFE CYCLE COST INTERFACE SOFTWARE MODEL

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Summary

UNIFE (European society of Railway Industry) created in 1997 a working group for Life Cycle Cost (LCC). It started by issuing “Terms and Conditions for LCC for rolling stock”. Working group II led by Pierre Dersin at Alstom will issue “Terms and Conditions for LCC for total rail systems”. Working group III lead by Ulf Kjellsson at Bombardier Transportation has issued the first European LCC Interface Software Model, UNIFE-UNILIFE and UNIFE-UNIDATA. Working group IV lead by M. Eberlein at Siemens will issue a document regarding “Validation and Field Data Assessment”.

Customers have increasingly asked for LCC data in request for tenders since more than 10 years. All main rolling stock suppliers have tendered to this request for LCC data but no common standard in calculation as well as format has been developed so far. With the introduction of UNILIFE and UNIDATA it is intended to improve a common interpreting and understanding of the LCC prediction and modelling for the railway industry.

UNILIFE and UNIDATA are free of use and more information is given on the UNIFE website at http://www.unife.org. It is important to spread and harmonise the knowledge and use of the software to enable and improve the unsatisfying situation regarding Life Cycle Cost prediction, calculation and data exchange in the railway industry.

Keywords
RAM, reliability, availability, maintainability, life cycle cost, LCC, software, UNIFE, UNILIFE, UNIDATA

1 In the following text UNIFE-UNILIFE and UNIFE-UNIDATA is only referred to as UNILFE and UNIDATA.
1 Introduction into LCC and Maintenance

RAM/LCC predictions and calculations which are at present often asked for in tenders can be made in different ways and a common understanding of these matters is very important for the accuracy of the data given. Even the same input data can lead to different results when the calculation is performed differently. To improve the current situation and to harmonise the different options UNIFE has formed a working group and an interface software model has been developed.

This paper describes the development and the status of the LCC interface software model UNILIFE and UNIDATA.

The different roles in the Customer/Supplier relationship for purchasing LCC in rolling stock is explained in the picture below.

![Diagram](https://via.placeholder.com/150)

Figure 1. The different roles in Rolling stock Customer/Supplier relationship

The customer for rolling stock is usually the operator, but can also be someone else. The operator sends a request for tender to the rolling stock suppliers (sometimes also called systems integrators). The rolling stock supplier interprets the request for tender, checks if there exists a LCC requirement, and transforms the requirements into own LCC specifications. A request and the specification is usually sent out to systems sub-suppliers, like door system supplier or brake system supplier or own internal departments, like converter department. These are here called sub-system suppliers. The data transfer is using a simple LCC interface software (EXCEL spreadsheet). The sub-system suppliers might in their turn need data from component suppliers also asked for in a simple LCC interface table.

All this data is collected into each rolling stock supplier’s own complex software and the data is reconfigured to a customer format and exported in the customer’s LCC software (if required). A few experts are the users of the complex LCC software.
The role of the LCC interface software can be fulfilled in a harmonised and standardised form by the UNILIFE and/or UNIDATA LCC interface software model.

Maintenance is split into traditional and balanced maintenance. **Traditional maintenance** is maintenance done in campaigns, like 1 hour each week, 8 hours each 4 months and 3 days each 5 years. **Balanced maintenance** is the same maintenance activities, split in smaller groups and done whenever the trains are not in operation, like during nights, over the weekend or some trains available between the morning and the evening peaks. The balanced maintenance increases availability for the train fleet, but requires more night and weekend work.

### 2 Development of UNILIFE and UNIDATA

UNILIFE/UNIDATA is a software tool for data collection, quality control and transfer between two parties, like from sub-system supplier to rolling stock supplier. It is an EXCEL application in which LCC data can be exchanged. LCC data can be composed in different ways, which then might lead to different results. Therefore, it is important that at least all rolling stock suppliers share the same modelling idea. This was the background for the creation of UNILIFE and UNIDATA.

Two different ways of working have been identified: Either a specialist group for LCC is created within the rolling stock supplier company or the responsibility for LCC is delegated to sub-system suppliers. Anyway which of the two ways is taken the responsibility for the Life Cycle Cost must be contractually defined between the rolling stock suppliers and the sub-system suppliers.

In way one a rolling stock supplier buys only “off the shelf” components together with the raw LCC data. The RAM/LCC specialists of the rolling stock supplier then transforms and composes the LCC data for the actual project, taking into consideration the configuration of the train with the number of components, duty cycles, redundancies etc.

In way two a rolling stock supplier tries to delegate the responsibility for LCC to the sub-system suppliers. In that case he must explain the configuration, the level of redundancy, duty cycles etc. to the sub-system supplier to get LCC data complete with contract values on Key Performance Indicators (KPIs) like total maintenance cost and failure rates for the different failure categories. This way is only possible with competent sub-system suppliers who know the railway business.

This lead to the development of the two different LCC Interface software types:

- **UNILIFE** which includes calculation capabilities and error checks, and
- **UNIDATA**, a spreadsheet with fixed and agreed field names (same as UNILIFE) to exchange component data only.
The two different ways of thinking were not obvious to the working group until half way in the project. This lead to the decision that the two different ways will exist side by side representing the two different ways of working. UNIDATA represents a harmonised interface tool between rolling stock suppliers and sub-system suppliers and between sub-system suppliers and component suppliers. UNILIFE will enables sub-system suppliers to perform some calculation to see the impact of their LCC data.

A typical problem in request for tenders is the lack of operating time duty cycle, number of door openings, braking effort, passenger flow or quality of track. This will be explained in an example: A supplier of a speed sensor mounted at the leading wheelset axlebox has been asked to reduce heavily the price for his component. By designing a lightweight speed indicator he performed this price reduction. It performed well under normal circumstances, but failed if exposed to excessive vibrations when running on bad tracks. Thus the track quality has been an important input to this scope leading either to the decision for the lightweight or for the heavy-duty speed indicator.

3 Function of UNILIFE/UNIDATA

UNILIFE and UNIDATA are totally free for use. UNIFE owns the software, but accepts no liability for eventual damage caused from the use.

UNILIFE and UNIDATA are made as EXCEL applications. All formulas and macros are unlocked. A user guide is included and an appendix with explanations of all macros and formulas. Improvement proposals and bug reports are welcome.

UNILIFE and UNIDATA contains a number of worksheets, which are defining: the project, revisions, global data (duty cycle), corrective and preventive maintenance, other fixed and running costs like energy, investment, training, documentation and tools. UNILIFE includes a report sheet containing the resulting LCC and its components and a reliability breakdown in the different failure categories.

Different customers are requesting LCC data in different ways, and rolling stock suppliers have each their own complex LCC software to store data for reconfiguring to the different requirements.

The following are some examples for requirements of different data breakdown and outputs:

- CM and PM
- Depot and component workshop
- man-hour cost and material cost
- cost per year
- cost per car

This has been taken into consideration in the development of UNILIFE and UNIDATA.
3.1 Structure in UNILIFE and UNIDATA

The structure of the items in the sub-system is presented in a tree-like structure suited for importing into a database where each item has a superior item. The number of items in each car in the train is presented as the number of items in the superior item. This means typically that there are two wheels in a wheel set, two wheel sets in a bogie and two bogies in a car. In UNILIFE a complicated macro calculates the total number of components per train. In UNIDATA only the structure numbering without calculation for the purpose of data exchange is used.

The structure of the items is entered in Corrective Maintenance (CM) spreadsheet only. The Preventive Maintenance spreadsheet can only use items already entered in the CM sheet, thus only one structure exists of the sub-system.

3.2 Input data in UNILIFE and UNIDATA

The following input data can be entered in the interface software program:

- failure rate
- maintenance man-hours
- repair cost
- failure categories
- PM maintenance interval
- PM man-hours
- Material cost
- Cost for maintenance equipment
- Miscellaneous costs, e.g.: acquisition cost, cost for spare parts, energy cost
The failure rates can use the units: failures per million km \([f/10^6\text{km}]\), failures per million hours \([f/10^6\text{h}]\), MTBF in hours or FIT (Failures in time, \([f/10^9\text{h}]\)).

The preventive maintenance can use intervals of days, month, year or km. Traditional or balanced maintenance can be entered, the difference in LCC is easily readable if both are given.

The built-in error check function reports of a number of typical logical errors, like if there is a repair cost stated for a not repairable component or if cost of spares is given in a currency not defined. The error check which is used in UNILIFE only will need to be updated when more experience is gained.

A colour convention is used with green coloured cells for data input from the rolling stock supplier, yellow cells for data input from the sub-system suppliers and blue text for calculated values.

### 3.3 Output data in UNILIFE and UNIDATA

The following output can be created with UNILIFE (UNIDATA is used as an interface software):

- Investment
- Energy
- PM
- CM
- Failure penalty cost
- Failure rate per failure category

UNILIFE is equipped with navigational buttons showing only parts of the data set to reduce the number of columns to work with at each session. Empty (unused) columns and unused (deep) structure (rows with structure only) can be hidden by a press on a button to improve reading and printing of the often very big and complex spreadsheets.

### 3.4 Registration and download of the software

UNIFE is responsible to register users and supply copies of UNILIFE/UNIDATA for use. This shall be presented in UNIFE website: www.unife.org.

### 4 Use of UNILIFE

UNILIFE has now been in use since mid 2000 in the first project at Adtranz Sweden (since May 2001 Bombardier Transportation), Bucharest Metro Line 2, which will be delivering the first metro train in 2002. Experiences so far have been good. One
bug has been discovered of UNILIFE V1.0 and a V1.1 has been sent out in December 2000.

Siemens has used UNILFE/UNIDATA as an internal interface software between different departments to exchange LCC data. An export function from their own complex LCC data program into UNILIFE/UNIDATA has therefore been created.

The following difficulties in the use of UNLIFE/UNIDATA have so far been reported:

- It is not clear what LCC information has to be entered because not all cells need to contain information. Which cell has to be filled depends on the status of the component, e.g. Line Replaceable Units (LRUs) are usually clear, repairable components need to have a repair cost specified, discardable LRUs will automatically get the spare part price as material cost. This is clear for LCC experts but not always to unexperienced users.
- UNILIFE can also model Shop Replaceable Units (SRUs) below a LRU. In that case the entire repair costs shall be included in the SRUs and not double counted with the LRU. The sum of the failrate of the SRUs shall be calculated and included as the failure rate for the LRU.
- Some typical errors have caused break-down of the quantity-calculation, like if the ident is equal to the superior ident or the break-down of the error check like if a question mark is entered in a cell intended for a failure rate.

These and other experiences will, if reported, lead to later improvements in the software, which might then be called version 2.0.

UNILIFE tolerates user specific modifications under certain circumstances. But any change to the existing columns will cause a breakdown of the error check and the navigational buttons.

The quantity calculation macro will accept less numbers of car types (minimum 3) and more than the 10 car types given in the applications.

Any wish to add information columns must be done outside the defined range in the Excel spreadsheet (to the right of the standard columns).

UNIDATA as non-calculating interface software tool do not cause problems with own modifications.

UNILIFE/UNIDATA is developed by UNIFE for European use, is freeware and not restricted to the use in Europe. Many of the Rolling Stock Suppliers have also business outside Europe.

5 Conclusion

Before the creation of the working group for Life Cycle Cost (LCC) within UNIFE no international organisation had tried to harmonise the different ways of LCC calculation and LCC philosophies. The draft III of the workgroup had the target to
create a LCC interface software model. During the work in that draft it had been realised that the different rolling stock suppliers use different LCC philosophies and that the same input data can lead to different results if another LCC calculation philosophy is used. On the other hand the input data needs to be changed depending on the view of the sub-supplier, either the LCC data is project specific or component specific.

To compromise and to find a right balance between all the different requirements which is still relatively easy to use UNILIFE as a calculating interface tool and UNIDATA as an non-calculating interface tool has been developed. This software has 80 - 90% of all users requirements included.

The work of the DRAFT III working group has been finished in presenting this harmonised standard interface tool and the future will show the acceptance within the rolling stock suppliers and their sub-suppliers.

BIBLIOGRAPHY


