CRITICAL REVIEW OF ENVIRONMENTAL ASSESSMENT OF BUILDING MATERIALS

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INTRODUCTION

Many interests and issues compete for professional building designers' attention and priorities. Indoor air quality and "sustainable design" have been increasingly among these interests in recent years. While neither has yet gained widespread acceptance or general use in the building design professions, both are now being used more frequently in the United States and certain parts of Europe. The tools available to designers include several directly using or derived from life cycle assessment (LCA) software and concept approaches.

Many diverse methods are available for assessment of the environmental performance of building materials and products. These methods are distinct from those used to evaluate whole building environmental performance or energy consumption. Product manufacturers, governments, building design professionals. and other decision makers are relying increasingly on such product assessments in making important decisions. Most of these assessments are dominated by analyses of embodied environmental impacts and fail adequately to address in-use performance. This is partly due to the complexity of the interactions among building components and between buildings and the environment during the use phase. A review of the most prominent of these methods shows them to be highly diverse in their focus, approaches, and intended uses.

Major shortcomings are the lack of comprehensiveness and the failure adequately to treat uncertainties. Methodological issues that should be addressed include integrating data uncertainty into decision analysis, rating the relative importance of various environmental impacts, and integration of indoor air quality, building energy performance, and life cycle assessment. Tools are needed that are focused on specific intended audiences and applications.

NEED FOR TOTAL LIFE CYCLE PERFORMANCE ASSESSMENT

While many LCA's have been performed on building materials, few have been extended over the whole product or material life cycle including the use phase. Among the most important but frequently neglected aspects of the use phase are 1) the operational energy implications of using one product rather than another and 2) the chemical or other product and process requirements for the maintenance, cleaning, repair, refinishing, and finally the removal and replacement of products at the end of their service lives.

Analysis or comparison of products that do not take into account the use phase will ignore energy consumption that may be many times that involved in the production, installation, and end-of-life disposition of a product or material. The longer the building life, the more important the use phase environmental costs and the less important the embodied environmental costs.

NEED FOR PRODUCT SPECIFIC ENVIRONMENTAL ASSESSMENTS

The practice of conducting LCAs on product categories ignores the large differences that can exist among products in a given category. However, designers and other decision-makers must compare and finally select specific products rather than product categories. Therefore, data on specific products and processes rather than generic product or process types are essential to increasing the relevance and applicability of product environmental assessments. There will usually be a range of product performance within a product category.

For example, when comparing two products from a single category, e.g., floor coverings, it is quite possible that the worst product in the best category performs worse environmentally than the best product in a less-highly rated category. Thus, by simply assessing product categories, the information provided by LCAs and other environmental assessment methods may mislead decision-makers and result in poorer environmental decisions.

Need for product specific data

One of the primary reasons environmental assessments are done on product categories rather than on specific products is that data are difficult to obtain on specific products. By including a whole industry, the variations in actual data versus reported data can be easily ignored. Manufacturers assert product proprietary information as an excuse for not divulging details of the materials and processes involved in production of their products. But the use of industry averages or aggregates can be very misleading when there are large differences among products.

Products vary over time. Feedstocks for chemical products can change from batch to batch where manufacturers change suppliers for cost or quality control reasons. Processes can vary from one factory to another within a company. In the U.S., one major composite wood product manufacturer standardizes its operations in all its plants while another does not. Even so, the products are labelled identically from the later company so that the purchaser does not know what materials actually went into the product or where it was produced. Different species of wood used in particle board results in different VOC emission characteristics, an important consideration in total life cycle assessment of product environmental performance.

LCAs that have been done on building materials have either ignored indoor air quality (IAQ) or have actually stated that integration of IAQ into LCA practice is either impractical or infeasible . Their assertion hinges around their perception of the relative availability of data and the complexity of its analysis for general environmental impacts and for IAQ impacts . Generally LCA practitioners lack awareness of the methods and practices available to evaluate or compare products' IAQ performance. This issue is addressed and methods for integrating IAQ into LCA practice are presented in a separate paper submitted for presentation at Sustainable Buildings 2000.

Selection of Building Materials is Product Specific.

Many materials require periodic surface treatments and cleaning in order to perform well. For example, many non-textile flooring products require lacquer and wax applications to protect their material surface and improve their appearance. The total life cycle emissions from such products can easily exceed those from the material to which they are applied. Therefore, emissions from products routinely used with a given material should be included in analysis of Life Cycle IAQ. They should also be used in building material selection processes based solely on IAQ. So-called "green" paints that are not easily cleanable result in more frequent painting and, therefore, potentially larger emissions over the life cycle.

NEED FOR INCLUSION OF UNCERTAINTY

The uncertainty in environmental assessment of building materials and products can be quite large. Many LCA's ignore this uncertainty. In fact, it is not uncommon to see impacts reported with three, four, or even five significant digits. In fact, variations in data reliability and accuracy suggest that two significant digits is often the best accuracy that can be obtained. Yet the precision of the reported values misleads the user into believing that there is appropriate accuracy to justify the precision. On the contrary, plus and minus value calculations or estimates ought to be included in order to convey more correctly the accuracy of the reported data.

Furthermore, data uncertainty can result in incorrect or inappropriate decisions. Where some factors or indices of environmental performance are well-characterized and others are less-well characterized, decisions should not be based on the less reliable data.

By explicitly identifying the data uncertainty, appropriate emphasis can be placed on the more certain data. Decisions should be avoided on the basis of uncertain data where the differences among products or materials is small based on the more certain data.

NEED FOR INTEGRATED DESIGN AND OTHER DECISION TOOLS

Designers and other product specifiers are not likely to perform LCAs on products if they must enter extensive data on their building in order to understand the implications of selecting one product or another. The most likely scenario is that LCA-based analyses will be transparently and seamlessly integrated into computer aided drafting and design (CADD) software so that data are automatically available to the program for the analysis. If designers can simply do what they are used to doing and be given data and other feedback on the environmental implications of the choices they make, they are far more likely to consider environmental consequences of selecting one or another product or material.

DISCUSSION

There are many shortcomings of the environmental analyses available to date on building materials and products. Yet there is a large demand for information in order to make “environmentally-correct” decisions. It is important to improve the methods and processes for evaluating building materials and products so that decision-makers do not draw inappropriate conclusions and select products without more reliable environmental impact assessment.

CONCLUSION

When more accurate, reliable, and easier-to-use environmental assessments are available, they will enhance designers’ and other decision-makers’ abilities to make sounder environmental decisions. Meanwhile, we must work to improve the accuracy, reliability, and transparency of environmental data on building materials by acquiring product specific data, including uncertainty in the analyses, and reporting the results with proper characterization of the inherent uncertainties. Furthermore, there is a need for integration of the environmental costs of the use phase of a product or material’s life cycle including energy and indoor air quality performance. In the future, integration into design professionals’ normal software of environmental analysis tools for comparing building materials and products will facilitate the more widespread acceptance and use of the data produced by environmental analyses such as life cycle assessments.