TIE
- an LCA methodology, simple to use, with high quality results

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Summary

LCA is a way to support environmental considerations in product development. Most companies do not have the time or the knowledge to perform full scale LCAs. A possibility is to use software, which provides databases with inventories of different materials and processes. Nevertheless, the designer, who is inexperienced in LCA or environmental issues, will meet with difficulties. First of all he will meet with practical LCA problems such as the choosing of a proper functional unit, the setting of the system boundaries and the solving of allocation problems. When using the software it may for instance be difficult to choose the best applicable data or make estimations when data is missing. The designer might also lack a knowledge of the manufacturing, usage and end-of-life processes of the product he is designing.

In the EU project TIE a tool is developed, which supports the designer in overcoming the problems mentioned above. First of all, the requirements which the tool has to fulfill were identified by interviews with and question forms to the seven product developing companies in the project.

A prototype of the TIE tool was developed and tested. In the prototype the performer of the screening LCA is guided through a script. He answers questions and makes specifications concerning the life cycle of the product, such as the manufacturing processes used to produce the materials, the alloy contents of the materials, the recycling rates, the standard details used, etc. If he does not know the answer then a probable suggestion is given. The scripts can either be tailored for one type of product, where for example probable waste scenarios are known, or more generalised with additional questions about for example the manufacturing of a material. A process tree of the life cycle is built up based on the answers collected. This result can then be weighted and analysed.

The prototype was tested and a case study of sanitary tap-ware is presented below.

The experience obtained from using the TIE tool has so far shown that the designer receives good support in choosing processes in the database and some support with
regard to problems with allocation and system boundaries. The tool allows great transparency with comparably high user friendliness. One dilemma is the fact that the more specifically and accurately the questions are constructed the less useful the script will be for handling complete innovations of products.

Introduction

Difficulties with Life Cycle Assessment in product development

Life Cycle Assessment, LCA, is a way to support environmental considerations in product development. Most companies do not have the time or the knowledge to perform full scale LCAs. A possibility is to use software, which provides databases with inventories of different materials and processes. Nevertheless, the designer, who is inexperienced in LCA or environmental issues, will meet with difficulties.

Of course, the performer of the LCA will meet with the well-known dilemmas of LCA. Choosing a proper functional unit is very important to the usefulness of the results. If the functional unit, for example for a product, is too narrow, the possibilities to compare it with other designing solutions will be decreased. To set logical and consequent system boundaries is difficult in practice, when choosing and adjusting average data in a database. Problems allocating the environmental load occurs in all LCAs and must be solved.

When making simplified LCAs it is necessary to use already collected data. Knowledge of environmental issues is needed when choosing the best applicable data out of a large database. The data may also have to be adjusted for the case in question. When data is missing estimations must be done.

When performing an LCA knowledge of the whole life cycle of the product is needed. The knowledge of the in house processes is usually good within a company but the knowledge of what happens before and after is often lacking. Especially the usage and the disposal of the product are difficult to have any precise knowledge of.

Until now user friendliness of LCA tools for designers has very much been a question of reducing the information available. By replacing the whole inventory with precalculated values, sometimes only a single figure, the information is reduced and the tool made simpler, but also less useful as a lot of information is lost. The challenge is to design a software which is simple to use but does not reduce the information handled.

State of software available today

Today, there are basically two levels of LCA software - advanced tools for making full scale LCAs and simple tools for screening only. By the advanced LCA tools it is possible to record and store inventories with inflows, outflows and meta data as specifications of system contents, time span, etc. The results can be evaluated with different weighting methods and be divided into different effect categories. Some softwares allow uncertainty analyses to be made. To run the software you have to have considerable training and be experienced in LCA. Examples of advanced software are LCAiT, EcoLab, SimaPro, KCL-ECO and TEAM. The simple LCA tools mostly provide databases consisting of already evaluated LCAs, i.e. for each process and material there are only one single figure. There are very limited possibilities to
review data quality, system boundaries or other meta data. There might be wizards, which help to calculate for example the transport distance. The result is shown in clear graphs easy to understand. To run the software and to make a screening you need only a few hours training. Examples of simple LCA tools are Eco-it and EcoScan.

It is necessary that product developers, designers and other non-LCA experts with limited resources learn more about the environmental effects of their products. If LCA should be used some shortcuts must be found without losing too much transparency, accuracy and control.

The TIE project

TIE is an EU project with the main objective to develop an LCA software solution easy to use, with high quality results. Seven SMEs, IVF, PRÉ Consultants - a Dutch software developer, and ITAC - an Austrian research institute, are participating in the project. The project is not yet finished but promising results have already been obtained.

Results

Requirements to be fulfilled by the tool

To really understand what requirements an LCA tool to be used by companies should fulfill, all the companies answered a detailed questionnaire. From the answers and complementary interviews it was possible to set up a list of requirements to be fulfilled by the tool. Of course it will not be possible to fulfil all the requirements but the list provides the designers of the tool with important information.

The most important requirements identified are:

- User friendliness is important. Some users may use the tool very rarely, maybe just a few days a year
  - The results should be transparent for the users who are able and want to handle detailed data, but less skilled users should not be hindered by this transparency
  - Company-specific process data, and data containing descriptions of the product and its lifecycle must be easy to change, provided that this can be done in a user-friendly way and provided that the original data always can be restored. It must be possible to make, maintain and use different versions of the company-specific data, in order to see the effect of process or product changes

- Data management must be simple
  - The user should not be able to change the data in the general process databases and to the evaluation data
- It should be possible to update the data in the general process databases and evaluation methods at regular intervals without influencing the company-specific data with a simple procedure.

- Apart from general data on commonly used materials, transport, energy and waste processing, a separate set of specific data for each company can be added in a separate section of the database.

- Results should easily be seen at different levels of aggregation.

  - The tool should provide environmental data at different levels of aggregation, a predefined set of individual emissions and resource extractions, a set of category indicator results, such as greenhouse effect, acidification, resource extraction, etc, and a single indicator, such as Eco-indicator 95/99 or EPS.

  - The results must be presented in an attractive graphical form, but it must also be possible to get the underlying data in numbers or tables.

  - The data should be well documented and uncertainty ranges should preferably be included.

  - The assessment of the relative contribution of individual processes is a very important aspect. Also here a high level of transparency is required as to what exactly causes a high (or low) contribution of a process.

### Principles of the TIE methodology

The fundamental idea of TIE is to use SimaPro, an advanced software for LCA, as a basis and work with a simplified user interface. The interface lets the user answer questions, about for example a product, in a script. Depending on how the questions are answered the script communicates calculations and operations to SimaPro.

![Diagram](image)

*Figure 1*  The user communicates with the script, which gives orders to the software. The software presents the user with results.

In a figurative way of speaking the script interprets the answers of the questions and gives an order to the main program, SimaPro, to execute. The order may go in terms of “create a process called copper wire 50 mm”. There is a default value for all questions and/or an “I do not know” alternative. This means that if the user does not know the answer to a question, he will still get an average value or a probable alternative.
Based on the orders of the script a process tree is automatically built in SimaPro and if desired a weighting is performed. It is possible for the user to investigate all processes like meta data, emissions, inflow of material, etc.

The script has to be designed and programmed for the type of product or process, which should be analysed. This work must be performed by a person experienced in LCA and familiar with the software interface. A script can be general, i.e. useful to many users. Common construction materials and manufacturing processes are examples of possible general scripts. General scripts are typically cradle to gate. Though, to be more supportive to the individual company, the script ought to be more specific. A specific script can be designed for a special type of product or range of products. When analysing products the whole life cycle is taken into consideration and questions are of course also asked about the use phase and the disposal.

**What problems are solved?**

What are the possibilities to solve the problems mentioned in the introduction by using the TIE methodology?

The choice of functional unit can be controlled within the script. The definition of the functional unit can be built into the script or alternatives to functional units with explanations can be prepared in the scripts.

The designer of the script has the possibility to harmonise the inventories included in the script, to get uniform system boundaries. He/she can of course also adjust the allocation rules in the inventories. Another possibility is to let the user choose how to allocate.

The scripts guide the user in choosing the best applicable data. Only a limited part of the database can be shown in the scripts and that simplifies the choice. An alternative is to let the specification of the data be dependent of the answer of one or more questions like “Is the paper used chlorinated?” Data gaps can be foreseen in a script and an expert can make investigations and estimations needed.

The knowledge about the life cycle of a product can be stored in the scripts as messages to the user or as default values, for example the life span of the product.

In comparison with any advanced LCA software the TIE tool is much easier to use. It requires less skills but it gives the user possibilities to find qualified information. To increase the user friendliness knowledge and help to calculate estimations can be
provided in the scripts. For example “What is the most common type of PUR foam used for packaging?” (knowledge) and “What is the weight if a five litre box is filled with it?” (calculation).

<table>
<thead>
<tr>
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<th>Support for functional unit, allocation, system boundaries</th>
<th>Support for choice of data</th>
<th>Support for estimations in the life cycle</th>
<th>Time to learn</th>
<th>Cost</th>
<th>Detailed results</th>
<th>Metadata provided</th>
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<td>Advanced tools</td>
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Table 1 Estimated evaluation of properties of different kind of LCA software.
− not so good, = medium, + good

Case study

In the TIE project nine scripts were developed, of which seven are general scripts for materials or processes, and two are branch-specific, i.e., for a special type of product.

As an example a branch-specific script for sanitary fittings will be presented. The script can be used to evaluate the environmental load of different designing alternatives. It can also be used to create one detail, as a part process in a larger LCA. The function of the script is briefly described point by point:

- First the user is asked to give the detail to be created a name. The process will be stored in the database under this name and can then be used in a future analysis
- The user is asked to specify the materials used and their weights. The choice will be made from a selected number of materials, which are commonly used by the company
- What surface treatments are used? The user marks one of the three alternatives, which is used by the company. Help is given to calculate the area to be coated
- How is the material processed, casting, machining, hot pressing, etc? The selection is made from datasets of production processes usually used for sanitary fittings. Also specific data for the in-house production are included. Help is given to calculate the material loss
- The user can specify standard details included in the product. The choice is made from a library, which is gradually built up
• Transportation should be specified. A suggestion is given based on the weights already given and the average distance to customer.

• The recycling rate and the lifetime of the product should be specified. A suggestion based on average figures is given.

Figure 3  General flowchart for a script for a sanitary fitting.

The program automatically draws a process tree for the sanitary fitting and the process is saved under the name given.
Discussion

There is a contradiction, which has to be handled when designing a tool, e.g., scripts or other software. If the script is made very specific, it will be very useful to one or a few companies. If the script is held general, many companies are able to use it but it will not be so powerful. This dilemma falls into a question of initial cost for designing and programming compared to how powerful the script will become for the individual company. In the TIE project two levels were tried, one general for which the scripts can be used by any engineering industry and one specific for which the script is suitable for a branch. Branch-specific scripts partly constructed with building stones of general scripts seem to be a good intermediate solution.

Conclusion

The TIE tool is a promising software for making LCA useful to companies. Further work is needed to investigate how the tool should be used by the industry and how the results can be communicated to customers and suppliers.

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