

6.4 Integrating Life Cycle Assessment tools and information with Product Life Cycle Management / Product Data Management

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Abstract

Integrating Product Data Management (PDM) solutions with Life Cycle Assessment (LCA) software offers the opportunity to obtain LCA results fast, based on high-quality, product-specific information and integrated into the design workflow, enabling thereby, inter alia, efficient Design for Environment (DfE).

In a recent project, Dassault Systèmes and GreenDelta have investigated different options for combining LCA tools and information with the ENOVIA platform, a broadly used PDM and Product Life Cycle Management (PLM) platform by Dassault Systèmes. In the course of the project, solutions have been developed for main LCA software systems, including SimaPro, GaBi, EIME, and openLCA. A demonstration implementation has been performed for the openLCA software. A specific connector interface, called 'eLCA', was developed in the project; it provides an interface which makes it easy for LCA software to "dock" to eLCA that in turn links to the ENOVIA platform. The paper will describe the technical solution that has been developed and show its benefit and further potential.

Keywords:

Bill of Material, Computer Aided Design, Life Cycle Assessment, Design for Environment, Product Data Management, Product Lifecycle Management

1 INTRODUCTION

Product data management (PDM) systems have been integrated within product life cycle management (PLM) especially for the design of complex products which allows companies to find correct data quickly, improve productivity and collaborate between global teams as well as to adapt product legislations. Environmental regulations and customer expectations enforce companies increasingly to also consider the environmental impact of products during design and manufacturing processes. Making right decisions in production and design stages requires a combination of product information and impact data. Material choices and manufacturing processes evidently have a high influence on the environmental impact of a product. Further, it is difficult to change those choices after a product has been designed. Late product changes can increase costs. Therefore, well-informed decision making at early product design stages becomes important. Life Cycle Assessment (LCA) is the accepted approach for providing comprehensive information on environmental impacts of a product. The information from LCA study should be consistent within the realm of decision making for different perspectives within product development process such as product designer, production and product managers. Especially for product managers, LCA can have positive affect on decision making if it is provided in operative routines; thus, performing an LCA study based on a real time Bill of Material (BOM) or Bill of Process (BOP) seems ideal for good decision support. However, collection of data for the product life cycle inventory can be expensive and time consuming. At the same time, a very large share of the required data is available in the PDM system.

2 LINKING PDM/PLM AND LCA

An approach to obtain LCA relevant information from the PDM system can be to export BOM or BOP in an LCA format (EcoSpold or ILCD) and import this into the LCA software;

likewise, calculated results from the LCA software can be exported in an LCA exchange format and imported back again into the PDM/PLM software. This import and export allows information exchange but is of course not very interactive. For this reason, development of a connector which supports the connection of LCA tools to PDM software helps designers and manufacturers to perform LCA studies more easily. In the project, such a connector software was developed, called eLCA.

2.1 eLCA Connector software principles

eLCA Connector is a software developed to support a connection between the ENOVIA platform and LCA tools; aim is to calculate reliable LCA cases based on information available in ENOVIA platform, using LCA background data and LCA Impact Assessment models from the LCA software. The interface eLCA is openly documented and invites LCA software providers to link to it. As a demonstration and guidance, a full implementation in the project was created in the project for the openLCA LCA software [4], linking thereby openLCA and ENOVIA. OpenLCA is an open source LCA software and therefore the code can be inspected for illustration and documentation purposes. Investigation of the use for other LCA tools such as SimaPro, GaBi and Eime is also discussed later in this paper.

2.2 Using the eLCA Connector

Required data available in the PDM system can be accessed via the eLCA Connector. An LCA tool for that links to eLCA needs to provide an API or service interface, with the following functions:

- Provide a list of available product systems / processes, Life Cycle Impact Assessment (LCIA) methods, dimensions, units for dimensions
- Return the functional unit of a product system

- Calculate a product system using, optionally, an LCIA method that returns a set of LCIA results, scaled to a given functional unit

These design requirements can be implemented in two different ways: Either, a direct Java API can be created that the LCA tool implements, referring to the eLCA Java API (fig. 1), or by RESTful web services whereas the LCA tool provides the eLCA web service protocol (fig. 2).

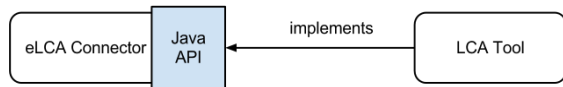


Figure 1: Direct Java API



Figure 2: RESTful Web Services

The eLCA Connector is in a first step developed to be connector between openLCA and Enovia PDM software. For the connection to openLCA, the eLCA Connector currently uses an API that directly uses the functions of openLCA (fig 3).

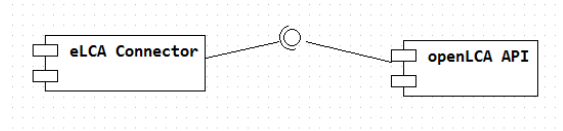


Figure 3: eLCA Connector with openLCA

To enable the use of other tools, this openLCA-specific API is replaced by a general Java API that defines all types and functions that should be provided by an LCA tool to be used in the eLCA Connector (com.elca.api). With this API it is easily possible to replace one LCA tool with another, provided that both tools implement this API. For openLCA a component is under way that provides an implementation of this API with openLCA functions (com.elca.openlca). Fig. 4 shows the structure of these components.

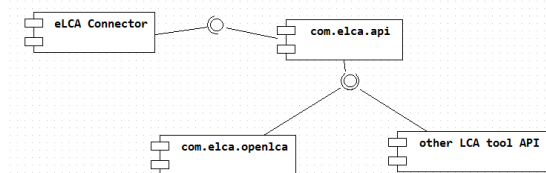


Figure 4: eLCA Connector with other LCA tool Java API

The eLCA Connector is only dependent from the general API which then is implemented by the respective LCA tool.

For a web based LCA software, a component is provided that consumes a RESTful web service and implements this API (com.elca.service.client). Fig. 5 shows the principle of this concept.

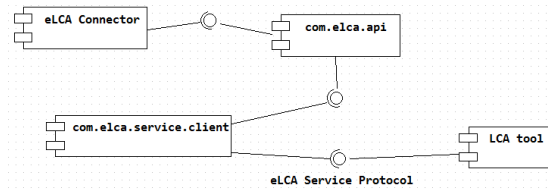


Figure 5: eLCA Connector with other LCA tool web service

The client API implements the general API described above and consumes a web service of a LCA tool that provides the eLCA service protocol.

Such a service is an independent platform and can be implemented in the language of the respective tool provider. It also allows a connection to the LCA tool via the network which in turn makes it possible to run the LCA tool in another operating system.

3 DEMONSTRATING CASE STUDY

While assembling a car, the environmental impact can be influenced and reduced directly in the engineering phase. The engineer can see and decide the use of more efficient materials directly during the construction. For example: "Does the screw that is used to connect the wheel rim to the axle has a low environmental impact or is there still another screw available with the same properties but with a much better environmental impact result?" To provide this information directly during the construction phase, the PDM system on which the engineer works can be extended with the eLCA Connector. The information is provided directly at, for example, the properties page of the screw like any other information. The LCA calculation is fully embedded in the work flow, and there is no need for the engineer to use any other tool than the PDM. The LCA tool can provide information about other parts of the life cycle that are related to the specific part that is currently designed, such as transport and waste management efforts. Of course, it is also possible to "assemble" the life cycle of a complex product based on information of parts of the product.

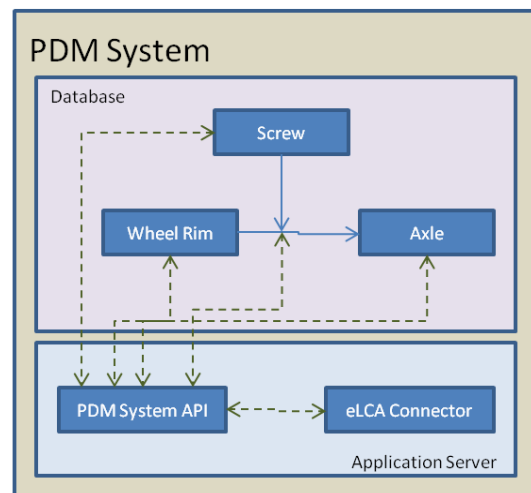


Figure 6: Structure of the case study, as linkages between database, PDM API, and eLCA Connector

4 INVESTIGATION OF OTHER LCA TOOLS

4.1 SimaPro

SimaPro is developed by PRé. It is a Windows desktop software and provides a COM interface which allows the use of SimaPro from other applications. The principle shown in fig. 7 and 8 is to implement a general Java API to call the respective COM functions of SimaPro.

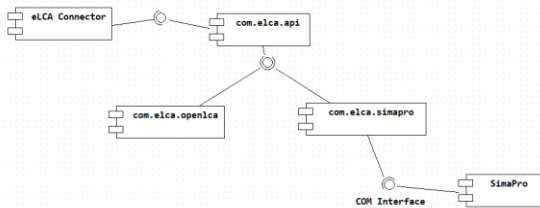


Figure 7: A connection solution for SimaPro, part 1

To use SimaPro via a web-based service in the eLCA Connector, a web-service wrapper prototype is developed which implements the eLCA service protocol.

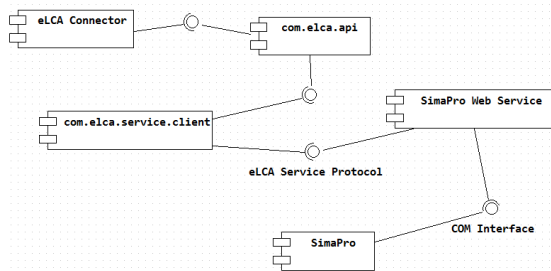


Figure 8: A connection solution for SimaPro, part 2: web-based solution

The SimaPro web-service wrapper provides the SimaPro functions using the COM interface. The eLCA service client consumes this web-service and provides the function of the eLCA Java API which is referenced by the eLCA Connector.

4.2 GaBi

GaBi [5] is developed by PE International. As SimaPro, GaBi is a Windows desktop software. It is not possible to access Gabi functionalities from other tools since there is no public API or service available. For this reason, two options remain to integrate Gabi into eLCA. Either PE International provides an API or service interface that implements the required functions above, or data can be exported from Gabi to transfer into another tool which supports the required

functions. The latter option does not allow a dynamic calculation.

4.3 Eime

Eime [6] is a web-application developed by Bureau Veritas CODDE. It is not possible to access Eime functionalities from other tools as there is no public API or service available, but data can be exported in an Eime-specific format. So a solution can be that Eime developers are providing an API or web service interface, or a data exchange is realized from Eime to another tool which provides these features. These options are very similar to the ones proposed for Gabi.

5 CONCLUSION

Linking PDM systems with professional LCA tools is an effective way to consider and reduce the environmental impact of products already in the design phase. Integrating LCA tools in a PDM software and user interface allows dynamic, real time decision, in line with the current design workflow. This integration can be done by a connector that links the PDM software with LCA tools. This paper analyses main, important LCA tools and proposes two generic options for linking suitable LCA tools with a so called "eLCA Connector", taking the PDM system ENOVIA as an example. One option implements a specific Java API, the other option specifies and implements a web-service with defined specific protocol. For openLCA and SimaPro, both of these options are possible; for Gabi and Eime, the other two analysed LCA tools, this approach is at present not possible since there are currently no APIs or services for function calls from these tools available. An alternative solution can, therefore, be to export data from these tools and transfer into ENOVIA using a file-based interface, relying on common LCA data exchange formats (EcoSpold, ILCD), losing some interactivity and making the exchange less fluent and flexible.

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