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EVALUATING AND IMPROVING THE ENVIRONMENTAL QUALITY OF BUILDING PRODUCTS WITH EQuity - SOME EXAMPLE APPLICATIONS

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ABSTRACT

The EQuity model is a Life Cycle Assessment-based tool aimed at evaluating and improving building products Environmental Quality aspects. Unlike most "classical" LCAs, EQuity is strongly based on users' statements about their perception of environmental quality, as well as their goals and constrains pertaining to a given product study.
Two applications of the EQuity model are presented in this paper. They illustrate the benefits of the case-by-case approach. Lessons drawn from these field-studies are detailed, and show that EQ can benefit from being integrated in all building products' life cycle steps.

INTRODUCTION

Tacking Environmental Quality (EQ) into account is not only a responsible attitude, but also a strong requirement in recent standards [1]. Thus, it is important to ensure that existing and new building products are designed with EQ in mind.
As the environmental concern is growing within the construction industry, various tools have been adopted or developed to evaluate how "green" a given product was. Such tools are either based on a list of "greenness attributes" (recycled, recyclable, natural materials, CFC-free, etc.), or on an assessment of every material and energy consumption or rejection from and to the environment [2]. The later approach being the basis of the Life Cycle Analysis (LCA) model. LCA is the most scientifically sound approach to this very complicated and broad notion [3].

The position of the author is that EQ cannot be measured objectively, exactly, and once and for all, as materials and products physical properties can. One main reason is that EQ encompasses the future, and hence nothing can be said with 100% certainty. However, potential sources of EQ problems can still be located in that way, providing that the necessary limited scope of such an assessment is not forgotten.

EQuity is an LCA-based tool, that includes building products and actors' specific characteristics. A general overview of the EQuity model and features is outside the scope of this paper, but can be found in [4]. As a quick introduction, though, EQuity is based on a case-by-case approach, taking into account actors goals and constraints to define both the inventory's boundaries and the content of the impact indicators' list. This approach has been successfully tested on real products, in partnership with various actors of the construction industry, including product manufacturers, building contractors, builders, recycling companies, etc. For reasons of confidentiality, few numerical results are given here. The main point of this paper will be to report on the main conclusions drawn from the results of each field-study and to highlight the strengths and weaknesses of the methodological approach.

TWO FIELD-STUDIES

Field-study 1 - manufacturing of a gypsum wallboard

This study was done at the Chambéry manufacturing plant of the Placoplatre company. This plant has been operating for a couple of years in conjunction with an on site plaster wastes recycling facility. So far, only local production wastes are recycled into the process. The product tree of the "new" process is drawn on Figure 1. This new facility was realised to anticipate on the forecast raise of dumping prices. Hence, this is a purely economical criterion that triggered this decision. The product studied is a sandwich panel made of two 10 mm plaster boards glued to a 30 mm cardboard honeycomb network in the middle.

The goal of this study was to evaluate from an EQ point of view how well this "new" process performed, as compared with the "old" process without recycling. Constraints imposed on the study led to exclude some processes from the system boundaries. Such processes include energy production, gypsum mining - gypsum ore is provided by the St Jean de Maurienne quarry, and paper manufacturing and transport since the Placoplatre group also owns a paper mill.

After aggregation of the product tree, aggregated flows are interpreted into indicators as far as data are available. However, due to restricted inventory boundaries, most aggregated flows cannot be directly related to impact categories. Hence, EQuity preserves information by adding all non interpreted aggregated flows to the impact indicators' list. Three indicators were selected from this composite list after a discussion with the industrial partner. Theses are reported in Table 1

It appears from those results as no surprise that gains on resource consumption are counterbalanced by losses on energy consumption. But, extending the boundaries to include ore mining and transport processes shows that the overall energy consumption is also reduced when recycling, as compared to the "old" process. Hence, what was done on a purely economical basis appears to also improve the product's EQ, *in that particular case*.

Impact Indicators	With recycling ("new")		Without recycling ("old")	
	Min	Max	Min	Max
Gypsum resource depletion [-]	3.67	5.21	3.76	5.34
Total energy consumption [MJ]	2508.7	3306.2	2498.4	2941.9
Total waste [kg]	17.9	25.3	76.7	89.1

Table 1 Comparison of impact indicators for gypsum wallboard manufacturing at the Chambéry plant

Unfortunately such a benefit offers little, if no, opportunity for further improvement, since the actual percentage of recycled matter introduced into the process is already close to its feasibility maximum. Further improvements should be looked for in the direction of packaging, since gypsum wallboards pallets are currently made out of gypsum wallboard, which implies an additional resource and energy consumption.

Field-study 2 - waste generation with waterproofing membrane

This second study was done for the SIPLAST company, a French bitumen waterproofing membrane manufacturer. Data were collected on a specific construction site with SOTRACIER as a general contractor and the TISSOT company laying the product. The specific product under study is an SBS bitumen membrane with self-protection. The technical solution chosen includes an insulation pane and a steel panel as underlay.

The main goal of this study was to determine exactly where and how much solid waste were produced along the product manufacturing and on site laying steps. A second goal was to determine how much the transportation required for the various semi-products influenced the final balance. A detailed product tree is drawn on Figure 2.

As a result of the aggregation of the inventory, it appears that packaging are the main source of solid waste. Detailed results show that for each 100 m² of final product, 9.8 kg cardboard, 5.7 kg polyethylene and 5.3 kg wood pallet are generated at the manufacturing plant.
Also, approximately 380 tons of solid waste are generated per year on building sites in France, due to the manufacturer's product, for an estimated total dumping price of 79000 to 270000 FF. These figures are big enough from the manufacturer point of view, to suggest that a solution be found, that not only spares resource, but should also prove less expensive. It has been mentioned by the manufacturer, however, that the "zero-packaging" option was not considered because packaging also played their part in the product marketing. As far are the transportation of semi-product is concerned, the energy equivalent appears to be very close to the amount consumed for the actual manufacturing of the product on the plant.

LESSONS DRAWN FROM THE FIELD-STUDIES

The case-by-case approach does not seem to be regarded as "the proper" approach by some part of the LCA research community. We consider however, that it is a very practical way to get precise answers to precise questions, and that it is probably the only way possible when dealing with building products, whose life length goes far beyond what can be observed by contemporary witnesses - typically 30+ years.

Also, as can be seen from the two field-studies presented in this paper, building products EQ can lead very different types of actors to ask very different questions, each being difficult to disconnect from a general context made of economical and technical goals and constraints. On this aspect, these field-studies have shown that :

- Defining inventory boundaries from the goals and constraints of the study has readily been accepted by the partners, who get readily relevant answers in return.
- Partners in each case are already familiar with concepts like process tree and i/o flow. In some cases, like in the gypsum wallboard study -, those data were already collected as part of the analytical accounting framework of the partner company. In other cases the gathering of processes data is always very close to existing practices.
- Without the case-by-case approach, it would be impossible to take into account the fact that the insulation product used for the waterproofing product is unspecified until the very beginning of the building site. This situation may not be similar in some other European countries, but has to be dealt with in the French context.
- A case-by-case approach is basically an iterative and incremental definition of inventory boundaries, as was exemplified in the first field-study.
- The final analysis of produced results on EQ is always interpreted in a context that goes far beyond EQ aspects only - improvement possibilities are constrained by technical limitations in the first study and by financial and marketing needs in the second one.
- Performing the final analysis at an intermediate state between inventory and impact assessment seems to be an optimal position as far as EQ information usability and users familiarity with the concepts and results are concerned.

OTHER FIELD-STUDIES AND FUTURE PERSPECTIVES

A comparative design of a PU-foam car seats recycling process into building products has also been completed in collaboration with a recycling company research centre. It basically brought the same methodological conclusions than those reported in this paper.
An additional conclusion also appeared, which is of great interest to open future perspectives to EQ in the construction industry : in this particular study, a tool like EQuity has proved very useful, although designing from scratch implied that LCA data were not available until the process had already been elaborated to a certain extent.

The reason is rather obvious. Designing involves technical and financial aspects that are also based on process and flow concepts - each transformation of the raw material into the final product being a succession of processes, each of them requiring material and energy input and output flows. Those flows also come at a financial cost, on which the financial analysis of the current design state is assessed. Hence EQ design can be part of the design process because its concepts are compatible with those routinely involved. Also, a tool like EQuity can be used as a data repository, documenting the current state of the technical process tree, i/o flows and their related financial aspects.

This possible integration has already been noted by some authors, who also developed interesting procedure to link routine practices to the EQ aspects [5]. Also, some tools are being developed, that will connect building EQ design models to cost estimation tools [6]. It seems, however, that such an approach has not been popularised in the building sector but still remains limited to plant operation and the product manufacturing steps.

A comparative study of on site EQ characteristics of three different types of fired clay brick house external walls is currently underway at CSTB, in collaboration with the project's architects and general contractor. Besides EQ information on various fired clay products and building techniques, this project should bring an interesting insight into the possible uses of EQ evaluation tools during the building site step, which is probably one where many potential environmental improvements can be identified and achieved.

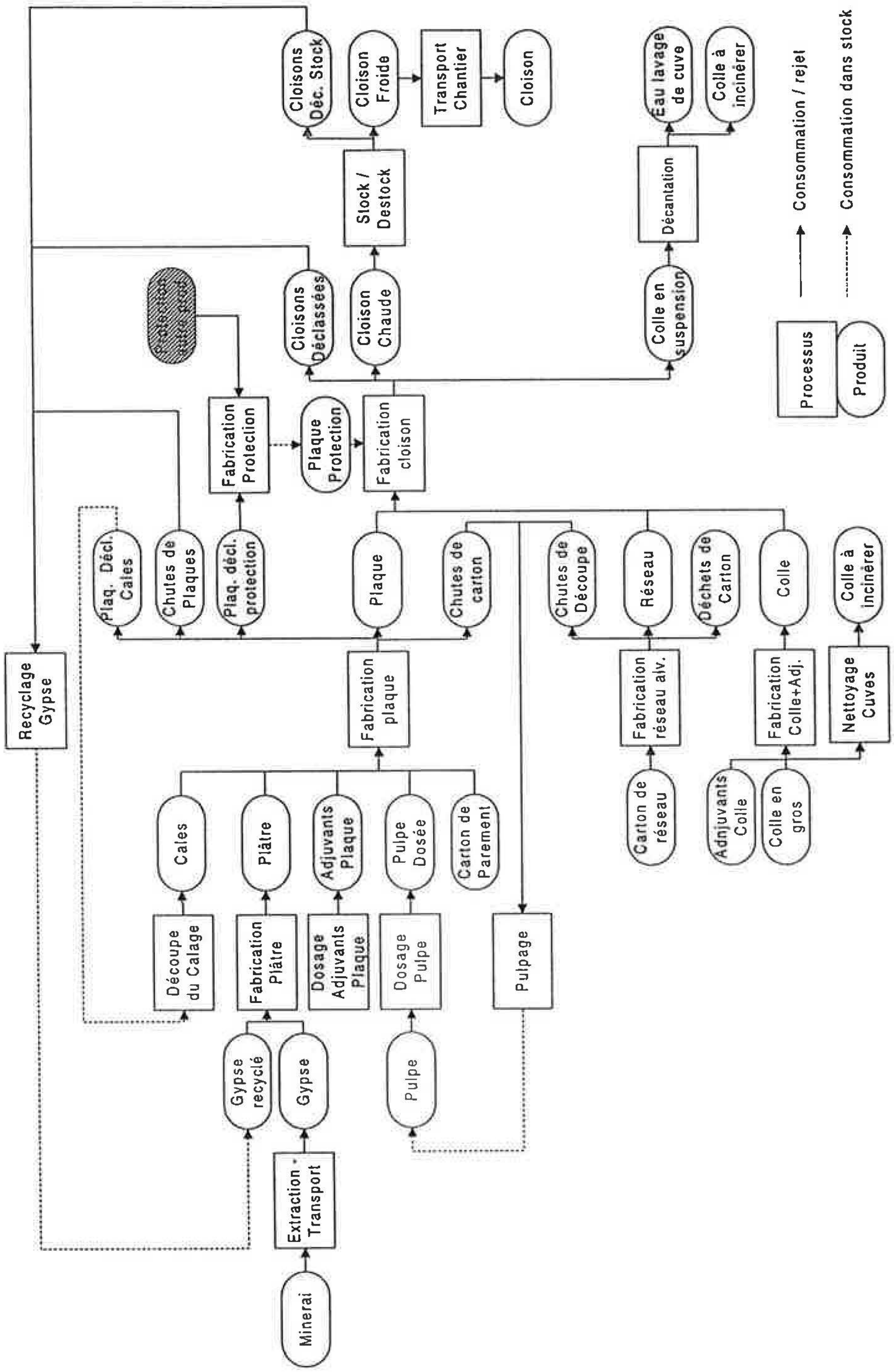

Figure 1 New plaster wallboard manufacturing process at the Placoplatre Chambéry plant (with recycling of production waste).

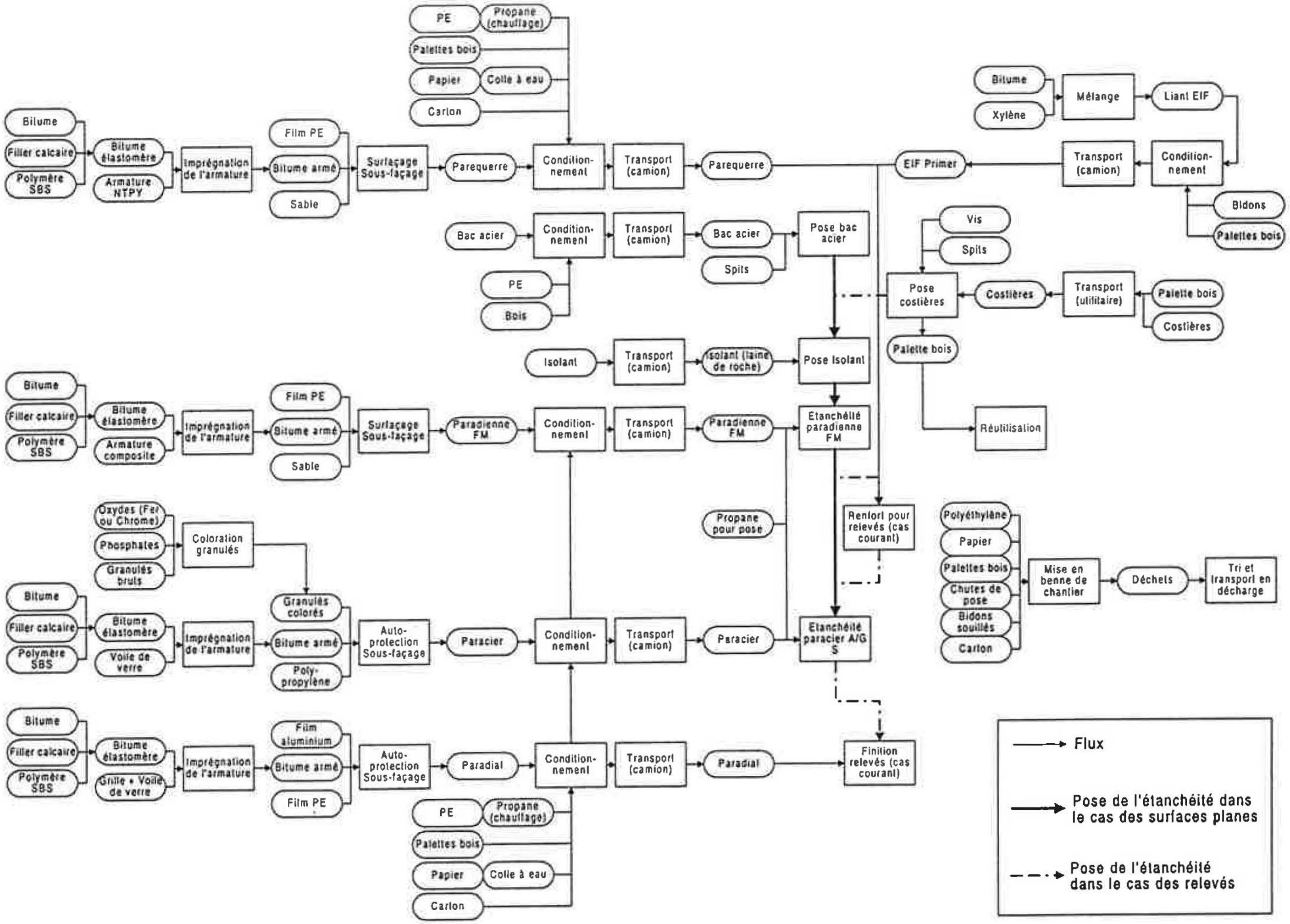

Figure 2 Product tree for the manufacturing and the laying of a bitumen based roof waterproofing solution

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