Toward the Design of a Generic Model of Interoperability for SIEC
SIEC: Eco-design Information System

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Abstract: Faced with the need to take into account environmental impacts, life cycle analysis (LCA) should emerge as an engine for innovation and eco-design. It is clear that there are many barriers to their deployment. There is thus a need for tools to facilitate their integration in business projects. These LCA tools must be compatible with different existing information systems. In addition, it is also necessary that the coupling of the different data sources helps to make decisions. This article shows the requirements of the company ACV Plus in terms of interoperability and HCI (Human-computer Interaction) in order to make its Siec software easily adaptable to various business sectors. Different peripheral tools have been developed to define data exchange formats and meet specific needs. This research aims to develop a generic bus in order to have easier process maintenance and avoid costly development for each new situation. Two PhD thesis have focused on the HCI aspects and on interoperability aspects. More generally, our project aims to develop a new system with interoperable design and management tools that can help any customer in the definition of its environmental projects and eco-design.

1 INTRODUCTION

Several software systems have been proposed to compute life cycle assessment (LCA). They are listed on the website of the Institute for Environment and Sustainability, a joint Research Centre of the European Commission (Institute for Environment and Sustainability, 2010). The main functionalities of these systems are usually restricted to the transformation of non-elementary flows to elementary flows in order to compute traditional basic environmental impacts. Moreover, these tools are mainly dedicated to environment specialists and they are still out of the reach of non-expert users for decision support. This has very negative effects on the use and distribution of these systems. For example, the difficulties met by designers to use existing LCA tools have been identified by several authors (J. Ammenberg and E. Sundin, 2005; W. Dewulf, 2003; M. Lindhal, 2006; V. Lofthouse, 2006; C. Luttrop and J. Lagerstedt, 2006) as a barrier to the use of these tools for eco-design. In fact, a study carried out in 2007 among a number of French companies and reported in (Tatiana Reyes, 2007) concluded that the failure of LCA to provide a real help in eco-design is one of the main reasons for which enterprises are reluctant in initiating eco-design practices. The above observations led us to think that to be of real use. LCA tools should go beyond this stage, be fully customizable and adaptable to business and domain specific issues by allowing the definition of goals, indicators, regulations, properties ... thus providing each department of the company with a specific and well suited view of the LCA. Finally, an LCA system should be able to be fully integrated in the company information system and be fully interoperable with its components: databases, Enterprise Resource Planning system (ERP), Computer Aided Design (CAD) tools, ... These ideas have led to the development of the SIEC system (SIEC is an acronym for "Système d'Information pour l'éco-Conception" meaning "Information System for Eco-Design" in French) (K. Khalifa and O. Camp, 2011).

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The paper is organized as follows: in the second section of this article we describe the SIEC system (its components, modules and the diversity of its databases) and how its use can be adapted to specific domains and business opportunities. In the third section, we describe all tools developed by our team, which will be used to collect data (supplier information, selection of materials, addition of some specific modules). We present their relationships with the SIEC system. In section four we describe the architecture model that will be implemented to achieve the interoperability between SIEC and various tools. Finally, we conclude and present some future works.

2 SIEC AND EXTERNAL DATA SOURCES

Companies have to achieve integration of new software quickly and as cheaply as possible, but still need to preserve software architecture and insure robust solutions that are easily maintainable over time. Today's business scenario challenges include the development of closer business partnerships, improvements in supply chain, customer support services and streamlining processes to achieve organizational efficiency.

However, most of the companies still use existing legacy applications, developed using different architectures and technologies that have usually not been designed for integration. Companies cannot afford to replace them quickly, because they are mission critical; also they cannot afford to develop their entire information systems from scratch in today's business environment.

Data-level integration is often the starting point where a company begins to work on integration. ETL process and ESB are two data integration solution to achieve this aim (K. Khalifa and C. Ahmed, 2012, P. Harneve, 2006). The purpose of these studies is to search for the solution from existing approaches to determine which one is most suitable for the web application.

Integration architecture is usually built from several layers. The most important types of integration are:

- Data-level integration
- Application integration
- Business process integration

SIEC centralizes in one collaborative platform all the data needed to design a product (performance, environmental quality, costs) and its Life Cycle Analysis. SIEC contains and can use simultaneously different types of databases for various purposes:

- Classic LCA databases (Eco-Invent, Buwal, ELCD, NREL ...) to generate outputs similar to those of traditional LCA software.
- Other statistical environmental databases (Air Chief, Bilan Carbone ®, CORINAIR ...) to facilitate interpretation of results for non-expert users in environmental assessment.
- Environmental/non-environmental databases (statistical data related to the chemical composition of materials, their collection rate, their lower calorific value LCV, their recycled content...) to shed more light and meet regulatory requirements.
- User database containing information on the function of the studied specimens, material properties...

The SIEC team works continuously on various external data sources to expand the interoperability of SIEC. Currently targeted sources are the outputs of the various Computer-Aided Design (CAD) tools, Excel files, Enterprise Resource Planning (ERP) systems (figure 1). Also, SIEC integrates a new data model called the PIVOT System. It is a device that allows SIEC to integrate environmental issues that are specific to each project, regardless of the industry, including ensuring the correspondence between:

- LCA databases
- Physico-chemical properties
- Other environmental data
- Data from other software tools (CAD, Excel, ERP ....)
- Designer database

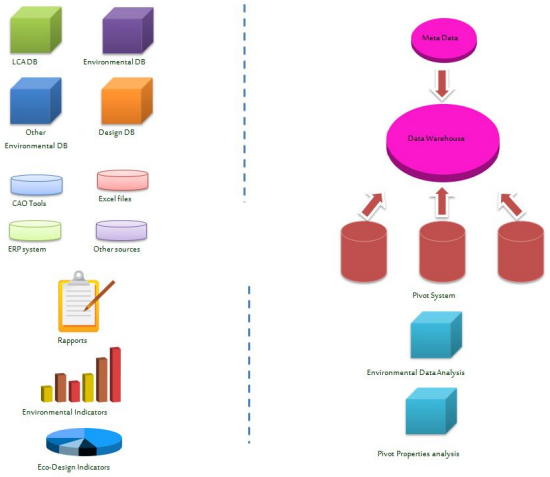

Figure 1: Siec database and external data source.

One of the purposes of the PIVOT system is to allow the system to use data from external sources by defining common interfaces. These interfaces should be the only data transfer channel, thus ensuring the collect of information from different types of external tools and heterogeneous systems.

Integration enables us to better exploit changes in the business environment. A well-integrated environment should handle the functionality of a priori incompatible applications to share data and to manage data transfer.

3 SIEC AND CURRENT PERIPHERAL TOOLS

Currently, SIEC is able to handle nearly all users' requirements such as the creation of products, their analysis, and so on...

However, this achievement is not the only purpose of SIEC and other LCA tools may also provide the same functions.

ACV Plus wants to provide a better integration in the design processes, for this reason a research project on interoperability has been launched.

On a complementary side, another team focuses on HCI (Human-Computer Interaction) in order to insure that the three key features "Fast", "Simple", "Interactive" are fully integrated in the SIEC design. The two teams collaborate because of their complementary objectives.

The SIEC system consists of a main software called Siec Genius and various applications for different needs. We will now present some of the peripheral tools around SIEC:

3.1 CHRONOSIEC

CHRONOSIEC is a tool which facilitates the rapid construction of a full product in collaboration with the suppliers. A user could also accomplish this activity in SIEC, but because of the the current web technology used by SIEC, the creation of the elements may take a lot of time. Moreover, the creation procedure is not as intuitive as the one provided by CHRONOSIEC. With the help of CHRONOSIEC, the user is thus able to create a product with its necessary elements, quickly and intuitively. Additionally, it is not necessary to connect to the SIEC data center to use CHRONOSIEC, and a user can create a product independently and import it into SIEC after having completed her/his project.

Figure 2 shows the functional model of CHRONOSIEC by suppliers.

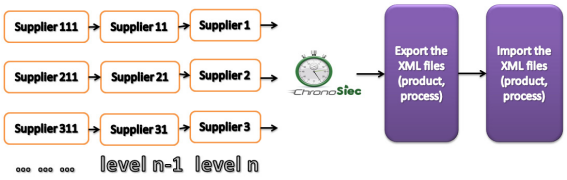

Figure 2: Functional model of ChronoSiec.

Chronosiec is also a small application of 20Mo which includes many LCA databases (Eco-Invent, Buwal, LCA Food, Siec …) The user may also add lots of product elements. This allows all participants to use the same language and avoid mappings which are often long and tedious.

A product in LCA is composed of a product itself, its components and pieces. A component is composed of pieces while a piece can't be divided any more. The construction of a product should be simple and follow these rules.

The construction of the data for each supplier is intuitive by dragging predefined boxes (product, component, piece, material …) as showed in the following figure (figure 3).

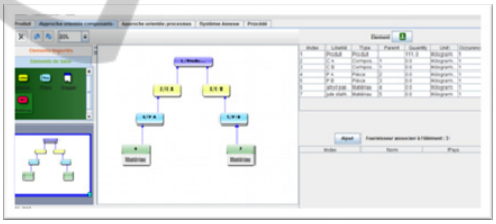

Figure 3: Interface of ChronoSiec.

3.2 SIECMAT

SIECMAT is another independent tool which allows the user to choose among the materials according to certain requirements. A user can select several filtering conditions and, after analysis, import the preferred materials into SIEC.

This tool concerns more mainly the material domain, and it gives SIEC another function in that field. Since not all users are interested in the material domain, SIEC doesn't provider a specific function to analyze and choose materials. However, users can choose materials in SIECMAT and import them into SIEC. SIECMAT has been developed by a strong collaboration between researchers of ACV Plus, École des Arts et Métiers Paris Tech (ENSAM) and ESEO.

Unlike ChronoSiec, the SiecMat application allows computation in order to classify materials according to their performance.

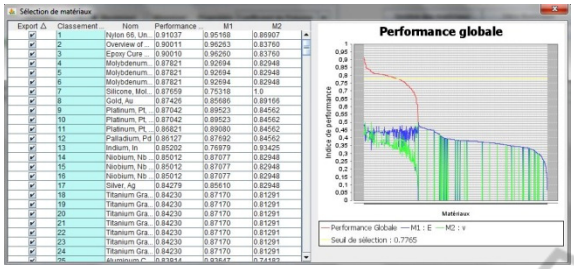

Figure 4: Material performance (Capture from SiecMat).

SiecMat is coupled to an American database "Mat Web" which contains more than 90 000 references and the database from CES EduPack.

After analyzing the results provided by SiecMat, the user can export these materials and compare them in Siec Genius from an environmental point of view (Figure 5).

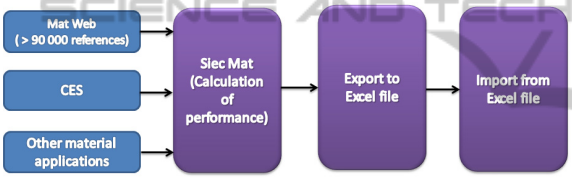

Figure 5: Functional model of SiecMat.

3.3 SIECTRANSFER

Nowadays, there exist several LCA tools. Some of them, such as SIMAPRO, benefit from a ten years history on the market. Therefore, it is likely that some users are already working with other LCA tools before turning to SIEC. They may thus have important data collections that they do not want to lose or for which they do not want to spend time to rebuild.

The SIECTRANSFER tool enables the users to import data from these LCA tools into SIEC.

If someone used another LCA tool and wants to change for SIEC, she/he will not lose any time re-building the products that he already has created. SIECTRANSFER offers the facility to analyze the files produced by other LCA tools and generate a file that respects the SIEC format, which can then be processed by SIEC.

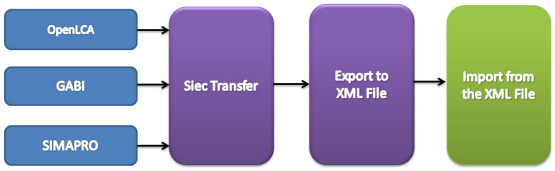

Figure 6: Functional model of SIECTRANSFER.

Figure 6 shows the different steps needed to transform data from external tools to Siec Genius.

3.4 CAD Interoperability

In some industrial domains, CAD software tools such as AutoCAD, Catia, Solidworks, ... are frequently used for project drawing purposes.

Thanks to the "CAD Interoperability" tool, SIEC is able to import files from these CAD software tools and directly generate a product with its associated elements as shown in figure 7.

Figure 7: CAD interoperability components.

3.5 Excel Interoperability

As everybody knows, Microsoft Excel is a spreadsheet application developed by Microsoft and very widely used. .

By using the "EXCEL Interoperability" tool, the users are able to import the EXCEL files (xlsx or xls format) into SIEC and directly generate a product with its associated elements.

Figure 8 explain the principle of Excel interoperability.

Figure 8: Functional model of EXCEL Interoperability.

4 EXPECTATIONS AND PROSPECT

Presently, peripheral tools such as SIECMAT and CHRONOSIEC work directly and independently from SIEC. However, the user has to download several tools if she/he wants to perform more than one activity. Moreover, there is no communication between these tools.

Thus, in order to insure communication and connection between these tools, ACV Plus is now investigating a solution in order to integrate the peripheral tools.

The diagram in figure 9 represents the current communication mechanism between SIEC and the peripheral tools. Each tool communicates directly with SIEC.

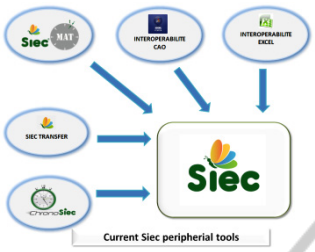

Figure 9: Communication mechanism between SIEC and the peripheral tools.

The aim of ACV Plus is to integrate all these tools into one single package (figure 10). Each function may communicate and share information with the others in the package. The communication between SIEC and these functions will be standardized and unified. In the near future, it will not be necessary to work independently with the peripheral tools thanks to seamless integration of all the tools.

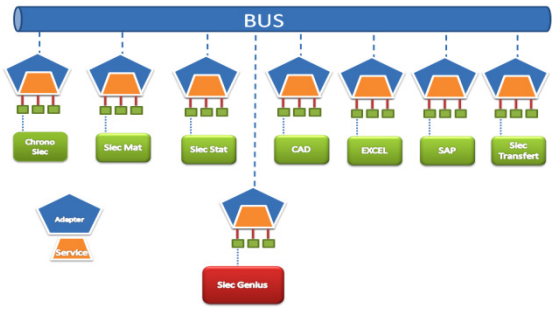

Figure 10: Proposal interoperability model between SIEC and the external tools.

In addition, ongoing research work in cooperation with ESEO (O. Beaudoux and M. Clavreul, 2012) and focusing on HCI aims at providing a better and more intuitive product creation and design process in the Siec System.

5 CONCLUSIONS

In this article the current Siec system and the communication procedure with peripheral tools have been briefly presented. In order to develop the system which meets the expectations of LCA experts, it is necessary to build a robust architecture in order to guarantee interoperability between Siec and external data sources and tools. We have already started implementing the connection of Siec with existing CAD tools and ERP systems. However, more analysis and experimentations of SIEC in different fields of activity are still needed in order to identify the components and define generic models for integration.

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