ENVIRONMENTAL LIFE CYCLE ASSESSMENT (LCA)

PENELOPE MITCHELL

1997 GOTTSTEIN FELLOWSHIP REPORT

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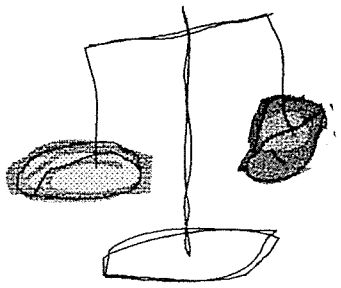
ENVIRONMENTAL LIFE CYCLE ASSESSMENT (LCA)

A REPORT FOR THE

JOSEPH WILLIAM GOTTSTEIN MEMORIAL TRUST FUND



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Penelope Mitchell is a Research Scholar in the Department of Architecture at the University of Queensland. She is studying Life-Cycle Assessment LCA) methodologies for building materials. Her particular objective during her Gottstein Fellowship was to concentrate on plywood architectural systems to enable life-cycle examinations of plywood-products to be undertaken in terms of their environmental sustainability. She visited research and industry organisations in Europe and North America and has presented 26 case studies outlining current developments in the LCA area..

The Plywood Association of Australia was also a major contributor towards the funding of this study.

JOSEPH WILLIAM GOTTSTEIN MEMORIAL TRUST FUND

The Joseph William Gottstein Memorial Trust Fund was established in 1971 as a national education Trust for the benefit of Australia's forest products industries. The purpose of the fund is *'to create opportunities for selected persons to acquire knowledge which will promote the interests of Australian industries which use forest products for the production of sawn timber, plywood, composite wood, pulp and paper and similar derived products'.*

Bill Gottstein was an outstanding forest products research scientist working with the Division of Forest Products of the Commonwealth Scientific Industrial Research Organisation (CSIRO) when tragically killed in 1971 photographing a tree-felling operation in New Guinea. He was held in such high esteem by the industry that he had assisted for many years that substantial financial support to establish an Educational Trust Fund to perpetuate his name was promptly forthcoming.

The Trust's major forms of activity are,

1. Fellowships - each year applications are invited from eligible candidates to submit a study programme in an area considered to be of benefit to the Australian forestry and forest industries. Study tours undertaken by Fellows have usually been to overseas countries but several have been within Australia. Fellows are obliged to submit reports on completion of their programme. These are then distributed to industry if appropriate.

2. Seminars - the information gained by Fellows is often best disseminated by seminars as well as through the written reports.

3. Wood Science Course - at approximately two yearly intervals the Trust organises a week-long intensive course in wood science for executives and consultants in the Australian forest industries.

4. Study Tours - industry group study tours are arranged periodically and have been well supported.

Further information may be obtained by writing,

The Secretary,
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Clayton South M. D. C.
VICTORIA, 3169, AUSTRALIA

ACKNOWLEDGEMENTS

This report is the result of overseas field research sponsored by the Gottstein Memorial Trust Fund. I express my sincere gratitude to this organisation for providing the opportunity of overseas research.

The report and information collected also represent the first year of research for my Doctoral Thesis. This is being undertaken within the department of Architecture, University of Queensland, Australia. I would like to thank my supervisor, Dr. Richard Hyde, and the main industry supporter, the Plywood Association of Australia (PAA).

I would also like to thank all the people and organisations who took time to see me and provide me with information during my travels. Without their cooperation this report would not have been possible. Also thanks to the Martin Centre for Urban Design, Department of Architecture, Cambridge University, for providing much needed facilities during my time in England.

Thanks to Harry Greaves, Richard Hyde, Kevin Lyngcoln, Leigh Punton, David Strohfeldt, Paul Raynis, and Peter Skinner, for their valued comments on, and editing of, this report.

On a personal note, I would like to thank my family here for much needed support during the researching and writing of this report, and in England for hosting my stay there. And thanks to Dion Keetley for salvaging most of my work from a corrupt computer file!

Penelope Mitchell

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All images are reproduced from photos taken by the author during the oversea field research.

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EXECUTIVE SUMMARY

1. BACKGROUND

The new awareness of the concept of sustainable development sets the background for this report. This notion of everyone taking responsibility for their actions in a holistic context is significant. It requires individuals and industry alike to account for their impacts on the environment. Problems exist in measuring environmental variables however, and sustainable development is far from quantifiable. Means to allow environmentally consistent scientific and systematic choices are required.

This report is an initial examination of one method for environmental management of environmental variables. Environmental Life Cycle Assessment (LCA) is being considered as appropriate for addressing specific environmental questions in relation to materials, products and processes. LCA is introduced and investigated as a tool which will aid industry in its environmental strategies.

2. KEY CONCLUSIONS

This report aims to consolidate the state of the art in Life Cycle Assessment. This field is rapidly expanding and the introduction into ISOs Environmental Management standards has seen much advancement. At the time of writing some major conclusions arose from the research conducted:

- LCA is under development. It is important that industry become involved in this process in order that LCA reflect its needs.
- The economic benefits for undertaking LCA should not be understated. The market advantage as well as the benefits of a more efficient process require acknowledgement.
- The LCA process is important in understanding all consequences. Ideally industry themselves should become involved in this undertaking in order to better realise the implications .
- Product comparison using LCA is at present problematic due to the underdeveloped nature of LCAs.
- The complexity of current LCA tools is detrimental to the implementation within wider industry. LCAs need to be simplified and issues that can aid this should be focussed on.
- All stakeholders need to be involved in both the model development and the LCA process in order for an appropriate tool to emerge and so that the issues involved are understood.

3. REPORT SUMMARY

Introduction

- Introduction to the Sustainable Development Concept and Environmental Issues and Impacts
- Introduction to Societal Responsibility and in particular the Building Industry's Responsibility
- Reasons for this Investigation,
- The Gottstein Fellowships role in this report
- Investigation Methodology and the Structure of the report.

Sustainable Development

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- Review of all organisations visited in case study form
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- Relevant documents supporting research methodology and analysis
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1.0

INTRODUCTION

Picture 1

1.0

INTRODUCTION

'Business and industry, particularly in developed countries, should fulfill their responsibility for managing the life-cycle of the goods and services they supply and are encouraged to provide information on the environmental and health effects arising from the production and consumption of their products.'

United Nations Commission on Sustainable Development, April 1995

1.1 AIMS

Sustainable Development has become a defining term for society over the last decade.[1] Issues including environmental destruction, use of unrenewable resources, pollution and energy use are being targeted for direct action.[2] Responsibility for environmental impact requires consideration and understanding by all sectors of society. Industry and architects need to be aware of their responsibility, since over 50% of material resources extracted from nature are used in building-related applications.[3] The building industry is also responsible for over 50% of waste discarded to the environment.[4] These are large stakes, and in order for industry to accept responsibility and meet environmental challenges, adequate information must be available to it.

Tools aimed at reducing environmental impact and aiding sustainable development are emerging. Environmental Life Cycle Assessment (LCA) in particular is considered appropriate for addressing specific environmental questions in relation to materials, products and processes. The International Organisation for Standardisation's (ISO's) adoption of the LCA concept is a significant advancement in sustainable development endeavours. The aim of this report is to introduce these issues and to investigate LCA as an appropriate tool to aid industry in its environmental strategies.

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1 Sustainable Development was brought to worldwide attention in 1987 when the World Commission for Environmental and Development commissioned and published the Brundtland Report on Sustainable Development. See **Section 2: Sustainable Development.**

2 The ISO 14000 Environmental Management Standards address environmental management tools and systems, which directly acknowledges the Business Council for Sustainable Development, who state industry and business need to deal with the environmental burdens they create.

3 Anink, D., Boonstra, C. and Mak, J. (1996) 'Handbook of Sustainable Building: An Environmental Preference Method for Selection of Materials for Use in Construction and Refurbishment,' James and James (Science Publishers) Limited, p. 8.

4 IBID.

This chapter discusses the background leading to the need for investigation in the LCA area, the purpose of the author"s Gottstein Fellowship study in analysing LCAs, the methodology used in the collection and interpretation of relevant information, and the structure of the following report.

1.2 BACKGROUND

The sustainable development concept[5] introduced the notion that our actions have some consequence not only on the environment, but also on the provisions for the future population. This concept is significant as it asserts that all of society is responsible for manipulating the environment, whether it be by the use of resources or by the emission of wastes, to meet its own needs. The use of the environment, in any endeavour, leads to impacts on natural systems. These impacts may be localised, individual or site specific, but their accumulative effects are now being experienced on a global scale.

It is recognised that business and industry need to be accountable for the goods and services they provide, in regard to the impacts caused by these commodities. The building sector in particular has significant impact with respect to resources used and wastes produced during operations. The timber industry, for example, has been under scrutiny for many years over forestry practices, biodiversity loss, timber consumption and emissions caused by the use of timber preservatives and chemical adhesives[6] in manufacturing processes. The burdens that the industry places on the environment need to be recognised, and awareness of the issues needs to be related to product development.

Means are required to address these issues in all stages, from extraction of resources, through manufacturing, distribution, consumption and re-use. Problems exist at present, though, for any organisation or individual trying to achieve these aims. Even though sustainable development issues have been of high priority since 1987,[7] there is a lack of scientific environmental information available. Appropriate methodologies to collect and analyse this data are also inadequate. The International Organization for Standardisation (ISO) has begun the process of introducing a series of environmental management standards, and the first standards were published near the end of 1996.[8] It is only recently, however, that these have started to be applied. 'In recent months the ISO 14000 standards have been

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5 See **Section 2: Sustainable Development**

6 The plywood industry, for example, uses phenolic resins to bind the ply veneers.

7 The World Commission for Environment and Development commissioned the Brundtland Report on Sustainable Development which was published in 1987, see **Section 2: Sustainable Development.**

8 The first ISO Environmental Management Standards were published as final documents in September 1996. These initial standards were:

- ISO 14001 Environmental Management Systems - Specification with Guidance for Use; and
- ISO 14004 Environmental Management Systems - General Guidelines on Principles, Systems and Supporting Techniques.

making the transition from the hands of the developers to the market place.'[9]

Although industry and architects have concerns with regard to sustainable development,[10] they do not yet have detailed information or adequate tools to measure environmental variables. General publications espousing 'green design' issues and 'healthy housing' concepts, however, are extensive.[11] This material often provides unsubstantiated and unverifiable information. The foundations for many of these claims are untenable and require some scientific verification. In order to meet the challenges of the emerging environmental agenda, architects and industry need to be equipped with precise information. Tools need to be developed that will allow environmentally consistent scientific and systematic choices to be made.

It has been suggested that a life cycle approach to material sustainability will address some of the issues and begin to examine 'the links between societal needs, economic systems and their environmental consequences.'[12] The Life Cycle Assessment approach is set to have major implications for industry in terms of product development, marketing and international trade. Although not a new concept, it has only been within the last decade that LCA has been given serious recognition within, for example, the European community, and thus it has had little impact so far within Australia. The majority of research and implementation in the LCA arena has occurred within Europe, and to a more limited extent within

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9 Bauer, L. (1997) 'Thinking Globally', Consensus, Canada's Newsmagazine of Standardisation, Vol. 24, No. 3, p. 3.

10 The Royal Australian Institute of Architects (RAIA), for example, have adopted broad environmental policies and strategies in their RAIA Environment Design Guide and International architectural, engineering and building institutes have implemented environmental principles in recognition of the environmental impact of buildings. See, for example, the Building Research Establishment's 'Environmental Assessment Method' [AJ (1991) 'Greening the Practice: 5 Sources of Information,' 27 Nov., pp 58 - 61] and the American Institute of Architects' 'Environmental Resource Guide' [Wilson, A. (1991) 'Material Alternatives,' Architecture: The AIA Journal, Vol. 80, No. 5, May, pp. 113 - 118].

11 For example, in terms of 'healthy housing', there has been a vast array of literature dealing with internal air quality, in particular, dealing with off-gassing from building materials:

- Lyons, M. (1987) 'General Air Quality,' A. A. A. News
- The Asthma Foundation of Victoria (1994) 'Major Allergens,' & 'Breathe Easy Home Design.'
- Greenpeace (Undated) 'Toxic Alert.'
- Choice (1993) 'Home Sick,' Jan. pp. 30 - 35
- Bita, N. (1996) 'CSIRO tests for Indoor Pollution,' The Australian, 8th May.
- Hammond, J. (1993) 'Toxic Gas Found in Building Materials', The Australian, 15th April.
- RAIA & Australian Federal Government (1993) 'Design for Better Living.'

This list is minor compared to the amount of publications, articles and brochures available on this subject

12 Keoleian, G. & Menerey, D. (1994) 'Sustainable Development by Design: Review of Life Cycle Design and Related Approaches', Air & Waste, Vol. 44, May, p. 645.

Canada and the USA. The ISO developments will set the boundaries for LCA applications, and tools relevant to Australian organisations will need to emerge from these standards.

It was with the aim of studying the international LCA developments particularly in relation to ongoing research, developments within the timber industry and LCA tools and their effectiveness, that the author applied for a Gottstein Fellowship.

1.3 PURPOSE OF GOTTSTEIN FELLOWSHIP

The purpose for the Gottstein Fellowship was to obtain funding in order to:

1. Examine the developments in the Life Cycle Assessment (LCA) field;
2. Analyse existing LCA models; and
3. Examine the response by the timber industry in particular to the need for a more comprehensive environmental assessment of its products and processes.

The lack of work on LCAs in Australia has made it difficult to obtain the relevant information with regard to research and development in this field. In Europe, and to a lesser extent in Canada and the USA, rapid development has been taking place. In order to explore the state-of-the-art in the LCA field, international research was considered vital. Examination of the overseas timber industries' utilisation and knowledge of LCAs was also made possible through such an exercise. To collect information which could be relevant to the Australian timber industry, its overseas counterparts needed to be examined in terms of their responses to environmental issues. The Gottstein Trust provided the means to accomplish these aims.

1.4 METHODOLOGY

1.4.1 Research Plan

The lack of investigation and development in LCA and the limited awareness of this concept within industry in Australia made overseas investigation essential. To achieve the aims set out in **Section 1.3: Purpose for Fellowship**, the author travelled to Europe, Canada and the USA. In order to determine the destinations of travel, a list of leading participants in LCA development was established. The author decided that principle players should be identified and visited in order to gain up-to-date knowledge of the LCA arena. An extensive literature search was undertaken of available LCA material and related information. This allowed key organisations and people to be identified, while also providing an initial background to LCA studies and associated issues. The determination of principle players within the LCA field established a basis for determining centres to visit.

The countries of travel were determined[13] and a diverse range of organisations were pinpointed, within these nations, to visit. The nature of the organisations differ considerably and cannot be easily categorised. Broad classifications, however, include:

1. **Forest and Wood Products Research Groups and Industry Bodies**
   Including BFH, Tratek, Skogforsk and WWPA[14]
2. **LCA Practitioners and Developers**
   Most importantly Sustainability, SPOLD, Ecobilan[15]
3. **University Research Bodies**
   Including CML, IVAM and TUDelft[16]
4. **Government Standards and Regulating Bodies**
   For example CEC and AFNOR[17]

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13 It was decided that Europe would constitute the main focus of the trip as the LCA field there is developing most rapidly. Fortunately many of the relevant parties are situated within Central and Northern Europe. The situation in Canada and the United States of America, however, is considerably different, with the organisations being widely dispersed. It was impossible, given the time frame, to visit all essential parties. It was thus decided that this part of the trip would be restricted to the West Coast of America. This choice was made primarily because of the availability of timber organisations along the West Coast, including the American Plywood Association (APA) and Western Wood Products Association (WWPA). See **Case Studies 24 and 25** respectively

14 See **Case Studies: 9, 15, 13 and 25** respectively.

15 See **Case Studies: 1, 4 and 21** respectively.

16 See **Case Studies: 7, 8 and 6** respectively.

17 See **Case Studies: 3 and 20** respectively.

Many of the organisations fall into more than one of the above categories,[18] some are dominantly environmental research bodies[19] and some are government-based environmental research organisations.[20] Not all important organisations and people involved in LCA were available for a meeting and in some instances time did not permit a visit. The additional contacts which are considered relevant are listed in the appendices.[21]

Once the principle organisations and people were identified, introductory letters were sent. The Plywood Association of Australia (PAA) established contact with the majority of the Timber and Plywood research bodies and organisations on the author's behalf.[22] Institutions and LCA organisations were contacted by the author[23] through the University of Queensland, with an accompanying letter of introduction from Dr. Richard Hyde.[24]

The author travelled to the United Kingdom and was based at the Martin Centre, Department of Architecture at Cambridge University. From this base, further literature was studied and an itinerary finalised. Communication with the necessary organisations in Europe was undertaken in order to determine an appropriate travel plan.[25] Two organisations[26] were visited prior to the finalization of the itinerary in order to investigate time considerations and interview structures.

1.4.2 Data Collection

The author decided to visit each principle organisation and conduct an interview in order to collect relevant knowledge.[27] At this stage general knowledge about LCA development and application, rather

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18 For example, some of the university research bodies are involved in environmental and LCA developments and, in fact, CIT Ekologik [see **Case Study 12**] are practitioners and also affiliated with the university.

19 For example, IIED [See **Case Study 2: IIED**].

20 For example, AFR - Naturvardsverket [See **Case Study 16:** AFR - Naturvardsverket].

21 See **Appendix 1: Contacts List.**

22 See **Appendix 2: PAA Letter of Introduction.**

23 See **Appendix 3: Letter of Introduction.**

24 Dr. Richard Hyde is a senior lecturer and the authors supervisor within the Department of Architecture at the University of Queensland.

25 See **Appendix 4: Overseas Itinerary.**

26 Sustainability (See **Case Study 1**) and IIED (See **Case Study 2**) were the initial organisations visited.

27 See **Section 5: Overseas Field Research: Case Studies**

than quantitative information, was required. An open, unstructured interview approach was chosen. It was thought that this type of interview would provide more wide-ranging investigation into the qualitative background knowledge which was required. Other tools to collect the required information were considered. Questionnaires, for example, were deemed inappropriate at this stage due to the nature of the information required. What was required from the interviews was an introduction to the organisation and to the LCA field from the interviewees' perspective.

The background information and information pertaining to the organisations' activities in this field would provide a state-of-the-art record of proceedings in LCA. The introduction would facilitate future correspondence in order that more specific questions could be posed at a later stage. Once an anlysis was done on the information collected, further questions or questionnaires could be referred to the organisations. The unstructured interview style also made interviewing vastly dissimilar organisations uncomplicated. Information that had not been previously considered was often identified and issues that may not have emerged in a structured question-and-answer style interview were raised.

The interviews commenced with the author's background and research topic. This statement included:

- The author's architectural background;
- The problems in obtaining accurate and reliable information on architectural materials for specification purposes, in order to take responsibility for materials used;
- The issues involved with the investigation of plywood products, such as timber and sustainability issues, plywood as a value-added product, and adhesive issues; and
- Architectural issues, including Australian building practices and, in particular, the practicality and appropriateness in using lightweight timber-framed and clad buildings in Queensland conditions, and in regard to the use of timber, for example, heavy timber-framed buildings require timber cut from mature trees, light timber frame and light plywood in-fill requires less timber from less mature trees.

After this introduction, a general description regarding the organisation's, and individual's, background and endeavours in the LCA area was sought. The diverse range of organisations meant that a standard format was inappropriate, so although the author had a standard set of questions, these were applied at the author's discretion. The standard question list incorporated issues regarding:

- LCA structure.
- Use of/ intentions of LCA.
- LCA techniques being used/ developed.
- Cradle-to-grave/ operation to operation.
- Outcomes of LCA studies, e.g. report, quantitative summary, etc.
- Advantages.
- ISO developments.
- LCA and Environmental Management Plan.
- Utilisation of other Environmental Management Tools.
- Industry participation.
- Forestry Issues, e.g. Certification, LCA.

As the interviews progressed the standard list of questions evolved and grew as more issues were identified. However, the interview technique did not change.

After each interview important points were documented and notes taken within the interview were reviewed. In many cases the interview was tape-recorded and this enabled a smooth discussion uninterrupted by note taking. The European section of travel ended with a revision and documentation period. During this time communication with Canadian and American organisations resumed and a timetable was organised.[28] This study tour and the interviews were conducted in the same way as the European study. The overseas field research has been important to the improvement of the author's state-of-the-art LCA knowledge and vital to this report and the author's thesis.[29]

1.4.3 Data Analysis

Once the data collection was complete, this report was produced. The information within this report is sourced from the literature studied prior to travel, from documents collected while abroad and the knowledge collected from the organisations visited. It was decided that each of these organisations would constitute a separate case study because of the diverse range of expert knowledge each had. Each person and organisation visited were leaders in their particular field in relation to LCA. The main areas of discussion in the report deal with the major concern of sustainable development and how industry has a major responsibility due to the impacts its operations cause. This is background to the report but sets the context in which to view LCAs.

Product development can play a major determining factor in sustainable development, and tools dealing with these issues need to be investigated. LCA is one tool that can be used. The ISO model is presented, with a description of its structure. Investigation of this structure as appropriate for product assessment needs to be undertaken in subsequent research.[30] The case studies form the major body of this report and are of vital importance to the entire study. They record the background, aims and LCA-Related projects and publications of each organisation as discussed and documented. Most importantly, the issues discussed in each interview are reported. The key issues drawn from this information and the literature study are those that the author found to be the main points for future research.[31] Readers may draw other information from the report depending on their requirements.

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28 See **Appendix 4: Overseas Itinerary**

29 See **Section 6.5 Future Research**

30 See **Section 6.5: Future Research**

31 See **Section 6.: Key Issues and Future Research**

1.5 REPORT STRUCTURE

The goal of this component is to provide an overview of the following report in order to render this document more coherent. It aims to detail the report and make the format comprehensible to the reader. It defines the discussion in each section and identifies those issues that are most relevant to the entire study.

Section two [2.0 Sustainable Development] presents a discussion of sustainable development which provides a basis for LCA considerations. It is thought that environmental considerations raised can be addressed by the introduction of sustainable development. [2.2 Background] Sustainable Development aims to deal with three factors: population; consumption; and technology. [2.3 Sustainable Development Concept] It is within industry's power to consider the reduction of raw material consumption and improvement in technological efficiency. Problems have arisen from the adoption of this notion in the form of 'green consumerism.' Many claims are being made on the basis of little or no scientific merit. [2.4 Responsibility] Tools are emerging in order to provide a framework with which to analyse the sustainablity of products, manufacturing techniques, designs and other human activities. There are many significant tools being developed that address different issues and environmental concerns. [2.5 Tools for Sustainability] The only scientifically based tool, however, to be developed within the international standard framework is Life Cycle Assessment. This will play an important part in all future industrial decisions. [2.6 Life Cycle Assessment Tool]

Section three [3.0 Life Cycle Assessment] details LCA by presenting an overview of the history and emergence. The background of environmental concerns and how LCAs grew out of these issues is discussed. SETAC's role, and that more recently of the International Organisation for Standardisation (ISO), are introduced. Life Cycle Assessment is discussed as a theoretically simple tool. [3.2 Background] The ISO structure is introduced and LCA is presented in terms of these developments. [3.3 International Standards Framework] This is the most widely accepted framework for LCA, even though the documents are not complete. This framework, however is not definitive and should change as new developments are realised and as codes of practice develop.

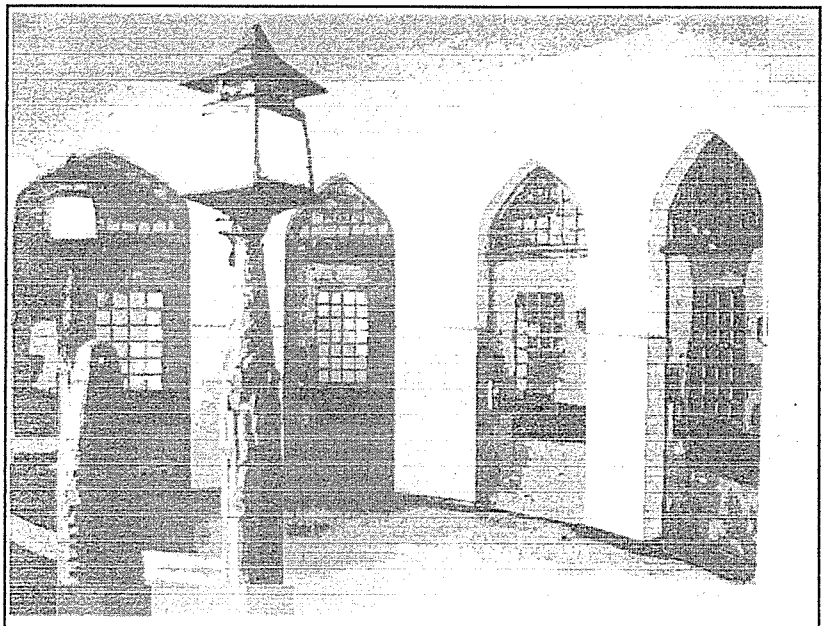
Section four [4.0 ISO Structure] presents the ISO structure as a basic framework for LCA. The LCA phases have been determined and each of these is presented in a basic form. [4.2 LCA Phases] Each of the phases is discussed as set out in the standards, including: Goal and Scope [4.3 Goal and Scope Definition]; Life Cycle Inventory Analysis [4.4 Life Cycle Inventory Analysis]; Life Cycle Impact Assessment [4.5 Life Cycle Impact Assessment]; and, Life Cycle Interpretation [4.6 Life Cycle Interpretation]. Conclusions, recommendations and reporting, as defined by ISO are also included. [4.7 Conclusions, Recommendations and Reporting] This section has been included primarily as a concise overview of LCA for those in the timber industry with limited knowledge of LCA. It is considered to be a good framework to work from in order to develop a simpler methodology that can be implemented by industry. It is not deemed to be a model that will be easily implemented in its current state, but should serve as a framework for subsequent analysis.

Section five [5.0 Overseas Field Research: Case Studies] reports the information collected during the interviews at 26 different organisations. Each of the organisations is presented as a separate case study. The case studies examine the organisations' background, goals, publications and projects undertaken in the LCA field and the issues discussed in each interview. The case studies form a substantial part of this report and are considered essential for those with an interest in the LCA field. Many references, including links to Internet sites, are included.

Section six [6.0 Key Issues and Future Research Areas] discusses each of the key issues considered relevant to the report and further study proposed. These issues are presented in two parts: those key issues determined from the literature [6.3 Key Issues from Literature]; and those from the case studies. [6.4 Key Issues from Case Studies] These points do overlap and reinforce each other. They are issues that need further analysis and development. The proposed scope and methodology of the authors Doctoral work is briefly detailed. This future work will investigate some of the possible issues and strategies regarding LCA for the Australian Plywood Industry.[6.5 Future Research]

2.0

SUSTAINABLE DEVELOPMENT



Picture 2

2.0

SUSTAINABLE DEVELOPMENT

'The major cause of the continued deterioration of the global environment is the unsustainable patterns of consumption and production, particularly in industrialised countries.'

Agenda 21, United Nations Commission on Environment and Development

2.1 AIMS

Environmental issues are becoming important in all aspects of society. There is a need to address problems through application of the concept of sustainable development. There is a requirement, however, to define sustainable development and how it can be achieved. Responsibility for actions is being placed on society as a whole and each individual and organisation needs to address its actions in regard to environmental burdens. Taking responsibility, however, is in many cases problematic since the structures are not yet in place to aid these endeavours.[1] Architects and industry require an environmental management "toolbox" in order to deal with their environmental obligations. LCA is one tool that may address the particular area of evaluating a products' environmental performance. The aim of this section is to introduce the concept of sustainable development and how industry and architects can address this concept.

2.2 BACKGROUND

Environmental protection is increasingly becoming a more important issue which will require progressively more attention in the future. Problems including the overexploitation and destruction of the earth's natural resources have been caused largely by lack of knowledge regarding ecological cycles. Nature was, in the past, considered an infinite resource and little care was taken to preserve this asset. We are now facing a critical challenge in the protection of the environment. We have seen a change in the nature of the problems we face. Localised point source damages have decreased,[2] while ubiquitous problems, including climate change and ozone depletion, have significantly increased. The injury that has been inflicted is not restricted to the environment. Toxic emissions and hazardous

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1 Although there exists some environmental guidelines (for example, the RAIA's Environment Design Guide for Architects) and the ISO 14000 Environmental Management Standards are emerging, the holistic structures are not in place. Those existing frameworks are only beginning to find their feet, and it will be a long process before the structures can be widely understood and readily implemented.

2 Lundberg, B. (1996) 'IVL: Facts For Action,' sourced from Internet, see **Case Study 11: IVL.**

substances are greatly affecting human health.[3]

Unfortunately there is no existing 'universally accepted and scientifically defensible way of prioritising environmental concerns.'[4] Environmental protection is a political, social and industrial issue, and as such needs to be dealt with on a broad scale. Market forces need to work 'to protect and improve the quality of the environment with the help of performance-based standards and judicious use of economic instruments in a harmonious regulatory framework' as this 'is one of the greatest challenges that the world faces in the next decade.'[5]

Sustainable development has been extensively acknowledged and should be widely implemented in order to 'balance with nature' through a 'better management of natural resources and energy.'[6]

2.3 SUSTAINABLE DEVELOPMENT CONCEPT

The Brundtland report published by the World Commission for Environment and Development (WCED) in 1987 bought to our notice the need for 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.'[7] Later in 1992, the Rio Earth Summit again focussed our attention on sustainable development and the concept has continued to have its audience strengthened over the last years.[8] Environmentally sustainable development is often discussed in terms of two issues: ecology and economics,[9] although, sustainability should ideally

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3 Abramson, M. (1992) 'Air pollution and Asthma,' Modern Medicine of Australia, July, pp. 84 - 90.

4 Kirkpatrick, N. (1995) 'Life Cycle Assessment,' Warmer Bulletin, No. 47, Nov.

5 The International Chamber of commerce (ICC) in West, K. (1995) 'Ecolabels: The Industrialization of Environmental Standards,' The Ecologist, Vol. 25, No. 1, Jan/ Feb., p. 17.

6 AFR (1993) 'Swedish Waste Research Council for a Low-Waste Ecocyclic Society.' Stockholm, p. 3.

7 In Hare [Editor] (1990) 'Ecologically Sustainable Development: A Submission,' Australian Conservation Foundation, Greenpeace (Australia), The Wilderness Society and World Wide Fund for Nature (Australia), p. 3.

8 There has been a large body of literature published in relation to 'Environmentally Sustainable Development (ESD)' [Elkington: 1995, Fry: 1994, Papenek: 1995, Pearson: 1989, Vale: 1991, for example]. Building and related materials industries are being targeted to adopt environmental principles in recognition of the environmental impacts of buildings [American Institute of Architects in Wilson: 1991, Anik et al: 1996, The Building Research Establishment Environmental Assessment Method in AJ: 1991, are just a few references]. In Australia, the Royal Australian Institute of Architects has adopted broad environmental policies and strategies [RAIA Environment Design Guide: 1994].

9 Hare [Editor] (1990) 'Ecologically Sustainable Development: A Submission,' Australian Conservation Foundation, Greenpeace (Australia), The Wilderness Society and World Wide Fund for Nature (Australia).

envelope 'resource and environmental management and social equity and cultural issues.'[10] This is in keeping with the 1992 Rio Declaration which states 'sustainable development requires not only external environmental aspects but also social and both occupational and environmental aspects.'[11] Ideally, sustainable development should encompass ecology, economics and social issues, that is what SustainAbility[12] terms the 'triple bottom line' - 'people, planet, profit.'[13]

The need for the term 'sustainable development' arose due to the magnitude of problems being caused on a worldwide scale. The high use of unrenewable resources, the major impact of waste disposal and increased incidence of, for example, pollution, acidification, ozone depletion and other greenhouse effects, has made it imperative that some action is taken. The concept of sustainable development has been generally accepted, although environmental marketing and 'green consumerism' has led to the liberal use of the term.[14] The concept that future generations be provided for by an 'awareness of the consequences of our actions'[15] is understood. To achieve this goal, strategies for sustainability will need to be adopted. That is : consumption of resources will need to be reduced; wasteful technologies substituted for resource efficient technologies; wastes reduced; pollution prevented; and efficiency promoted. The Australian Federal Government's sustainability principles include: conservation of biodiversity and ecological integrity; constant natural capital and 'sustainable income'; social equity; limits on natural resource use; qualitative development and, pricing environmental values and natural resource use.[16]

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10 Hare [Editor] (1990) 'Ecologically Sustainable Development: A Submission,' Australian Conservation Foundation, Greenpeace (Australia), The Wilderness Society and World Wide Fund for Nature (Australia), p. 4.

11 Udo de Haes, H. [Coordinator](1997) 'Progress report to EU on LCANET for the period March 1996 - March 1997,' European Network for Strategic Life Cycle Assessment Research and Development, Concerted Action in the EU environment and Climate Programme, Leiden, May, p. 42.

12 See **Case Study 1: SustainAbility**

13 SustainAbility (1996) 'Company Profile,' p. 2.

14 Many industries, in recognising environmental marketing, are developing tactics to sell their products. The basis for these claims are generally unsubstantiated by scientific methods. Nearly all the Timber Research Groups and Industry Bodies visited had consumer oriented pamphlets advocating the 'environmental soundness' of wood. Ms Hershberger, of Western Wood Products Association (WWPA) [see Case Study 25: WWPA] commented that most of the brochures contained rhetoric that is not supported by any clear evidence.

15 Meltzer, G. (1995) 'Eco-architectural Education: The Value of Integration and the Integration of Values,' Ecological Perspectives and Teaching Architectural Science, ANZAScA Proceedings, University of Canberra, 11 - 13 July, p. 189.

16 Australian Federal Government (1990) 'Ecologically Sustainable Development: A Commonwealth Discussion Paper,' June.

In order to achieve this goal three key factors need to be addressed - population, consumption and technology. It is within Australia's present capabilities, and crucial to worldwide sustainability, to substantially reduce consumption levels and to greatly improve technological efficiency, that is to improve product design, manufacture and use.

2.4 RESPONSIBILITY

The need to address environmental concerns is clearly the responsibility of society as a whole, as suggested previously. Individuals, industry and commerce, and local and state governments, all need to address specific challenges on both an individual and collaborative basis. [See **Figure 1: 'Responsibility for Environmental Sustainability'**]

Responsibility for Environmental Sustainability

Industry and Commerce responsible for:
- development of environmentally sound products/ processes
- recycling materials from disused products
- management of waste in an environmentally sound way

Individuals responsible for:
- life style and consumption
- choice of products and goods
- how products are used, and turning products in after use for appropriate management

Local Government responsible for:
- efficient waste treatment
- collection systems
- waste treated using environmentally sound methods

State Government responsible for:
- comprehensive responsibility for facilitating changes e.g. Funding research/ development, using appropriate economic instruments

Figure 1: Based on 'Shared Responsibility and Collaboration,' AFR (1993) 'Swedish Waste Research Council For A Low-Waste Ecocyclic Society,' Stockholm, p. 5.

Industry has a direct economic stake in resource use and technology, and precedence has most often been given to its requirements. 'Under our existing economic system, market forces are considered of primary importance in determining what and how industry produces.'[17] The recognition that industry plays an important role in sustainable development has increased, but the technical ability of industry far exceeds the understanding of environmental impacts.[18] Industry needs to adopt technology, products and processes to meet the future expectations of nature and society. 'We must develop production,

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17 Lawson, B., Partridge, H. and Gelder, J. (1995) 'Assessing the Environmental Impact of Building Materials,' RAIA Environmental Design Guide, Feb., Pro. 1, p. 6.

18 In Dow and SuistainAbility's Business Guide, 'Who needs it? Market Implications of Sustainable Lifestyles,' they discuss results of environmental studies as being uncomprehensible to industry.

distribution and consumption systems that reflect the idea of ecocycle society.'[19] [See **Figure 2: Ecocyclic Society'**]

The challenge is to establish a tool that will enable industry to address given environmental criteria, research inadequacies, develop appropriate solutions and inform the community. Industry, it has been determined, must reduce waste replace harmful substances, limit use of non-renewable natural resources, and 'integrate remaining waste products into technical or natural 'ecocycles.''[20] The development of tools for use by industry in its environmental management strategies gives it the ability to take responsibility for its actions.

'ECOCYCLIC SOCIETY'

AFR (See Case Study 16) discusses sustainability in terms of an 'ecocyclic society', whereby all resources are re-routed back into production and consumption flows, thereby reducing raw material and energy consumption.

Characteristics of an 'ecocyclic society' include:

- Uses renewable resources consistent with long term production capacity of nature and ecosystem;
- Reduces consumption of non-renewable resources, dramatically in comparison with current levels;
- Products designed to have least possible impact on the environment and to be optimally recycled and reused;
- Industry uses streamlined, low-resource consuming, environmentally sound manufacturing technology;
- Systems developed and introduced for efficient reuse of products and recycling of materials and energy; and
- Waste that ultimately cannot be directly returned into the ecocycle deposited in a manner that is safe in the long term and sound to the environment.

Figure 2: AFR (1993 'Swedish Waste Research Council For A Low-Waste Ecocyclic Society,' Stockholm, p. 5.

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19 Annenburg, R. (1996) 'Environmental Issues: Working for a better environment,' Naturvardsverket, Swedish Environmental Protection Agency, sourced from the Internet [see Web Address] See also **Case Study 16: AFR - Naturvardsverket.**

20 AFR (1993) 'Swedish Waste Research Council for a Low-Waste Ecocyclic Society.' Stockholm, p. 3.

Environmental impacts could also be reflected in material costs. Resources 'should' be audited by the use of a broad environmental system, allowing access to information and evaluation of the environmental impacts of products and services. The influence that the different methods, research and development, and regulations would have on industries' ability to improve marketing operations, supply better information and analysis, and educate the community could be enormous. Provision of a methodology to assess material impact would allow industry 'which relies so heavily on standards and specifications'[21] a frame work on which to build better practices and indicate areas which need further development. 'Market forces could be harnessed for environmental ends, promoting better industrial practices and reducing related environmental impacts.'[22] Tools that aid development of products with less harmful environmental impact and waste are important in providing industry with the ability to environmentally manage its operations.

2.5 TOOLS FOR SUSTAINABILITY

Environmental problems associated with all areas of a product's life require consideration in a consistent and systematic manner.[23] Guidance is required in order to harmonise with nature's cycles. There is no specific tool to define sustainable development, and a number of tools may be required in order to achieve sustainable development.[24] It is impossible to measure and monitor sustainable development at present without environmental tools to provide scientific knowledge. Without a common framework, decisions in regards to environmental implications are impossible to make.

A case can be presented for the development of scientific tools which can assist industry economically and environmentally in a coherent manner. Many tools dealing with environmental concerns have emerged lately. [See **Figure 3: Environmental Management Tools**] Concepts for product improvement, environmental management, environmental auditing and environmental planning are diverse. Most of these analytical tools are decision making tools aimed at sustainable development, and thus they do not replace the decision making process itself.[25]

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21 Mosberg, S. (1991) 'What Do We Mean By Green?' Progressive Architecture, Vol. 72, No. 3, March, p. 62

22 West, K. (1995) 'Ecolabels: The Industrialization of Environmental Standards,' The Ecologist, Vol. 25, No. 1, Jan/ Feb, p. 16.

23 Danfoss General (Undated) 'Life-Cycle Assessment in Conjunction with Product Development,' sourced from Internet: http://www.danfoss.com/

24 The forestry industry, for example, is currently concentrating all its efforts on certification in order to determine the sustainability of forest management. A scientific and holistic basis is not covered by this means and many issues, including land use issues, are not addressed.

25 See **Section 6.4.1 Decision Making Tool**

2.6 LIFE CYCLE ASSESSMENT TOOL

What is of concern in this case are assessment methods that present an objective way to assess the environmental sustainability of building materials and products. Aside from gaining valuable knowledge on environmental impacts, tools should have the potential to be used to inform the public on environmental issues relating to the product or service. Many tools are based on life cycle models which 'provide a framework within which an LCA process can be designed and implemented.'[26] This life cycle concept is beginning to obtain greater recognition. 'The concept that good product policy is based on an approach in which the entire life cycle of a product is assessed in relation to all aspects of the environment has been highly significant in gaining broad acceptance in society.'[27] In fact LCA is being considered as a widely accepted 'philosophy.' ' Consumers in the shops will become aware that there is such a thing as a 'life cycle,' a highly polluting process may have been used to manufacture an apparently 'environmentally friendly' (e.g. Biodegradable) product.'[28]

Environmental Management Tools

~ Environmental Management Systems
~ Total Quality Environmental Management
~ Environmental Analysis Methods
~ Design for the Environment
~ Environmental Impact Assessment
~ Substance Flow Analysis
~ Environmental Audit
~ Process Technology Study
~ Embodied Energy and Operational Energy Studies
~ Risk Assessment
~ Market Analysis
~ Environmental Monitoring
~ Environmental Performance Analysis
~ Strategic Environmental Assessment
~ Integrated Assessment Modeling
~ Industrial Ecology
~ Total Cost Analysis
~ Waste Stream Analysis and Waste Reduction Schemes
~ Sensitivity Analysis

Figure 3

There are still many reservations with regard to the use of LCA, including the rigid scientific systems inherent and the often hidden values and judgements.[29] However, 'LCA will be a critical component of the emerging business tool-kit for environmental management, and longer-term, sustainable

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26 Elkington, J. et al (1993) 'The LCA Sourcebook: A European Business Guide to Life Cycle Assessment,' SustainAbility, SPOLD and Business for the Environment.

27 Heijungs, R. [Final Ed.] 'Environmental Life Cycle Assessment of Products: Guide,' CML, TNO and B&G, NOH (Coordinated by NOVEM and RIVM), p. v.

28 IBID.

29 Personal phone conversation with Dr Weenen from UNEP who suggested there may be alternatives that also need to be investigated.

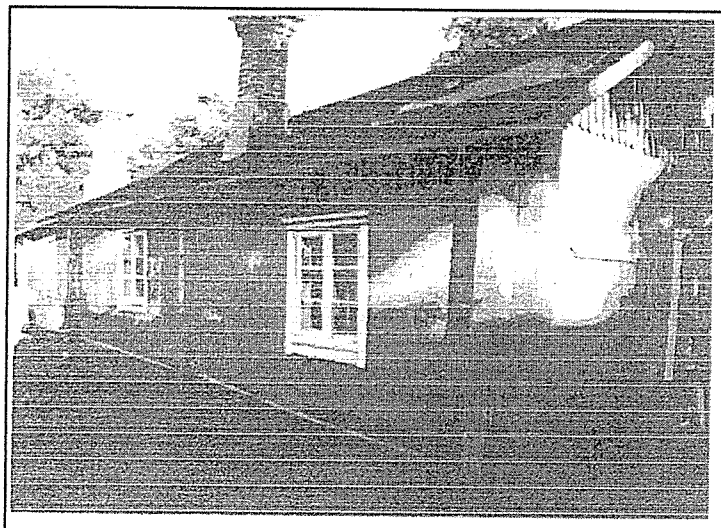
development.'[30] The case for life cycle assessment has already been made; there is a substantial body of literature and numerous companies are making use of tools based on the LCA model. LCA is the only scientific tool of this kind being developed within ISO, which is providing environmental management practice with scientific rigour and regulation.

In order to better understand the inclusion of LCA within the International Standards and the use it may be to the Australian Industry, it is important to note the background developments and today's interest in the field. The next section details the background of LCA in terms of its development, definition and emerging methodologies.

30 Elkington, J. et al (1993) 'The LCA Sourcebook: A European Business Guide to Life Cycle Assessment,' SustainAbility, SPOLD and Business for the Environment.

3.0

LIFE CYCLE ASSESSMENT



Picture 3

3.0

LIFE CYCLE ASSESSMENT

3.1 AIMS

The increasing awareness of environmental concerns and the acceptance of the sustainable development concept, has led to the realisation that society is responsible for its actions. Accepting responsibility is a major step, however, implementing positive change requires knowledge. It has been determined that Life Cycle Assessment tools may aid in providing information in regard to environmental impacts. This would aid in environmental product and technological development in particular, which could in turn lead to a significant reduction in the major negative environmental impacts currently associated with the building industry.

It is important to understand the developments of LCA and to be aware of the people and organisations involved in the development process in order to appreciate the future implications of this tool. LCA has emerged from other environmental research, specifically in the energy field, and has been presented in numerous model forms. The most recent, widely accepted model, has been developed under the International Standards banner. The aim of this section is to discuss LCA in terms of its historical context, definition and implications of developed models, and in particular the ISO framework.

3.2 BACKGROUND

3.2.1 Emergence of Life Cycle Assessment

The 1960s saw an increasing concern for raw material and energy consumption, which was reinforced by the oil crisis of the early 1970s. These issues directed attention towards the need for the development of resource accounting methods, including embodied and operational energy assessment methods and resource inventories. A study undertaken by the Coca Cola company in 1969 acted on these considerations. The organisation endeavoured to determine which packaging posed the least imposition on the environment and its resources. The study, by collecting data on the raw materials consumed, energy utilised, emissions to air and water, and solid wastes associated with the product system, resulted in the initiation of what we now consider the second stage of LCA, the 'Life Cycle Inventory Analysis' (LCI).[1] The report set the standard for conducting life cycle resource inventory studies.

[1] See **Section 4.4: Life Cycle Inventory Analysis.**

Interest in this field, however, somewhat subsided after this due to a shift in environmental concern, particularly in the United States, where the majority of studies were being undertaken. It wasn't until the 1980s that interest in life cycle analysis was reignited, this time within Europe.[2] The Society for Environmental Toxicology and Chemistry [See **Figure 4: Society for Environmental Toxicology and Chemistry, SETAC**] established themselves as a professional body in 1979. Since this time they have been at the forefront of LCA development, and still remain involved in the critical LCA activities.

Society for Environmental Toxicology and Chemistry, SETAC

Formed in 1979, the Society for Environmental Toxicology and Chemistry (SETAC) have been actively involved in the LCA arena. They have been the major LCA discussion and development platform and their 'Code of Practice' was considered the 'LCA Bible'. The organisation is a scientific body and have professional members from many organsations in Europe (See Appendix 1: Contact List)

SETAC developed the first widely accepted LCA methodology and have served as a focal point for further developments. In this capacity they hold workshops focusing on the technical framework, impact analysis, data quality, methodology and acceptable practices. SETAC is endeavoring to focus on appropriate methodologies for industry, as opposed to ecolabelling.

Figure 4

The European Commission created The Environment Directorate (DGXI),[3] and numerous other bodies involved with life cycle thinking, from government, industry and academic sectors, were formed throughout Europe. This led to the re-emergence and further development of initial LCIA studies. It wasn't until the 1990s, however, that Life Cycle Assessments emerged out of LCI, and also energy analysis, research. In the last few years, LCA investigation has rapidly increased and it is now acknowledged by some business, industry and government sectors as a priority issue.[4] Although, it is still a very young and developing area of research, already LCAs have progressed from the purely conceptual level within the academic and scientific arenas to implemented tools. These applications have provided case study accounts of LCA use. The analysis of these practical undertakings have improved understanding of LCA considerably.

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2 SustainAbility, SPOLD and Business for the Environment (1993) 'The LCA Sourcebook: A European Business Guide to Life Cycle Assessment.'

3 See **Case Study 3: CEC.**

4 SustainAbility, SPOLD and Business for the Environment (1993) 'The LCA Sourcebook: A European Business Guide to Life Cycle Assessment.'

This decade has seen continuing discussion on LCAs and SETAC's landmark 'Code of Practice,' [See **Figure 5: From SETAC's 'Code of Practice'**] published in 1991, has become the LCA 'bible'. This laid out a framework for LCA development expanding from the LCI concept to incorporate impact assessment and improvement. The codes provide a solid discussion and development platform, and a focus for technical developments. Workshops staged regularly became the arena for the determination of an agreed methodology and acceptable LCA practices. This has led to increased development within the LCA field and although SETAC has attempted to establish a widely acceptable framework, there still remains a broad range of approaches and methodologies.[5]

Two other widely accepted frameworks include:

- The Nordic Guidelines, published by the Nordic Council of Ministers, that has been widely implemented within Denmark, Finland, Norway and Sweden;[6] and
- The Netherlands' Environmental Life Cycle Assessment of Products guide, commissioned by the National Reuse of Waste Research Programmes (NOH).[7]

Both have been based on SETAC's work, but have been developed more specifically for the countries involved.

From SETAC's 'Code of Practice'

'Life cycle assessment is a process to evaluate the environmental burdens associated with a product, process or activity by identifying and quantifying energy and materials used and wastes released to the environment; to assess the impact of those energy and material uses and releases to the environment; and to identify and evaluate opportunities to effect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing extracting and processing raw materials; manufacturing, transportation and distribution; use, reuse, maintenance, recycling and final disposal.'

Source: Group des Sages (1994) '*Guidelines for the Application of Life Cycle Assessment in the European Union Ecolabelling Programme*', Final report of first phase, Commission of the European Union, Leiden, The Netherlands

Figure 5

5 An analysis of some LCA models available will be undertaken as part of the following doctoral study.

6 See for more information, **Case Study 11: IVL** and **Appendix 1: Contacts List.**

7 See for more information, **Case Study 7: CML.**

Most recently, the International Organization for Standardization (ISO) [See **Figure 6: International Organization for Standardization (ISO)**] has been compiling standards for LCA methods. The basis for these guidelines has been SETAC's work. The ISO Committee consists of members who have been and still are actively involved with SETAC, LCANet and other LCA development organisations.[8] It is expected that these regulations will assist in making worldwide LCAs 'broadly comparable.' LCA is the only environmental scientific tool of this kind to be adopted by the Standards Organization.

INTERNATIONAL ORGANISATION FOR STANDARDISATION (ISO)

It was suggested to ISO by the Strategy Advisory Group on the Environment (SAGE) that standards for 'environmental and management tools and systems be developed'. Technical Committee 207 was established and in 1996 the first ISO 14000 standards were published. The ISO 14000 series are voluntary standards developed in order to assist in the management of environmental impacts within companies.

Endeavours are already being made by ISO to build infrastructure to support the standards. Accreditation of environmental auditors, registrars and certifying bodies, as well as auditor training schemes are being implemented.

Figure 6

3.2.2 What is Life Cycle Assessment

Life Cycle Assessment (LCA) is theoretically a very simple tool for determining the 'cradle-to-grave' impacts of a product on the environment. The logic of LCA is uncomplicated, but the implementation of methods has so far been extremely complex.'[9]

A systematic tool, LCA is utilised in the evaluation of a product's environmental impacts during its entire life cycle. All stages and processes involved in a product's life are ascertained - from raw material acquisition through manufacture and use to ultimate disposal. At each stage within a product's system the environmental burdens need to be identified and quantified. Methodological steps to achieve this have been generally agreed upon and are being set out in ISO 14040.[10]

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8 See **Appendix 1: Contacts List** for people involved in SETAC, LCANET and other LCA organisations.

9 Brady, K. [Ed.(1996) 'Ecocycle ... a newsletter on life-cycle tools, management and product policy', Issue No. 3, Winter/ Spring, Editor's column.

10 See **Section 4.0 ISO Structure.**

3.3 International Standards Framework

ISO is in the process of developing a framework for LCA. This section is based on the ISO 14040 series on Life Cycle Assessment. Specifically, the following standards have been utilised:

- ISO 14040 — Environmental Management - Life cycle assessment - Principles and framework.
- ISO/DIS 14041 — Environmental Management - Life cycle assessment - Goal and Scope Definition and Inventory Analysis
- ISO/CD 14042.1 — Environmental Management - Life cycle assessment - Life Cycle Impact Assessment
- ISO/CD 14043.1 — Environmental Management - Life cycle assessment - Life Cycle Interpretation

The first standard has recently been published and support is 'overwhelming'.[11] At the time of writing, the latter three documents had not been finalised and research was proceeding. The documents do, however, give an idea where efforts are being focussed. It also must be understood , that these documents are not definitive and not all aspects that may be relevant to particular countries or industries are included.[12] As a framework the standards are considered to provide a useful basis for interpretation needed for the analysis of individual products.

The ISO framework is considered to be relatively flexible and should provide the necessary parameters for LCA decision making. It is an important methodology to take into consideration as it will set the future standards. An overview of this structure is crucial to the broader discussion of implementation of LCAs within industry. Firstly, the complexity of LCA needs to be understood, as does the need for transparency in any model which is adopted. There are many LCA models besides ISO's, mostly derived from either the ISO or SETAC structures. Differences between the numerous models exist, and these variations ideally need to be investigated in order to understand why they have been adopted.[13] What is most significant here, though is not the models' differences, but the need for transparency throughout the study and in the model itself. Any assumptions made must be clearly stated and the model and all its phases must be well defined.

It is significant to note the persons and organisations involved in the process of standardisation. The ISO 14040 series development is being aided and influenced by numerous, mainly European, groups and committees. The interrelationships between organisations and people within the LCA field is of particular interest. A table outlining the connections existing between those groups visited and other

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11 CEEM Information Services (1997) 'International Environmental Systems Update,' August.

12 This is particularly so for the wood and wood products industry.

13 It is intended that these models will be investigated more thoroughly in the doctoral study in order to determine an appropriate model for the Australian conditions.

important players in the LCA arena is presented in Appendix 5.[14] Briefly, the tasks of investigating particular areas of the LCA framework have been distributed to organisations and persons with LCA expertise. For example, Erwin Lindeijer of IVAM Environmental Research Group[15] has written a report on 'Valuation in LCA'[16] for the SETAC-Europe Working Group on Impact Assessment. Other documents presented as drafts include a 'Discussion of General Principles and Guidelines for Practical Use,' H. A. Udo de Haes, CML,[17] and a draft on 'Resources,' by Goran Finnveden, IVL.[18] Many of the key researchers throughout Europe are involved with the standardisation process.

Section four of this report is based on the ISO 14040 series. An overview has been presented and this structure will need to be analysed to determine its relevance to Australian industry conditions. It is not considered that this framework is an adequate structure to be able to implement immediately into the Australian industry context.[19] This structure, however, is a good basis to work from in order to develop a simplified model, readily useable by industry. This framework, for example, is being considerably modified and developed for use in the European Union Ecolabelling programme, due to its appropriate structure.

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14 See **Appendix 5: Organisations Connections within the LCA Arena.** This should ideally be read in conjunction with the contacts list.

15 See **Case Study 8: IVAM.**

16 Lineijer, E. (1956) 'Valuation in LCA,' Draft Chapter 7 of WIA report on Impact Assessment.

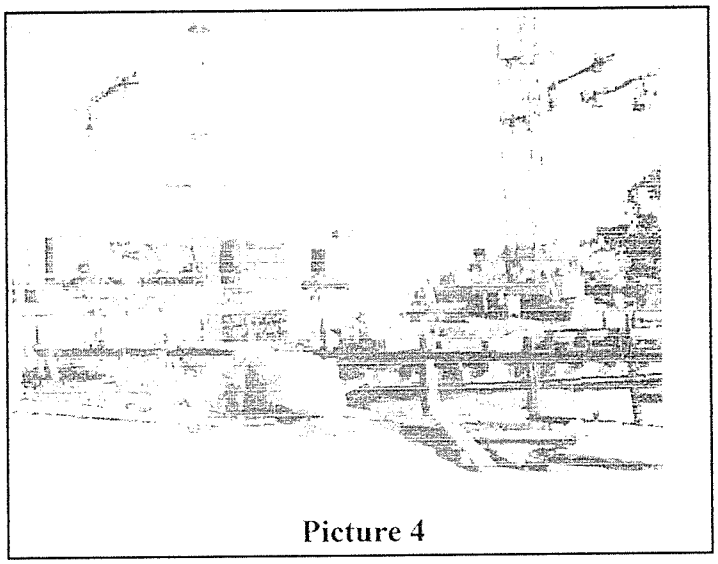
17 See **Case Study 7: CML.**

18 See **Case Study 11: IVL.**

19 Industry context here relates to Australia's conditions and also the lack of research undertaken in this area, including a lack of adequate data which will be required in order to carry out intensive LCAs.

4.0

ISO STRUCTURE



Picture 4

4.0

ISO STRUCTURE

4.1 AIMS

Life Cycle Assessment is considered to be an appropriate tool for industry to environmentally assess its products and the products' processes. ISO has developed a series of standards dealing with LCA which form a basic, but encompassing, framework. It is considered that this structure may be too involved for industry to implement immediately. It is a very important framework, however, to analyse so that an appropriate tool can be developed. The aim of this section is to provide a description of the key parts of ISO. This is not an analysis, although issues considered important are noted as are areas that are deemed to require further research. This overview is drawn from the ISO 14040 Environmental Management series presented in the previous section, which were the latest offerings at the time of writing.

4.2 LCA PHASES

The four phases discussed by ISO originated from SETAC's methodology. It is important to note that initially only three stages were suggested by SETAC at a workshop in 1990: Inventory Analysis; Impact Assessment; and Improvement. These were generally accepted and considered within subsequent organised workshops and finally adopted within SETAC's 'Code of Practice.' [See **Figure 7: SETAC's Initial LCA Phases**]

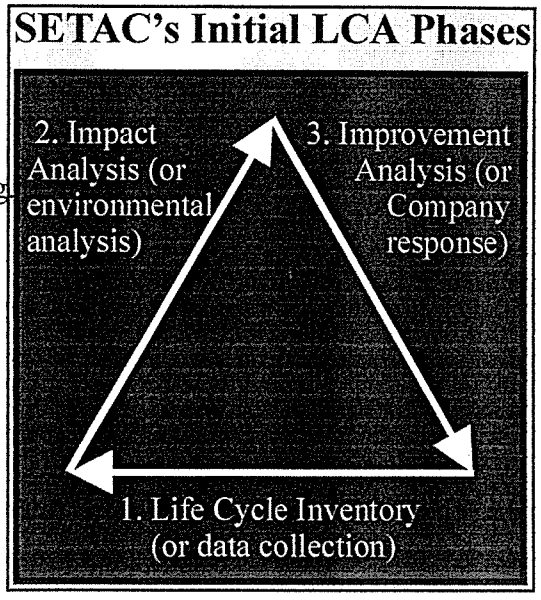


Figure 7: Sustainability, SPOLD and Business for the Environment (1993) 'The LCA Sourcebook,' p. 20.

The expansion to include the initial step of goal definition and subsequent scoping analysis is a significant one. The 'Goal and Scope Definition' is the defining phase for an LCA study. ISO discusses LCA as being composed of the following phases: [See **Figure 8: ISO Phases of a Life Cycle Assessment**]

- Goal and Scope Definition, which defines the purpose and scope of the study;
- Life Cycle Inventory Analysis (LCI), in which resources (including energy) inputs and outputs to a product system are compiled;
- Life Cycle Impact Assessment, which determines the resource use, human health and ecological consequences associated with the inputs and outputs into a product system; and
- Life Cycle Interpretation, in which opportunities to reduce environmental impacts and implement improvement are interpreted and evaluated

This suggests that the goal and scope definition is an integral stage in an LCA rather than a prior consideration.[1] This basic structure, it seems, has been accepted and the standards to date have been well received.[2] Although the LCA phases are distinct and separate, they rely on and compliment each other. They are not required to be undertaken consecutively, in a step-by-step manner. In fact, an iterative process, where the procedures are undertaken co-jointly or are repeated with an increasing level of detail, is part of the approach. The phases themselves do not constitute the LCA procedure, it is the process, and importantly the iterative process, that forms an LCA and enables key areas to be focussed on.

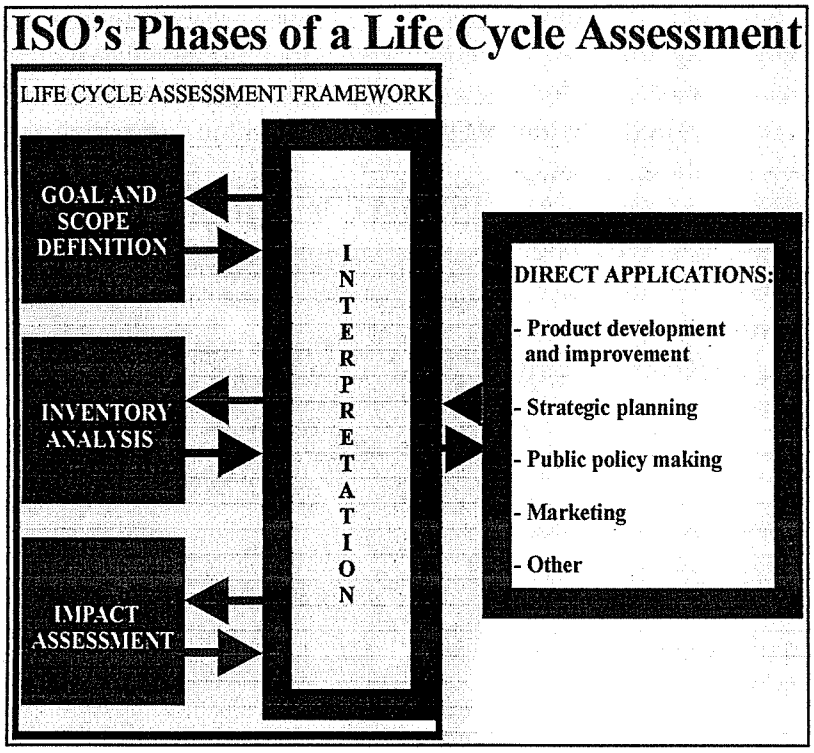


Figure 8: ISO 14040 Environmental Management - Life cycle assessment - Principles and framework, p. 10.

It is important to note that a full LCA need not be undertaken all at once, if at all. The decisions made in the Goal and Scope Definition phase can determine this. It may be that an inventory study is undertaken and its processes understood long before the impact assessment is carried out.[3] The process of selecting key issues occurs in all LCAs, although this process occurs at different stages in an LCA study depending on the methodology used.[4]

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1 See **Section 4.3: Goal and Scope Definition.**

2 The ISO 14040 - Environmental Management - Life Cycle Assessment Principles and Framework, has received a 97 percent approval rating. CEEM Information services (1997) 'International Environmental Systems Update,' Vol. 4, No. 8, p. 20.

3 For example, EPEA's model allows for the inventory to be limited to those factors that can be improved. The initial inventory list is determined by a qualitative assessment procedure. By limiting the inventory list the mass of data generally collected during an LCA study is avoided. EPEA's approach utilises a 'reduce or substitute' ideology and focuses on simple orientation towards improvement which can be implemented immediately. See **Case Study 19: EPEA.**

4 For example, CIT Ekologik uses a screening approach. See **Section 4.3.2.2 Definition of initial system boundary** and **Case Study 12: CIT Ekologik.**

Following is a discussion of the components of an LCA study. Each section is briefly discussed and references to further documents and key literature is provided for clarification.

4.3 GOAL AND SCOPE DEFINITION

The Goal and Scope Definition is the initial phase of a Life Cycle Assessment (LCA). This stage is extremely important because it defines the study in terms of its aims and what is intended from the subsequent report. It also provides overall direction for conducting an LCA study. This phase initiates the LCA process by defining its purpose, procedures and boundaries, as well as the context in which the assessment is being made.

LCA studies are influenced by a number of issues and these need to be clearly defined at the outset of the study. Like all sections in LCA, the scoping phase is an iterative process. That is, it may be necessary to revise and re-evaluate the scope at anytime during the course of study. There must be valid reasons for conducting changes and the purpose of the study must be clearly understood or the scope could be under continual evaluation. The assumptions made also need to be explicitly stated if the study is to be fully understandable and reproduceable. This is true for all sections of an LCA study.

ISO has determined that the Goal and Scope Definition phase consists of several components which need to be coherently expressed, including:

- Aim or purpose of the study;
- Function and functional unit of the product system;[5]
- Systems boundaries;
- Data requirements;
- Assumptions and limitations; and
- Critical review considerations.

A brief description of these aspects considered in ISO/DIS 14041 follows.

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5 The 'product system' is a fundamental term used in LCA. It is defined by ISO as 'a collection of operations connected by flows of intermediate products which perform one or more defined functions.' [ISO/DIS 14041] The 'operations' are defined by 'unit processes' which are interlinked by the processes of intermediate products, for example, materials and wastes. By dividing the processes up as units, the inputs and outputs to and from the product system are more readily recognised. For example, a product system may include the operations of raw material extraction, production, use, recycling, etc., which are divided into 'unit processes.' The processes are linked by 'intermediate product flows' within the system, while elementary flows and product flows are across the system boundary. 'Elementary flows' consist of materials or energy, which enter or leave the system having no human processing outside the 'product system.'

4.3.1 Goal of Study

It is important that the purpose of the study be clearly stated. The actual question or questions being asked, what the intended use or uses are, why the study is being conducted and who the final report is intended for, all have an important influence on the entire report. The methodology, considerations and outcomes may be considerably different depending on the goal of the study. For example, the study may be addressing a particular problem, or may be required for general product development, or it may be that the report is intended for internal use by organisations or for external use for marketing purposes.[6] It is imperative that all assumptions and boundary conditions are clearly defined in order to provide a credible study.

4.3.2 SCOPE OF STUDY

4.3.2.1 Function, functional unit and reference flow

In this section the function of the product has to be comprehensively stated. From this a 'functional unit,' which is a measure of the service of the product can be determined. This 'functional unit' may serve as a means for product comparison,[7] but its main purpose is to 'provide a reference to which the input and output data are normalised,'[8] that is, the amount of materials and energy, for example, that are needed for a 'functional unit,' The quantity of the product taken to fulfil the functional unit is described as the 'reference flow.' The reference flow is used to 'calculate the inputs and outputs of the system performance.'[9] It has been stated by LCA practitioners that the choice of a simple functional unit is imperative.[10]

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6 It is suggested that, due to the underdeveloped nature of LCAs at the present time, LCA use should only be used as an internal tool for companies' environmental development. See **Section 6.3.4 and 6.4.4: Product Comparison and LCA Use.**

7 See **Section 6.3.4 and 6.4.4: Product Comparison and LCA Use.**

8 ISO/DIS 14041, p. 7.

9 IBID.

10 Vignon, B. [Ed.] (1997) 'LCA News,' SETAC Foundation for Environmental Education, Vol. 17, No. 3, May.

4.3.2.2 Definition of initial system boundary

The system boundary defines the operations or unit processes, that compose the system under assessment. It is a description of what is included in each stage of a life cycle, specifically where the unit process begins and ends, and the changes and processes occurring during operations. The system boundary needs to be accurately described and decisions on inclusions justified. There are a number of unit processes ISO considers to be important inclusions:[11]

- The flow of materials and energy in the main manufacturing/ processing sequence;
- Distribution/ transportation;
- Production and use of fuels, electricity and heat;
- Primary fuel acquisition and processing of fuel into a useable form;
- Use of products;
- Disposal of process wastes and products;
- Recovery of used products (including reuse, recycling and energy recovery);
- Manufacture of ancillary materials;
- Manufacture and maintenance of capital equipment;
- Maintenance operations such as lighting and heating; and,
- Other considerations related to assessment (if any).

A fully inclusive system boundary is not practical at present due to time and resource considerations as well as data availability. Unfortunately, the boundaries are often defined by data accessibility. ISO states that 'inputs and outputs that will not significantly change the overall conclusions of the study'[12] do not need to be included.[13] Of course, the wider the boundaries 'the more likely you are to find opportunities for real innovation.'[14] Industry involvement in the development of the system boundary is imperative, although often in LCA studies a practitioner undertakes this process in isolation.[15]

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11 ISO/DIS 14041, p. 8.

12 ISO/DIS 14041, p. 8.

13 Another approach used by CIT Ekologik uses a 'screening' approach. 'Screening,' that is, the choice of significant issues, needs to be undertaken 'carefully and systematically.' 'An analysis in which environmental impacts or stages in the life cycle are omitted from the outset is not a proper screening.' Thus determining the key issues in this phase, is not a screening approach. It is important that the determination of significant issues does not occur until a later 'screening phase. See **Case Study 12: CIT Ekologik**

14 SustainAbility, SPOLD, Business for the Environment (1993) 'The LCA Sourcebook: A European Business Guide to Life Cycle Assessment.'

15 It was made quite clear in the interviews that direct involvement with industry was of benefit to an LCA study. Most often, though, the actual LCA model has been developed in isolation which is problematic when it comes to implementation. It is considered that industry involvement from the outset is required in order to determine and conduct an appropriate LCA.

4.3.2.3 Data Categories

Data relevant to the product system under investigation is required for an LCA. The data necessary to satisfy the goal of the study is highly dependent on the studies purpose. For example, it may be that the study is being conducted within one organisation, in which case data may be site specific. In other cases averaged data from many production sites or from published sources may be satisfactory, or even a mixture of data from all sources may be included. That is, data that is 'either measured, calculated or estimated.'[16] This data is 'utilised to quantify the inputs and outputs of a unit process.'[17] ISO categorises the data into three categories:[18]

- Energy inputs, raw material inputs, ancillary inputs, other physical inputs;
- Products; and
- Emissions to air, emissions to water, emissions to land and other aspects.

Within these categories, data can be further broken down and defined into subcategory criteria which fulfil the purpose of the study.

4.3.2.4 Criteria for initial inclusion of inputs and outputs

Practicality limits data collection and the 'initial identification will be made using available data.'[19] The selection of data chosen for study 'should be based on an identification of the inputs associated with each of the unit processes to be modelled.'[20] The inclusion of data and identification of inputs and outputs is an iterative process. Thus, throughout the study more data may be added to this collection. The data chosen for inclusion has a significant effect on the final report. ISO names three criteria that aid in the decision of which data should be used in the study:

- Mass;
- Energy; and
- Environmental Relevance.

All criteria should be utilised for a comprehensive picture. If one criteria only is used the results can be distorted.

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16 ISO/DIS 14041, p. 6.

17 IBID.

18 IBID.

19 ISO/DIS 14041, p. 10.

20 IBID.

4.3.2.5 Data quality requirements

'Data quality is considered to be one of the most significant limitations of LCA application.' [21]Data quality required needs to be accurately described in this phase in order to render the study results reliable. Particular characteristics 'that describe both quantitative and qualitative aspects as well as the methods used to collect and integrate those data'[22] need to be utilised. Specific criteria to achieve this are described by ISO[23]:

- Time-related coverage, e.g. data age and collection period;
- Geographical coverage, e.g. local, regional, national etc.; and,
- Technology coverage, e.g. averaged data, best or worst technology.

Other important variables include:

- Precision of data;
- Completeness;
- Representativeness;
- Consistency; and
- Reproducibility.

4.3.2.6 Critical review

A critical review can be undertaken in order to ascertain whether the LCA has fulfilled ISO requirements. This needs to be defined in the scoping phase in terms of whether one will be carried out, who will conduct it and how the review will be administered.

4.4 Life Cycle Inventory Analysis

The Inventory Analysis is the second phase of an LCA study and has been developed to a greater extent than all other LCA phases.[24] In this phase all input and output data is identified and quantified within the inventory table. The data for raw material and energy consumption, for example, is collected and calculated according to the outline in the goal and scope phase. The collection of data needs to focus on 'material and energy balances for each operation within the system and for the entire life cycle

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21 Todd & Higham (1996) 'Life Cycle Assessment for Forestry and Wood Products - Vol. 1: Review and Discussion,' p.11, quoting Young & Vandenburg, 1995.

22 ISO/DIS 14041, p. 11.

23 IBID.

24 The methodology for the Inventory Analysis has been developed over 20 years with much refinement and improvement occurring since SETAC's initial workshop in 1990.

of the system.'[25] As mentioned previously, the inventory process, along with all LCA processes, is iterative.

ISO sets out a specific process to follow in undertaking an inventory analysis. This inventory flow chart incorporates the significant processes within the product system boundary as defined, in the goal and scope phases.[See **Figure 9: ISO's Simplified Procedures for Inventory Analysis**]

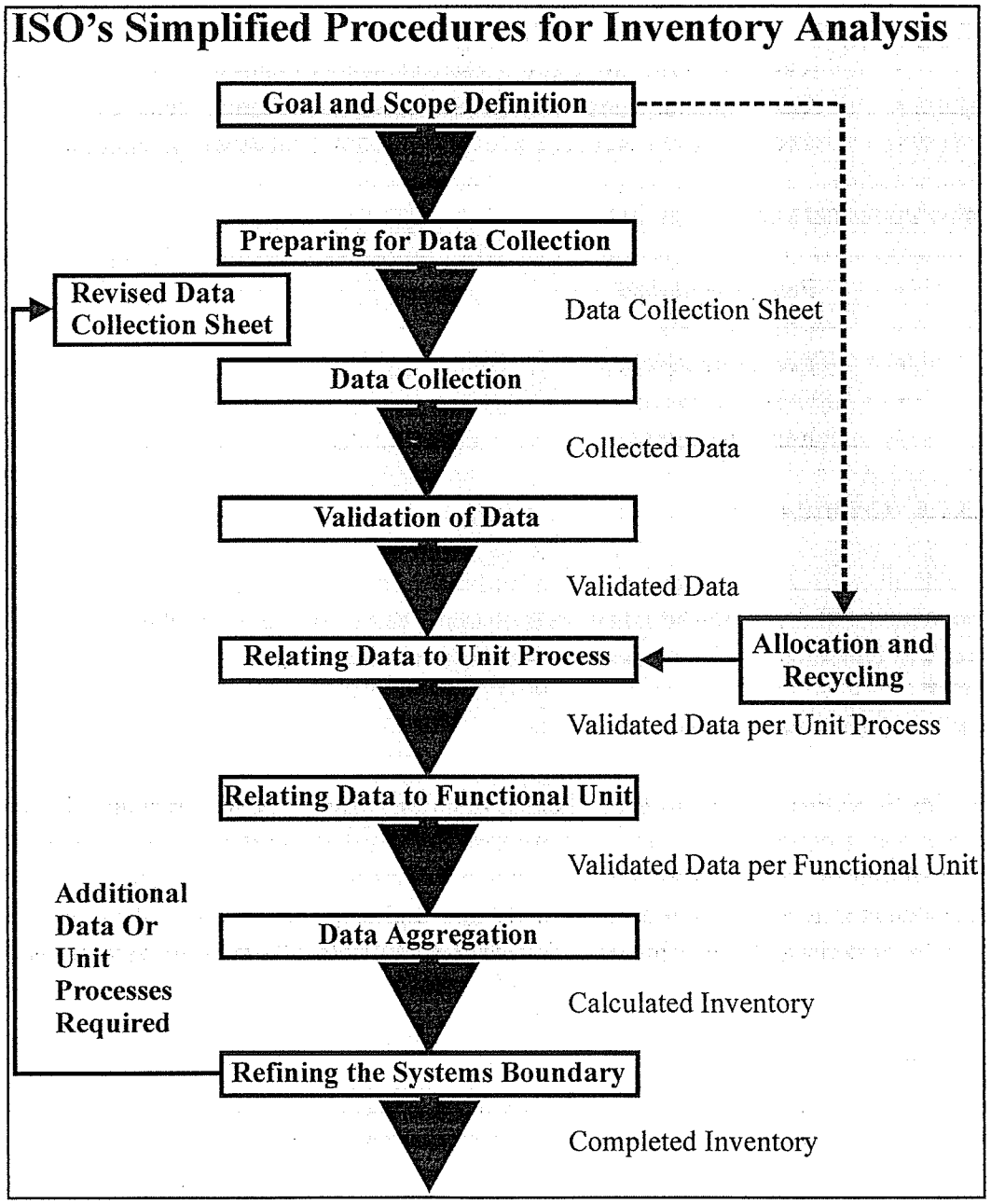

Figure 9: ISO/DIS 14041 Environmental Management - Life Cycle Assessment - Goal and Scope Definition and Inventory Analysis

[25] Stone, K. (1997) 'What EPA means when it Says, "Life Cycle Assessment",' National Risk Management Research Laboratory, US Environmental Protection Agency, Cincinnati, Ohio.

It is important that the data requirements, as stated within the goal and scope definition are observed and all assumptions are clearly stated. The processes that need to be incorporated in an inventory analysis are defined below.

4.4.1 Data Collection Preparation

This ensures that data from numerous sources (for example, specific data, published data, etc.) is presented in a common format in the inventory in so that data is consistently categorised. This includes:

- Presenting process flow charts;
- Categorising data;
- Defining units of measure;
- Describing data identification and quantification techniques; and,
- Providing data recording personnel with clear instructions for reporting aspects associated with data collection.

4.4.2 Data Collection

Data Collection procedures need to be coherently reported as these may differ in each process and system. Input and output data should be refined in regard to the beginning, function and end, in order that no 'double counting' or 'gaps' of data occur. In order to achieve a thorough collection of data an intimate understanding of each process is required.[26]

4.4.3 Calculation Procedures

'Calculation procedures are needed to generate the results of the inventory of the product system.'[27] In order to calculate the data ISO recommends particular procedures:

- Validation of data, that is, data should be checked throughout the data collection process using such procedures as mass balances, or energy balances;[28]
- Relating data to the unit processes, for example, the reference flows defined for each unit process need to be used in order to calculate data;
- Relating data to functional unit and data aggregation, that is, in order to assess the data from each unit process within the system boundary it needs to be referenced in regards

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26 In order for the data to be properly identified and recorded there needs to be a comprehensive understanding of all the processes involved in the system. This can only be achieved by the co-operation of industry and practitioners and data collection would ideally be undertaken by manufacturers in order to obtain site-specific information. This data is considered more valuable than data from other sources, although the collection is a time and resource intensive process.

27 ISO/DIS 14042, p. 14

28 Mass inputs will equal mass outputs (including the product).

to the functional unit. This involves aggregation of the data; and,

- Refining the system boundary, for example, a 'sensitivity analysis' should be carried out in order to determine the significance of data on the product system. This may result in a revision of the system boundary. 'This analysis serves to limit the subsequent data handling to those input and output data which are determined to be significant to the goal of the LCA study.'[29]

4.4.4 Allocation

Allocation of inputs and outputs needs to be identified and defined, since there is often more than one product that results within a system, and also materials and wastes from one process may be recycled within the system. The practicality to determine the relative contributions made by each product, co-product, etc. is problematic and, in many cases, the best possible estimation is required. Ideally, the best solution is to divide the unit processes or change the system boundary so allocation is not required.

If this is not possible, procedures are required in order to allocate inputs and outputs to specific unit processes. Firstly, the inputs and outputs must be divided between the products and/or functions in the system using physical relationships. 'The resulting allocation will not necessarily be in proportion to any simple measure such as mass or molar flows of co-products.'[30] Secondly, if physical relationships can not be identified then another relationship (for example, the economic value) needs to be determined.

Reuse and recycling of products may need to be considered in the allocation process. Further investigation in terms of the product system and system boundary is required. The procedures that compose the inventory analysis should be investigated in terms of the aspects set out in the goal and scope of the study. It is also important to realise the inventory does not relate to actual environmental impacts and therefore the results should be used with caution. The report should follow the items set out in ISO 14040 and ISO 14041.

4.5 Life Cycle Impact Assessment

The life cycle assessment phase is the most difficult and, as yet, the least developed stage of an LCA study. An impact assessment seeks to examine the parameters identified in the inventory stage and relate them to their consequences on the environment. The potential environmental and human health effects caused by the utilization of materials and energy and releases back into the environment are studied. Further, the categorisation, characterisation and valuation of environmental impacts are undertaken in order that different impacts be compared (e.g. global warming and land degradation).

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29 ISO/DIS 14042, p. 16

30 ISO/DIS 14042.1, p. 16

Life cycle impact assessment is intended for use in:[31]

- The identification of significant potential environmental loadings and resource depletion for evaluation for system improvement opportunities;
- The identification and characterisation of loadings and resource depletion by the system as a whole and by particular life cycle operations and stages;
- Comparisons between product/service systems, although the comparisons may be difficult and remain inconclusive;
- Prioritization and decision making from the LCA findings; and,
- Identification when other environmental tools may be needed to analyse actual impacts from the inputs and outputs flagged or identified by the study.

The aim is to use indicators to define the impact parameters in order to ascertain problems in three distinct categories:

- Resources;
- Natural Environment; and,
- Human Health.

The procedure to conduct a life cycle impact assessment is still under development and different categories are being developed more rapidly than others.

As yet there is no single methodology which has been widely accepted. The ISO standard is 'intended to be flexible to accommodate a wide spectrum of applications by providing the necessary range of guidance and caution based on the current state-of-the-art.'[32] Thus a specific methodology is not defined. ISO does, however, give a description of the 'framework, principles and requirement' needed to carry out a life cycle assessment, including:

- A general description of life cycle impact assessment;
- Relationship of life cycle assessment to the LCA framework;
- Framework for life cycle assessment;
- Techniques and information for analysing life cycle impact assessment results; and
- Reporting and critical review.

This differs from some other LCA methods, including SETACs, in which an 'Analysis of Significance' phase is included. An Analysis of Significance, allows a perspective of the results for different impact categories to be gained.

A concise summary of each follows.

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31 ISO/DIS 14042.1, p. 2

32 IBID.

4.5.1 General Description of Life Cycle Impact Assessment

This section defines the aims, key features and minimum requirements for an impact assessment. The goal to 'examine and to structure the inventory input and output results from and environmental perspective'[33] allows for significant interpretation. The fundamental aspects provide an important summary of life cycle impact assessment characteristics encompassing the following points:

- The lack of a single LCA methodology;
- The flexibility and viability of requirements in conducting an LCA including, the depth of detail required and the time frame;
- The fact that Life cycle impact assessment is only one decision making tool;
- The distinction between life cycle impact assessment and environmental impact assessment;
- The assistance life cycle impact assessment provides in interpreting inventory data;
- The definition life cycle impact assessment gives to environmental impact parameters;
- The ability to use quantitative, qualitative and value based judgements in category definitions;
- The lack of inclusion of spatial, temporal, threshold and dose-response information;
- The need for value and subjective judgements for weighting and aggregation due to limited scientific knowledge in these areas at present;
- The differing quality of indicators for categories; and,
- Problems in demonstrating variations in indicators from different systems.

As well as these key aspects, the standards set out requirements for conducting a life cycle assessment. These consist of the minimum specifications, including, the selection of relevant environmental categories, the relation of inventory data to categories and the transparent documentation of these.

Important aspects for inclusion, such as value judgements, assumptions made, limitations, etc. need to be identified and justified, This section also discusses the requirements for comparative assertions[34] in some depth.

4.5.2 Relationship of Life Cycle Impact Assessment to the LCA Framework

Although a distinct phase in an LCA, the life cycle impact assessment is dependent on all other stages. Each stage undergoes an iterative process and one process may determine whether or not revisions are necessary in other stages. The life cycle impact phase is dependent on the goal-and-scope phase, in that the section defines all aspects of an LCA study. All stages are dependent on this definition. The inventory analysis data collection is the basis for an impact assessment. The stages in an LCA do not have to be carried out in succession: they may be undertaken simultaneously. The interpretation section

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33 ISO/DIS 14042.1 p. 4

34 ISO/DIS 14042.1 p.10.

utilises both the inventory analysis and impact assessment profile to arrive at conclusions and make recommendations. This phase also provides a check for the inventory and impact results.

4.5.3 Framework for Life Cycle Assessment

The framework for the impact assessment phase is divided into distinct categories:

- Selection and definition of environment categories;
- Classification;
- Characterisation; and,
- Weighting.

Not all of these will necessarily be required for a study and use depends on the goal and scope definition.

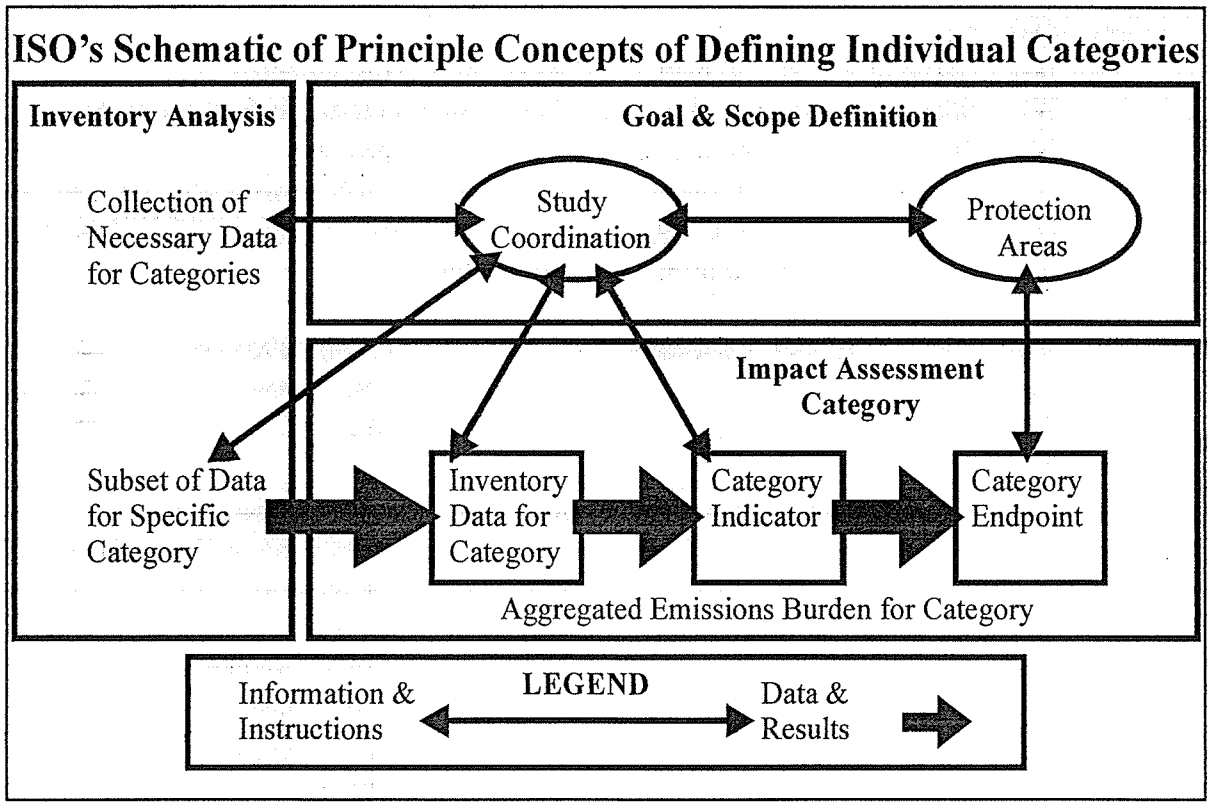

Figure 10: ISO/CD Environmental Management - Life Cycle Assessment - Life Cycle Impact Assessment

4.5.3.1 Selection and definition of environmental categories

This component aims to help in the identification and definition of categories that should be considered in an Impact Assessment. 'Numerous environmental categories have been proposed for life cycle

assessment. Most studies will select from these previous efforts and will not define their own categories.'[35] Requirements enabling this procedure are defined by ISO and include transparency, representativeness, independency and scientific definition. It must be noted, however, that in many cases a specific basis is not available and value judgements need to be made. In the case of each defined category, ISO requires the inclusion of: [See **Figure 10: ISO's Schematic of Principle Concepts of Defining Individual Categories**]

- An endpoint for each category;
- An indicator for this endpoint; and
- The identification of relevant data.

4.5.3.2 Classification

Classification is the stage in the LCA where data from the inventory is grouped into impact categories. The standard describes how this can be achieved, however, it gives no specific requirements, only options which include:

- The placement of inventory data specific to one category;
- The identification of inventory data common to more than one category;
- Distinguishing these data by mechanical means; and,
- Dividing those data between categories if they cannot be assigned to only one category or, if an indirect impact, assigning to the initial impact category. SETAC has produced the following default list of impact categories[36]

• Input related categories	1.	Abiotic resources
	2.	Biotic resources
	3.	Land
• Output related categories	4.	Global warming
	5.	Depletion of stratospheric ozone
	6.	Human toxicological impacts
	7.	Ecotoxicological impacts
	8.	Photo oxidant formation
	9.	Acidification
	10.	Eutrophication
	11.	Odour
	12.	Noise
	13.	Radiation
	14.	Casualties

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35 See **Sections 6.3.4 & 6.4.4: Product Comparison and LCA Use**

36 The SETAC - Europe Working Group on Life Cycle Assessment, headed by Udo de Haes, decided this list by vote. Udo de Haes (1996) XXX

These are not definitive and other categories can be used, as long as they are well defined and choices are justified. The majority of characterisation models, including SETAC's and ISO's, use an applied, equivalency factor approach. There is another lesser used method, called the 'Threshold approach,' in which predictions of actual effects are determined.

4.5.3.3 Characterisation

The characterisation section discusses the application of indicators to categories in order for aggregation of data to be conducted. The indicator is applied after consideration of the loading and 'the combination of category indicators represents an initial loading and resource depletion profile.'[37] Again, value judgements and assumptions may be the basis for decisions, rather than scientific knowledge at this time. So the final outcome will be reliant on all the assumptions and choices made throughout the entire LCA process. 'Often a trade off exists between the model simplicity and the accuracy of the result.'[38]

The ISO requirements for this process incorporate a valid description and identification of the characterization indicators, involving whether or not these are supported by a scientific basis and to what extent value judgements are used. The main concerns with characterization is the accuracy and validity, which depend on a spatial, temporal and dose-related responses. ISO concedes that 'Depending upon the scale and mechanism of each category, aggregation may not be the only approach.'[39]

4.5.3.4 Weighting

The weighting process is often referred to as the 'valuation process,' although often the valuation process is a phase between the characterisation phase and the subsequent weighting phase, whereby scientific gaps in knowledge are filled. This process is involved with the ranking, weighting, and possible aggregating of the impact categories in order that a comparison of the different groups can be made. At the present time there are no technical or scientific models to achieve this weighting, but there are techniques that can be used to assist the process.

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37 ISO/DIS 14042.1, p. 13.

38 ISO/DIS 14042.1, p. 14.

39 ISO/DIS 14042.1, p. 13.

Weighting is not a necessary procedure in an LCA study, and it is usually undertaken in order to conduct product comparisons.[40] Although ISO recommend that 'Weighting is not a basis to make a comparative assertion disclosed to the Public.'[41] ISO provides processes that can be utilised to conduct the weighting element:

- Ranking of the category results;
- Assigning weighting values (using value judgements);
- Selection of the significant issues; and,
- Aggregation to an overall score.

ISO stresses that the reduction of the impact assessment to a single score is not a requirement. It is advisable that several weighting procedures are trialed in order for differences in results to be examined.

4.5.4 Techniques and Information for Analysing Life Cycle Impact Assessment Results

The results of the life cycle impact assessment phase need to be interpreted and this component in the standards, provides a framework to achieve this. Analytical tools should be used in order to 'distinguish important results from negligible ones, to check for errors, to establish if relative differences in indicators exist between systems for a category, to assess whether the results appear environmentally meaningful, or all of these,'[42] Accuracy is improved through the use of analytical procedures. Several techniques are discussed, incorporating:

- Sensitivity analysis - which can be used to identify the significant aspects in the impact assessment study;
- Uncertainty analysis - in which the dependability, representativeness and/or confidence of the results are discovered;

These processes 'address independent data characteristics and are separate procedures.'[43]

- Normalization - in which the contribution of a unit processor or the whole system is calculated in respect to human loadings; and,
- Comparison - in which indicator results and environmental data are correlated.

'The application of analytical techniques may also lead to removal of trivial or negligible results thereby reducing the complexity and effort of a study.'[44]53

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40 See **Sections 6.3.4 & 6.4.4: Product Comparison and LCA Use.**

41 ISO/DIS 14042.1, p. 15.

42 ISO/DIS 14042.1, p. 15.

43 ISO/DIS 14042.1, p. 16.

44 IBID.

4.5.5 Reporting and Critical Review

The final requirements for a life cycle impact assessment undertaking is to report and review the results. The standards provide requirements to achieve these requirements.

4.5.5.1 Reporting

All results from each phase in a life cycle assessment need to be reported in a comprehensive document. All sections must include the assumptions and value judgements made in a transparently recorded report. Conclusions need to be reported, as do any aspects relating to the life cycle impact assessment results.

4.5.5.2 Critical review

The critical review section aims to provide a check for the preceding study. The standards state that reviewers must possess appropriate scientific knowledge and the review should include an assessment of all elements, including the classification, characterisation and weighting stages. It is stressed throughout the ISO document for life cycle assessment that 'No one life-cycle assessment study can collect all of the data for a system or include an examination of all possible types of either loadings and resource depletion or possible impacts. Simplification and omissions occur in all studies.'[45] Thus it is vital that all assumptions and decisions made are undertaken in a transparent manner. This means that LCA studies can be undertaken with a very flexible approach as long as the methodology is accurately recorded in the report. This will allow for precise understanding and thus the ability to recreate the study.

4.6 Life Cycle Interpretation

Life Cycle Interpretation within a Life Cycle Assessment study is the last phase in the ISO framework, although it doesn't necessarily occur subsequent to the other stages. It may be that this phase is undertaken simultaneously with other phases. As with the other standards discussed, this structure is still under development. The aim of the life cycle interpretation section is to compare the results of the inventory analysis and impact assessment phases with the goal of the study in order to provide a foundation for decision making.

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45 ISO/DIS 14042.1, p. 6.

The standard describes the life cycle interpretation process as a systematic procedure to identify, qualify, check and evaluate information'[46] that has been obtained from the inventory analysis and or impact assessment, in order to communicate results to the decision maker in a 'comprehensible and useful'[47] way. It is important in this that conclusions, recommendations and results are reported in a transparent and understandable document. 'It may be stated that the choices are made in an integrated, iterative decision making procedure, replacing the conventional linear approach, where the alternatives finally selected will have passed technical, economic and environmental assessment ('filters') in a linear and non-interactive procedure.'[48] Another objective of the interpretation phase is to establish any connection that may exist between LCA and other environmental tools, in order to demonstrate any limits of LCA.

The standard defines three steps that comprise the interpretation phase:

- Identification;
- Evaluation; and,
- Conclusions, recommendations and reporting.

A discussion of each of these stages as defined by ISO is presented below.

4.6.1 Identification of the Most Important Inputs, Outputs and Potential Impacts

To identify significant data, information must first be identified and structured. All information should be 'gathered and consolidated for further analysis.'[49] It should then be structured according to procedures as defined in the goal and scope. For example, this may be done using data lists, profile diagrams or potential impacts.

4.6.2 Evaluation

The evaluation step must occur in an iterative process in conjunction with the previous identification step. To evaluate and present the data, the end use of the report must be understood. The standards define three checks that must be completed in order to carry out a comprehensive evaluation.

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46 ISO/DIS 14043.1, p. 2.

47 IBID.

48 IBID., p. 3.

49 ISO/DIS 14043.1, p. 5.

4.6.2.1 Completeness Check

This check allows the examination of all significant information determined in the previous step in order to be confident all relevant data has been included. The standards state that if information is missing that is deemed important then further examination must be undertaken. 'This may necessitate a revision in the inventory analysis and impact assessment, or, alternatively, an adjustment to the goal and scope definition.'[50]

4.6.2.2 Sensitivity Analysis Check

This insures that results from previous sensitivity analysis undertaken in during an LCA study are collected and the effects of data inclusion variations are determined. This is undertaken in order to ascertain 'the robustness and stability'[51] of the data included in the study. This check should be undertaken if variations are shown to be excessive in terms of those set out in the goal and scope definition.

4.6.2.3 Consistency Check

This check ensures that the identified data accurately expresses the inventory analysis and the impact assessment results. The results need to be analysed in relation to alternative outcomes because, 'if small changes in the parameters lead to other conclusions, the original result is deemed to be insignificant or inconsistent, and therefore needs to be revised.'[52]

All the information used in the evaluation phase is provided by the life cycle inventory and life cycle impact assessment results. 'After weighting and aggregation of data, a final, single value as to potential environmental impact may be derived. However, the reverse, that is to calculate and report only the final accumulated value is not acceptable if disclosed to the public.'[53]

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50 ISO/DIS 14043.1, p. 6. This is a particularly important point. If there is a problem in obtaining data, then the initial goals need to be changed, so the data is no longer required. It is vital to note that at this stage it is impossible with current knowledge and resources to quantify everything. This seems tp indicate a simpler procedure may be required.

51 ISO/DIS 14043.1, p. 6.

52 IBID., 8.

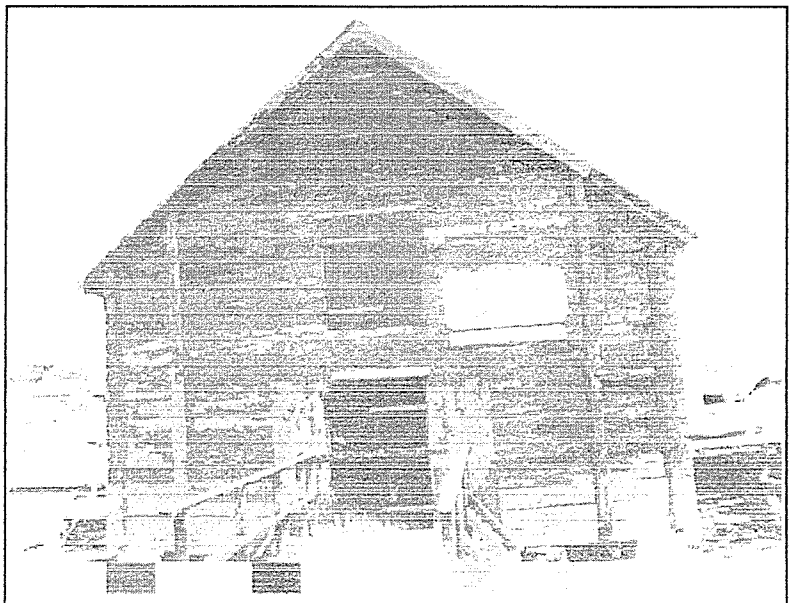
53 ISO/DIS 14043.1, p. 6. This concept of single values for environmental impact is considered problematic, even for provision to public. A simple way to record and provide data to consumers which would give a more realistic picture of impacts is needed. For a product, such as a timber product, there are few trade secrets, so vital information can be provided.

4.7 Conclusions, Recommendations and reporting of LCA

This is the final step in the interpretation phase and its function is to provide conclusions and recommendations for the entire LCA study in an appropriate report. The report must address whether the goal and scope definition of the study has been suitably followed. Conclusions and recommendations should be reported in regards to, and include only the important data of the study. This step is very significant in the overall Life Cycle Assessment study and without accurate and proper presentation the study may not be useful to decision makers. This phase can also lead to other investigations which may include a critical review.

5.0

OVERSEAS FIELD RESEARCH: CASE STUDIES



Picture 5

5.0

OVERSEAS FIELD RESEARCH

4.1 AIMS

The aim of this section is to present the information collected during the overseas field research. This research consisted of communication with particular organisations and an interview period lasting an average of three hours. Each interview is presented as a case study, examining the organisation's background, their goals and the publications and projects they have undertaken in the LCA field. Most importantly, the issues discussed at each meeting are detailed.

4.2 BACKGROUND

The overseas field research consisted of establishing relationships with leading LCA experts and researchers and industry bodies in order to determine existing LCA activities in Europe, Canada and the United States. As discussed in the Methodology Section of this report,[1] the organisations fall into numerous categories and thus have not been ordered according to type. Rather they have been presented simply in chronological order. The case studies are an important, if sizable, contribution to this report. For those with particular interest in LCA, these are significant and many inferences and issues may be drawn from them. The author has presented the key issues[2] of import to the objectives of this report and the doctoral study. Other main points, however, may justifiably be drawn by researchers with differing aims.

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1 See **Section 1.4: Methodology**

2 See **Section 6.4: Key Issues from Case Studies**

CASE STUDY 1:

SUSTAINABILITY

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'SustainAbility has won a well-deserved reputation for persuading business of the logic of enlightened self-interest, pointing out the competitive and financial advantage to be gained by taking environmental issues, literally, into account.'[3]

BACKGROUND

SustainAbility formed in 1987 with the premise of consulting with companies on environmental strategies management. Since this time they have evolved into an 'internationally respected, award-winning environmental management and sustainable development consultancy - offering specialist services in corporate environmental policy, strategy, management systems, product life-cycle management, auditing and verification, communications and reporting, and training.'[4] Their organisation has been described as a mix between a consultancy, think-tank and campaigning group[5] and they are one of a very few companies designated as a Registered Environmental Audit Practice. Their central agenda, however, is consulting, and the bulk of SustainAbility's work is at the strategy level. Clients from organisations[6] are aided in identifying problems and opportunities within their businesses, 'defining agendas, setting priorities, developing strategies and policies, putting in place management systems, assembling resources, conducting audits, reviews, verification and reporting processes and encouraging

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3 As quoted from Tomorrow Magazine, in SustainAbility (1996) Company Profile, p. 3

4 SustainAbility (1996) 'SustainAbility News', Review of 1995, No. 7: Published Annually, p.1

5 SustainAbility (1996) Company Profile, p. 5

6 SustainAbility's past and present clients include: the British Airways Authority (BAA); Proctor and Gamble; Novo Nordisk and others who are being aided with their environmental strategies; the European Environmental Agency (EEA)[see LCA-Related Projects]; and other companies such as the Finnish company Neste, whose reports undergo a verification process.

customer and stakeholder dialogue.'[7] Corporate clients are encouraged to invite 'radical campaigners and stakeholders to challenge operations.'[8]

SustainAbility's work has led to a vast experience within the corporate sector and an awareness of the emerging environmental agenda. Their dedication to promoting environmental strategies within business has prompted them to redefine sustainable development around the 'triple bottom line.'[9] That is, social responsibility, environmental protection and economic viability - 'people, planet, profit.'[10] They take this line seriously, and take a public stance on all issues they feel are important.

Within this programme, tools aiding the shift to sustainable environmental management have been an issue, and examination of innovative developments has been encouraged. SustainAbility recognise that LCA will 'be a critical component of the emerging business tool-kit for environmental management and, longer term, sustainable development.'[11] They are, however, not an LCA consultancy. They do not undertake LCAs, but aid companies to carry out their own, and also verify LCA work.[12] LCA is a part of SustainAbility's strategic philosophy as far as life cycle thinking is concerned, but it is not the central issue; Mr Elkington stated that the life cycle perspective was the most useful component of an LCA, regardless of what LCA methodology is used, or whether a full LCA is carried out. It can aid a company in thinking through their priorities and identifying the critical points on which they should act, not only in their own business, but down the boundary chain.

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7 SustainAbility (1996) Company Profile, p. 3.

8 IBID., 6. SustainAbility has also produced numerous reports on Stakeholder input, see SustainAbility publication list available from the above address.

9 The 'triple bottom line' is more than a concept, it is an attitude pervasive throughout the entire practice. The implication of this notion is a 'profound value shift' and this is explored further in the report 'Who Needs It?: Market Implications of Sustainable Lifestyles', A SustainAbility Business Guide, Dow and SustainAbility, 1995.

10 SustainAbility (1996) Company Profile, p. 2.

11 Elkington, J. et al (1993) 'The LCA Sourcebook: A European Business Guide to Life-Cycle Assessment', SustainAbility, SPOLD and Business for the Environment, p. 5.

12 SustainAbility, for example, undertook an environmental strategy plan with the British Airways Authority for the controversial terminal 5. The issue of using an LCA was central. Also Dr Vernon Jennings, SustainAbility's Director, aided Novo Nordisk A/S, a Danish company, in carrying out ' the first LCA of an enzyme product.' [SustainAbility (1996) 'SustainAbility News,' Review of 1995, No. 7: Published Annually, p. 2].

GOALS

In 1990, SustainAbility produced their Mission Statement, which has been updated, re-examined and most recently revised in 1996. This statement consists of eight key objectives:[13]

- **'Our mission is to help create a more sustainable world by encouraging the evolution and widespread adoption of thinking and practices which are socially responsible, environmentally sound, and economically viable - that is, the 'triple bottom line of sustainable development.**
- We will influence business, government agencies, other organisations and citizens by promoting environmental, social and ethical consciousness and responsibility.
- To achieve our goals, SustainAbility itself must be a successful business. We will build a high quality organisation at the leading edge of environmental and sustainable development thinking and consultancy.
- We will be open, fair, honest and challenging in all our activities, and always act in an ethical, environmentally and socially responsible manner.
- To implement our mission, we will develop ongoing action plans and regularly review our environmental, social and ethical performance. Periodically, we will open ourselves up to scrutiny by external stakeholders.
- Our people are our major assets, and their personal development is a key priority. We seek the active participation of all members of SustainAbility in the definition and achievement of our goals. We recognise the need for a healthy balance between professional and personal life. Work, we believe, should be challenging, rewarding and fun.
- We will not knowingly accept commissions or undertake projects which conflict with our principles. In selecting clients, partners and colleagues, we seek commitment to real progress in relation to the 'triple bottom line' of sustainable development.
- We will inform our colleagues, clients, partners, suppliers and contractors of our commitment to these principles, seeking active support.'

LCA-RELATED PROJECTS AND PUBLICATIONS

The issue of life cycle thinking was first introduced to SustainAbility while they were writing their first renowned Consumer Guide.

- Elkington, J. et al (1988) ' The Green Consumer Guide.

A fair amount of consumer pressure was bought to bear as a result of this publication. In response, organisations began employing early versions of LCA. Work has just started on the next consumer guide, which should be available in June 1998, in which LCA data is used to form conclusions.

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[13] SustainAbility (1996) 'Our Mission,' sourced from the Internet [see web address]

Life Cycle Assessment is further addressed by SustainAbility in the guide commissioned by SPOLD:[14]

- SustainAbility, SPOLD and Business for the Environment (1993) ' The LCA Sourcebook: A European Business Guide to Life Cycle Assessment.'

The guide explains LCA, specifically in terms of the impact this concept will have on companies. It is the first review of the businesses currently involved in the LCA area and profiles the state-of-the-art in LCA within Europe and North America.

Other related projects have included and include:

- Work with Proctor and Gamble (1993 - 1994) who were carrying out work with LCAs;
- A project with the European Environmental Agency (EEA) and the Danish firm dk-Teknik, who are developing a LCA guide and Web Site;[15] and
- Julia Hailes'[16] work on the UK ecolabelling board, which uses LCA to determine whether a project receives an ecolabel.

ISSUES DISCUSSED

Life Cycle Assessment

- Different levels at which an LCA can be useful:
  1. Carrying out LCA regardless of methodology can help a company think through priorities and identify critical points on which they should act, not only in their own business, but also down the boundary chain.
  2. Comparability between companies and products - bench-marking of different problem aspects. This is hard enough to do currently within sectors; the problem is even greater when trying to benchmark different industries. For example, it would be beneficial to have an appropriate LCA for the timber industry that all forest and timber companies agreed with, but it would also be extremely difficult to reach such an agreement. An even greater problem is comparing, say, steel and timber.
- LCAs are often being developed with the idea of product bench-marking in mind.
- Certain common features need to exist in all LCAs if cross comparisons are to be made possible.
- The most focus and interest should be placed on LCA for internal use by companies in order for them to better understand and identify priorities and critical points on which they should act.
- Generic LCA methods avoid credibility problems. If developing a product specific LCA there may be problems with gaining the necessary credibility, if the method simply suits a single product. Generic LCA models, however, do not address forestry issues such as harvesting, forest as a carbon sink, social aspects, biodiversity etc.

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14 See **Case Study 4: SPOLD.**

15 It was mentioned that these facilities would soon be available.

16 Julia Hailes was co-founder of SustainAbility and is now a SustainAbility Council Member.

- LCAs have evolved with a great deal of inefficiency.
- There is a need for a modular system of sorts, whereby a company can link directly with what the industry sector is doing, and up and down the whole boundary chain to what customers and suppliers are doing - cannot see this happening in a short time frame.
- Some major companies are putting a lot of time and effort into the development of LCAs - unfortunately they are isolated from the LCA community and the developments are a bit like those within information technology, for example, Macintosh computers versus Windows. There needs to be a convergence of ideas which, will be a critical process in the LCA field.

Stakeholder Input

- SustainAbility is very keen on stakeholder input - working with companies involves a long process including strategic reviews, inviting other stakeholders into discussions, participation workshops etc. Their relationship with companies tends to last over years.
- Outsiders/ stakeholders have to be highly involved in process to allow for transparency. The process must be critiqued and challenged at all times to enable an outcome that is credible and of interest.
- SustainAbility recently had a stakeholder interview for the European Environmental Agency. The stakeholders were fairly sceptical about LCA and did not trust LCA practitioners in general. They thought problems occurred due to people making false claims on the basis of LCAs, many methodologies, over-hype by companies involved and competitors coming up with vastly different results. They agreed that investment was needed and welcomed in this area, but the bottom line was they weren't really sure about LCAs.

CASE STUDY 2:

IIED
(International Institute for Environment and Development)

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	iiedagri@gn.apc.org
Internet:	**http://www.oneworld.org/iied**

'All our work tells us is that for development to work, people have to feel that they directly benefit. And for that to work, there has to be a mix of market mechanisms (as private capital and investment is needed), civic society (including local institutions and community organisations organised into some kind of accountable and representative structure) and, of course, a governmental system or framework of support ... All three parts of the development equation need the other parts.'[17]

BACKGROUND

The International Institute for Environment and Development (IIED) started work as a non-governmental, research and development organisation, in 1972. Their focus on social science and environmental development is promoted by encouraging 'sustainable patterns of world development through research, training, policy studies, consensus building and public information.'[18] Over the years IIED have built up networks around the premise of the 'Development Triad' - that is, each of the three parts of the development equation relying on the others.[19] They have also spent a lot of time looking at how decisions are made and investigating who controls the decision, how economics incentives can be used and the cost of environmental damage.

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17 IIED (1995) 'Annual Report - Time to Admit to the Development Triad', Foreword.

18 IIED (1997) sourced from the Internet [http://www.ids.ac.uk/eldis/data/d012/e01272.html].

19 That is, the government, civic society and private sector, see quote above.

Research and policy studies in seven particular programme and discipline areas are operated by IIED, including:[20]

- Environmental Planning and Management;
- Human Settlements;
- Sustainable Agriculture;
- Forestry and Land-Use;
- Drylands;
- Environmental Economics, including Collaborative Research in the Economics of Environment and Development (CREED); and a
- European Programme.

Many innovative developments have emerged from these programmes, specifically the importance of crossing program boundaries to aid an increase in positive 'impacts, to encourage learning and critical reflection, to develop our inter-disciplinary and multi-disciplinary potential and thus promote innovation and experimentation, to strengthen and broaden our networks of working partners, and to release the full potential of IIED as a bridging or linking organisation.'[21] Although IIED instigate these programmes, they rely on other researchers and experts for the scientific analysis such as ecological assessments and modelling. Through this cross-programme initiative, methods for working with the private sector have also been established and instigated.

IIED, like SustainAbility, have started an auditing process to determine the soundness of their performance. Recently there was discussion as to whether the functioning of the organisation compared with their outlook. The company's strategic review revealed that one of the organisation's strategies on environmental trends was seldom discussed. The majority of time was put into the consideration of globalization and issues that have an influence on how people are affected by the environment. It was found that discussion was largely centred on an anthropocentric view of the environment. It is under consideration at present as to whether this view is potentially adverse or beneficial to achieving the organisation's goals.

GOALS

The goal of sustainable development within IIED is central to the focus of the interconnectedness of economic development, the environment and human needs. The specific aim is to 'have impact, so that over time [they can develop] approaches to research and policy analysis which are action-oriented, collaborative, which develop capacity, and which involve the major stake-holders around a problem.'[22] It is considered that crossing program boundaries and developing a 'whole diversity of cross-

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20 Thomson, K.,(1997) 'IIED's Cross-Cutting Programme: Activities which cut across programme Boundaries,' p. 1, available on the Internet [see web address].

21 IBID., 2.

22 IBID., 1.

programme ways of working'' is vital in 'increasing impacts; encouraging innovation and cutting-edge thinking; and, the development and spread of practical tools for identifying and solving complex environment and development problems.'[23]

LCA-RELATED PROJECTS AND PUBLICATIONS

The European Programme, which was established by IIED in 1994, has focussed on sustainable development action within the European Union (EU).[24] One of the main emphases has been on 'reducing the negative social and environmental impacts of European consumption and production patterns ('ecological footprints')'[25] - that is, a rethinking of consumption. Within this programme, they have worked with other organisations in various research fields.

For example, IIED have recently completed a report commissioned by the World Business Council for Sustainable Development. The project, 'Towards a Sustainable Paper Cycle,' examined the international paper cycle using an LCA basis and looked at ways paper consumption could be addressed in a more sustainable manner. Within this framework, ecolabelling initiatives for paper products and experiences around the world were also discussed. The aim of the study was within the context of 'sustainable development, to objectively assess the role of paper and the paper industry worldwide focussing on the entire cycle from fibre production (including forestry) to pulp and paper production, paper usage, recycling, energy recovery and final disposal.'[26] The executive summary to this report is available on the Internet (see web address) and a copy of the report can be arranged via this source.

Maryanne Grieg-Gran has herself produced papers on the life cycle assessment of paper products. For example:

- Grieg-Gran, M. (1995) 'LCA of Paper Products - What can they tell us about the Sustainability of Recycling?,'' 'Life-Cycle Analysis - A challenge for Forestry and Forest Industry,' Proceedings of the International Workshop organised by the European Forest Institute and the Federal Research Centre for Forestry and Forest Products, 3 - 5 May, 1995, Hamburg, Germany.

In relation to the Forestry and Land-Use Programme, the main issue has been the 'continuous improvement towards sustainable forest management (SFM). Within this broad boundary, research has

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23 Thomson, K.,(1997) 'IIED's Cross-Cutting Programme: Activities which cut across programme Boundaries', p. 5, available on the Internet [see web address].

24 See **Case Study 3: CEC.**

25 IIED (1997) 'European Programme', sourced from the Internet [see web address].

26 IIED (1997) 'Towards a Sustainable Paper Cycle: Executive summary', sourced from the Internet [see web address].

been placed into four categories, including:[27]

- Collaborative research and training;
- Facility policy improvement;
- Defining roles and building capacity; and
- Creating incentives for sustainable forestry and land-use.

IIED have become involved with the World Commission on Forest and Sustainable Development recently, and have also been involved in forest certification by providing advice on the implications. Steve Bass, the director of Forestry and Forest Programs, has been undertaking a sub-study looking at the different initiatives for standard indicators for sustainable forests. This is providing a useful survey on the main emergences, the ISO frameworks, different meetings that have been organised and planned and the principles involved.

IIED, in their endeavours to provide information to the public, have established an Internet site[28] and have an extensive resource centre containing collections, bibliographical references, IIED archives, country environmental profiles, a database on environmental consultants etc., which is open to the public by appointment.

ISSUES DISCUSSED

Ecolabelling

- The first ecolabelling schemes, in particular ecolabels for paper, focussed on recycling. They are now more sophisticated and based on a better set of principles. The Canadian Environmental Ecolabelling Scheme initially looked broadly at different stages of the life cycle. They now utilise a more detailed LCA. The European Union also uses LCA and they have special consultation forums and interview processes so that different stakeholder groups can have input.
- Priorities and conditions vary between countries and regions - ideally they should allow for local variations.
- There has to be a mutual recognition of ecolabelling schemes between countries, assuming all countries have ecolabelling schemes. If no such scheme exists, other equivalent improvements might be recognised.
- Ecolabels concentrate on environmental issues - there is a parallel movement looking at Fair Trade, that is, social conditions, treatment for workers, pay, and child and adult slavery. This does not address environmental concerns. It would be ideal if all issues were discussed concurrently, for example, fair trade, environment, economics, properties, etc.
- Simon Counsil (formerly of Friends of the Earth) and Marcus Colchester (from the World Rainforest Movement, Oxford) are currently undertaking an analysis of ecolabelling criteria.

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27 IIED (1997) 'Forestry and Land-Use Programme,' sourced from the Internet [see web address].

28 See Internet address above.

Life Cycle Assessment

- Arguments that LCA is not scientific still exist.
- LCA is an important tool, but it may be overrated at present because it is not fully developed.
- It is important to have an inventory of what is happening at each life cycle stage, but assessment is the key.
- It is problematic if LCAs are seen as tools that will automatically give an answer. Ultimately it is the interpretations that will lead to conclusions and development.
- Some LCAs use the system of dividing various indicators into groupings and devising a numbering method for the groupings. This may be helpful so long as the method is totally transparent - someone else may use this method and not agree with the groupings or weightings attached to each category.
- Need to look at how LCAs can be implemented, Scandinavia's system of training workers for example. Chainsaw operators are trained to think about the ecological aspects of what they are doing.

Sustainability Tools

- Other tools and processes need to be analysed in order to develop tools.
  - How tools are developed is very important:
  - Who is involved in process?;
  - Is criteria defined at a national or international level?
  - Is there scope for local and site specific level?;
  - If much is left open to interpretation is there a lot of scope for corruption?

  Thus it is very important for the process of developing tools to be very well understood, and all assumptions need to be stated in detail.
- Certification - people are still sceptical about whether a forest is sustainably managed. There is a lack of confidence in the ability to verify a sustainably managed forest, despite the huge amount of concentration in this area.

Towards a Sustainable Paper Cycle Report

- This report was an independent study partly financed by the industry - 60% funding from a diverse range of companies was channelled through the World Business Council for Sustainable Development.
- Industry gave opinions and a lot of time to look at the report drafts and to make comments. To counterbalance this, the report was also sent to NGOs, various government representatives and other interested parties. There was also an advisory group which was made up of a mixture of stakeholders, and a task force that was mainly industry-based, coming from the sponsoring sectors.
- The process of having all parties involved slowed down the proceedings tremendously, and there was a major initial problem of defining all the stakeholder groups.
- The report is qualitative and puts data from around the world into perspective. That is, it looks at where fibre for paper is coming from, the state of pulp and paper mills around the world, and identifies problem regions.
- In Scandinavia, some companies are so large they incorporate many operations including wood

chipping, paper production, sawn timber manufacture, etc. This seems a very efficient process as everything throughout the production phases gets utilised to their best advantage, rather than simply being burnt or used as mulch, etc. Sweden also has a system of evaluation, whereby after trees have been cleared evaluators assess what has been cut and what has been left. The evaluation is based on criteria which includes social aspects such as whether a house has retained its view, and also ecological criteria.

- Problems with the report in hindsight, include not incorporating representatives from the user groups, such as the packaging manufacturers, etc.
- A follow-up project looked at the consumption side and included a report for the OECD. In it the services the product provided, it was concluded, were just as important as the product; a tissue, for example, needs to be looked at rather than the product paper, with the first question obviously being, 'Do we need this product?' This is a different type of analysis, and if the tissue, isn't being used, what is instead?

CASE STUDY 3:

CEC
(European Commission)

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DIRECTORATE GENERAL X11 - Science, Research and Development

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'The role and responsibilities of the EC place it firmly at the heart of the European Union's policy-making process. In some respects, it acts as the heart of Europe, from which the other institutions derive much of their energy and purpose.'[29]

BACKGROUND

The European Union was established as a binding body for the European Nations. Within the large

[29] European Commission overview sourced from the Internet [see web address].

structure of this organisation, including the European Parliament and the Council of European Union, is the European Commission (EC). The EC was created to serve three separate functions, 'initiating proposals for legislation, guardian of the treaties, and the manager and executer of Union policies and of international trade.'[30] Under the EU framework there are numerous directorates serving many different aspects. For example, the two main directorates visited were: Directorate General (DG)XI - Environment, Nuclear Safety and Civil Protection; and DGXII - Science Research and Development. In each of these directorates there are also sub-sections, including the DGXIE4 - Eco-labelling section.[31] The European Union itself consists at present[32] of 15 countries, thus coordination is a very slow and tedious process.

GOALS

Each section within the European Commission has its own Mission Statement. For example, the aims of DGXI are five-fold:[33]

- Implement a high level of environmental protection;
- Improve the quality of life;
- Increase the environmental efficiency;
- Preserve the rights of future generations to a viable environment; and
- To ensure an equitable use of our common environmental resources.

DGXII focusses on the European Union's Research and Technological Development Policy. Within this framework, the aims are to:[34]

- Supplement national research efforts;
- Strengthen the scientific and technological bases of European industry; and
- Support the policies followed by the Union in its major fields of jurisdiction (environment, health, education, energy, etc.)

The departments within the EC, however, are not mutually exclusive. Much collaborative work is carried out among the numerous directorates. Programmes with other research institutions, including universities, are common, and work with different companies is encouraged. Practical work and

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30 European Commission overview sourced from the Internet [see web address].

31 It is not within the scope of this report to go into a detailed discussion on the European Union's, or the European Commission's, organisational structure. For information regarding the EU's framework the Secretariat can be contacted at the above address, or alternatively, the Internet is a vast source of information [see web address].

32 There are new countries set to join the Union. 'Agenda 2000' details the process of 'strengthening and widening' the Union in the early 21st century, with Hungary, Poland, Estonia, the Czech Republic and Slovenia having negotiations open to them early next year.

33 European Commission Mission Statement DGXI, sourced from the Internet [see web address].

34 IBID.

information programmes, for example, for specific areas including Environment and Climate[35] are conducted. This fits into the education program which is an important factor in increasing awareness of the EU, its activities and its roles within individual nations at a public level.

LCA-RELATED PROJECTS AND PUBLICATIONS

The most relevant project at the European Commission is the 'eco-label award scheme.' The European Union eco-label award scheme is 'a voluntary market instrument that allows manufacturers whose products have received the eco-label to demonstrate to the public that their products meet the high environmental standards that have been set. Equally important, it also helps consumers make an informed choice before making a purchase.'[36] This scheme works on a very general level, but the feeling is that only very general impacts can be dealt with at present with the limited knowledge available. In July the number of products being presented with the label had exceeded 160. Numerous publications come out of the EC on eco-labelling. For example the commission publishes information, in the form of a newsletter on eco-labelling three times a year, which summarises the state-of-the-art. Also recently documented have been suggestions for council regulations:

- Commission of the European Union (1996) 'Proposal for Council Regulations on a revised Community eco-label award scheme,' COM (96) 603 final, Brussels 11.12.1196.

Within the context of the eco-label scheme there has been work on developing the LCA methodology. This undertaking commenced in 1993 after it was decided in 1992 that eco-label criteria should be based on a cradle-to-grave approach.

- Commission of the European Union (1992)'Council Regulation (EEC) No 880/92 of 23 March 1992 on a Community eco-label award scheme,' Legislation, Official Journal of the European Communities, L99, Vol. 35, 11 April, 1992.

A methodology to put this cradle-to-grave principle in place had to be developed. It was at this time that the 'Group des Sages' were established. This group consisted of numerous experts and specialists from both the industry and universities, including H. A. Udo de Haes (Chair) from CML.[37] The job proposal for this group was to develop a clearer methodology. There were limitations to the scope of the development. Due to environmental and trade issues, the International Standards had to be adhered to as closely as possible. Fortunately, the standards were being developed simultaneously, and many people were working in both the Group des Sages and on the ISO Committee. The Group des Sages have so far produced reports summarising LCA methodology and framework, the final one being:

- Group des Sages (1996) 'Practical guidelines for the Life Cycle assessment for the EU eco-labelling programme,' Final report of third phase, Leiden.

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35 European Commission (1996) 'Practical Information and Programmes: Environment and Climate 1994 - 1998 - Workprogramme,' Edition 1996, Science, Research and Development.

36 European Commission (1997) 'The flower starts to bloom!166 products receive EU Eco-label', Press Release, also available on Internet [see web address].

37 See **Case Study 7: CML.**

From this report the EC have produced a simplified text:

- European Commission (1997) 'Guidelines for the Application of Life Cycle Assessment in the EU Eco-Label Award Scheme,' prepared by the Group des Sages.

At the end of these reports a list of research areas for further development is given. Problems that exist in the methodologies to date are also explored. To continue a focus on LCA methodology is no longer a priority for the EC, as they are satisfied with other work by, for example, ISO and LCANet.[38] LCANet has been commissioned under the EU Environment and climate programme to report on LCA:

- Udo de Haes, H. [Co-ordinator] (1997) 'Progress report to EU on LCANet for the period March 1996 - March 1997,' EU nr. ENV4-CT95-0153, European Network for Strategic Life Cycle Assessment Research and Development, Concerted Action in the EU Environment and Climate Programme, Leiden.

ISO's methodology is generic and can be adapted for different needs, so can be used by the EC for the eco-label scheme.

- Standards such as those mentioned in Section 3: Life Cycle Assessment are developed through the EU. For example:
    1. ISO 14040 - Environmental Management - Life Cycle Assessment - Principles and Framework.
    2. ISO/DIS[39] 14041- Environmental Management - Life Cycle Assessment - Goal and Scope Definition and Inventory Analysis.
    3. ISO/CD[40] 14042.1- Environmental Management - Life Cycle Assessment - Life Cycle Impact Assessment..
    4. ISO/CD 14043.1 - Environmental Management - Life Cycle Assessment - Life Cycle Interpretation.

The EC are following up how results can be used for policy purposes and how the LCA tool can be used. They are also undertaking work at present that focusses on different LCA areas, for example, on how LCA results can be co-ordinated, and what objectives and goals are used to carry them out.

An LCA was carried out on paper products within the EC. However, the raw materials were not investigated, except as a supplementary aspect. The fibres were looked at using the concept of sustainable forestry management. It was thought that to include forestry in LCA would be too difficult at this stage, although this will be very necessary in the future.

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38 See **Case Study 7: CML** and **Appendix 1: Contacts List**.

39 Draft International Standard.

40 Committee Draft.

Other publications and information includes:

- A recent publication launched by DGXI and the European Environment:
- European Commission (1997) 'Caring for our future - Action for Europe's environment.'

A database, under construction, which lists European companies that provide environmental services, products and technologies. This is still incomplete, but information regarding the database can be sourced from Mr J. Delbeke, DGXI.B.1 at the second address above or via e-mail: stagiare-b1@dg11.cec.be

There is also a substantial amount of information available on the Internet.[41]

ISSUES DISCUSSED

Ecolabelling

- It is possible to use different tools from LCA for eco-labelling. LCAs have been chosen, however, because they have a scientific basis for their criteria.
- Eco-labels are foremost marketing tools. Consumers will want more and more information in the future.
- Existing eco-label types:
  - Type 1 - Environmental claim certified by 3rd party.
  - Type 2 - Environmental claim issued by manufacturer themselves.
  - Type 3 - Information (information could be way to inform public on the environmental impacts of products.

Forestry

- Forestry issues are extremely difficult to assess. The same problems exist for textile analysis, for example, since it is extremely difficult to quantify inputs and outputs of agriculture products.
- An LCA of agriculture products will eventually be carried out, but we may as well concentrate on where we can make a change at present, for example make a change and improve many aspects by focussing on industrial processes.
- A factory can basically be put anywhere in the world and it is universal. That is, the same processes apply, there are similar standards, etc. Land, however, even just in Europe, has so many differences; it is not yet possible to define criteria or standards on how you can use land to its optimum.
- It will be an enormous piece of work to define ecological land-use - unsure as to whether it would be worthwhile.

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41 See for example http://europa.eu.int. Europa is the European Commissions service on the Internet the homepage links to all the EU directorates. See **Case Study 3: CEC** http://europa.eu.int/en/comm/dg11/ecolabel/index.htm in regards to the EU eco-label award and papers relating to the consumer point of view on eco-labels, such as Bjerregaard, B. (1997) 'Promoting 'sustainable consumption': How can consumers contribute?,' The green Alliance, London.

Life Cycle Assessment

- Generally trying to follow what is going on in LCA field is difficult as the field is rapidly expanding
- Universities, ISO and other bodies are trying to establish the advantages of using LCA as a tool.
- So far the main difficulty has been the bad understanding of LCA - this is on the way to being solved.
- There is not just the problem with the methodology, but problems with the whole concept of LCA - what kind of results you can get, how far you can go with LCA, etc. There is still a very limited understanding of LCA.
- People do not understand how to go about the decision-making process after the LCA has been carried out. LCA is only a tool, to gain results - must make something out of the results by drawing conclusions etc.
- LCA hasn't been very well understood, but now industry is using LCA to lobby the commission, hence a change in favour of LCA.
- Not too many industries are using LCA at present in Europe, only big industry federations can afford it. The most advanced carry out very expensive and very impressive work. There are organisations, for example, who are working on car manufacturing but they have to be large companies because LCAs are extremely resource intensive.
- Environmental NGOs seem to have a better understanding of LCAs now that they a becoming better developed - the tool is becoming more widely accepted.
- LCAs are being used to establish ecological criteria for eco-labels. Eco-labels are becoming widely used and very authoritative.
- Priorities in waste management are being determined by the use of LCAs.
- LCAs are being consideration for future use in general product policy - eco-labelling is only one aspect of product policy. LCA can be used for broader product policy.
- It is hard to define public policy for such a range of values places and values conditions.
- LCA objectives - industry do not have the same objectives in using LCA to interpret raw materials use as, say, a public authority has. The same general framework, however, may be used.
- There is no one unique LCA methodology. The ISO methodology should not be considered as the one methodology - this is a framework methodology, out of which you can pull the material you need to fulfill your objectives.
- If we really want to do anything immediately for the environment, or for any other purpose, ecolabels can be used - they may not be perfect but they seem to work well in this area and can be used while other tools are developed.
- Problems may occur if other issues are included in LCA such as ethics, social issues, etc. - very difficult to quantify. A separate tool may be needed for those types of aspects.
- Industry-based initiatives to carry out LCA on building materials are being developed - industry initiated this because they feared ecolabels would force ecological criteria on them.
- There are different ways for architects to use LCAs, for example, in the selection of materials once information is available, or for the selection of commodities within buildings, such as energy, electricity, etc. In France they have started looking at these issues including the use of

round-swing doors as opposed to self-sliding doors. The energy used in both production and operation, the amount of energy escaping through the doors and the recycling ability of the doors are some of the issues being addressed.

- This looks not just at the choice of material but also at the choice of technology within a building.
- The interaction of LCA, Industry and Architects in bringing the whole process of making a building closer to the environmental ideal, needs to be addressed.
- Everything in LCA depends very much on local conditions.
- The problem is not obtaining information or even distributing it - it might cost, but it can be accessed. The problem is how the information is used. That is, how decisions are made from the information and what trade-offs are made, for example trade-offs between greenhouse gas emissions and acidification. For the same product type there may be different processes - one may have high greenhouse effect and low acidification and one vice-versa. What are choices currently based on in choosing between these products? Own principles/ bias?
- Another model, 'environmental screening,' simply provides a tag that can be attached to a material, product, etc. to show the environmental burdens, for example a contribution to acidification. The tag can be added to with each new process the material, product, etc. undergoes. That is, a piece of timber is tagged by the forestry industry, then the tag is added to when the timber is processed, and it is further modified with each process.

CASE STUDY 4:

SPOLD
(Society for the Promotion Of LCA Development)

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'...uniquely concerned with the practical means of dealing with interactive [LCA] issues and the societal acceptance needed.'[42]

BACKGROUND

The Society for the Promotion Of Life-cycle assessment Development (SPOLD) were founded as a professional body in August, 1992 with the main aim of promoting LCA development. The twenty member companies forming the society identify the issues of most concern regarding LCA development. These member bodies, from industry, regulatory bodies, institutes and organisations with LCA interest, combine a wealth of knowledge and resources, including the funds to undertake such endeavours.

Critical issues identified by the members are addressed by the Board of Directors. This governing board elected by member organisations consists of a maximum of eleven people, with three of these being independent scientific experts. Programmes and strategies to address priority issues are implemented by the board. Projects are undertaken by independent experts or in some cases scientific institutions who have been made associate members in return for their expertise.[43]

GOALS

SPOLD's establishment came about from the need for LCA development and implementation. There are two main parts to their programme resulting from these needs - technology and social dialogue.

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42 SPOLD'S Mission and Strategy Statement available from the above address.

43 For example, SPOLD in conjunction with 'Business for the Environment' commissioned 'The LCA Sourcebook: A European Business Guide to Life-Cycle Assessment,' SustainAbility, SPOLD and Business for the Environment, to 'make LCA more transparent to companies across Europe.' See also Case Study 1: SustainAbility.

SPOLD are committed to promoting the development of an objective, scientifically based LCA methodology in order to reduce environmental impacts of products and services. They are also endeavouring to communicate LCA principles to society so its use is supported within, for example, eco-labelling schemes, and also to communicate with government during development of LCA legislation.

To achieve these goals SPOLD have developed three Key Strategies:[44]

1. Promote Sound Strategies

1.1 Make a common format for Life Cycle Inventory (LCI) data in order to allow users to judge data quality.

1.2 Develop a network of existing databases, to allow easy identification and access.

1.3 Design and publish guidelines for critical (or peer) reviews to enhance the credibility of LCA studies.

2. Integrate of LCA with other Environmental Management Tools

2.1 Establish a coherent framework for environmental management integrating:

1. Human and environmental safety;
2. Regulatory compliance;
3. Design for the environment, efficient resource use and waste management; and
4. Societal concerns.

Products that perform and meet societal demands for environmental quality should be the result.

3. Win Acceptance and Promote Correct use of LCA Studies

3.1 Use constructive dialogue between industry, governments, environmental groups, professional groups and academic institutions to get broad acceptance of study output.

LCA-RELATED PROJECTS AND PUBLICATIONS

SPOLD's main recent development has been the creation of a database framework.[45] Ms van Schaardenburg explained that the initial brief was to develop an inclusive database. Subsequently, it was decided that this was not a feasible study, due to cost and unwillingness of companies to expose their data. Instead, a common framework for data handling has been developed. This concept was proposed so all data could be used in the same form. Instead of providing data, SPOLD can now act as intermediary between data users and suppliers. This project is for LCI databases rather than LCA, that is, about materials rather than impacts.

SPOLD worked with industry not to collect data, but knowledge on how data is collected, what data is used for, etc. Software has been developed with the aid of 25 consultants, scientific institutes and university groups. A multi-user test was undertaken over a two-year period to examine the data framework. The framework is supported by a database network which is an 'electronic library' of

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44 SPOLD's 'Mission and Strategy Statement,' available from address above.

45 Published on the 1st of July, after my visit to SPOLD.

existing LCI databases.

As well as this project, other initiatives being undertaken include:

- Life Cycle environmental management;
- Social Dialogue project;
- Critical (Peer) Review Guidelines; and
- Environmental education for small and medium enterprises.

SPOLD's publications to date include:

- Elkington, J. et al (1993) ' The LCA Sourcebook: A European Business Guide to Life Cycle Assessment,' SustainAbility, SPOLD and Business for the Environment.
- Grisel, L., Alstrup Jensen, A. and Klopffer, W. (1994) ' Impact Assessment Within LCA,' SPOLD.
- Fussler, C. (Undated) 'Life Cycle Assessment: A New Business Planning Tool?,' SPOLD.

ISSUES DISCUSSED

Life Cycle Assessment

- There are many problems with establishing databases.
- Companies are developing a database and selling the information on to those who want it.
- This does not need to be regulated as it would be in everyone's best interest to provide correct and up-to-date information.
- Industry still hesitant to give away data, which is understandable if there are trade secrets. Information and data is, however, necessary in order to carry out LCAs or other environmental audits.
- Many companies use the same basic materials, which means there is a lot of common data that can be made available in a database.
- Instead of everyone starting LCA from scratch they could get general information from a database.
- Not everything can be regulated, so data could be compared using a common framework.
- Currently there is only access available to LCI databases, rather than LCA.
- There will always be different schools of thought as there are so many subjective issues
- One LCA framework, which can be used with interpretation is required.

CASE STUDY 5:

TNO Building Construction and Research (Netherlands Organisation for Applied Scientific Research)

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'The issue addressed by product assessments, and therefore by product policy, is that every product and every activity has an adverse effect on the environment. This causes problems: one particular product may produce a lot of waste while another product requires a lot of raw materials. One product results in more emissions in the usage stage while another results in more emissions during the production stage. This hides the overall effect on the environment: all life cycle stages and all environmental effects are important; shifts to other effects or stages in the life cycle must be avoided.'[46]

BACKGROUND

TNO Building Construction and Research are one institute out of fourteen that forms the Netherlands Organisation for Applied Scientific Research (TNO). TNO are a broad-based, scientific research body which undertakes international research, advisory work and the development of standards. Independent from the government, the organisation is operated with a commercial policy on a purely objective basis. The practical application of knowledge and technology is an important consideration, and research which gives a competitive market advantage is investigated through research means. Their aim is to 'provide clients with solutions to real problems.'[47] TNO's multi-disciplinary framework allows them to liaise with government, business and industry communities, and also university bodies. The organisation is considered a part of the 'National System of Innovation' in the Netherlands.

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46 Heijungs, R. (Final editor) (1992) 'Environmental Life Cycle Assessment of Products: Backgrounds', CML, TNO and B&G, NOH coordinated by NOVEM and RIVM, p. 1.

47 TNO's Company Profile, sourced from the Internet [see Web address].

TNO Building and Construction Research Department communicate with government bodies, building and engineering companies and other companies involved in the building, construction and materials industries. Research covers a wide range of areas, specifically concentrating on investigations within ten major sectors:[48]

- Building processes and construction;
- Informatics and knowledge-based systems;
- Advanced calculation techniques;
- Product development;
- Production methods;
- (Sustainable) materials and components;
- Sustainable management;
- Sustainable energy;
- Indoor environment; and
- Underground construction.

GOALS

The pursuit of knowledge is the key basis for TNO achieving their mission of 'strengthening the technological power of trade and industry and of the government.' They aim to do this through the employment of three methods:[49]

- Strategic Research (which in the majority deals with longer term research);
- Applied Research and Development (which deals more specifically with practical needs and applications); and
- Consultancy (which is research undertaken in regards to particular client questions).

LCA-RELATED PROJECTS AND PUBLICATIONS

Life-sys wood

Petra Esser and David Robson, acting for TNO, are the coordinators for the Life-Sys Wood project. Life-Sys Wood involves wood and wood product organisations from both industry and institutions around Europe, including VTT,[50] Tratek[51] and EMPA.[52] Canada and the United Kingdom are also

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48 TNO General Introduction, sourced from the Internet [see Web address].

49 TNO's Mission and Profile, sourced from the Internet [see Web address].

50 See Case Study 15: VTT.

51 See Case Study 14: Tratek.

52 See Case Study 19: EMPA.

represented by Forintek[53] and Imperial College respectively. The project has been initiated in an attempt to keep up-to-date in LCA endeavours. Its objectives include:[54]

- Undertaking of LCA's for specific wood products
- Development of a common approach to input data for wood product LCAs;
- Comparison of LCA methods;
- Development of a consistent approach to LCA; and
- Investigation of knowledge transfer systems for LCA comparisons.

To date the network has been established, a background literature check has been undertaken and a 'decisions list' developed. The 'decisions list' includes those issues that particularly relate to the wood and wood products area that are often not covered in other LCAs. It has been decided by the group that these areas need investigation and decisions made in regards to them. The list includes:

- 'Sustainable Forestry';
- Impact of Forestry Processes
- System Boundary of Forestry;

as well as issues pertinent to most LCAs such as:

- Product Definition; and
- Allocation Processes etc.

It is an important endeavour to disseminate this information to the participants. A computer program has been developed to the demonstration stage in an attempt to create an appropriate informative tool. This program analyses a particular wood product, in this initial stage a window frame, to particular specifications. Most of the information gathered has come from the project partners and is only available within this group. There have therefore, not been documents published for general availability. Papers have, however, been presented by project partners that do relate to the Life-Sys Wood program.[55]

A brochure defining the Life-Sys Wood concept is available from Petra Esser or David Robson at the above address.

- TNO (1997) 'Life-Sys Wood: A consistent approach to the life-cycle analysis of wood products.'

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53 See Case Study 23: Forintek.

54 TNO (1997) 'Life-Sys Wood: A consistent approach to the life-cycle analysis of wood products.'

55 For example, see TNO (1997) 'Life-Sys Wood: A consistent approach to the life-cycle analysis of wood products.'

ISSUES DISCUSSED

Life-Sys Wood

- Life-Sys Wood is a knowledge based computer program.
- It is nearly up and running for trial basis.
- Input data is used to determine particulars about window frames (this will eventually be expanded to include many wood products).
- The program considers environmental issues such as logging, transport, manufacture, etc.
- My note - I think the program mainly focuses on the energy use in these processes. It is more of an energy input model than a full LCA system.
- At this stage only a demonstration version, designed as a trial and comment vehicle for project partners, is available.
- Further tools need to be developed and trialed.
- Tools specific to wood and wood products industry need to be developed and trialed within industry.
- Small organisations and industries must get together because the LCA area too vast to tackle alone.
- Industry must get involved at the ground level.
- Problems in data collection - collecting more specific data from partners for particular products.
- This is for use within participant organisations rather than for external use, but it has been designed to eventually be used for comparative purposes.
- TNO are trying to develop a standard format.

CASE STUDY 6:

TUDELFT
(Delft University of Technology)

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'Product designers are fit for applying the principles of sustainable development. This is the reason that the school for Industrial Design Engineering started a department for environmental product development.'[56]

BACKGROUND

The Faculty for Industrial Design Engineering at Delft University of Technology (TUDelft) are an education and research department. Environmental design principles are the essential basis for the activities within the faculty. Solutions to environmental problems through sustainable development, environmental design methods and life cycle assessment are emphasised by practical design tasks.

AIM

The main aim of the Industrial Design Engineering Department is to research and develop eco-design tools and provide education in this area. In particular their goals are to address the principles of construction, ergonomics, business and aesthetics in the development of consumer products. To achieve the integration of these principles with environmental issues , 'the students need to be introduced, early

[56] Green Product Design (1993) 'Environmental Product Development in Delft', Newsletter of the Section for Environmental Product Development, Faculty of Industrial Design Engineering, Delft University of Technology, Newsletter 0, December.

in their studies, to the environmental problems and the complex relations with product development.'[57]

LCA-RELATED PROJECTS AND PUBLICATIONS

TUDelft Faculty for Industrial Design Engineering have been involved with many other organisations in both research and development projects. Joint projects with companies are encouraged in order to facilitate the practicality of solutions to design problems. There are currently three main research areas of focus:

- Environmental design and product management;
- Environmental load and use of consumer products; and
- Development of systems and tools for reuse, re-manufacture and recycling.

The Faculty have participated in PROMISE, an Eco-Design project, with companies such as TNO.[58] They have also cooperated with TNO on environmental product development projects. These have so far been mainly 'brainstorming' sessions focussed on the generation of new products and product systems for the 'Economy, Ecology and Technology' (EET) program funded by the Dutch Ministry of Economic Affairs (EZ) and the Ministry of Education, Culture and Sciences (OCW). The EET program endeavours include:

- The development of new technologies,
- A focus on substantial environmental improvement;
- A concern for economic viability; and
- The achievement of an eco-efficiency factor four.[59]

The Environmental Product Development Section within the Faculty of Industrial Design Engineering have been working on a computer database for designers. The resultant program is IDEMAT. This program investigates the environmental impacts of materials, in an aim to aid designers in their section of materials. IDEMAT contains all relevant technical information relating to materials, processes and products. This allows the user to set the criteria to suit their own needs, in order to determine all materials that fulfil these requirements.

The program uses SETAC's and CML's LCA methodologies in relation to the Characterisation and Evaluation phases. 350 materials have so far been included in this database and each material is analysed according to 40 aspects, including environmental, physical, mechanical and optical properties, and any other information deemed important. The environmental information has been ascertained using

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58 See **Case Study 5: TNO.**

59 This is a European eco-efficiency rating scheme.

the Dutch national effects score in association with one kilogram of the material.[60] An 'eco-indicator'[61] for each material is determined in the program. There is further information on IDEMAT and a demonstration of this program on the Internet.[62]

The Section for Environmental Product Development in the Faculty of Industrial Design Engineering publish a newsletter, 'Green Product Design.' Started in 1993, each copy is available on the Internet.[63] Each addition presents a number of papers relating to environmental product issues, including Life Cycle Assessment.

Maarten van Hees is currently undertaking a Doctoral study on the reliability of Life Cycle Assessment. He has published one paper in the 'Green Product Design' newsletter.[64]

ISSUES DISCUSSED

- LCA and other environmental tools are being introduced to designers at the educational level at TUDelft.
- Industry are involved in the universities endeavours, and students work directly with industry and organisations.
- The university, industry and research organisations work together to develop environmental solutions. In particular the EET - Economy, Ecology and Technology program is very valuable combining the skills of the different sectors to develop appropriate environmental technologies.
- There are two IDEMAT computer databases - one for student use and the other for practitioners. This database is proving to be very useful.
- LCA due to all the assumptions made is very unreliable at present. It must be understood that what LCA determines at present may not accurately portray the actuality.

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60 This is not considered an appropriate method of assessment for building materials. It is much more relevant to assess a material by its use in a particular application. As it may be that one kilogram of a material achieves what ten kilograms of another does. For example, a particular paint may cover a particular area and last for 10 years. Another may cover the same area but only last for five years. So for comparative purposes, the functional unit may be the amount of paint needed to cover one square metre for 20 years. Rating by function seems to be a more appropriate solution than rating by weight.

61 An Eco-indicator is used in Life Cycle Assessment to determine the total environmental impact and is most often expressed by a single figure.

62 Information and a demonstration program is available on the Internet at: http://www.io.tudelft.nl/research/mpo/index.html

63 Green Product Design is available on the Internet at: http://www.io.tudelft.nl

64 Van Hees, M. (1993) 'Reliability of Life Cycle Assessment: What problems occur with the (lack of) accuracy of LCA Data?,' Newsletter of the Section for Environmental Product Development, Faculty of Industrial Design Engineering, Delft University of Technology, Newsletter 1, December.

CASE STUDY 7:

CML
(CENTRE OF ENVIRONMENTAL SCIENCE, LEIDEN UNIVERSITY)

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'The description of nature is not stripped of arbitrariness by naive absolution, but only by recognition and formulation of the points of arbitrariness. The only path to objective knowledge leads through conscious awareness of the role that subjectivity plays in our methods of research.' Hans Reichenbach, The philosophy of space and time.[65]

BACKGROUND

In 1977 the Centre of Environmental Science (CML) was established as an Interfaculty Department within Leiden University. Research and education form the majority of CML's activities and the main focus is to determine environmental problems and find solutions. CML's role is science based and research is undertaken on this basis in order to improve methodologies and to apply them in case studies. The research and educational sections that constitute CML's most rigorous areas of work comprise:

- Substances and Products;
- Ecosystems and Environmental Quality;
- Programme Environment and Development; and
- Education - Western and Eastern.

Research projects are undertaken within this framework and contribution from many faculties, and

65 Heijungs, R. (Final editor) (1992) 'Environmental Life Cycle Assessment of Products: Backgrounds,' CML, TNO and B&G, NOH coordinated by NOVEM and RIVM, p. 10.

within disciplines, is common. Students are also encouraged to be involved in all stages of analysis and areas of investigation, including field research. Their research is generally client-based, with work being contracted by government, industry and organisational bodies. Research, however, is only undertaken if it adheres to CML's aims and research policies. For example, they have worked closely with SETAC,[66] within the LCANet group,[67] and within ISO.[68] CML has been instrumental in the development of 'environmental theory and methodology,' but they generally do not become involved in the application within an organisation. Most of the research work undertaken at CML involves defining a function and trying to be objective.

GOALS

The major aim of CML is to provide impartial, high-quality research, education and consulting services, specifically in regard to complex environmental questions, with a comprehensive and interdisciplinary approach.

LCA-RELATED PROJECTS AND PUBLICATIONS

CML's active participation in the LCA field has been continuous and ongoing. Their guide and background to LCA, jointly undertaken with TNO[69] and B&G for the National Reuse of Waste Research Programme(NOH), were the first reports consistently looking at LCA.

- Heijungs, R. (Final editor) (1992) 'Environmental Life Cycle Assessment of Products: Backgrounds,' CML, TNO and B&G, NOH coordinated by NOVEM and RIVM.
- Heijungs, R. (Final editor) (1992) 'Environmental Life Cycle Assessment of Products: Guide,' CML, TNO and B&G, NOH coordinated by NOVEM and RIVM.

These reports placed them in a good position in the international LCA field. More recently a third guide, researched in conjunction with Unilever and published by the NOH, was released. This report gives an overview of how to carry out an LCA and also provides a guide for determining whether an LCA should indeed be undertaken.

- Van Den Berg, N., Dutilh, C. and Huppes, G. (1995) 'Beginning LCA: A guide into environmental Life Cycle Assessment,' CML & Unilever, NOH coordinated by NOVEM, RIVM.

Since these reports much advancement and development has taken place. A new project started in

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66 See **Case Study 4: SETAC** and LCA-Related Projects and Publications below.

67 See **Case Study 11: IVL, Case Study 21: Ecobilan**, and also LCA-Related Projects and Publications below.

68 See **Case Study 3: CEC, Case Study 21 : Ecobilan**, and LCA-Related Projects and Publications below.

69 See **Case Study 5: TNO**.

June 1997 and set to be completed in mid-1998, will endeavour to update the previous documents. The aims of this undertaking are:[70]

1. To indicate the necessity of an LCA methodology for environmental policy in general, and product policy in particular;
2. To stimulate a broad acceptance of the LCA methodology within The Netherlands through a Steering Committee and 'think-tank'
3. To indicate the potential areas of application of LCA, including the conditions and starting points';
4. To steer the LCA methodology development with respect to:
    - Integration of all developments, nationally and internationally, Since the publication of the previous methodology reports in 1992;
    - Shaping a simplified LCA methodology; and
    - Indicating the gaps in the methodology;
5. To elaborate in detail on a number of methodological issues; and
6. To write a new guide and backgrounds document.

Professor H. A. Udo de Haes, the Scientific Manager of CML, has been a major participant in many of the European LCA initiatives.

He is Chair for the 'Group de Sages.'[71] Gjalt Huppes and Nicole Wrisberg of CML are also contributors.

- Group des Sages (1994) ''Guidelines for the application of life-cycle assessment in the EU ecolabelling programme,' Final report of first phase, Leiden, September.
- Group des Sages (1996) ' Research needs in life-cycle assessment for the EU ecolabelling programme,' Final report of second phase, Leiden, July.
- Group des Sages (1996) 'Practical guidelines for Life Cycle Assessment for the EU ecolabelling programme,' Final report of third phase, Leiden, November.

He is also editor of a draft report for SETAC-Europe.

- Udo de Haes, H. A. [Editor] (1996) 'SETAC-Europe Working Group on Life-Cycle Impact Assessment,' Draft report.

Maybe most importantly, Professor Udo de Haes is also coordinator of the European Network for Strategic Life Cycle Assessment Research and Development (LCANet was formed under subsidy from the DGXII[72] in order to provide information to the European Union in regards to the Environment and Climate Programme). The main function of the group is to analyse and describe the state-of-the-art

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70 Guinee, J. (1996) 'Life Cycle Assessment in Environmental Policy,' CML.

71 See **Case Study 3: CEC**

72 See **Case Study 3: CEC**

LCA methodology. To do this they have set up critical objectives to fulfil:[73]

- To be a platform for discussion on LCA research and development by regular and rapid exchange of information between European universities, research institutes, companies, non-governmental organisations and the European Commission;
- To draw up a coherent strategic LCA research programme, including developments needed to employ LCA effectively as a policy support tool and as a 'driving force' for technological development in particular in the field of environmental technologies.

These objectives are carried out through regular meetings, workshops and interactive reports. Members of LCANet can also be found on the 'Group des Sages' committee,[74] which includes members from IVL[75] and Ecobilan.[76] LCANet also cooperates with other European LCA Programmes, working with organisations such as SETAC and SPOLD,[77] for example.[78]

So far a number of documents have been published under the LCANet banner. The first and second phases have resulted in a definition document, theme report and final reports.

- Wrisberg, N. (1996) 'Definition Document,' LCANet Board, Leiden.
- Finnveden, G. and Lindfors, L. (1997) 'LCANet Theme Report Life Cycle Impact Assessment and Interpretation,' IVL, CML, Leiden.[79]

Recently a progress report was submitted to the European Union.

- Udo de Haes, H. A. (Coordinator) (1997) 'Progress report to EU on LCANet for the period March 1996 - March 1997,' European Network for Strategic Life Cycle Assessment Research and Development, Concerted Action in the EU Environment and Climate Programme, Leiden.

There are four areas of research that LCANet is following:[80]

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73 Udo de Haes, H. A. [Coordinator] (1997) 'Progress report to EU on LCANet for the period March 1996 - March 1997,' European Network for Strategic Life Cycle Assessment Research and Development, Concerted Action in the EU Environment and Climate Programme, Leiden.

74 See **Case Study 3: CEC.**

75 See **Case Study 11: IVL.**

76 See **Case Study 21: Ecobilan.**

77 See **Case Study 4: SPOLD.**

78 See **Appendix 5: Organisation Connections within the LCA Arena**

79 See **Case Study 11: IVL**

80 There are the following theme reports that are available also:
- 'Positioning and application of LCA' from CES
- 'Goal and scope definition and inventory analysis' from ETH

- Positioning and Applications of LCA
- Issues related to Goal and Scope Definition and to Inventory Analysis;
- Issues related to Impact Assessment and Interpretation; and
- Issues related to databases and software.

There is also much information in regards to LCANet available on their Internet site.[81]

Nico van den Berg had a Phd position with CML during 1997. His work was involved with developing improved methods for data collection. The gathering and collecting of data is at present very difficult and there is not really a standardised way of obtaining this information. It was his endeavour to make an 'estimation model' to be used as an estimation for the real data.

ISSUES DISCUSSED

Life Cycle Assessment

- In the international arena there are currently many methods and proposals within LCA development.
- Most data has been collected from European or North American sources.
- LCAs need to be analysed to see whether they are viable for Australia.
- LCAs are good tools but:
    - They are very hard to manage at present.
    - It is doubtful that important issues, emissions, etc. will be looked at if the tool becomes simplified. LCA is large, but this is necessary if you want to be correct.
- For natural materials it is very hard to score methodological problems.
- LCAs are very large and very comprehensive. In the long run you may find out what you already knew - for some products this may be true.
- There is no rating system for different types of emissions available. For example, C02 and CH4 both contribute to global warming. It is not known, however, whether CH4 is 11 times worse than C02, so require some form of analysis model.
    - This is only one environmental theme - global warming.
- Toxicity problems need to be addressed using models. It is argued that toxicity is very difficult to add up and weigh and personal bias forms the discussion.

- 'Databases and software,' from Ecobilan
- 'Work environment and LCA,' from dK-TEKNIK

For more information see Udo de Haes, H. A. (Coordinator) (1997) 'Progress report to EU on LCANet for the period March 1996 - March 1997,' European Network for Strategic Life Cycle Assessment Research and Development, Concerted Action in the EU Environment and Climate Programme, Leiden.

81 Internet site: http://www.leidenuniv.nl/interfac/cml/lcanet/hp22.htm

- With Plywood, for example, the human toxicity of formaldehyde[82]0 needs to be compared to cutting down extra trees, or using other products, and the burdens this may place on the environment - that is a choice everyone has to make themselves, for example if you are asking 'can I make a comparison between plywood and chipboard using LCA?,' of course you can, but don't expect absolute answers just expect more insight.

- It is preferable to be given the facts about all the issues and weigh them up according to own personal biases in order to make choices.
- Industry also needs facts so they can weigh up and make decisions about processes and develop products environmentally.
- LCA is meant to be a quantitative method. As soon as there is a model quantitatively dealing with societal issues, this can be included in an LCA. At the moment there is no such model though.
- The LCA methodology is used for a whole range of things including making an upstream inventory of processes involved and applying the methodology.
- In the past, strange comparison measures have been used to compare products, for example, one kilogram of timber to one kilogram of steel. Rather, the comparison should be made in terms of function, that is, a steel door handle compared to a timber one.
- The LCA process is important:
  - The system boundary must be drawn in order to define the function;
  - Inside the system a lot of things are happening including the extraction of materials, electricity production, upgrading of production, etc.;
  - From every process the data is collected for extractions from the environment, emissions to the environment, etc.;
  - All the processes, including recycling, need to be looked at
  - Conclusions need to be drawn from the data;
- Most LCA models are input/output models.
- Processes outside of the factory have not been addressed as yet. For example, if zinc is used for a gutter the acidity of rain may make it leach cadmium - this area isn't currently investigated.
- The LCA instrument is just diagnostic. It doesn't help to create a process or anything, it just measures or makes an inventory of environmental harm.
- The communication of LCA knowledge also need acknowledging:
  - Is the information purely for the manufacturer/ company etc.?
  - How is knowledge communicated?
  - In Europe Shell had an LCA done to determine what was the best option in the case of the Brent Spar Oil Rig. It was determined the best environmental alternative was to sink it. Greenpeace had a lot of power and fought this sinking but not on a scientific basis. Shell should have communicated the results in a more accessible way to the interested parties

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82 It is considered that once the formaldehyde is set within a sheet of plywood there is only a release of 0.02 - 0.04ppm which is not considered to be toxic. The effects however, of formaldehyde on humans working with the substance are under enquiry here.

- It is very important to communicate transparently.
- LCAs should be undertaken in order to determine the issues that need to be addressed:
  - Emphasise and make clear assumptions;
  - Find out common goal, common aim and what any pre-assumptions are; and
  - In every iteration try to keep everyone included.

This type of model has more chance of success if transparent.

Sustainability Tools

- Every environmental study is trying to understand, 'how much comfort do I get from this product and how much harm does it cause in the environment?'
- Does this need to be communicated with figures to this, or can it be done some other way? There are no qualitative methods developed that are totally objective - need to have a more applicable and relevant societal model
- Environmental Modelling uses scientific methods based on the attributes of the substances and mechanisms.
- Sustainable building material lists that state, for example, PVC should not be used, but PE can be, are dangerous - it will never be true for all applications.
- These types of lists often come from arguments formed without LCA or other scientific verification:
  - Often these types of lists are very wrong.
  - For instance, in Europe insulation is needed to lower heating use, so cork, a natural material, was promoted. The performance of cork, compared to other insulation materials was, however, not assessed.
- Other environmental initiatives include Eco design projects. These address such issues as:
  - Energy used in building operation which is most important in Europe; and
  - The disassembly of building and building components.
- The Netherlands have a famous packaging covenant which emerged when the Government wanted to diminish packaging. The industry was not impressed, and a compromise covenant was put in place in lieu of laws.

CASE STUDY 8:

IVAM ENVIRONMENTAL RESEARCH

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'IVAM Environmental Research is involved in research in the field of 'sustainable use of materials and energy.' Key concepts are: cleaner production waste and emission prevention, integrated chain management [also referred to as life cycle assessment, environmentally oriented product development (Ecodesign), efficient use of energy and materials, introduction of renewable energy sources, company environmental management and sustainable building.'[83]

BACKGROUND

Incorporated in 1993, IVAM Environmental Research is the environmental research, training and consulting firm of the University of Amsterdam. As such, they provide a multi-disciplinary base for research into environmental issues. Their main area of focus deals with the sustainability of raw materials and energy. There are five categories which form the major areas of IVAM's research:[84]

- Product Studies (including LCA and Environmental improvement of products);
- Production Process Studies;
- Energy Studies;
- Sustainable Building (including improvements in the areas of energy savings, minimising toxic materials, efficiency in material use etc., by applying life cycle thought to these issues); and
- Technology Transfer for Sustainable Development.

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83 IVAM (Undated) 'IVAM Environmental Research', Brochure.

84 IVAM (1997) 'Overview of Publications.'

These sections are not exclusive and the boundaries between them are not strictly defined. For example, Mr Fraanje works closely with LCA and is conducting a thesis on sustainable use of wood in the building sector,[85] but he is situated within the Sustainable Building Department rather than the Product Studies Department. The Product Studies field deals with LCA and 'systematically takes stock of the environmental impact of the manufacture, use and disposal of products.'[86] Under SETAC's supervision, IVAM works with other researchers nationally and internationally, to further develop the LCA body of knowledge. Within this area of Product Studies, companies are aided in determining environmental 'bottlenecks' within their production processes. They also contribute to the development of less harmful products.

GOALS

As a university body, IVAM's major aim is research, but providing practical environmental advice and training is an important aspect of their objectives. Governmental bodies, private companies and non-governmental organisations alike are included in IVAM's provision for knowledge transfer. Innovative research and development is also high on the agenda, and research areas are explored through interdisciplinary co-operation within the university structure, specifically with the Interfaculty Department of Environmental Science. The practical application of the methods and techniques developed is a high priority and is considered to be a workable goal. For example, Mr Fraanje advises on building projects and conducts research studies for the government, local organisations and companies.

LCA-RELATED PROJECTS AND PUBLICATIONS

Mr Fraanje is currently looking at the sustainable use of wood in buildings, taking a cradle-to-grave approach. He is considering the initial use of a piece of wood, so that it can be employed to its full potential in its first application. 'Cascading' of wood is concentrated on; this concept explores the potential of utilising wood initially in a high-value application. After its first use the wood can then be recycled into a product of maybe lesser value and so on for each new life, rather than utilising wood initially in a low-value application. Also being explored are the environmental impacts of a 'Beam of Poplar Wood'[87] and Glue Laminated applications. Published papers include:

- Fraanje, P. (1997) 'Cascading of pine wood,' Resource, Conservation and Recycling 19, pp. 21 - 28, Elsevier Science.
- Lafleur, M. and Fraanje, P. (1997) 'Towards sustainable use of the renewable resource wood in the Netherlands - a systematic approach,' Resource, Conservation and Recycling 20, pp. 19 - 29, Elsevier Science.

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85 See LCA-Related Projects and Publications.

86 IVAM (1997) 'Product Studies', sourced from the Internet [see web address].

87 See Issues Discussed.

Most important within the LCA field has been the development of the 'IVAM LCA Data,' which is a building material's database designed to be used for LCA. It consists of over 250 processes and 100 materials specifically aimed at the building sector. The database uses SimaPro software, which is internationally recognised, and has been kept up to date with the latest LCA methodology developments. The database's features include:[88]

- Dutch data supplemented with European or Worldwide data, for detailed information;
- Concentration on material production steps as individual process sub-steps;
- Labels for emissions related to transport and energy processes; and
- An additional method for data aggregation to environmental problems.

Using this database IVAM have conducted numerous LCAs studies, including LCAs of window frames and inner-wall partitions, and data from these studies are incorporated within the database.

IVAM has completed numerous other LCA reports, including a 'LCA Peer Review of a study on PVC packaging performed by VITO, Belgium,' and an 'LCA on Window Systems.' Most are only available in Dutch, but have English summaries.

Reports have also been carried out in conjunction with other institutes. For example, a 'Life Cycle Design Manual' is currently being developed in conjunction with IZT (Berlin), IOW (Vienna) and INETI (Lisbon). The SETAC-Europe Working Group on Life Cycle Impact Assessment commissioned Mr Lindeijer of IVAM to produce a chapter on valuation within their report 'Towards a Methodology for Life Cycle Impact Assessment.' A draft copy of this chapter is available on the Internet (see web address).

Mr Lindeijer has also presented papers on the valuation step within LCA, including:

- Lindeijer, E. W. (1994) 'The valuation within LCA: Aim, Criteria and Procedure,' presented at a SETAC workshop at ETH, Zurich and published within the 'First Working Document on Life Cycle Assessment Methodology.'
- Lindeijer, E., Sprengers, M., Kortman, J. and Sas, H. (1994) 'Comparison and Integration of Two LCA Valuation Methods for Impacts Due to Emissions,' presented at the 4th SETAC-Europe Congress, 11/14th March 1994, Brussels, Belgium.
- Lindeijer, E. (1994) 'Allocating Recycling for Integrated Chain Management: Taking Account of Quality Losses,' in Proceedings of the European Workshop on Allocation in LCA at CML, Leiden.

A 29-page overview of IVAM's 'Environmental Research Publications' (1997) lists all publications and other activities since their inception in 1993. Most of these publications are available for purchase through the secretariat.

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88 IVAM (Undated) 'IVAM LCA Data: the IVAM Environmental Research LCA Database on building materials.'

ISSUES DISCUSSED

Wood and Wood Products

- Cascading deals with wood products over many applications rather than just one.
- Traders may not be interested in recycling wood without incentives. From an environmental point of view, if wood can be reused a certain amount of times impacts will be reduced. This will improve the timber industry's marketing position.
- If a plastic or steel window, for example, can be recycled and a timber one can't, this puts the timber industry at a distinct disadvantage.
- It is also 'good housekeeping' for the timber industry if the wood can be recycled from an out of use building for another application
- Mr Fraanje estimates that wood can be cascaded seven times.
- The idea of cascading is not a new one - in traditional housing it was very normal to use wood from destroyed or unused houses.
- Mr Fraanje does not feel that tropical timber is necessary in a building application and propagates a method of building which doesn't utilise hardwoods.
- Poplar wood is very common in The Netherlands, Belgium and France and there is work being done to re-establish it as a building product, rather than just timber for packaging, pallets and crates, which are low-value applications for this timber
- Ways to reintroduce this wood into buildings are being investigated.
- The timber industry is not picking up on the need and do not see aim in pursuing poplar wood. They need to be encouraged that in order to fill an ecological niche, they have to fight for it. They can no longer just rely on timber being a sustainable product.
- Industry cannot just defend the norm - they must really begin to understand and know how to develop and improve production, raw material use, etc.
- Timber companies still prefer to have contacts with official wood institutes rather than environmental bureaus.
- There is a problem in obtaining good data from companies.

Life Cycle Assessment

- IVAM developed one of the first LCAs in The Netherlands and are now very familiar with methods and LCA developments.
- It is very important to be up to date with LCAs if conducting LCA projects
- IVAM works closely with small companies - mainly companies dealing with timber rather than forestry as most of the timber used in The Netherlands comes from outside of the country, in particular, Scandinavian timber and tropical imports.

Health Aspects

- Human health aspects cannot be ignored in environmental studies - working conditions and health hazards are very important factors.
- All factors are integrated.
- A very low use of formaldehyde is advisable due to emissions, particularly in manufacture.
- There is a board being developed in Belgium that has a very low formaldehyde emission, almost lower than natural wood - all woods have some emission of formaldehyde.

CASE STUDY 9:

BFH
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'In order to maintain and to enhance the forests, concepts for a purpose-oriented forestry and an efficient wood processing technology are essential.'[89]

BACKGROUND

The Federal Research Centre for Forestry and Forest Products (BFH) was first founded in 1931 as the Institute for Foreign and Colonial Forestry. From its initiation the institute underwent name and various other changes until 1951 when it became known as BFH. Since this time the organisation has survived many more additions and changes. Now, although under the German Federal Ministry of Food, Agriculture and Forestry, BFH is an independent scientific institution. BFH is a provider of public information and advice, and as a government organisation, provides advice in legislation and standardisation. This advice is not restricted to national activities and in international affairs, cooperation with international organisations is often sought.

BFH has also evolved into an educational and teaching organisation and has close contact with the University of Hamburg's World Forestry, Wood Biology and Wood Technology Fields. There are

89 BFH (1994 a) 'Federal Research Centre for forestry and Forest Products,' Brochure, p. 2.

eight institutes that comprise BFH and each of these deals with a differing area of research:[90]

- Institute for world forestry
- Institute for forest genetics;
- Institute for economics;
- Institute for wood biology and wood protection;
- Institute for wood chemistry and chemical wood technology;
- Institute for wood physics and mechanical wood technology;
- Institute for forest ecology and forest inventory; and the
- Institute for tree breeding.

LCA was first investigated within the BFH in 1993. An LCA on forestry has never been undertaken in Germany and certification is still more in discussion than LCA. BFH has recently seen LCA flourish within its ranks due to the thinking that 'LCA can be very helpful to support the marketing of forest products by underlining their environmental benefits.'[91] People such as Arno Fruhwald, Jorge Schweinle and Mohammed Scharai Rad are all actively involved in LCA research and development in the forest and forest product arena.

GOALS

Since forests still cover approximately one-third of Germany's land, they are of great importance. The aim of the BFH is to provide 'scientific fundamentals and to broaden the scientific knowledge for the benefit of forestry and forest products industries.'[92] This goal is achieved through the concentration on specific aims:[93]

- Assessment and monitoring of forests and forest ecosystems with respect to their structure and development;
- Interactions between forests, environment and economics;
- Conservation of forests with respect to their diversity and the genetic resources;
- Improvement of productivity of the forests for the conservation of the natural environment and for the supply with the renewable raw material wood;
- Promotion of the competitiveness of forestry and forest products industries as well as the design and organization of working processes;
- Determination, conservation, improvement and standardization of properties of wood and wood-based products;
- Development and rationalization of processing technologies in forest products industries with

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90 BFH (1994 b) 'Federal Research Centre for forestry and Forest Products,' p. 4.

91 Schweinle, J. (1997) 'Life Cycle Assessment of Forestry as a Basis for Ecological Valuation of Forest Products', XI World Forestry Congress, Atalya, Turkey, 13 to 22 October, Vol. 4, Topic 22, Summaries of voluntary papers.

92 BFH (1994 a) 'Federal Research Centre for Forestry and Forest Products', Brochure, p. 2.

93 BFH (1994 b) 'Federal Research Centre for Forestry and Forest Products,' p. 4.

respect to an improved product quality;

- Determination of potential hazards to the environment from timber-processing industries and from wood products and the development of environmentally tender technologies; and
- Effects of environmental changes (pollution, climate) on forests, forest management, productivity of forest and their potential for utilization.

LCA-RELATED PROJECTS AND PUBLICATIONS

Recently studies have been undertaken in relation to forestry and forest products at BFH. The investigations concentrate on LCA as a method for ecological evaluation. An initial study on Germany's roundwood production concluded that LCA results will prove useful for 'the improvement of technical processes and products, new marketing strategies or as a basis for the valuation of external effects of forestry.'[94] They used as a comparison in this report the Forintek[95] study of roundwood production in Canada.

- Schweinle, J. (Undated) 'About Life Cycle Assessment of roundwood production in Germany,' Federal Research Centre for Forestry and Forest Products, Institute for Economics, Hamburg.

Other research in this area focuses on LCA as a basis for analysis of forest products. Some of the findings were reported at the recent XI World Forestry Congress:

- Schweinle, J. (1997) 'Life Cycle Assessment of Forestry as a basis for an Ecological Valuation of Forest Products,' Summaries of Voluntary Papers, XI World Forestry Congress, Antalya, Turkey, 13 - 22 October, 1997, Vol. 4, Topic 22.
- Scharai-Rad, M., Hasch, J. and Fruhwald, A. (1997) 'Life Cycle Inventory for Wood as a Building Material,' Summaries of Voluntary Papers, XI World Forestry Congress, Antalya, Turkey, 13 - 22 October, 1997, Vol. 4, Topic 22.
- Scharai-Rad, M., Fruhwald, A. and Hasch, J. (1997) 'Life Cycle Assessment as an Instrument for Ecological Valuation of Forest Products,' Summaries of Voluntary Papers, XI World Forestry Congress, Antalya, Turkey, 13 - 22 October, 1997, Vol. 4, Topic 22.

All of the above reports use the ISO draft version of LCA as a basis and follow the methodological structure, even though the methodology is as yet still incomplete.[96]

Another investigation area is impact assessment on land-use for forestry. Investigation into this area has been initiated by the government debate in Germany in regards to policies assessing land-use. At the moment there are problems in the translation of the term 'land-use' and political debate focuses on the definition. BFH has felt the significance of this discussion and the importance of comparing different

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94 Schweinle, J. (Undated) 'About Life Cycle Assessment of roundwood production in Germany', Federal Research Centre for Forestry and Forest Products, Institute for Economics, Hamburg.

95 See **Case Study 23: Forintek Canada Corporation.**

96 See **Case Study 3: CEC.**

forms of land-use including forestry, industrial land-use, agriculture, etc. It has also been noted that land-use can play a substantial role in product choice. In examining this issue, BFH is working on an approach to use the LCA methodology. Both the inventory and impacts caused by land-use, such as soil erosion, vegetation destruction, biodiversity, water use, etc. are difficult to define. It is even more difficult to obtain data.

Within the Forest Inventory section,[97] methods and procedures for collecting and recording data have been in operation and development. This information plays an important role once interpreted in ecological and economical matters.

ISSUES DISCUSSED

Forestry

- Consideration of biological processes of wood production are essential for sustainable, renewable raw material, like wood, in comparison with other raw materials that don't have biological component.
- The energy input and output for trees can be assumed the same.
- If we burn wood it only releases the same amount of CO2 that was stored, not more.

Land-Use Policies

- It is dangerous if a system is developed and policies implemented that are not satisfactory because they will still be used, and often without questioning.
- There are very few big privately owned forests in Germany - mainly small (approximately five hectares).

Life Cycle Assessment

- The problem in LCA is that non-quantifiable data is not included - can't mix qualitative and quantitative data.
- For non-quantifiable data;
    - Can use solid descriptive analysis; and
    - Should use specific methodology to do so.
- Nobody does LCA on forestry in Germany at present. There is interest but certification is much more in discussion than LCA - specific site conditions in forestry are hard to deal with.
- If you are doing LCA on a forest product you first have to carry out an assessment on forestry.
- 20 million cubic metres of timber are grown with no market - so the industry can not see that LCA, and LCA for a wood product itself, in comparison with competing products, could be an advantage for them on the market.
- Social issues should be assessed - but not within LCA, according to ISO.
- Forintek Canada Corp's.[98] study of building materials - forestry is a small part.

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97 This section is part of the Institute for Forest Ecology and Forest Inventory.

98 See **Case Study 23: Forintek.**

CASE STUDY 10:

EPEA
(Environmental Protection Encouragement Agency)

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'EPEA is a very small organisation and not very professional. However, it has everything, just like a small grocery store.'[99]

BACKGROUND

The Environmental Protection Encouragement Agency (EPEA) was founded in 1988 by Michael Braungart,[100] as a mainstream waste-management organisation. The main focus of their work for the first few years was from a waste point of view, dealing with incineration and the opposition of these methods. This led to issues of environmental impact, waste reduction and 'product optimisation.' Now an independent scientific consultancy, EPEA's work focuses on the optimisation of products by forming cycles, that is, technical, biological and recycling cycles.

Although EPEA claim to be specialists in the field of environmental product improvement, they do not claim to have comprehensive knowledge. They do, however, state that they are flexible and can rapidly find and interpret information by using their network and resident scientists. These staff members are generally knowledgeable in the state-of-the-art and come from international and interdisciplinary backgrounds, including the biological, chemical, agricultural and economical sciences.

As a consultancy group EPEA works not only with industry, but also with non-government organisations and other interest groups to develop environmental solutions. EPEA has collaborative partners on an international basis, for example in the USA, Russia, Great Britain and Japan. Knowledge of environmental and social issues is therefore collected from a wide basis and variant conditions in

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99 Jens Soth, private conversation, July 1997.

100 Prof. Dr. Michael Braungart is a chemist and a chemical engineer and was a founder and former leader of the chemical division of Greenpeace.

nearly all of the worlds' countries are known. EPEA also attends conferences worldwide dealing with environmental and social concepts. 'This international experience is linked with their global approach to transfer their scientific work into practical and feasible solutions according to local requirements.'[101]

EPEA were early on involved in life cycle thinking. SETAC's inventory, impact and improvement assessment triangle 'evolved from some earlier work undertaken in the area of environmental assessment from work done by EPEA.'[102]

GOALS

EPEA's goals are to develop 'environmentally safe, economically feasible and socially acceptable methods for converting industry from 'Waste Management' practices to systems creating environmentally intelligent products.'[103]

LCA-RELATED PROJECTS AND PUBLICATIONS

In opposition to the term 'cradle-to-grave,' whereby all products end up in a graveyard, EPEA developed the 'intelligent product system.' The idea of this concept is to assign all products to only three categories:[104]

- Consumption goods;
- Service goods; and
- Unmarketable goods.

Consumption goods are categorised by EPEA as those products which can re-enter biological cycles after their use without harm to the eco-system. These products, which can include food, shampoo, detergents, textiles, even some packaging, mostly change form during their use so can only be used once. Any biodegradable product designed to run in biological cycles is included in this category. Service goods provide a service and fulfill a specific function. They cannot return to a biological cycle without some form of treatment and remain unchanged in their physical and chemical composition. These products, including such goods as cars, televisions and other appliances, should be designed to circulate in technical cycles.

The final category defined by EPEA is unmarketable products, which are really the hazardous waste

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101 Klopffer, W. (Editor-in-Chief) (1996) 'The International Journal of Life Cycle Assessment', Ecomed publishers, Vol. 1, No. 2, p. 119.

102 SETAC (1990) 'A Conceptual Framework for Life Cycle Assessment - Impact Assessment', p. 2.

103 Klopffer, W. (Editor-in-Chief) (1996) 'The International Journal of Life Cycle Assessment', Ecomed publishers, Vol. 1, No. 2,

104 EPEA (1996) 'Profile and Scope of Work: EPEA, Environmental Protection Encouragement Agency,' Hamburg.

of production. These are products which cannot be bought or used in an environmentally sound way and currently there exists no safe recycling techniques. The approach here is to improve the production processes in a way which the hazardous product can be reduced or substituted. This category is not one that should be continued or expanded on and needs to be reduced.

- Braungart, M. and Engelfried, J. (1993) 'The Intelligent Products System (IPS),' EPEA, Hamburg.
- EPEA (1996) 'Profile and Scope of Work,' Hamburg.

The whole idea of the 'Intelligent Products System' has to do with LCA and environmental improvement through correct environmental management techniques. In order to achieve this, EPEA have developed their own set of tools in order to aid industry in creating environmentally intelligent products. [See **Figure 10: EPEA's Toolbox Diagram**.]

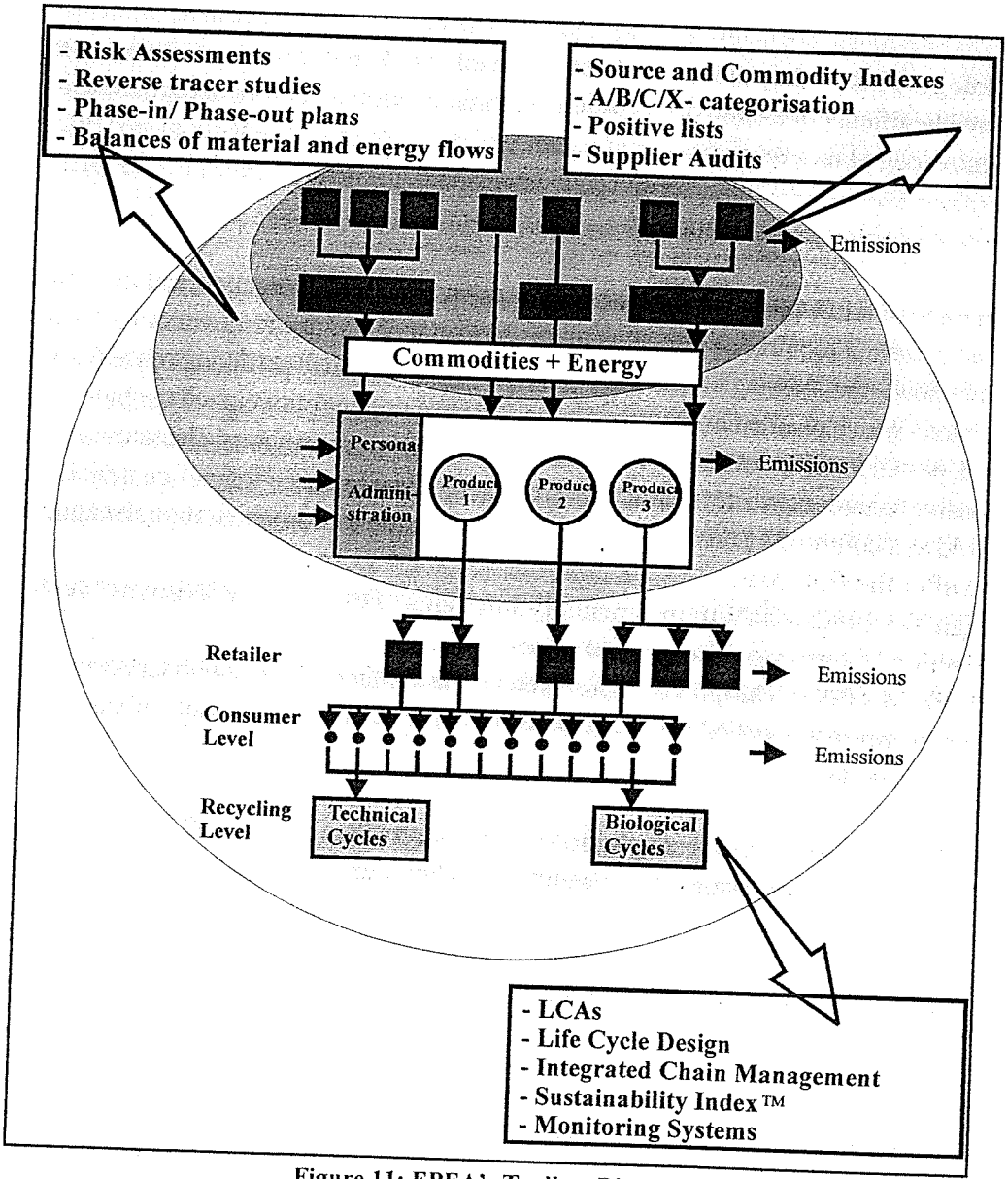

Figure 11: EPEA's Toolbox Diagram

EPEA's LCA methodology is perhaps of the most importance here. This is quite different to the mainstream LCA methodologies. A concept of Life Cycle Development has evolved which 'aims at increasing ecological and economic efficiency through the integration of its four elements Scoping, Inventory, Impact Assessment and Optimization.'[105]

- Riviere, A., Soth, J., Ketelhut, R., Rinkevich, J. and Braungart, M. (1997) 'From Life Cycle Assessment to Life Cycle Development,' Air and Waste Management Association's 90th Annual Meeting and Exhibition, June 8 - 13, 1997, Toronto, Ontario, Canada.

Within this framework EPEA has undertaken numerous studies on different products. The Design Tex textile study is perhaps the most well-known example of EPEA's work, and is a very good example of what is possible within industry. The Swiss Textile Company was considering closure or a move to the Czech Republic or Hungary as they could no longer afford to stay open. They decided instead to investigate some form of product redesign after speaking to EPEA's Michael Braungart and Jim McDonald. Environmental considerations were first posed and EPEA carried out an LCA using their own methodology. That is, they did not undertake a whole LCA, but improvements were made as problems were identified. For example, EPEA did not initially do an inventory of the synthetic fibres; they just acknowledged that these fibres did not fit with the 'intelligent products system.' It was decided, therefore, that natural fibres should be located and that dyestuffs should be biodegradable. A natural pool of resources was found.

By using this particular LCA process an orientation was given and much data, for example regarding synthetic fibres, was not required. The results of this project included the removal of two production steps - the chemical strengthening of the synthetic yarn and the chemical shrinking of the textiles were no longer needed - which resulted in economic benefit. These savings outweighed the higher expense for the natural, pesticide-free, raw materials. Trimmings, which were previously hazardous waste and needed expensive hazardous waste treatment, were then turned into fleece for garden mulch, which is now being sold as a commodity product. This entire process took three years, though changes were taking place after the first year.

- Design Tex (undated) 'Environmentally Intelligent Textiles: The William McDonough Collection,' Consumer Booklet (70 pages).
- Mehalik, M. (1996) 'Design Tex Incorporated: The William McDonough Collection,' School of Engineering and Applied Science, University of Virginia, and University of Virginia Darden School Foundation.

Following on from the Design Tex example , EPEA has concentrated on dyes and textile dying, textiles (including organically grown cotton), paper, nutrition, and cosmetics, in regards to environmental and human health concerns.

- Riviere, A (undated) 'EPEA: Reducing the threats of textile dying and finishing to human health and the environment,' EPEA, Hamburg.

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105 Riviere, A., Soth, J., Ketelhut, R., Rinkevich, J. and Braungart, M. (1997) 'From Life Cycle Assessment to Life Cycle Development', Air and Waste Management Association's 90th Annual Meeting and Exhibition, June 8 - 13, 1997, Toronto, Ontario, Canada.

- EPEA (1995) 'Steps towards Sustainability of Clothing, Part 1: Requirements for textiles as consumption products' and 'Steps towards Sustainability of Clothing, Part 2: Requirements for textiles as service products,' Hamburg.

Other projects have included: a risk-management project for an international nutrition and cosmetic company (just completed); risk-management for another cosmetic company (the outcome has so far been disappointing due to problems with packaging); an Asian project in progress on biodegradable foil; and a project assessing the manufacture of leather by natural rather than chemical means, for the production of natural shoes.

ISSUES DISCUSSED

Design Tex Example

- It is considered that EPEA wouldn't have achieved same results if a complete inventory had been undertaken first; Things can be optimised without doing a whole inventory.

Environmental Design

- The term 'environmental design' and 'ecological design' are rather fashionable and trendy, but are still not being approached on a very deep level.

'Intelligent Product System'

- A product is considered intelligent if it's running in a biological or technical cycles.
- Quantitative LCAs usually provide a mass of data that you don't know what to do with.
- 'Intelligent Products System' are very simple and give orientation for improvement.
- The general approach is to reduce it or to substitute it:
    - Substitution or reduction of unmarketable goods;
    - Optimization of consumer goods so they are really biodegradable; and
    - Optimisation of serviceable goods that can run in technical cycles.

Life Cycle Assessment

- No two projects are the same with EPEA's methodology.
- EPEA's LCA:
    - Even the inventory stage is different from the typical scientific LCA;
    - All levels are looked at and the LCA is more qualitative until direction has been ascertained;
    - There is opportunity to improve the product and also look at production processes and recycling;
    - When based on EPEA's LCA the main ingredient of a product can be replaced faster than typical LCA;
    - Changes can be seen with EPEA's qualitative LCA's;
    - It looks at the inventory in specific way, that is, an inventory is not made of something that will be replaced;
    - Data is collected as the process evolves and improvements occur

simultaneously - iterative process;

- All data does not have to be available up front, but it is questioned that you cannot know where to start if you don't have all the data - with EPEA's model you only need to carry out a full inventory if you don't know what to optimise

- Traditional LCA:
  - Focus on material flows over 5% of material weight.
  - An energetic assessment of whole production process is made. This may be of long term aid, but does not aid in implementing improvements.
  - Often LCA results in a mass of data, but no direction is given for how to deal with this data.

CASE STUDY 11:

IVL
(Swedish Environmental Research Institute)

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'There is increasing awareness of the meaning that we are dependent on the environment we live in. A changed lifestyle of consumers and an increased environmental awareness of company clients are today's largest driving forces towards developing more environmentally adapted processes and products.'[106]

BACKGROUND

IVL were established in 1966 as an institute serving Sweden's forestry industry, which were at the time was having problems with:

- Emissions to water;
- Fibres; and
- Toxic substances.

Before this formation the organisation formed a part of the Chalmers University structure. The laboratory research and consultation work, however, did not fit with the university's policies, so the organisation was sold and they have since become an independent environmental research institute providing knowledge for industry and authority.

IVL is majority-owned by the Foundation for the Swedish Environmental Research Institute (SIVL) but the basic premise is that government and industry provide matching funding. In support of this, government funding is channelled through the Swedish Environmental Protection Agency and industry funding comes from industry associations. This endeavour enables IVL to retain its independence. As a way of funding basic research, IVL undertakes consulting work on a large scale. This is now a major

106 IVL (1996) 'Environmental Research for a Sustainable Society', Brochure, p. 3.

source of research funding which wasn't available five to ten years ago.
Over the last ten years IVL's focus has changed from basic research to making more sense of, and applying, information collected. In this capacity IVL have become a leading European organisation, providing comprehensive and interdisciplinary expertise. Their position on an international scale has led to involvement in projects, conferences and European Union Developments, and also cooperation with various universities. Within IVL, specialists from various fields, including engineers, scientists and sociologists, cooperate in a diverse range of projects and programmes which provide 'impartial and high quality research for the needs within society, and thereby guid[ing] policymaking decision.'[107]

IVL were introduced to LCA ten years ago by Lars Gunner-Lindfors, who was at the time the scientific director of IVL. He is now Sweden's most important player in the LCA field and is associated with many LCA developments and programmes.[108] He now has the position of Head of Section in 'Life Cycle Assessment and waste research.' IVL, along with CIT,[109] are important in Sweden's LCA arena and since both organisations have good working relations with industry, the concept of LCA is starting to expand. LCA supports IVL in a 'comprehensive view of the environment in its entirety.'[110]

GOALS

The major aim of IVL is to 'discover, prevent and solve environmental problems, preferably before damage occurs.'[111] Within this aim IVL seek to become the major and leading authority in Sweden for industry and government agencies. Their goal is to be comprehensive and impartial in all research, especially that regarding today's environmental problems.

LCA-RELATED PROJECTS AND PUBLICATIONS

There are many activities currently underway within IVL's 'Life Cycle Assessment and waste research' section. Projects areas include:[112]

- International LCA co-operation, including active involvement in SETAC,[113] ISO[114] and EU

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107 IVL (1996) 'Environmental Research for a Sustainable Society', Brochure, p. 3.

108 For example, LCANet (see **Case Study 12: CML**), the EU (see **Case Study 3: CEC**) etc.

109 See **Case Study 12: CIT**.

110 IVL (1996) 'Environmental Research for a Sustainable Society', Brochure, p. 3.

111 IVL (1996) 'The aim of environmental research' sourced from Internet, see address above.

112 IVL (1996) 'Life Cycle Assessments and waste research,' sourced from Internet, see address above.

113 See **Section 3: Life Cycle Assessment**.

114 See **Case Study 3: CEC**.

LCANet[115] activities;

- Development of LCA Impact Assessment Methodology, mainly concerning the development of characterisation methods for global and regional impacts, resources and valuation methods;
- Waste management processes in LCA, e.g. the development of inventory methodology for waste management processes;
- Applied LCA research, including the adaption of LCA methodology to ecolabelling programmes, mainly ISO type I and type III labels; and
- LCA contract work, including LCA studies in a variety of fields on contract basis.

This area has a large technical section and has been involved in many LCA developments, including methodology development.

- Finnveden, G. and Lidfors, L. (1997)' LCANet Theme Report - Life Cycle Impact Assessment and Interpretation,' IVL and CML, Leiden.
- See also publications list available on the Internet.[116]

IVL have also completed many LCA studies, mainly inventory studies and impact assessment studies. For example, IVL have been involved with the pulp and paper industry, refinery and petrol chemical industries, the Swedish National Road Administration, and the PVC industry. The study for the Swedish National Road Administration looked at the construction of roads rather than car usage and public transport, but these issues were heavily investigated and a lot of data was collected.

- Stripple, H. (1995) 'Life Cycle Assessment for Roads: A model for inventory,' IVL, Goteborg, November 1995.
- Finnveden, G. (Editor) 'Resources and related impact categories,' SETAC - Europe's working group on Life Cycle Impact Assessment (In preparation).

Acidification research, once the cornerstone of research at IVL, has been cut down significantly although it remains a significant issues with scientists from all over the world. IVL's acidification research stations are still operational, but their activity has been greatly reduced. In one project a large forested area has been covered by a roof. Rain water is captured and purer water imitates the natural conditions under the roofed area. A lot of assumptions have been made with this project, for example in regards to natural conditions including wildlife inputs and seed transferral issues. The aim is to see how reversible acidification is. The project has been going for five years and will continue for at least another two.

- Gardsjo Foundation (Undated)'Gardsjon,' IVL.

Another significant project deals with Ozone and the effects of elevated CO2:

- Skarby, L., Karlsson, P., Pleijel, H., Sellden, G., and Wallin, G. (undated) 'Effects of ground level Ozone on plants,' IVL and Department of Plant Physiology, The Botanic Institute, Sweden.

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115 See **Case Study 7: CML.**

116 Publications list Internet address:

Land use issues and environmental impact also are beginning to obtain more focus. Land use aspects, including environmental impact assessment, are more and more being declared a high priority. IVL have not yet produced a body of work in this area, but are currently in the early stages of research.

- Report (in preparation) on how the environmental effects of land-use can be quantified.

ISSUES DISCUSSED

Certification

- The situation of LCA in relation to forestry is such that there is conflict between two difficult schools of thought:
    - One (dominated by forestry people) - forestry shouldn't be included in LCA, instead start assessment from logs/transport; and
    - Two - land-use must be included in LCA.
- The Forest Stewardship Council is currently discussing forest certification:
    - This certification discussion has dominated the situation, so it is very hard to discuss any other approaches to the evaluation of forestry;
    - This is problematic because certification and LCA are two different things.
- Certification sets level and forests to be certified have to be above this level to be certified. LCA does not work like this.
- Different degrees can be discussed within certification , but there are still fundamental differences between certification and LCA.
- Certification is not very helpful if you want to compare forestry products with other products.
- There are two main problems with combining LCA and certification:
    1. Level in certification - this is a judgement, which has to be based on what forest steward council says and has to be applied in local situation. (e.g. Nordic and Swedish);
    2. Not developing tools;
- European Conference on pulp and paper research - The Present and the Future.' - there was one section dealing with LCA, but the conference was dominated by certification discussion.
- Negotiations are still problematic in regards to certification.
- The aim of the forestry industry in Sweden is to make something out of certification - it is one of the countries hottest areas of environmental conflict.
- There is a long way to go to combine LCA and certification, and there is currently little interest to do so.
- Certification includes social and aesthetic aspects, as well as ecological issues.

Computerised LCA Systems

- Computerised systems allow the input of data and provide a simplified answer - debate as to whether this is a feasible process. It must be considered that if LCA is going to be used in the everyday work of people who are not highly educated in environmental systems, a tool must be made available which is simple to use and understand.
- This may not guarantee or optimise the environmental performance of a product, but it will pressure the need for improvement and give everyone a better comprehension of the processes

involved.

- There are three levels that an LCA needs to work on:
    1. Decision maker who is not educated in environmental sciences requires a simple computerised system;
    2. Important Strategic Decision Makers will use LCAs, but will not want to undertake the whole process themselves and will need some input from computerised models; and
    3. Environmental Expert will be able to conduct a full LCA.
- There are different purposes for doing an LCA - need for more than one approach. For example, a computerised system may be more useful in a small company rather than another approach which demands a high degree of information and knowledge of environmental problems, etc
- There is much debate about the different systems. Developed programs often end up with different results which is very confusing for people.
- Theory is:
    - If there are a lot of little decisions, program may improve some or all;
    - They may not be totally accurate, but at least it's a start in the right direction;
    - If they are used it in a too scientific way the wrong answers will likely be given.

Forestry

- The forestry industry is not in competition in Sweden. They have an agreement and cooperate. Industry sits on one side of the table, environmental groups, such as WWF, sit on other. Many small owners form bigger groups mainly to keep prices up, but also as good management practice.
- Different systems to look at ecosystems have been developed.
- There are problems with the strong romanticism of old times:
    - Many suffer from view that original nature, not touched by humans, is the goal to use as a reference. This is not possible, and it needs to be accepted that humans are in the equation;
    - An idea inherent in romantic ideals is that humans are bad things - if humans weren't here there would be no need for LCAs! This is a negative view.
- Need to have a view of co-existence.
- Many values are connected with different land-use types. That is, for different types of land-use there are specific goals, for example, we don't want species to become extinct, don't want too much drainage so that the land changes character, etc
- There is a need to implement land-use in LCA and find ways to quantify this.

Life Cycle Assessment

- The inclusion of land-use aspects, in both environmental impact assessment and LCA, needs to be assessed.
- There are currently in existence different methodologies in different countries which all have a very similar basis - most have been based on SETAC and ISO frameworks.
- There are LCA hot spots worldwide.

- The same people sit on different LCA committees including ISO and individual country LCA bodies.
- Thought and development of LCA in Sweden existed at about the same time SETAC started their work, but their studies and methodologies differed.
- The Impact assessment phase is still a problem phase, with much discussion occuring and as yet no agreement.
- LCA Studies are not fully developed and there is no data for many processes.
- LCA evolved from energy studies in the 1960s. SETAC started with theory development and then focussed on developing practical applications for Europe.
- LCAs are developing so rapidly that standards may hinder development - they have to be constantly changing.
- At present guidelines and procedures are considered sufficient.
- Some attempts have been made with computer programmes to try to solve problems - the EPS System developed in the USA.
- Discussion about aggregation of LCA results:
    - The initiated decision maker does not want too high a degree of aggregation, where the process is not transparent and only the results are provided. Some computerised systems only provide a single figure;
    - In a lot of cases simple information is not required - a higher degree of complexity may be wanted;
    - Results can not be too complex either - there will always be only a limited amount of time and a limited capacity, so a certain degree of aggregation is required.
- LCA workers have to consider this aggregation debate:
    - Not too simple - the decision makers want to make decision;
    - Not too complex - too much information, reading, analysis and may become redundant.
- LCA is difficult to start from scratch even when data is available.
- It is important to have a good system and know exactly what you are analysing, otherwise there will be a lot of discussion about what needs to be included, what doesn't, etc.
- A lot of work is happening in the LCA field relating to ecolabelling:
    - There are many different ecolabelling schemes in existence;
    - There has been an improvement in type 3 ecolabelling, in a hope for a standardisation of labels;
    - The Nordic label is fairly generally considered;
    - The German label is the most well accepted.
    - Ecolabels have become a bit of a business and companies are paying for them.
- The complete use of timber, when used in a building, needs to be considered:
    - Design for recycling, reuse etc.;
    - Making best use of timber products in the first place;
    - From architect's perspective.

Life Cycle Assessment and Industry

- Not too many industries implement LCA at present, however, larger companies are considering LCA and working with other environmental aspects.
- Many larger organisations have people specifically working on LCA - in many cases the information obtained is not released from within the company.
- Smaller companies are more likely to use consultants, such as IVL, to check specific issues or carry out an analysis for them. The smaller companies, however, are not using LCA in everyday work.
- Organisations such as IVL and CIT,[117] work closely with companies in the LCA field.
- Network organisations, such as Chalmers Centre for Products and Material Systems, do the research rather than provide financing. They do work with IVL.
- Industries are hesitating about what to do with LCA, and what they think about it, but knowledge of LCA is growing within this sector.
- Environmental labelling, ecolabelling for example, and environmental management systems based on LCA or at least the environmental life cycle concept, are emerging.
- The main reasons for conducting an LCA include;
    - Provision of information externally for marketing and commercial reasons;
    - Provision of knowledge internally for the company to fully comprehend what they are doing, what chain of processes they are involved in, etc.

Nordic Guidelines

- The Nordic Guidelines are considered to be one of the best LCA methodologies to date.
- The focus within LCA development is now on the methodology, and a mainstream methodology is being developed within the ISO framework. The Nordic guidelines are based on this, and they cover the basic methodology, different steps of an LCA, etc.
- The Nordic Guidelines are more fundamental than the ISO framework and describe different theories and principles.
- They were developed by the Nordic Council of Ministries with representatives from Denmark, Finland, Norway and Sweden.
- There is a heavy focus on LCA in Sweden especially.
- The Nordic Guidelines are the closest thing to standards they will accept. They do not want implemented rules and regulations, although standards are being written very generally.

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117 See **Case Study 12: CIT.**

CASE STUDY 12:

CIT - EKOLOGIK
(The Environmental Division of Chalmers Industriteknik)

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'An investigation of the environmental impacts of the company's products and activities is essential for the environmental work. Thereafter, other aspects, such as economic and quality issues have to be included in the process.'[118]

BACKGROUND

CIT Ekologik were instigated in 1989 as a division of Chalmers Industriteknik (CIT),[119] to deal with environmental analyses of products and processes. This connection with the university allows CIT Ekologik to access resources, including a long history of technical experience and also the scientific knowledge of over 2000 researchers from over 100 different areas of expertise. The organisation have gained vast insight and experience from working within industry over the years. They offer their knowledge, through consultancy work, to both national and international industries and public organisations. The research work provided by CIT Ekologik, mainly focusses on using scientific based research tools[120] to properly assess and manage the environmental impact of organisations and their products.

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118 CIT Ekologik (undated) 'Consultants in Management and Product Ecology: Environmental Assessment of Products and Processing; Environmental Quality Economy; and, Training Programmes and Software Tools,' CIT Ekologik, Chalmers University of Technology, Goteborg.

119 CIT is the contract research department for Chalmers University of Technology.

120 CIT E Ekologik uses tools that they have developed or have helped to develop or further investigate. Examples include SETACs and ISO's LCA methodologies with which CIT Ekologik has had input to.

CIT Ekologik have a proactive philosophy towards environmental strategies and consider 'environmental aspects should be integrated with economic and qualitative issues to develop an overall strategy for the company.'[121] In this endeavour, the organisation has a number of supporting research and working activity areas:[122]

- Environmental Management, including the identification and prioritising of environmental opportunities and the proposal of solutions;
- Environmental Assessment of Products and Processes, which includes Life Cycle Assessment, as a tool that can improve an organisation and its products from an environmental standpoint, and also Substance Flow Analysis; and
- Integration of Environmental Issues in an Organisation, including Quality and Economic Aspects, Transportation and the Environment and Process understanding.

CIT Ekologik's other services include:[123]

- Training programs, designed to meet each organisation's individual needs, in the following areas:
    - Environmental Management;
    - Life Cycle Assessment;
    - Substance Flow Analysis;
    - Sustainable Product Management;
    - Design for Environment; and
    - Environmental Performance Indicators.
- Software and Tools.[124]

The major field of activity for CIT Ekologik is Life Cycle Assessment. In this area they have been active participants in the international LCA network and also in methodological developments. For example they contribute to the work of SETAC, cooperate with the Nordic Council of Ministers[125] and are the Swedish representatives on the ISO[126] committee. CIT Ekologik have undertaken a substantial number

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121 CIT Ekologik (1996) 'Consultants in Environmental Management', sourced from Internet, see above address.

122 CIT Ekologik (undated) 'Consultants in Management and Product Ecology: Environmental Assessment of Products and Processing; Environmental Quality Economy; and, Training Programmes and Software Tools,' CIT Ekologik, Chalmers University of Technology, Goteborg and Internet information, see above address.

123 IBID.

124 See LCA-Related Projects and Publications.

125 The Nordic Council of Ministers has published the Scandinavian LCA report, 'Nordic Guidelines,' which is considered to be one of the state-of-the-art publications in the LCA field.

126 See **Case Study 3: CEC**

of LCA projects within many branches of industry.[127]

GOALS

CIT Ekologik have as their major aim the education of clients in environmental improvement opportunities. That is, to 'assist clients in identifying and prioritising environmental challenges and generating economically sound solutions using the latest scientific methods.'[128] Communication of information is a very important goal and this task is undertaken through means including publications, training programs and software packages.

LCA-RELATED PROJECTS AND PUBLICATIONS

CIT Ekologik has been working mainly on LCA projects. LCAs are generally undertaken within a company's Environmental Management Strategy (EMS),[129] in which the company's flows are identified. Their first LCA project started in 1990 on packaging. They have since worked with many large Swedish companies, and some medium-sized companies. These projects have been within a vast array of differing industries, including packaging, pulp and paper, chemical, automotive, transportation systems, telecom services, electronics etc.

- Tillman, A., Baumann, H., Eriksson, E. and Rydberg, T. (1991) 'Packaging and the Environment: Life-cycle analyses of selected packaging materials: Quantification of environmental loadings,' Chalmers Industriteknik, Goteborg, Sweden, Offprint for SOU, 1991:77.

In the LCA arena CIT Ekologik has been working as part of the development team within SETAC and ISO. These frameworks are very general and CIT Ekologik have further developed a 'screening method' based on the Nordic Guidelines. This method is a quite unique and involves identifying key issues and components that contribute to the nine impact categories. This does not mean that parts are excluded, however. Instead a point is reached where problems are identified. For most LCA work the same database is used in order to maintain coherency. There is necessity, however, to be product specific and site specific.

Elin Eriksson has recently completed a report on microwave ovens using this 'screening method.' In cooperation with Samsung electronics in Korea all upstream processes were identified. Data used was taken from CIT Ekologik's own literature and database. The study took over a year with several people working on it.

- Eriksson, E., Kim, S. and Lee, K. (Undated) 'Screening LCA of a Microwave Oven,' CIT

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127 See LCA Related Projects and Publications.

128 CIT Ekologil (1996) 'Consultants in Environmental Management,' sourced from the Internet, see address above.

129 CIT Ekologik generally do not undertake the actual EMS.

Ekologik and Samsung Electronics.

Recently CIT Ekologik undertook another report for the Nordic Pulp and Paper Industry, investigating the pulp and paper industry. There were a lot of criteria involved in this report, including chlorine use.

- Stromberg, L., Haglind, I., Jacobson, B., Ekvall, T., Eriksson, E., Karna, A. and Pajula, T. (1997) 'Guidelines on Life Cycle Inventory Analysis of Pulp and Paper,' STFI, Stockholm, Chalmers Industriteknik, Goteborg and KCL, Esbo, Nordpap DP2/30, Scan Forsk-Rapport 669, February, 1997.

Within CIT Ekologik , further LCA areas are being investigated, including:[130]

- Improving the presentation of environmental analyses to decision makers;
- Adapting work to ISO standards; and
- Increasing the understanding of how the results of environmental analyses can be integrated with other fields in an organisation.

Numerous other environmental studies undertaken by CIT Ekologik include substance-flow analysis, environmental education for companies, and the development of software such as:

- An LCA inventory Tool[131], which enables rapid calculation of a products environmental loadings;
- EcoNice, for assessing environmental impacts of products;
- EMAS Guide, to aid in obtaining EMAS registration or ISO 14001 certificate; and
- LCA Databases.

An extensive publications list can be obtain from CIT Ekologik.[132]

ISSUES DISCUSSED

Life Cycle Assessment

- From the beginning LCA focussed on transportation.
- There has been a lot of work done in the pulp and paper processes area, and processes have since been made quite efficient. Now the forestry part of life cycle needs to be focussed on.
- LCA can be used as product development tool.
- LCAs can take from a couple of weeks to years depending on the complexity, availability of

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130 CIT Ekologik (undated) 'Consultants in Management and Product Ecology: Environmental Assessment of Products and Processing; Environmental Quality Economy; and, Training Programmes and Software Tools,' CIT Ekologik, Chalmers University of Technology, Goteborg and Internet information, see above address.

131 For more information, CIT EKOLOGIK (1996) 'LCA Inventory Tool,' sourced from Internet (see address above) provides an order form, detailed presentation and LCAiT demonstration.

132 CIT Ekologik can be contacted at the above address or alternatively through the Internet (see above address).

data, etc.

- The LCA team is very important as many ideas and inputs need to be obtained.
- According to a Swedish consumer body, companies can not just claim 'environmental friendliness.'
- LCA is a very useful tool which is here to stay.
- Knowledge is imperative to the implementation of LCAs. It may be impossible to reach the stage where an LCA can be quickly undertaken by a lay person.
- Ecolabels are an external communication tool - Type 3 labelling has just been included in ISO14000.
- The ISO 14000 Standards are developing rapidly.
- ISO framework is very good, but like all LCA methodologies it still need much development.

Industry

- Companies need to learn about their own environmental performance, - both products and processes.
- Companies are beginning to put a lot of pressure on each other. For example, Volvo puts pressure on suppliers, which is making many smaller companies think about environmental strategies and LCA.
- It is very important that a company has its own staff learn about environmental processes, give environmental input, and keep knowledge within the company.
- Packaging LCAs have forced the forestry industry, or at least put pressure on them, to think about LCA. Plastic companies are focussing on LCAs, which will provide even more incentive.

CASE STUDY 13:

SKOGFORSK
(The Forestry Research Institute of Sweden)

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'SkogForsk's task is to furnish Swedish forestry with the knowledge it requires to remain competitive and sustainable.'[133]

BACKGROUND

SkogForsk are a research institute that were established to work with applied forest research and development. Their organisation was founded in 1992 by the Federation of forest owners and companies in Sweden's forestry sector,[134] as a response to a growing awareness of the need for research into 'long-term, economical, ecologically sound forestry.'[135] In this capacity SkogForsk now deal with forest production and biodiversity, in respect to both the environment and economics. It is SkogForsk's endeavour to provide the forestry industry with relevant information to help it become and remains not only economically sound but also ecologically sustainable.

SkogForsk are funded by fees from all forestry members[136] and also a charge levied on each cubic metre of wood harvested. The government also provides substantial funding under research and scientific fund agreements. This funding structure allows for cooperation between the forestry centre

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133 Fryk, J. (Director) (1997) 'Our goal and Mission', sourced from the Internet (see address above).

134 50% of Sweden's forest are owned by small owners, 37% by companies and the rest by the state.

135 SkogForsk (1996 - updated regularly)' SkogForsk - The Forestry Research Institute of Sweden', Publication Brief, Uppsala, Sweden.

136 Members are all forest owners. Any other interested parties or companies can also become members. Presently, SkogForsk has in excess of 90 members.

and government. SkogForsk also work in close collaboration with other organisations, including IVL and Chalmers University of Technology.[137] Funding is also obtained through the consultancy work which SkogForsk undertake for forest enterprises, machine manufacturers and government bodies.

SkogForsk are a very closely integrated organisation comprising a board, chief directors, administrators, information and research people, and an advisory group, composed of forestry people. This advisory group meet twice a year to discuss the areas of future focus. Currently, research at SkogForsk has been focused on four key areas which represent the direction for the future:[138]

- Product value and production efficiency;
- Ecological forestry;
- Organisational structures; and
- Regional Material.

There are, however, no borders defining the departments, and interactive work between two or more sectors is common. Research covers a wide range of disciplines and the skills within SkogForsk reflect their interdisciplinary philosophy, 'which is based on integrating the different branches of knowledge so that a holistic approach can be made to the relevant fields of research.'[139] All of SkogForsk's research becomes public knowledge. Their production of information is extremely efficient[140] and the information generally reaches its target groups. There is a significant difference to universities in this respect.

SkogForsk have just recently acknowledged the potential of LCAs and has started investigations in this area. The whole LCA field is very new in Sweden, but is developing extremely rapidly due to the development of ISO 14000. SkogForsk are closely following the progress in this area and also the developments in Forest Certification. Wood companies have also recognised the necessity to be involved in these activities and many organisations are conducting their own research. LCAs, however, are still not widely implemented yet in Sweden.

GOALS

SkogForsk have two major goals:

- Increased Profitability;
- Greater concern for the environment.

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137 See **Case Study 11: IVL** and **Case Study 12: CIT Ekologik**.

138 SkogForsk (1997) 'Forestry for the new millennium: A presentation of SkogForsk's activities 1997 - 2000,' Uppsala, Sweden.

139 IBID.

140 See LCA-Related Projects and Publications.

These are interlinked as the 'environment is becoming more and more of an economic issue.'[141] Any developments providing economic benefit and also ecological sustainability are sought. Ecolabelling, for example, is becoming a major issue in Sweden, and the environmental labelling of products has been found to provide a definite market edge for products on a national and international basis.

SkogForsk's other topic specific goals[142] include:

- The improvement of revenue and lowering of costs;
- Forest management for both biodiversity and forest product;
- Efficient organisation; and
- Regeneration material for productive, high quality forests.

These goals support SkogForsk's underlying mission of contributing to international competitiveness and ecological sustainability.

LCA-RELATED PROJECTS AND PUBLICATIONS

SkogForsk's undertakings include work with environmental evaluation systems. It is only recently, however, that they have become involved with LCAs. SkogForsk have recognised the need for forestry to accept the concept of LCA. They have not published a large body of work as yet, since their involvement in the field is so new. Staffan Berg has been working with LCAs since 1995 and so far has completed a few studies in this area:

- Berg, S. (1996) 'Some Aspects of LCA in the analysis of Forestry Operations,' International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro-Industry and Forestry: Achievements and Prospects, April 4 - 5, 1996, Brussels, Belgium.
- Berg, S. (1996) 'Comparison Between Clear Cutting And Shelterwood Cutting - A Life-Cycle Analysis Approach,' Joint Conference CWF/IUFRO, 'Certification: Environmental Implications for Forestry Operations,' Quebec, September 9 - 11, 1996.

This paper discusses LCA use in the evaluation of only one aspect of environmental loading.

Yvonne Aldentun has been working within the Swedish Forestry Committee. This committee is investigating where and how Swedish forestry should be going over the next ten, and twenty years. Within this committee framework, a large body of figures has been produced by researchers in order to help the determination of direction. These up-to-date figures are also being used by researchers, and Staffan Berg has been using them for SkogForsk's LCA studies. They are only averages, however, and data is produced for four divisional areas in Sweden.

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141 Fryk, J. (Director) (1997) 'Our goal and Mission', sourced from the Internet (see address above).

142 SkogForsk (1997) 'Forestry for the new millennium: A presentation of SkogForsk's activities 1997 - 2000,' Uppsala, Sweden.

Reports in regard to forest conservation have come out of SkogForsk, dealing with numerous environmental issues pertinent to the Forestry Industry.

- Nohlgren, E. and Gustafsson, L. (1995) 'Vegetation corridors - a literature review with comments from a Swedish forest perspective,' SkogForsk, The forestry Research Institute of Sweden, Report No. 1, 1995.
- Gustafsson, L. and Wilson, P. (1996) ' Conservation in forestry in Britain and Sweden - exchange of knowledge and ideas,' SkogForsk, The forestry Research Institute of Sweden, Report No. 1, 1996.

SkogForsk publish a vast array of Newsletters, results from research and project findings, comprehensive reports on research and development projects,[143] comprehensive scientific reports and manuals, which are mainly instructional. SkogForsk publish an extensive guide which lists all publications.

- SkogForsk (1997) 'Knowledge available from SkogForsk,' Uppsala, Sweden.

ISSUES DISCUSSED

Forestry

- There are very few people actually in forests nowadays:
    - Over the last 20 years, the degree of mechanisation has increased rapidly;
    - Machines have taken place of human labour;
    - Machines are very useful and efficient;
    - People in forests have to be competent and able to make important decisions.
- There are only a very few species in Sweden's forests.
- 58% of Sweden is covered in forest.
- Many people in Sweden are employed with the forest and forest products industry.
- A combination of agriculture and forest is very common for farmers. In some cases, mostly in the north, forest is more important economically than agriculture.
- Most forests in Sweden are owned by small private owners. It is a kind of biodiversity having many different forest owners.
- There are only handful of large companies owning forests. These larger companies are willing to try out a few different things.
- A new forestry act was implemented in Sweden in 1994.

Life Cycle Assessment

- It is very hard to make a start in the LCA area:
    - The more you explore in the LCA field, the more you find, and the more you need to explore;
    - SkogForsk are just scratching a little on the surface at the moment because there is so much to discover;
    - Knowledge is very incomplete and nothing has been finalised.

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143 These 'Redogorelse' are only available in Swedish, but English summaries are available.

CASE STUDY 14:

TRATEK
(Swedish Institute for Wood Technology Research)

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'Tratek promotes the characteristics of wood, not least its aesthetic qualities, by developing building systems based on wood and by disseminating scientifically-based information about wood, both as a sound engineering material and an environmentally acceptable construction material.'[144]

BACKGROUND

Tratek are the main research and development institute for the wood and wood products industry in Sweden. They were formed by a collective of organisations from all woodworking areas including sawmill companies and wood product producers, in order that information be produced that would aid in the competitiveness of this industry. Research into areas including wood chemistry and physics, market development, environment and quality assurance, is undertaken to improve the knowledge base. The increase in information will enable the wood and wood products industry to improve their long term efficiency, productivity and profitability in both the national and international market

Funding to carry out initiatives in research and development is covered partly by membership fees and partly by the government. Member representatives, however, are responsible for determining areas of work, which are generally in diverse sectors. Tratek's work conventionally falls within four areas:[145]

- General research and development - new information is sought and provided to all member companies, on areas of interest to all members;

144 Tratek (1995) 'Talking to Tratek: An introduction to the source of knowledge used by the Swedish wood-working industry', Sweden, p. 2

145 IBID., 7

- Industry related projects - two alternative project options:
    1. Member companies have the option of being involved in the project and funding is provided by them, the government and any other party who might be involved. All member companies and other involved parties receive the results of the project;
    2. More than three companies with specific research topic must be involved. The results are only provided to the companies involved, but after a two year period all member companies can receive a copy;
    3. Testing and Inspection - Tratek has the correct accreditation for both and offers this service to all companies; and
    4. Education and Training - helping companies to effectively implement the results of Tratek's work.

In order to efficiently deal with all research problems Tratek employ their own staff of experienced researchers, but often collaborate with Swedish and international organisations, including other research institutes and universities. Tratek also work closely with the forestry industry, although they do not personally deal with forestry issues. Their organisation is also a member of the Eurowood Network[146] which has increased international research cooperation and has also increased Tratek's involvement with European projects. Tratek's main collaborative partners, however, mainly come from within the Nordic countries, such as Finland and Norway.

Life Cycle Assessment has become a much discussed issue in Sweden recently. Tratek have had initiatives in this region for several years now and have worked in collaboration with Chalmers in looking at the development of assessment methods. The majority of their work in this field, however, has consisted of the collection of data specifically for industry. They are now beginning to feel some pressure from member groups to investigate this area more thoroughly and their 'Environmental Declarations' are being focused more towards this holistic assessment method.[147]

GOALS

It is Tratek's aim, through research and development, and education and training, to increase the competitiveness of the Swedish wood and wood products industry, materials and products.

LCA-RELATED PROJECTS AND PUBLICATIONS

Environmental initiatives are of fundamental importance and Tratek started handling this issue by providing environmental information in the form of 'Environmental Declarations' for wood and wood products. The declarations, for sawn timber for example, are not site-specific examples. Rather,

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146 The Eurowood Network is an organisation of timber technical centres and research institutes within Europe.

147 See LCA-Related Projects and Publications.

inventory data is averaged from 15 sites. A one-page leaflet is produced for communication of knowledge to consumers, and internally companies receive information pertinent to their operations in the form of a short report, which is used for product developed amongst other things. Companies involved may also access confidential background information which is compiled in a more substantial report.

- Erlandsson, M. and Andersson, B. (1997) 'Environmental Declarations of Products from the Swedish Wood Working Industry,' Tratek, Rapport L 9703022, March, 1997.
- Andersson, B. (1996) 'Environmental Declaration - Sawn timber (pine/ spruce),' Nordic Timber Industry, Tratek, April, 1996.
- Beyer, G. (1996) 'Environmental Declaration - Pallets (Single-trip pallet 800x1200mm),' Nordic Timber Industry, Tratek, September, 1996.

Other environmental reports have been done specifically on wood and wood products. These reports may be produced in more of a report form rather than as an 'environmental declaration.'

- Tratek (1996) 'Wood Products and the Environment,' In Brief - Results in Brief from the Swedish Institute for Wood Technology Research, Tratek.

The 'environmental declaration' reports are beginning to evolve more around the LCA methodology. One study of timber in buildings uses an LCA inventory to compile all the variables, and an impact assessment is also being looked at. This report will be compiled in the declaration form.

Tratek has just begun to focus on LCA, and so far only a small body of literature has been produced in relation to timber and timber products.

- Erlandsson, M. (1996) 'Methodology for Environmental Assessment of Wood-Based Products - General and specific questions related to the life cycle inventory,' Tratek Rapport I 9608070, Stockholm, August, 1996.

Another LCA research project, studying the use of timber in housing, is underway. All timber resources and products that have gone into making up the building are being investigated. Within this project another study comparing different walls types, for example light-weight studs with wooden cladding versus a concrete wall, are being analysed using LCA methodology. The project is still in the early stages and data is still being collected on each specific wall type in order that an LCA can be undertaken for each wall type. Tratek will use the Nordic Guidelines in this project. They have had prior experience with this methodology as it is the most popular methodology in the Nordic countries and has been developed specifically to their requirements.

Tratek are also working with Environmental Management Systems in accordance to ISO 14000.

Emissions from timber and timber products are also being focused on, and Ralph Nussbaum is working in this area.

ISSUES DISCUSSED

Life Cycle Assessment

- Much work is involved in the collection of data. Data can either be specific for industry and products, or general and averaged. Site-specific data is preferable.
- LCAs are currently difficult to compare.
    - LCAs shouldn't always be used just for comparisons.
    - Can use LCAs for product development and communication rather than for comparative purposes. They are not really developed enough to use as comparative tool yet.
    - A lot are used in comparative work already, which is dangerous. For example, it is problematic for timber industry to use LCA to compare timber with concrete, as they do not have access to specific data for concrete, and averaged data may not be up-to-date.
- Communication of LCA results is difficult:
    - May be too complex for some people and too simplistic for others;
    - Five star model may be very good for general public, but an architect, for example, may need more information to make informed choices;
    - The results need to be presented in a standard format using a life cycle thinking concept.
- LCA is a new area, so tools need to be developed, trialed, analysed, etc.
- There is a need for industry to get very involved.
- For comparative purposes, it is essential that other external people also comment on LCA's.
- Seems that big industries can afford the time and resources for and LCA;
    - Time for undertaking LCA becomes big factor; and
    - Tool needs address this or else LCA will always be a major undertaking.
- If LCA becomes more regulated it will be very hard for smaller companies to compete and even keep up, unless things are done on a average or general level for, say, all plywood companies.
- Certification discussion:
    - Not in use yet;
    - Big companies can afford this also, but small companies won't be able to;
    - Maybe this should be done on a per yield type basis where a payment per tree, for example, will reflect the using cost.
- Nordic Guidelines have emerged early and many people and organisations seem to be using this as a standard framework in the Nordic countries.

CASE STUDY 15:

VTT TECHNICAL RESEARCH CENTRE OF FINLAND

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'VTT develops technologies to improve both the competitiveness of companies and the basic infrastructure of society, and to foster the creation of new businesses.'[148]

BACKGROUND

VVT, Technical Research Centre of Finland are an expert and impartial organisation which undertake technical and 'technoeconomic' research and development work in nine separate research institutes.[149] Covering most fields of Finish Industry and society, each of these institutes operate independently, although projects are often executed interactively. Product improvement, knowledge enhancement, quality control and the development of systems for design, production and processing are all part of VTT's operations. This applied research is actively undertaken in order to provide companies with appropriate knowledge and technologies. They carry-out contract research for industry and aid organisations to make best use of information detailed. VTT also assist industry in export related

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148 VTT (Undated) 'VTT Technical Research Centre of Finland,' sourced from Internet

149 VTT's Research Institutes are:

- Electronics;
- Information Technology;
- Automation, Chemical Technology;
- Biotechnology and Food Research;
- Energy;
- Manufacturing Technology;
- Communities and Infrastructure; and most importantly, in this case,
- Building Technology.

studies, development projects, preparation of product information and product approval projects. Both national and international companies can utilise VTT's research and development services, and long term strategic plans are provided. The emphasis, however, is on small and medium sized Finish organisations and projects that provide 'industry and society as a whole with the greatest possible benefit.'[150]

VTT house Finland's largest wood technology research institute as part of the Building Technology Institute. They play an important role in wood technology research both nationally and internationally and are considered the largest and most versatile establishment of the kind within the Nordic Countries. Essentially VTT's Wood Research Institute is concerned with product development. New research methods and tools are developed and utilised in order to increase the understanding of wood's material properties.

GOALS

VTT's main goal is to undertake research for industry and society and apply this knowledge. Within this goal the Building Technology Institute aims to 'develop low energy, ecological buildings and building components with good long term performance properties.'[151] The Wood Technology department, in fulfilling these endeavours aim to fully understand each stage of wood processing, from harvesting to use.

LCA-RELATED PROJECTS AND PUBLICATIONS

VTT Building and Technology, Wood Technology department have been and are currently working with environmental impacts and life cycle assessments of wood and wood based products in Nordic, European and domestic projects. Little has been published at this stage, however, as it is still early stages. Much of the work being undertaken is in participation with the Life-Sys Wood Collaborative.[152] Most information arising remains among the participants of this program. Arja Merra is in the final stages of her thesis in the Wood Technology and Life Cycle Assessment field.

ISSUES DISCUSSED

- VTT are very interested in LCA and are beginning to get involved in research in this area.
- Industry are showing an interest in developments in LCA.
- The Life-Sys Wood endeavours are being carried out in an attempt to keep the timber industry up-to-date in LCA.

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150 VTT Technical Research Centre of Finland (1995) 'VTT Directory,' p. 4.

151 VTT Technical Research Centre of Finland (undated) 'Processing wood products from forest to building,' Building Technology Institute.

152 See **Case Study 5: TNO**.

- Other industries, for example the steel industry, have been interested in the manufacturing processes from an environmental point of view, for many years.
- The Nordic guidelines are widely accepted in Finland as a LCA framework among researchers.
- VTT will be investigating LCAs in a few of their research institutes.
- Different tools will need to be researched and trialed for use in industry applications.

CASE STUDY 16:

AFR - NATURVARDSVERKET
(The Waste Research Council - Swedish Environmental Protection Agency)

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'The next few years will be crucial to humanity's prospects of dealing with the threats to health and the environment we now face. We must develop production, distribution, and consumption systems that reflect the idea of an ecocyclic society.'[153]

BACKGROUND

The Waste Research Council (AFR) were established in 1990 as a special section within the Swedish Environmental Protection Agency (EPA).[154] As a government research organisation, AFR both under

153 Annenburg, R. (1996) 'Environmental Issues: Working for a better environment,' Swedish Environmental Protection Agency, sourced from the Internet [see web address above]

154 The Swedish Environmental Protection Agency - Naturvardsverket (EPA) is Sweden's central environmental agency. The main aims of the Swedish EPA is to generate a knowledge base, by research means, and to follow through on the distribution and use of this information. The knowledge collected by the EPA is central to the development of the Swedish government's environmental policy. Three main focus targets have been employed with the aim of establishing clear priorities in environmental protection:

- Transport;
- Agricultural and forestry Sectors (biological diversity) - these land use sectors represent a major threat to biodiversity;
- Trade and Industry (industrial production, goods and waste) - government has set a target for industry to reduce CO2 emissions to levels causing no environmental harm by the year 2000.

[Swedish Environmental Protection Agency (1996) 'Environmental Issues: Priorities,' sourced from the Internet, see web address above]

take and fund research in an effort to provide up-to-date information and tools essential for Swedish industry to develop environmentally sustainable products. In this pursuit AFR coordinate research activities and establish collaboration amongst researchers, trade and industry, organisations, consumers, with a long term interdisciplinary approach. Resources are concentrated into four high priority research areas in order to push the frontiers of knowledge:[155]

- Systems Science;
- Environmentally Sound Products;
- Environmentally Sound Recycling; and
- Safe Waste Deposition.

Within each of these areas Life Cycle Assessment is a very important tool, especially for environmental performance of products. The Swedish Research Council has been funding LCA research for the last five years , thus AFR have a fair overview of the field, at least from an academic point of view. AFR strongly support LCA research, through, amongst other means, funding, and encourage international collaboration with institutes, such as SETAC. LCA, it is considered, needs to be further developed in numerous areas, including methodology development, data collection, and the comparison and correlation of various environmental effects, in order that they can become effective tools. 'LCAs may eventually also provide facts and figures for choosing among alternatives ecological cycles and thus, for determining which economic instruments society should employ.'[156]

GOALS

It is AFR's goal to undertake and fund research in order that the environment be protected by appropriate management initiatives. It is essential that all research be managed and understood so that the knowledge obtained can be easily disseminated. It is important that the research results are properly distributed and that environmental issues 'receive increased attention and that more people will be involved in working together to find new facts and contribute better solutions to the waste and resource problems in our society.'[157] This aim includes making LCA as reliable and as easy as possible to understand and use. AFR's mandate is to:[158]

Work methods established by the EPA are used by all sections in the agency, including AFR. Methods include, environmental research, environmental monitoring and surveys, action programs and studies, international efforts, implementation of environmental legislation, grants and compensation, and land acquisition and conservation.

155 AFR (1993) 'Swedish Waste Research Council for a Low-Waste Ecocyclic Society,' Stockholm, p. 8.

156 IBID., p. 10.

157 IBID., p. 2.

158 IBID., p. 8.

- Present information to facilitate development of a low-waste society with environmentally sound products, state-of-the-art resource management, and effective and safe waste management and deposition;
- Promote the creation and coordination of forceful Swedish research, soundly anchored in the international community;
- Organise and subsidise pilot projects for the demonstration and application of new information;
- Enable industrial development of environmentally sound products and technologies for waste product use; and
- disseminate information on research findings and results.

LCA-RELATED PROJECTS AND PUBLICATIONS

AFR are focused on many research areas, and have produced a substantial body of work relating to many environmental issues, including research into 'sustainable societies.' They have a range of projects being implemented in the environmental design field, especially in the area of product dismantling after use. It is of vital importance that this issue be dealt with in the design stages, rather than when the product is at the end of it's life. AFR have given a grant to the Royal Institute of Technology in Stockholm to develop new teaching material on the re-use of construction elements from old buildings into new ones. Also a session was held within AFR in which architects were involved in a basic recycling course where they learnt about the possibilities of a systems approach to recycling. The architects were also introduced to technical solutions available, recyclable materials, etc. This program went extremely well and was very well received, and is now set to become an annual event.

There are many people working with LCA methodology and AFR have published a number of research reports, mainly on the development of LCA methodology:

- Finnveden, G. and Lindfors, L. (1996) ' Survey: Assessment of Resources in LCA - State-of-the-Art and Research Needs,' AFR - report 140, Swedish Environmental Protection Agency and IVL, Stockholm.
- Finnveden, G. (1996) 'Report: Life-Cycle Assessment as an environmental systems analysis tool - with a focus on system boundaries,' Licentiate of Engineering Thesis, Applied Electrochemistry, Department of Chemical Engineering and Technology, Royal Institute of Technology, KTH Stockholm, AFR - Report 137.

Martin Erlandsson has produced a number of reports dealing with both LCA and building.

- Erlandsson, M. (1995) 'Environmental Assessment of Building Components,' Licentiate of Engineering Thesis, Division of Building Materials, Department of Building Sciences, Royal Institute of Technology, KTH, Stockholm 940202, AFR-Report nr. 129.

Studies focusing on forestry and environmental issues have also been produced.

- Jerkeman, P. and Largerstedt, P. (1996) 'Report: CIRCLE - A Modeling Approach to the Forest Sector, Final Report,' AFR - Report 143, AFR, Swedish Environmental Protection Agency and Jaakko Poyry Consulting AB, Stockholm.

AFR publish a list of publications which can be obtained from the above address.

ISSUES DISCUSSED

Life Cycle Assessment

- Some of the more active companies in the LCA field in Sweden include the Pulp and Paper Research Institute (STFI), in Stockholm.
- There is a fairly good understanding of LCA in The Netherlands and Germany, in particular, and also Scandinavia.
- Research needs to be done on material recycling, in particularly in regards to landfills, etc.
- A combination of new technology and a new social behaviour/organisation needs to be included in LCA.
- The key to success in the LCA field at present is keeping a very active network.
    - Need to know what is going on and also to tap other people's research.
- The LCA tool can be used as a decision making tool for material choice, in terms of all environmental issues. A draw back to LCA is that the same quality standards are not always applied:
    - Major aspects, including quality, durability, etc. are not usually included in LCA.
- LCA must be used with a lot of caution:
    - Results are not always truthful - in-discriminatory evaluations.
    - If used with awareness and transparency LCAs can be extremely useful
- LCA can at present only assess the potential environmental impact.
- Some methodologies do not allow for certain issues to be taken into account, such as local conditions. If the tool is developed for site specific or local scales/ dimensions, it would be very complicated.
- Often judgments need to be made which may be based on personal bias.
- It may be problematic if large firms start demanding LCA's. Small firms may not be able to afford the time or resources to undertake LCAs as they currently exist
    - Small firms may need aiding with resources, financial backing, etc.
    - A tool that can be simply implemented by smaller firms is required
    - Small scale operations are often more environmentally sound - so it will be a concern if LCA's are demanded and small firms can not deal with them or compete.
    - There may be constraint on third world countries also, for exporting and marketing.
- Informing small and medium sized firms is also a major problem.
    - How do they deal with information?
    - Data banks, for example, wood data bank, metal data bank, etc. may aid these organisations. Compatible data can be used from each organisation so an LCA can be done on averaged data. Individual companies, however, may not want to release data, so aggregated data can be used in data banks and companies can compare their results with the averaged information.

- At Chalmers[159] research is being conducted on data banks. The structure of the actual data bank is under investigation since it is required to handle a lot of data, with quality checks, etc. This means that a sophisticated design is needed in order for the data bank to work. A framework data bank has been developed. Some strategic decisions had to be made in regards to:
  - How data is calculated;
  - Obtaining proper data, which is considered the key to quality.
- Communication of LCA results is vital. A report is generally provided for industry, but architects and consumers need to be given the information in a more understandable form:
  - Consumers may not want to use LCA's for comparative purposes, they just may require information for decision making.
- The philosophy behind LCAs is very good and it is not too hard to understand. Quantification, however, is a problem though as no precise tool has been developed.
- The Nordic Guidelines were published by the Council of Nordic Corporation in 1992 - a new edition came out in 1995. The report was the final results of an extensive project, involving a lot of people from industry and research. Research projects within industry, were funded and money was supplied for both researchers and to train people in industry.
- Most people undertaking LCA's in the Nordic countries use this framework.
- The Nordic council is now looking at the Nordic Product strategy, including aspects of products for the future. LCA will be a part of the future, so there is discussion on such things as:
  - What types of materials will be used in the future?;
  - Long lasting products, etc.;
  - Laws concerning product responsibilities.
- The Swedish Government has decided regulations should be introduced which make producers responsible for products. This is being implemented now for packaging, and tyres, and soon will be for cars and furniture. They want to implement a general bill which will regulate all products.
- SETAC input into the Nordic Guidelines. It is considered that all countries should develop their own guidelines based on SETAC''s.
- SETAC's methodology is widely accepted in Europe.
- SETAC has two 2 branches, one in North America and one in Europe. Sometimes these two branches do not follow the same lines of thinking. LCA thinking differs in USA and thus differences would be expected in the models, however, they should unify around the guidelines.
- The major players in LCA in the future will be industry, and the LCA itself will focus more and more on industry. The concept needs to be introduced into industry;
  - Practical applications need to be developed by, and within industry.
  - The LCA tool really needs to be used in conjunction with industry.
  - LCA work is generally still being done by consultants.
- Segmented LCAs may be necessary. That is, LCA for forestry, LCA for manufacture, etc.

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159 See **Case Study 12: CIT - Ekologik**

LCAs currently are trying to cover everything at present.

- It is still impossible to put numbers on a lot of issues.
- LCA was developed for a very narrow application and now people are trying to extend that application.
- There is still a lack of reliability with LCA models.
- Simpler systems need to be encouraged, but there are no good examples yet.
- Hopefully ISO will help clean up LCA, by standardising it and giving it a seal of approval.
- Practical application is still a problem. Industry may get a consultant to do an LCA but as soon as they get the final report they think the process is finished. Industry needs training and knowledge to understand process.
- LCA needs to become part of the education, part of the mentality, almost an automatic process.
- It is hard to tell how LCAs will be used in 50 years time. Development and use should be proceeding with caution.

Forestry

- Forestry is a very special industry and all issues are not being currently dealt with, for example biodiversity.
- Sweden wants to implement certification of forest products. A united view is necessary, but there are major debates at present on issues such as, environmental performance data, etc.
- There are a number of discussions occurring between industry and organisations, however, the discussions break down and fundamental issues are stumbled over.
- The forest industry is reluctant to use LCA's and they don't think that LCA's will have an impact on customers. There are currently looking at other indicators. LCAs are losing out to other environmental indicators/evaluation methods.
- There is divided opinion in the environmental movement.

CASE STUDY 17:

ifw
(Initiative for the Promotion of Sustainable Forest Management)

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'Unions, industry and trade have for the first time made a common commitment to the principle of sustainability, driven by the responsibility for the environment as well as a justified degree of self-interest (protection of resources).'[160]

BACKGROUND

The need for a new organisational structure to deal with certification and labelling issues in the timber industry was the basis for the introduction of the Initiative for the Promotion of Sustainable Forest Management (**ifw**). Originally Initiative Tropenwald (**itw**), the change to **ifw** took place in April 1997, under the direction of the German Timber Workers Union (GHK) and the Central Federation of German Timber and Plastics Processing Industries (HDH). This change came about in order for ifw to better introduce the basic propositions of the 'Joint Declaration on the Protection of Tropical Forests.'[161] The report deals specifically with forest certification and **ifw**'s function is to instigate a labelling method for timber and timber products which have come from sustainably managed and certified forests. **ifw** have made an extremely important contribution to the certification debate in Germany, and more importantly the international arena.

ifw have been established as an independent organisation in order to both, develop an appropriate method for timber labelling and to guarantee the correct use of certification. In this capacity they support endeavours to develop an internationally recognised certification and labelling scheme and also

160 Schardt, S. (1997) 'Its time for action! The certification of forests and labelling of timber must be put into practice now', translation of article published in 'Holz-Zentralblatt', April.

161 Union for Furniture, Timber, Plastics and Allied Trades (GHK), The Central Federation of German Timber and Plastics Processing Industries (HDH) and The German Timber Importers Federation (VDH) (1992) 'Joint declaration on the Protection of Tropical Forests.'

a common accreditation body, in particular the Forest Stewardship Council (FSC). 'The FSC is currently the only active accreditation body and, being supported by the major environmental organisations, has a great potential to establish itself as an internationally recognised accreditation body.'[162] It is considered that, although not solving all the major environmental problems involved with forestry and deforestation, certification and labelling will at least contribute to addressing some of the issues.

GOALS

It is **ifw**'s goal to introduce 'certification of forest enterprises and labelling of timber products on a voluntary and non-discriminatory basis' in order to 'make an important contribution to the introduction and promotion of sustainable forest management.'[163] Applying these measures is a very crucial factor and needs much consideration and emphasis. It is a 'primary task of ifw to ensure that all interested businesses are provided simple and inexpensive access to timber from certified forest enterprises.'[164]

LCA-RELATED PROJECTS AND PUBLICATIONS

ifw are developing a methodology for certification of forest management units and labelling of products which originate from forests managed under a sustainable management system. **itw** started work in this area when there was a call for a ban on tropical timber in Germany. They took the position that there was a better solution than to boycott this timber. The issue that deforestation isn't solely due to forest management practices, and in fact, practices are not even the main cause, needed to be addressed. Instead of bans, a solution that improves forest management is required. As **ifw** is a very new organisation they have not produced many documents.

ifw have been investigating the position of Indonesian forestry in regards to forest management systems. In Indonesia, most resources, apart from timber, are limited. They have a right to use this resource but as it is the only resource for the future this issue needs to be addressed. **ifw**'s target is to aid this and other similar countries to start sustainable management schemes in their forests in order to support their own interests, now and for the future.

In order to do this **itw** aid work developing criteria indicators for evaluation of sustainable forest management. It is extremely difficult to describe 'sustainable forest management' for certification without a framework of criteria indicators. From 1992 until 1994, along with a group of experts, including researchers from a technical background, foresters, biologists, etc., they defined the most important requirements for good forest management from an operational, technical, and 'good management,' point of view.

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162 Schardt, S. (1997) 'Its time for action! The certification of forests and labelling of timber must be put into practice now', translation of article published in 'Holz-Zentralblatt', April

163 IBID.

164 IBID.

Once these criteria indicators were developed they had to be put into practice. In this case **itw** were one of the first organisations to make a certification proposal, so they felt under obligation to put it into practice. All indicators developed or in development for certification means, need to be field tested in order to achieve acceptable and practical results. **itw** undertook field tests in Germany, Indonesia, Africa and Brazil. These tests were completed in 1996, and a large report has been produced in the form of a handbook for 'Sustainable Tropical Forest Management.'

The certification of forest management was only the first step in a very long process. Now the issue for **ifw** is to develop a system to assess timber from the forest to end use. These processes are very different and complicated. Defining criteria indicators for sustainable forest management is a politically sensitive issue and indicators need to be acknowledged from a social and political standpoint. The other stages, however, are more technical issues. Both areas need to be developed equally but they are different components that have to be dealt with separately with different tools and structures adequate to different requirements.

- Schardt, S. (Undated) 'Timber Certification - Limitations and Possibilities,' **ifw**, Berlin.
- Schardt, S. (1997) 'Its time for action! The certification of forests and labelling of timber must be put into practice now,' translation of article published in 'Holz-Zentralblatt,' April, 1997.

ifw were not considering LCA. They can not reconcile certification with LCA as the same issues are not dealt with. This highlights the fact that there are problems if LCA is not utilised within the forestry industry, and the information is needed at latter stages.

ifw are now considering the methods appropriate for the next stage and are dealing with products that originate from sustainable managed forests. They have been considering the structure of ecolabels and simple systems such as the Blue Angel label.[165] This system has an independent jury which is composed of experts from different sectors of society, who create and set standards. **ifw**'s position is to apply same system for timber products. They have so far reached the stage of setting up a trade mark association with all stakeholders. It is their job to bridge the gap between the producer and consumer and to provide members with information on certified timber and provide producers with market opportunities.

ISSUES DISCUSSED

Environmental Awareness

- Ecological awareness is becoming more apparent in business and public.
- In Germany only certain products can be used in public buildings and other big corporations are following this lead:
    - An ecological point of view is being considered in material choice;
    - Industry needs to have better knowledge of products and labels to obtain

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165 The Blue Angel Ecolabel is the longest running ecolabelling scheme. Developed in Germany, this label offers a definite market advantage. It has been noted that consumers will pay more for products labelled with the Blue Angel Mark.

some market advantage.

- Sustainability is a large and evolving target. The requirements and definition of sustainability are not the same as, say, 50 years ago.

Environmental Tools

- The majority of non-government organisations are now pushing labelling.
- Organisations based on private industry, concentrate on labelling rather than certification.
- It is the job of industry to put environmental tools into practice. That is, industry has associations who are responsible for administering the whole discipline.
- Companies interested in the Blue Angle Ecolabel have to sign licence agreement.
- Certification and Labelling are now mainstream discussion issues as tools for sustainable management.
- Certification discussion is on international agenda.
- There is consensus that certification is only one tool to promote better forestry management, it is not the only tool.
- Certification combined with other tools may be very useful.
- The effects of certification tools are dependent on the circumstances in respective countries. They may not be comparable from country to country unless a specific framework is devised.

Forestry and Timber

- Timber is the most important renewable raw material for human kind.
- The ecological quality of timber is mainly dependent on the quality of production in the forest, which in turn is dependent on forest management.
- Sustainable forest management guarantees that less timber than is grown is harvested.
- In the past the production function was the most important function of a forest. Now more is expected from sustainable forest management than just the harvest rate, annual yield, etc.
- Forest management should fulfill many different functions, such as biodiversity, ecological function, production function, etc.
- A system that combines all requirements, from social to forest requirements is needed.
- Germany is characterised by situations of past centuries:
    - Lack of timber;
    - Economy as the most important function - first half of this century.

  They now only use only 2/3 of the yield and other functions have become much more important due to greater understanding and the requirements of sustainable forest management.
- Germany is not dependent on tropical timber. Only a very small portion of timber consumption is from tropical imports.
- There is difficulty defining social functions of forestry and specific ecological requirements:
    - There is international discussion on this issue which is concentrated on criteria indicators.
- Timber is winning market shares against other materials in the building industry in Germany, however, there is still not a huge use of timber in buildings, such as in Scandinavia. There is only a low use of timber generally in buildings in Southern Europe.
- The timber industry has been under attack for destroying forests in other countries:

- The ecological quality of timber as raw material is under question;
- It is in the timber industry's interest, however, to use timber from sustainably managed sources;
- 'cutting the branch on which they sit' otherwise.

- It is urgent to demonstrate to consumers that responsible use is being made of timber resources.

Life Cycle Assessment

- To monitor flow of timber through industry, it is not necessary to know ecology of forest, suffice to say that certified timbers are used.
- An LCA methodology is only of interest for a specific product not for raw material, that is, an LCA of furniture in which timber is the most important raw material.
  - How can an LCA be done on the furniture and not the raw material though
- An LCA of furniture must look at many components such as the production method, energy, end of use, etc. Other materials are also included in furniture manufacture which need to be addressed. This adds up to a lot of questions!
- LCA is very holistic approach and focuses on all stages.

CASE STUDY 18:

INSTITUTE FOR WOOD SCIENCE AND WOOD RESEARCH

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BACKGROUND

The Institute for Wood Science and Wood Research are closely linked with the University of Munich. Within their structure the institute is sub-divided into four departments:[166]

- Forestry and biology;
- Chemistry and Ultrastructure;
- Mechanics and Physics; and
- Materials and the environment.

Research and education are the main basis for the Institute's work. They are active in main areas including, materials testing. They have an official testing laboratory which is unusual for this type of facility. German testing laboratories are mainly part of independent organisations who undertake separate and isolated research. Although closely linked to the university, the Institute for Wood Science and Wood Research undertake research and educational training among industry and the public.

LCA-RELATED PROJECTS AND PUBLICATIONS

The Institute for Wood Science and Wood Research have published two papers detailing their LCA activities. They have not been working in this field long enough for much information to have been produced. A general paper deals with environmental LCAs and also their use in eco-auditing in regards to the forestry industry. That is, proving, for example, that an organisation, factory, etc. is adequately addressing environmental aspects. In carrying out this study Environmental Management and environmental sustainability were focus areas and LCAs for products and production lines were under investigation.

166 University of Munich (1997) 'Institute for Wood Research.'

The Institute started with forestry issues making calculations concerning carbon, carbon dioxide, energy input/output, etc. and followed on through the whole cycle, from the forest to the product in the building. All the potential energy uses were calculated after the product had completed its first life in use. Most of the data was obtained from the institutes own research data and calculations, however, a lot was provided by industry, especially the production data.

Another paper produced by the institute focuses on the research done on managing LCAs. The researchers went to industry to try and educate them in establishing LCAs, from accumulating all the data to improving product development. They also dealt with issues including forestry to sawmill, production of timber, final product (e.g. a house roof), and removal/next utilization/or energy after 50 years. Examples are given in the report for how to establish such an LCA for different areas, for example forestry, sawn timber, drying of timber, input/output data, production of glue-lam, etc.

There are two papers summarizing the methods the institute uses and how to implement them. They are not full scale evaluations of different products.

The Institute for Wood Science and Wood Research also publishes two journals that have articles dealing with LCA developments, one, however, is only published in German ('Wood as a Raw Material'). The other is the 'Wood Science and Technology' journal, available from the above address.

ISSUES DISCUSSED

Life Cycle Assessments

- ISO 14000 is a very important framework, which in the long term will be the standard for LCA.
- ISO defines modules for LCA.
    - Sub-modules need to be defined according to specific requirements, such as forest production, wood production, timber production, etc.
    - These sub-modules may differ from country to country, for example, this is the timber for buildings, this is industrial wood for pulp and paper, for particle boards, fibre boards, and so on.
    - With the whole building all the individual products need to be discussed, including forestry inputs, outputs, etc.
- Results need to be described very simply as the information should be published publicly - can not go into too much detail.
- LCA ideas should ideally be widely dispersed:
    - What is important in LCA?;
    - How LCA operates;
    - The balance of all inputs/ outputs, for example, all the electrical power, thermal power, water, that are required in order to make a laminated beam.
- Industry need to be convinced that they themselves need to do LCA assessment:
    - Costs time and money;
    - Takes many months or years.

- In undertaking an LCA many questions need to be considered:
    - How to set up LCA system
    - How to deal with environmental issues;
    - How to decide how deep to go into detail;
    - How much data is required.

  These are very big problems, but it is necessary to answer them.
- It may take some time but regulations will become much stronger.
- The development will be that all countries will have to prove that their raw materials are 'environmentally friendly.'
- Mr. Schweinle has looked at forestry related issues and has carried out the evaluation of the data for harvesting, etc.
- He has produced one of very many papers on this topic, which start to summarise the state-of-knowledge. It will take a few years still to develop this area further .
- It is very important to have a label in the forest - forest certification.
- Companies are just starting to show an interest in environmental management schemes, however, they are not widely established.
- At present different LCAs cannot be readily compared. Comparative means will be very important and necessary in the future.
- International regulations are still not very thoroughly developed, but at least there is now a framework.
    - This gives an international basis for establishing an LCA.
    - It will take a few years to standardise LCAs on an international scale.
- Klaus Richter[167] is very experienced with different products in relation to LCA. He has conducted studies on:
    - Different window materials;
    - Floors;
    - Railway sleepers; and
    - The construction of prefabricated walls.
- Particle board and prefabricated walls are very important in Germany.
- Production of particle board is to the magnitude of 9 million cubic metres per year, as compared to plywood which is only 5% of this.
- There are two lines of particle board - 50% for building purposes and 50% for furniture applications.

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[167] See **Case Study 19: EMPA**

CASE STUDY 19:

EMPA
(Swiss Federal Laboratories for Materials Testing and Research)

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'Research, testing and services in the fields of construction, materials sciences, energy conservation, environmental technology, waste management and recycling, textile and printing techniques.'[168]

BACKGROUND

EMPA were established in 1880 as a independent government body, in order that material properties be studied and evaluated. They are now a renowned research and development organisation as well as a consulting service, collaborative body[169] and participant for enforcement of government regulations. The organisation, divided into two institutes, one located at St Gaul and one in Dubendorf , comprises a board which oversees the two testing and research areas. The board also manages the logistics, controlling and marketing of EMPA. Within the two main areas, technical sections exist, each dealing with a particular interest area, for example, the wood section.

EMPA are accepted by industry as a neutral and independent partner in the assessment of materials and products. Researchers are obliged not to be influenced by specific groups or interests. In this capacity, they have to state when a particular product or material is not the best option. If this is the case, EMPA supports the particular industry in reducing impacts so that it becomes a more viable product in the market place. They have retained over the years a strong bond with all industries in

168 Elkington, J. et al (1993) ' The LCA Sourcebook: A European Business Guide to Life-Cycle Assessment', Sustainability, SPOLD and Business for the Environment.

169 EMPA collaborates in the development of standards, within national and international working groups and commissions, and in the formulation of regulations , recommendations and ordinances. See EMPA (1996) 'Who are we? What is our goal?'

Switzerland because of these policies.

EMPA began work in the LCA field in the 1970's. Their initial studies concentrated on public and industrial packaging. At the St. Gaul institute research was started in the early 1980's to develop a specific LCA methodology. Impact Assessment was the main area of focus. In 1984 EMPA were one of the first organisations to make public their LCA framework, in a database format, and a specific Swiss based model of critical volume. In St Gaul there now exists an LCA group which consists of about eight people. LCA and LCA research is undertaken at both the St Gaul and the Dubendorf sites. They are no longer so involved in methodology development. They do, however, communicate with the Swiss members of the ISO committee and provide relevant information to them and also follow up general questions on LCA methodology.

GOALS

The broad goal of EMPA is to promote 'the safety of people and the environment' and to further promote 'projects which help to strengthen the competitive position of the Swiss economy.'[170] As a materials testing unit, it is the aim of the organisation to deal closely with industry as an independent collaborator. Each of the sections in EMPA's Institute also have their own goals. The Wood Section's major areas of research relate to the properties of wood, composite wood structures, drying of structural timber, and glue bonding qualities. Environmental considerations and the 'ecological aspects of wood and its processing, application and disposal; life-cycle analyses (ecobalance) of wood and competitive, materials,'[171] are also taken into account.

LCA-RELATED PROJECTS AND PUBLICATIONS

There are many LCA projects being undertaken within EMPA. The ones of most concern in this case are those specifically related to the timber industry. There are only two or three people working in detail on LCA in regards to building and as they are all situated in the wood science section, there is a very high emphasis on wooden materials. Klaus Richter entered the LCA arena recently from a wood and timber science background. He has taken part in the development of eco-balance and LCA tools, however, he is not an expert in methodology, more a practitioner. He is currently looking at LCAs on wood products and their possible effects on climate change strategies.

- Richter, K. (1997) 'Life Cycle Assessment of Wood Products,' Swiss Federal Laboratories for Materials Testing and Research, Dubendorf, Switzerland

Collaborative work with the University of Hamburg and the European Research Programme, Life-Sys Wood, is being undertaken in order to advance the timber industry's position in the LCA field. All other industries including the PVC, Steel and Aluminium industries have published inventories for the European situation. This is difficult for forestry, as data for logging, harvesting, etc.. are vastly different

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170 EMPA (1996) 'Who are we? What is our goal?', p. 5.

171 IBID.,12.

in various countries. The collaborative efforts focus on gathering all knowledge together and reaching a generalised agreement, in order to develop an effective tool which may be used by industry and architects.

EMPA use this basis to look at the building sustainability issue. They have started to put together data inventories for products and will eventually evaluate processes, so that the whole building will be able to be modeled over its life time. This model will include all direct and indirect energy and mass flows which are relevant for an overall environmental characterisation.

Issues were raised within EMPA on environmental impacts about ten years ago. The first questions were from architects and these could not be answered because, although all technical and statistical parameters could be measured, environmental parameters were not developed. EMPA started to address the energy questions which had been widely published after the oil crisis. Energy, it was subsequently decided, was only one important issue. Questions on emissions, sustainability, resources, etc. could not be covered by pure energy figures. EMPA began to look at the whole impact, of not only energy ,but also impact on resource availability, air and water from emissions, biodiversity, etc. All criteria, EMPA decided, are important, so they began to look at how energy and mass flows could be modeled and how different figures from industry could be evaluated and assessed in order to provide architects, for example, with a reasonable answer to their questions.

Research programmes undertaken in quantifying the environmental characteristics of forestry and forest products, place industry in a better position to develop their products, compete against alternative materials, and provide information regarding their products. Research started in this area by looking at data inventories for raw materials and products out of the forest industries. It was soon recognised that it was impossible to focus on one product group if there was no standard for comparison. This comparative issue was raised by industry. EMPA recognised that comparative research, of specific material combinations and groups in specific functional units, was a better assessment means. For example, a functional unit of window frames can be used to compare window frames of wood, steel, PVC, aluminium, etc. These types of studies focused on how LCAs could be used in a comparative fashion.

In their more recent LCA work, EMPA follow the SETAC and ISO activities and they orient their activities to the general rules, guidelines and requirements. This is especially important when undertaking their comparative assessments, in order to keep in line with general strategies also used by other groups in Europe. EMPA do not participate directly with either SETAC or ISO developments or in modeling or standardisation process for LCA. They are, however, indirectly involved through dissemination of knowledge and research undertaken at the institute, and also respond to any questions and give statements when required. When specific developments occur in ISO that may affect wood's rating and position, or that puts wood at an unfair disadvantage, then EMPA responds with opinions and comments to the Swiss ISO committee members.

EMPA have noticed a specific interest from industry to participate in combined research programmes and in carrying out their own data inventories. There is much demand for evaluation and assessment of

data. It is very important to have industry input in the development of inventories as up-to-date information is required. Acceptance of all industry and material groups involved in a specific project is needed. Guidelines are given to industry in order to collect statistics.

Other specific projects in the LCA area include studies on:

- Adhesive and paints
- Door frames;
- Power distribution poles.

There have also been shorter programs undertaken on glazing and wooden flooring.

ISSUES DISCUSSED

Building Sustainability

- Architects play an important role in building sustainability so it is important to get information across to them. Architects have influence in the very early stages of the whole process, not only in cost but also ecological aspects.
- The education of architects in these specific areas needs to have a greater priority than it has at present.
- Questions regarding education and architects need to be established which could affect sustainability, building processes, etc. to a large extent.
- The sensitivity of the population in Switzerland is making people address environmental issues:
    - They are looking at safer construction methods through the reduction of direct and indirect impacts of building materials.
- There needs to be a lot more emphasis on design so other alternatives and options become available.

Life Cycle Assessment

- There is an effort to harmonise the European situation as much as possible. Each country, however, has special circumstances. LCA complexity is not easy to manage.
    - Much information is gathered, and currently there are no simple and easy answers on how to deal with this.
    - Either the whole gamut of information or a single figure, giving a yes or no answer, are provided. What is needed is something in middle where choices and decision can be made based on understandable information
- A changed system boundary can affect the results of the environmental research programme or LCA.
- Within ISO industry groups are quite well represented, however, small groups have little weight in general committees.
- Small and medium sized industries will require support from universities and the state, for example.
- In Switzerland LCA questions are treated by industry on a very high level:
    - A lot of companies have actively implemented LCA philosophy and are now doing their own industrial scale inventories and are trying to be sensitive to

environmental issues.

- In Germany the number of LCA studies done by industry are also quite high.
- Industry and architects need to be working closer together to determine solutions with less impact to the environment.
- Questions of sensitivity and acceptance of development need to be addressed. That is, if industry has been doing it this way for the past 40 years, why should they change their industrial production, and invest a lot of money, now?
- There has been a very decent increase in the importance and acceptance of LCA by industry:
    - It is shown by general statistics that industry has a lot of interest in at least the detailed energy and mass flows of their production processes
    - From this information they can see a lot of possibilities to reduce their energy and mass flows without affecting the outcome of their products;
    - Reduction in specific energy and mass flows is normally also connected to a reduction in input in money;
- Economically the benefit is also combined with reduction strategies for emissions:
- This is interesting for many companies who see that they are, and have been, using the same product, but they have never looked in detail at the energy and mass flows.
- Industry have been quite astonished with LCA results and have been shown to follow up with at least the inventory work.
- Legislation will in the future be more strict in regards to environmental problems.
- Industry's position increases with knowledge and documented LCA information.
- Europe has a specific sensibility to environmental quantification measures including ecolabelling and so on:
    - LCA can provide specific information and answer specific questions.
    - LCAs will be used in the future in this way.
- Problems exist, however, if LCA is used to punish specific industry groups.
- LCA can be used for specific improvement possibilities and the optimising of flows and processing steps.
- LCAs should not just be used for environmental reasons but also for efficiency and economic benefits;
    - This is most important benefit of whole LCA procedure.

Timber Issues

- Switzerland, The Netherlands, Germany and Nordic countries are pretty high in importance based on their inputs to methodology development and data inventories.
- Nordic Countries have high percentage of timber in buildings.
- In Germany and Switzerland only about 5-8% of new buildings use timber derived products such as particle board, sawn timber, plywood, etc.
- Concrete, brick and steel have much higher importance than timber in these countries.
- Knowledge that buildings up to five storeys can be built in wood is increasing.
- There is a mentality of brick solidness, however, timber has survived for many centuries:
    - Historically timber was used properly with protection from climatic factors, etc.

- New construction methods do not reflect this, for example, eave overhangs have been reduced.
- Timber can not be used in same way as bricks, steel, etc.
- It is not easy to use timber and more knowledge is required than for other materials such as steel, which have simple formulas for calculations. When using Timber more issues must be addressed.
- Education is an important factor.

- CCA treatment is a big issue in Europe:
  - In Germany and Switzerland arsenics have been prohibited for over 10 years;
  - They are still used in France, UK, USA, and Australia;
  - Environmental legislation look on the problems associated with CCAs quite differently;
  - It has been demonstrated that arsenics can be substituted and these substitutes impact less on the environment;
  - There are other possibilities in termite protection, for example, but these alternatives need to be assessed.
  - Have to assess how CCA treated timber compares with using steel or concrete for the application, from an environmental point of view.
  - There has been a lot of discussion on these types of issues, which has led to discussion on toxicity and eco-toxicity.
  - Steel it can be argued can be recycled so is not so harmful in the long term.
- Evaluation of plantation grown timber is difficult in Europe:
  - The system is more than 200 years old;
  - A general rule of not taking more than grows exists;
  - If these trees are immediately chipped, however, is this really sustainable?
  - It is a problem when a tree is taken for chipping rather than used in higher purpose applications.

CASE STUDY 20:

AFNOR
(Association Francaise de Normalisation)

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BACKGROUND

AFNOR are a government body under the authority of the French Ministry for Industry. The main area of consideration within AFNOR is standardisation, but a small group concentrates on certification, specifically ecolabelling. The Ministry provides AFNOR's funds, equivalent to 20% of their financial revenue. The majority of this money goes into standardisation. Although AFNOR operates as an independent body, the ministry has a control over the certification section which they do not have over the standardisation department. This causes tension within the certification section as the ministry often sides with the industry Federations who do not want the introduction of ecolabels within their industries. The Ministry currently has the power to inform which industries should be receiving the label.

AFNOR work closely with the European Ecolabelling development organisation, as part of the French contingent. In this endeavour they are able to obtain useful knowledge from the European experience. They also have the opportunity to provide input relating to their own observations in developing the French ecolabel, that is, the NF Environmental Mark. In this capacity they endeavour to obtain information from industry and producers and involve them in the processes. One of AFNOR's major criticisms of the European Union's ecolabel, is that advice and comments from industry are not sought. The Union decide which category to develop without an investigation of the market or industry.

AFNOR's major partner in both standardisation, specifically in regards to LCA, and the development of the NF ecolabel, is the French Agency for the Environment (ADEME).[172] ADEME work on

172 ADEME are an independent organisation who play an important role in French regulation policies by controlling all preliminary environmental studies. They are also involved in the development and control of the use of LCA methodologies in France. They carry out their own

environmental criteria from a life cycle point of view. They are specialists in the LCA field and draw on this knowledge in carrying out and developing LCAs for, and with, many organisations. They have, for example, worked with SETAC in LCA development. AFNOR work with ADEME to develop standards on LCA methodology, environmental measurement methods and ecological labels for each product. They have also aided in the determination of the overall LCA approach for the French ecolabel. They developed a simplified matrix approach working with impacts on the environment, based on LCA methodology. The certification label is awarded to producers, who comply with criteria, by AFNOR. The producers pay for this entitlement and revenue is raised for the section.

GOALS

AFNOR's main missions are mainly in regards to standardisation. That is, AFNOR aims to:[173]

- Pilot and coordinate the preparation of standards;
- Represent and defend French interests within all standardisation bodies;
- Approve standards; and
- Promote and facilitate the use of products and services, which relates strongly to the certification of products.

It is also a goal of AFNOR's certification section to become a self-governing organisation, so that they can act independently in regards to all labelling and industry issues.

LCA-RELATED PROJECTS AND PUBLICATIONS

AFNOR have instigated proposals on French LCA standards, aided by ADEME, and have done a substantial amount of work in the ecolabelling field. AFNOR founded the French ecolabel, the NF Environmental Mark, in 1991. This Mark is a voluntary labelling system which producers can obtain if their products meet certain ecological and sustainability criteria. The criteria were produced with the aid of ADEME and in consultation with industry, consumer, distribution, environmental and public authority representatives.

- AFNOR (1997) 'Information File On: The NF-Environmental Mark and The European Ecolabel,' Association reconnue d'utillite publique, Comite membre francais du CEN et de l'ISO, Siret 775 724 818 00015, Code APE 751 E

The French ecolabel uses a simplified LCA approach in looking at the different cycles of a products life. Each new product group has different categories that relate specifically to the product type, which can be, for example, vacuum cleaners or detergents. To determine these categories the different impacts of the product on the environment are ascertained. LCA criteria are used to establish the impact categories, for example, acidification, energy use , raw materials, emissions, wastes, risk of accidents, durability in use, optimization of packaging, etc. This approach uses both qualitative and quantitative assessment means. Firstly, impacts are discussed with the manufacturer to determine where problems

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LCA studies and finance eco-labelling studies.

173 AFNOR (undated) 'About AFNOR,' sourced from the Internet [see above address]

may be located. Subsequent to this discussion, AFNOR puts in place quantitative criteria which the manufacturer must adhere to. For example, they may only be able to use a certain amount of energy. Since products have to conform to environmental criteria the product can only be improved. As each product category has it's own criteria, inter-product comparisons are irrelevant. AFNOR decided on this approach because they considered SETAC's approach, which they began by using, too complex and expensive. They consider SETAC's model useful, however, in initially approaching environmental problems and in determining which impacts are relevant to the product types.

There are now six categories of products established, with over 250 labelled products. As yet there have been no consumer reports carried out to determine how the label is being received, since the label is not widely recognised. It wasn't until the beginning of 1997 that four more product categories were added, increasing the product categories to six. AFNOR are currently attempting to work with industry and to motivate them in environmental awareness. To establish an ecolabel for a certain product group there has to be a demand from at least one producer. When an applicant from a new product category applies for a label, AFNOR sends comprehensive information to all product manufacturers, in the same category, explaining ecolabelling. It is better that the producers initiate the labelling process as there is generally more motivation to properly use and implement environmental issues. There were several categories in the process of being recognised in 1997, including photocopiers, school and office furniture and coffee filters. In one category there is only one applicant who is a foreign applicant. The industry's Federation is strongly opposing this.

AFNOR have also been working with Germany on a mutual recognition for ecolabelling basis. This work is being instituted on a product by product basis presently, and no results have been finalised. This is difficult because of AFNOR's simplified LCA approach. They are considering talking with industry in other countries to find common criteria.

ISSUES DISCUSSED

Ecolabelling

- The ecolabelling process is slow and it is difficult to introduce this type of label.
- There is growing awareness in regards to ecolabelling, however.
- Some industry federations do not want ecolabels for their products. For example, detergent manufacturers do not agree with LCA or equating of labels:
    - One detergent manufacturer asked for an ecolabel and the federation responded by threatening to coerce their packaging supplier not to supply packaging. The packaging people do not agree with ecolabelling, and would be in trouble if all the other detergent manufacturers stopped using them, so agreed.
- Both AFNOR and the EU have asked for comments on the ecolabel and guidelines from industries. The reply is usually that they, 'don't agree' and the labels are 'not good.'
    - There is continued opposition to ecolabelling.
- There is fear within industry that the French Label will eventually become regulation and they don't want this to happen:

- So instead of working with the labelling experts, they are simply responding negatively.

- The EU ecolabelling board only work with certain countries, for example, Germany and the Nordic countries:
  - They do not investigate all European situations.
  - This means there is a need for individual country labels.
- National labels have been developed in response to the EU ecolabel:
  - Before the EU ecolabel only 3 or 4 national ecolabels existed.
  - From 1992 ten national labels had emerged.
- Countries are not happy with the work being done on the European Ecolabel:
  - They are developing their own labels to gain experience and to decide what they want in an ecolabel, rather than just relying on EU ecolabel.
- Countries are starting to investigate mutual recognition between eco-labels:
  - At the beginning of 1997 work was undertaken on 3 categories to see if it was possible to find mutual recognition criteria;
  - Mutual recognition means having the same criteria, the same procedures for checking, etc.;
  - For example, each country has it's own label for paint, with it's own criteria. The criteria is similar, but not mutually recognisable at present;
  - There needs to be a kind of recognition where certain issues are accepted.
- Most countries in the European Union have similar approaches in checking products on the market.
  - Mutual recognition is a considered to be a better way at arriving at a common label than the EU ecolabel;
  - It is easier to define the same criteria between a couple of countries. For example, France and Spain can mutually recognise each others schemes with just a few changes.
  - This is simpler than trying to develop environmental criteria for all EU countries who have different environmental issues and beliefs and not the same interest in the environment.
- The Netherlands and Germany are looking at starting their criteria search again rather than having a mutual recognition basis, despite Germany's work with AFNOR.
  - Perhaps new criteria will be uncovered
- AFNOR only give non-French products a NF Mark if there is no label available for the particular product in its country of origin or the European ecolabelling scheme.
- In Europe each country wants to keep it's own experience and own label, but at same time they want a common European strategy:
  - They must work on a unique label and harmonise;
  - This is very difficult as each country has its own interests. For example, in the North there is much ecological concern. They are very strict and want a very selective label. In the South, however, they cannot yet answer to such strict criteria and will not be able to conform.
- Regulation for the European Ecolabel is in progress

- In the new regulations the commission states that National labels must disappear in 5 years:
  - That is, if there is a European label on a certain category of products, then this supercedes the National label.
- Industry want to be able to chose which label they use:
  - If a producer comes to AFNOR to obtain a label, they cannot be forced to instead get a European label.
- Cannot be obliged to give up labels:
  - Germany's label has existed for much longer than the European eco-label and is much more widely recognised.
  - Consumers know the Blue Angel, they do not know the European label.
- It is easier to have one label, but much harder to implement.
- Positives of a single label:
  - Less expensive for each applicant;
  - Recognizable logo for all countries;
- Negatives of a single label:
  - Only the Northern countries require a single label;
  - Their standards are vary high;
  - Only a small number of products would be granted labels from South Europe.
- In the future, harmonization may be arrived at for a European Ecolabel. One which would take into account the different interests of all the countries. This will take a lot of time and effort
- National labels themselves are very difficult and usually only producers from this country obtain labels for their products.
- No ecolabel currently deals with materials. Labels are generally only for products which are for consumer purposes or products for activities.
  - Materials are looked at, but only in the sense that they are used in products
  - The principle is that ecolabels are for finished products.
- LCAs can be done on materials and this information used in ecolabels for products.

CASE STUDY 21:

ECOBILAN

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'The day we knowingly give Greenpeace - or anyone else - the wrong figures, will be the day our reputation dies.'[174]

BACKGROUND

Ecobilan were founded in 1990 as a company of Life Cycle Assessment practitioners. Evolving from the academic research centre at the Paris School of Mines, they have since progressed to become the most widely recognised and largest organisation in the fields of both LCA and Environmental Life Cycle Management. Composed of scientists and engineers with experience in the methodology and use of Life Cycle Costing (LCC) and Life Cycle Assessment (LCA), Ecobilan have substantial experience with industrial and research activities. They are actively involved in:

- The development of methods combining environmental issues with economics, cost and decision analysis;
- Strategic planning using life cycle assessment; and,
- Work on maintaining the database developed for undertaking LCAs on materials used in the building industry.[175]

Ecobilan have active affiliates and subsidiary companies in a number of countries, including Belgium, Italy, UK, and Ecobalance, Inc. in the USA, which add to their international awareness. Ecobilan also act in collaboration with most of the main LCA organisations including SETAC, CML,[176] the European

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174 Elkington, J. et al (1993) 'The LCA Sourcebook: A European Business Guide to Life-Cycle Assessment', SustainAbility, SPOLD and Business for the Environment, p. 32

175 See LCA-Related Projects and Publications

176 See Case Study 7: CML

Commission target groups and the ISO standards committee,[177] Neil Kirkpatrick,[178] and AFNOR.[179] Ecobilan are also the main LCA consultancy organisation used by the French Ministry of the Environment and ADEME,[180] for carrying out LCAs, developing ecolabelling criteria, and generally on all issues relevant to LCA. Ecobilan also maintain strong links with academic research institutes, actively participating in university engineering programs at both the under- and post-graduate levels.

Ecobilan works in many areas, utilising LCAs to explore the environmental possibilities in producing goods and services. They have focused over the years on a substantial range of areas including, for example, the;

- Aluminium industry;
- Automotive industry;
- Construction materials;
- Ecolabels;
- Electric and electronic industry, including energy;
- Food industry;
- Glass industry;
- Insulating materials;
- Personal care, including cosmetic and toiletry packaging, and aerosols and animal testing;
- Petrochemical industry;
- Packaging, specifically aerosol and beverage containers;
- Paints and varnishes;
- Petrochemical including polyethylene film and PVC packaging;
- Pulp and paper;
- Steel industry;
- Transport and distribution; and,
- Waste management options.

GOALS

Ecobilan's aims focus on the advancement of LCA, including, the harmonization of LCA methodology, the technical improvement of methodologies, development of LCA as a valuable business tool, implementation of LCA within industry, and, so on.

LCA-RELATED PROJECTS AND PUBLICATIONS

As an LCA consultancy Ecobilan have undertaken numerous LCA studies within industry, however,

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177 See **Case Study 3: CEC**

178 See **Appendix 1: Contacts List**

179 See **Case Study 20: AFNOR**

180 See **Case Study 20: AFNOR**

due to confidentiality requirements only a limited numbers of these have been published. Ecobilan undertakes Life Cycle Management strategies and life cycle assessments within businesses. This involves cost reduction programs, research and development activities, strategic planning and external relations. Ecobilan have developed numerous tools in order to undertake these environmental assessments.

- Tools for Ecological Analysis (TEA) is an inventory model which includes a comprehensive data base. It is designed to be utilised within large industrial companies and on complex products.
- Ecobilan have also been working on a 'Building Environmental Assessment Methodology.'

They have undertaken industry based, comparative assessments on different structural solutions. Theoretical research on the main issues of LCA methodology, in respects to buildings and materials, has also been concentrated on in order to develop this model. Research in these areas has led to assessment of 'environmental burdens of buildings, encompassing the construction stage of the buildings and their use over a given period of time.'[181]

- Osset, P. and Cortijo, P. (Undated) 'Building Environmental Assessment Methodology,' Ecobilan, Paris

Ecobilan has developed another tool in order to perform LCAs of buildings. 'TEAM' 'assesses the environmental burdens of buildings, encompassing the construction stage of the buildings and their use.'[182]

- Osset, P. and Cortijo, P. (Undated) ' TEAM for building,' Ecobilan, Paris

Ecobilan are actively involved in international LCA development. For example, their work includes:

- Work within the European Unions target group dealing with ecobalances of packaging materials;
- Work with ADEME in developing LCA;
- Aid to AFNOR with their methodology;
- Work with the European Commission in charge of establishing the guidelines for ecolabelling, as the official expert and advisor on ecolabelling issues;
- Involvement with ISO 14000 activities, as technical advisor to the Committee Secretariat in charge of LCA;[183]
- Work with SETAC's LCA steering committee and active participation in LCA-Related workshops;
- Participant on SPOLD's[184] board committee; and,

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181 Osset, P. and Cortijo, P. (Undated) 'Building Environmental Assessment Methodology', Ecobilan, Paris

182 Osset, P. and Cortijo, P. (Undated) ' TEAM for building', Ecobilan, Paris

183 See **Case Study 3: CEC**

184 See **Case Study 4: SPOLD**

- Official advisor for the European Community Commission for the European Ecolabel.

ISSUES DISCUSSED

Life Cycle Assessment

- Many conflicting studies on the pulp and paper industry have been undertaken. Controversial aspects, include:
    - The use of wood in the paper industry;
    - Possibilities for drawing a representative average when most of the companies are different and not comparable;
    - All processes are very different, for example, water treatment.
- Sites could be classified in LCA. That is, timber should be recovered from a specific site so lesser transportation is required, for example.
    - Could also classify products and sites.
- Patricia Osset (CTBA - Centre for Wood Applications) is involved in LCA for wood and wood products and has contacts with the French Wood Agency.

CASE STUDY 22:

CPA
(CANADIAN PLYWOOD ASSOCIATION)

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Member of COFI - the Council of Forest Industries

ISSUES DISCUSSED

Forestry Issues

- Some factions within the Forest Stewardship Council (FSC) are opposed to ISO.
- Canadian standards for forest management practices exist already: The CSA 808 series.
- British Columbia, it is considered are a target for forest management issues:
    - Greenpeace are very active in BC, although over last few years public opinion has swung away from Greenpeace and towards Industry.
    - Forest based industries in Canada are receiving a lot of negative comments. Mr Kempthorne considers British Columbia's forestry practices to be the best in the world.
    - A lot of focus is still on clear cuts which were done 20 years ago, and there is ingrained opposition now to clear cutting, particularly from environmental groups. In some cases clear cutting is good forest practice in terms of speed of regeneration, etc.
- Monumental changes in regards to the perception of forestry practices are occurring.
- The provincial government have instituted the 'Forest practices code':
    - It is the only jurisdiction in the world that has one legislation;
    - When the Codes first came out they comprised of eleven x three ring binders and contained huge amounts of information.
    - When they were first published their only achievement was to create a lot of paper work. That is reports, plans, etc. had to be filed and it turned out to be a very costly exercise for the industry.
    - The codes have been in place for three years now, but early in 1997 revisions were made and much paper work was eliminated.
    - Companies can now put more resources into issues, such as, better forest

practices etc., which is a great improvement.

- The Forest Alliance of British Columbia is a multi-interest organisation, composed of industry bodies, unions, environmental groups, committees, etc.
    - Address Benthall Centre,
      Dunsmir Street,
      VANCOUVER, B.C.
    - The Forest Alliance is a very good source of information.

Life Cycle Assessment

- They are not experts in the LCA area, and are really only beginning to recognise the concept at the CPA.
- ISO is going ahead and Canada have been at the forefront in getting LCA into the ISO process.
- Architects need to know where materials came from and what consequences these materials are causing. The steps and processes need to be included in a report for architects, consumers, etc.
- Environmental NGOs and Industry need to work together to decide what actions best serve the interest of both parties.
- The Canadian Home Building industry has developed a program to minimize wastes.
    - 10 years ago after a building was finished there would be a huge pile of waste.
    - Now there probably would not be a pile bigger than a desk.
    - Some of these issues go back to the design stage (e.g. modules are based on material sizes), better site control, less mistakes, etc.
    - There is an initiative for recycling being developed by the house builders association, where waste wood from building sites would be consolidated somewhere and eventually it would work it's way back into the system as chips or fuel or whatever.
    - Environmental pressures have had roles in this initiative, but the cost of disposal is the biggest single driving factor.
    - This would not effect the plywood industry.

Plywood Industry

- There are fourteen ply mills in CPA's association.
- All mills draw resources from their own allocation/ lease of forest land, which they have to maintain. The Government owns 98% of forest land and leases it to mills.
- There is an annual allowable cut, called 'Public Sustained Yield Units.
- The mills do not cut anymore timber than is grown in any year. That is, at least as many trees must be planted as are taken, which means the standing resources remains at a given level.
- The bulk of the plywood industry now is in the interior of the Provence and based on small logs. 25 years ago it was all situated on the Coast and based on old growth timber. Log diameters have gone from 50cms to 30cms over the last 20 years. The larger logs are now going to other higher application uses which is partly to do with technology, but mostly to do with economics.

- Annually approximately two million cubic metres are produced, and this has been fairly stable over the last 5 years.
- A lot of mill closures have occurred, particularly the big companies. The industry is now in the hands of smaller companies. Although some are still pretty big in size. Most are family owned companies, however, some are beginning to go public.
- Twelve companies operate fourteen mills.
- The CPA does not know what the main uses of plywood are - "To be brutally honest we don't know!!!!" - although, everyone assumes that the main use of the plywood produced is in residential construction, for roof, wall and floor sheeting. Mr Kempthorne's guess is 35% to residential sheathing, 15% to 'Shoulder Trade,' such as retail outlets, 15 - 20% in concrete formwork, the remaining to other uses such as, factory built buildings, trailers, packaging for shipping, crates, industrial uses, highway signs, upholstered furniture, etc
- 65% of the plywood produced in Canada is used in Canada.
- 34% exported, mainly to the Japanese market, then the UK and Germany, then other parts of Europe, and a small amount to other places.
- In the export industry plywood is mainly used for residential framing and pre-fabricated building in Japan, residential framing and packaging in the UK and concrete formwork in Germany
- The prominent species use are Spruce (40%) and Pine and Douglas Fir (40-50%)
- All industry is based on phenol formaldehyde, waterproof resins and these resins have been used since the 1970s.
- Phenolics are used for their waterproof bonds and industry has standardized on this, rather than because of health reasons.
- Mills believe that they are about as environmentally friendly as anyone. They have not really considered implementing environmental tools, etc.
- The Workers Compensation Board and governmental regulations are as stringent as anywhere.
- It is considered that virtually no waste escapes the plywood mill.
    - Logs come into log yards, bark comes off and goes for fuel;
    - Preliminary peel, round up and scrape veneer all goes for chips to pulp mills;
    - Cores are either re-manufactured into timber, with chips going to pulp mill, or simply chipped; and
    - Sawdust and residues are used for fuel.
- In terms of overall utilization of the resource, it is considered that the plywood and timber industries are relatively resource efficient.
- Most plywood companies are also in saw-milling. Two to three mills also have pulp connections. There are only three plants which don't have sawmill operations, but they do have small sawmills for chipping and to obtain 2 x 4 logs from the cores.
- The peeling technology is improving and this means logs are being peeled down to smaller and smaller cores.
- Other products are also emerging from plywood mills, including, veneer. Veneer mills usually produce veneers and sell them to the plywood industry.
- Overall the industry is fairly complete in it's utilization logs and pretty innovative with what ends up in the log yard.
- Plywood mills need to see the possible innovations and work with other timber industries.

- In British Columbia one of forest ministers in late 60's started to really try and integrate forest industry so that there wasn't waste.
- Today, manufacturers producing plywood or lumber is as interested in health of the pulp industry as is own industry, because a significant part of the revenue comes from the chips sold to the pulp and paper mills. If pulp mills are in a slump they will not be able to pay so much for chips, which means there will be a slump in whole industry.
- The industry has evolved without standards.
- The manufacturing process requires care from the point of view of resins and environmental and health issues. Once cured in panels it is considered that there are no emissions of concern.
    - Formaldehyde emission has, however, become a big issue in Japanese market and has standards on Formaldehyde emissions. The CPA has just gone through a series of tests using the Japanese test procedure. Everything tested had less than 0.01ppm emissions, so nothing tested was considered a problem.
    - Some workers' compensation board regulations, in regards to handling of the resins, give certain mixes in plant situations
    - Waste resin, wash water that they use to wash applicators and other things that have resin content is recycled back into the mixes so no resins are emitted from the plywood manufacturing plant.
    - The glue mix includes resin, water, filler and a caustic of some kind, which are all mixed together in big tank. If there is any wash water it goes straight into a holding tank ready for the next mix.
- There is no waste out of a plywood plant anymore.
    - Off-cuts/ trims are utilized in the mill, for example they may be nailed together and used for stickers between lifts.
    - What cannot be used for chips is ground up for fuel.
- Forintek completed a series of tests on the burning of OSB to test the emissions. It was found that once the glues came out of press, it was totally inert and there were no problems with burning boards with formaldehyde.
- In Canada they are just now starting to look at the cost of disposal of everything and a sub-industry in recycling building materials is developing. Plywood, after it has finished its use in application has not been looked at. There is no reason, however, why any plywood that's been in a house for 25 years couldn't be reused. The Plywood industry would not get involved in this side of things though.

CASE STUDY 23:

FORINTEK CANADA CORP.

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'Better understanding of the basic characteristics of the forest resource will help the industry make better decisions about how to process it and what products to make from it.'[185]

BACKGROUND

Forintek Canada Corp. are an independent research centre for wood products and processes. As the nations principle research institute in this area, Forintek operate as a private, non-profit organisation. Funding is obtained partly from public and partly from private sectors. Members from the wood products industry, and federal and provincial governments, maintain Forintek in their endeavour to develop and transfer technical knowledge. Information and solutions generated by Forintek provide industry with necessary background that allows them to retain and increase their position on the national and international markets.

Forintek's main core of research focuses on safety, reliability and efficiency of wood construction. They have also put a lot of effort into environmental research, including life cycle analysis and environmental sustainability research, and have focused on such issues as fibre recovery for use within composite products, including plywood. 'Improving fibre recovery is important because the forest resource is

185 University of British Columbia (1996) ' Forintek Canada Corp.' sourced form Internet, http://www.mech.ubc.ca/

precious, expensive and more respected now than ever.'[186] In these environmental endeavours, Forintek have been at the forefront in the examination of environmental impacts of building materials. Their Life Cycle Assessment research and involvement in the LCA movement over the past decade has lead to the development of the Athena™ systems model.[187] The model, developed in conjunction with a varying group of different industry sector bodies, presents balanced information regarding the environmental life cycle implications of complete buildings or components, such as walls or roofing structures, for example, in the design stages. The development is an endeavour to relatively assesses construction materials and systems.

GOALS

Forintek's main goal is to develop and provide technology in the aim to advance Canada's wood products industry. Primary aims in assessing wood resources include:

- The maximisation of present forest returns; and
- The determination of impacts of forest management practices on wood quality and product performance.

LCA-RELATED PROJECTS AND PUBLICATIONS

Forintek realised several years ago that there was a need for being able to compare the environmental characteristics of different materials. They decided that it would not be seen as a balanced and unbiased report unless several corporations from other material sectors, including Steltech, representing the steel industry, and Canmet, representing the aggregate industry, were involved. Based on this Forintek coordinated a research program, which was funded by NRCan, through the Canadian Forest Service, and private sector sponsors from each of the wood, concrete and steel sectors. They began by investigating the life cycle assessment concept to specifically assess building products, single assemblies and systems, and entire buildings in relation to the environmental burdens associated with a product over its entire life. The Environmental Research Group at the Trent University dealt with resource extraction of all materials, as they had no affiliations with any involved industry.

From these initial investigations, a body of literature was produced:

- Forintek Canada Corp. (1993) 'Building Materials in the context of Sustainable Development: Raw Material Balances, Energy Profiles and Environmental Unit Factor Estimates for Structural Wood Products,' Sponsored by Natural Resources Canada.
- Phaelke, R. (1993) 'Building Materials in the context of Sustainable Development: Ecological Carrying Capacity Effects of Building Material Extraction,' Forintek Canada Corp. and Environmental Policy Research.
- Wayne B. Trusty and Associates, Ltd. And Environmental Policy Research (1994)'Building

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186 University of British Columbia (1996) ' Forintek Canada Corp.' sourced form Internet, http://www.mech.ubc.ca/

187 See LCA Related Projects and Publications

Materials in the context of Sustainable Development: Assessing the Relative Ecological Carrying Capacity Impacts of Resource Extraction,' Forintek Canada Corp.

- The Environmental Research Group, School of Architecture, University of British Columbia (1993) 'Building Materials in the context of Sustainable Development: Building Assemblies: Construction Energy and Emissions,' Forintek Canada Corp.
- The Environmental Research Group, School of Architecture, University of British Columbia (1993) 'Building Materials in the context of Sustainable Development: Equivalence Measures for Environmental Hazards and Toxins,' Forintek Canada Corp.
- The Centre for Studies in Construction, University of Western Ontario (1994) 'Building Materials in the context of Sustainable Development: Demolition and Disposal: Environmental Implications,' Forintek Canada Corp.
- Zev Kalin and Associates Inc. and The Centre for Studies in Construction, University of Western Ontario (1994) 'Building Materials in the context of Sustainable Development: The State of Demolition Waste Recycling in Canada,' Forintek Canada Corp.

The result has been the Athena™ system, which has been designed to give totally objective results and show the full environmental impact of all building construction materials in a comparative form. What makes this model so unique is how it deals with ecological impacts and how it converts subjective and qualitative issues into numerical factors. The benefits of the Athena™ model include the ability for manufacturers to identify the affects their products have on the environment in all stages of a products development and life, the provision of answers to consumers questions, and a useful technology for government to implement in updating building codes, policies and regulations relating to environmental objectives. The overall objectives were to put together sound data in a way that would be easily used so that people could make their own decisions based on their priorities.

The Athena™ model has gained international recognition and credibility. There has been queries from Boral Australian Gypsum, UK Steel Construction Institute and Czech Republic Steel Industry, requests for collaborative projects with the European Consortium of Building Research Institutes regarding LCA of wood and alternative products, with UK and Danish researchers on a proposal to the EU regarding life cycle costing and embodied energy estimates, with Berkeley National Laboratories to combine their model, Building Design Advisor, with Forintek's for the US market and they have had an offer to join the European Life-Sys Wood project.[188]

Forintek have developed prototype software, which is the result of a three year research program. They are not sure whether they will sell their software or the service. It has been suggested that selling the use, via paid Internet access, will allow instantaneous upgrades, without every purchaser having to buy new software. But these are still in the ideas stages. There has been numerous reports published in regards to the Athena™ model and research undertaken in this endeavour.

- Canadian Wood Council (1995) 'A Case Study: Comparing the Environmental Effects of Building Systems,' Wood the Renewable Resource, No. 4, Canada.
- Canadian Wood Council (1997) 'Environmental Effects of Building Materials,' Wood the

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188 See **Case Study 5: TNO**

Renewable Resource, No. 2, Canada.

The Athena™ Institute has now been established as a separate body, so the activities are no longer handled by the Forintek corporation. The Institute is now organised by an research alliance whose members include, Forintek Canada Corp., the Environmental Research Group, School of Architecture, University of British Columbia, Steltech, Professor Paehlke of the Trent University, Wayne B. Trusty and Associates, Ltd., Centre for Studies in Construction, University of Western Ontario, Canada Centre for Mineral and Energy Technology and JKM Associates.

Recently Forintek have been involved in another project, The Canadian Raw Materials Data Base, which focuses on different packaging types, including glass, paper, plastic, steel and wood. Each sector has compiled its own information using a common methodology. The data was all collected within a two year time frame and had to be collected from a certain number of facilities. The intention was to provide a common set of results regarding specific materials in order that further manufacturers can also address environmental issues. The thinking behind this concept is if each sector can provide an eco-audit of their product and processes, then the scope for the next sector is greatly reduced.

Other work includes projects in support of Canadian and International codes and standards that govern the use of wood in construction. A current study with Pace University looks at placing figures on human health impacts, and social consequences in order to develop the environmental 'cost' of a building in these terms. This area will provide a whole new area of discussion, and Forintek is not focusing too heavily on this area as it is a diversion from their primary focus.

Forintek also works on the principle that any research work they undertake they eventually publish. Industry is often wary of this since they may not like the results. Forintek, however, argue that it is just a matter of time before some one will do the study, so industry may as well be a part of this research effort in order that they have input of their intimate knowledge. All industries will need this information themselves at some point to deal with environmental issues and they will need to work in collaboration with other industries, as nothing can be built out of just one material.

ISSUES DISCUSSED

Athena™

- Athena™ allows understanding of building construction and materials in order that comparative assessments can be made. That is, it allows understanding of processes, including:
    - Which products use more water;
    - Which produce more CO2;
    - Which use more energy;
- Athena™ deals with specific regions.
- The project was implemented in 1992, beginning with the premise that the forestry industry cannot respond to the constant bombardment of environmental questions.
    - The discussion focused on resource extraction, including the impact of logging, reduction of habitat and ecological diversity, visual amenity, etc.

- Forintek wanted to move away from the exclusive focus on resource extraction and think about environmental issues in the context of shelter.
- Forintek's endeavour was to try to bring together a set of data that would broaden the discussion and that was relatively consistent and objective. Objectivity was a critical element.
- Other organisations, all with their own interests, were involved.
- Forintek worked hard to keep study independent.
- The methodology was agreed to in advance, before any data was collected:
    - All methodological arguments were dealt with prior to collection of the data;
    - Industry weren't very comfortable with this approach, as they did not know the results in advance.
    - This process however, gave the project validity and credibility in the market place.
- Solid data wasn't collected until 1995, after the methodology was worked out:
    - It took eight months to work out methodology.
- Each report was reviewed and critiqued by each group and also an independent reviewer. The information was presented as figures, graphs and tables, with everything being quantified:
    - This was originally in a spreadsheet format, but it is currently changing.
- Alliance with other organisations is important:
    - Athena™ is one tool, that should be used with other tools such as design tools, energy tools, etc.;
    - The processes is more effective with the use of a group of tools.

Life Cycle Assessment

- Some organisations involved with LCA:
    - Imperial College;
    - Jamie Meil and Wayne Trusty;
    - Professor Paehlke of the Environmental Research Group, Trent University;
    - The Canadian Standards Association, with the support of the Federal Department of the Environment, secretary for LCA methodology.
- There has been lots of interest in LCAs in Canada since the development of Athena™.
- Credibility issues are important.
    - If Forintek had undertaken LCA in isolation there may have been little credibility. Because many parties were involved, however, the project has been widely respected.
- The process has to be undertaken to ensure objectivity, quality and rigor of assumptions, and it must be put to a public scientific forum for critical examination.
- Life Cycle is a holistic term, however, so many assumptions are made in LCAs.
- Many things can not be weighted, or quantified:
    - What are the environmental costs of these things?
    - Forintek has chosen not to get into this debate. They are instead keeping things on a relative scale.
- It is considered that everything must be quantifiable and have some value to it, in order to be useful in an LCA context. That is, if it is not quantifiable, it cannot be assessed in an LCA.

- Getting everybody to agree on the same definitions and practices is very difficult.
- Data gets old, but since improvements are being made all the time in technology, the data has to be at least as good as what is actually happening. It is in industries best interests to give up-to-date data.
- LCA models should be dynamic and change as additional scientific analysis are made available. New data also need to be collected to fill the gaps.
- All countries need to work together to make sure methodologies are compatible.
- The Canadian Standards Association (CSA) are the secretariat for environmental assessment methodology in ISO.

Timber Industry

- Full spectrum of operations in the timber industry:
    - From completely integrated strategies in which wastes from one process become raw materials of another process; to
    - Small and totally independent systems.
- Canada's forest products industry is the largest generator of foreign exchange. That is, the values of exports of wood products exceeds the value of the three next largest exports combined;
    - Canada produces 50% of the world trade in export lumber.
- The capabilities of industrial practices and processes have improved continuously over the last fifty years, but unfortunately records, data and observations from 20 years ago are still being used:
    - The underlying message is that using wood destroys the environment;
    - If wood is not used, what are the alternatives?
- Industry needs to relate correct and up-to-date information to consumers and society at large.

CASE STUDY 24:

APA - THE ENGINEERED WOOD ASSOCIATION

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'APA and it's members recognise the benefits of promoting a family of engineered wood products in a 'systems approach' as a way to expand product use.'[189]

BACKGROUND

APA - The Engineered Wood Association, formerly the American plywood association, were actually founded in 1933 as the Douglas Fir Plywood Association. The name change in 1994 was in an effort to better reflect both the scope of products produced by APA members and also the international capacity of the Association. Members of APA, as well as handling plywood, manufacture many engineered wood products including oriented strandboard (OSB), structural composite panels, glue laminated (glulam) timber and wood I-joists.

The trade association is a non-profit organisation and endeavour to provide comprehensive knowledge regarding engineered wood products, and their uses and services, to all wood product manufacturers, users, specifiers, dealers, distributors and universities. To fulfil these functions APA conduct research programs and undertake extensive testing in their world class facilities. They also work very closely with the Engineered Wood Systems (EWS) association in these activities.

The primary concerns of APA are quality assurance, market support and promotion of engineered wood products. All products manufactured by APA members undergo rigorous quality testing and inspection in order to carry the APA trademark. APA are obviously considering environmental tools

189 Adler, C. (1997) 'APA Economics Report E62: Regional Production and Market outlook for structural panels and engineered wood products 1997 - 2001,' APA - The Engineered Wood Association, Tacoma, Washington

as a long term option, but are not ready to take the leading hand at the moment. They would like to obtain an outline of LCA developments and full complexities, but are not yet ready to undertake that task. They have become involved on the sidelines in initiatives such as the activities of the Consortium for Research on Renewable and Industrial Material (CORRIM).[190]

They are involved in these activities purely because in the future they may need environmental information for their export markets. In a sense they also require the information for marketing purposes. Their brochures and Internet site use both environmental concepts and life cycle assessment to portray their products. 'Although an evolving methodology which has yet to prove itself scientifically objective and reliable, measure of a product's environmental impact, LCA is supported by a growing number of organisations, including the International Standards Organisation (ISO), the American Society for Testing and Materials (ASTM), the American Institute of Architects (AIA) and others' and '...ongoing LCA research supports the hypothesis that increasing the use of wood fiber (sic) based products obtained from forests managed on a sustainable yield basis would help solve some of our toughest environmental problems.' [191]

GOALS

APA's goal is 'to be the world leader in creating growth for engineered wood products.'[192] In attempting to fulfill this mission the APA aims are to maintain a high standard of conduct in their:[193]

- APA Trademarked Product Promotion;
- Quality Assurance;
- Technical Support

LCA-RELATED PROJECTS AND PUBLICATIONS

APA are not actively participating in any LCA studies. They are, however, looking at different environmental initiatives, including CORRIM's endeavours. CORRIM have been 'formed to establish, support, and manage research and educational programs relating to renewable industrial materials focused on the environmental impact of the production, use, and disposal of wood and other bio-based materials.'[194] CORRIM are actively engaged in LCA work and are currently working towards the

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190 See LCA-Related Projects and Publications

191 APA - The Engineered Wood Association (undated) 'APA - The Mark of Quality: Engineered Wood and The Environment,' sourced from the Internet, see address above

192 APA - The Engineered Wood Association (undated) 'APA - Vision and Mission', sourced from the Internet, see address above

193 APA - The Engineered Wood Association (undated) 'APA - Vision and Mission,' sourced from the Internet, see address above

194 Briggs, D. (1996) 'CORRIM Research Planning: Issues and Organization Pursuant to Developing a Research Plan', Ad-hoc Steering Committee, CORRIM, University of

development of a life cycle inventory database for solid wood and composite based wood products used in building construction.

CORRIM are funded by a group of members, including the APA, who have contributed to the scheme. There are initiatives currently to obtain funding from the Department of Energy and other government and industry sponsors. APA is supporting the project from a distance and are trying to understand the whole process and value of the project. APA considers that LCA is effecting Europe but not themselves in the US. They rely on consumer pressure and there is not currently a domestic interest in the concept.

ISSUES DISCUSSED

Life Cycle Assessment

- LCA requires rational thought in regards to it's consequences.
- LCA is still most prevalent in academic circles and a lot more industry participation is required.
- It is considered that there are no strong public pressure groups in US, thus there are no requirements to become more environmentally aware!
- The US has tax incentives for recycling, but the APA is not involved in recycling building materials.
- The APA do not support ISO 14000 and neither does the US.
- There is no need for Green labelling in the US as it is understood that consumers will not pay more for environmentally friendly products in America.

Wood and Wood Products

- Most of APAs plywood comes from 'intensively managed stands.
- APA do not consider a Forest Stewardship Council is necessary.
- Canada is a strong supporter of certification activity.
- Forests are mostly privately owned in the US:
    - Owners have long term commitments to land and industry;
    - Owners take care of their own future by proper management practices.
- US plywood manufacturers are mainly multi-disciplined organisations. That is, they own forest, manufacture plywood, etc. They are not, however, integrated with other wood product activities, although timber scraps and wastes do tend to go to pulp mills or are used for energy.
- Energy from waste is considered an environmental activity, because it reduces the amount of energy needed from other sources.
- Fibre utilisation from trees has gone up consistently in the last 20 years. That means industry is getting better use from what it harvests.
- The US plywood industry is over 1000 times bigger than Australia's industry.
- The proper species are available to produce quality veneers.
- There are maintenance issues to do with any timber products.

Washington, p. 2

- Phenol Formaldehyde is required as a resin for all plywood products:
  - Durability is required, and phenol formaldehyde provides this;
  - It is considered that there is no issue in regards to emissions.
- The rainforest debate is not considered an issue in the US:
  - Activist countries include The Netherlands and Scandinavian countries;
  - Asia is also beginning to address these issues, since they more directly effect these countries.
- The Netherlands is one of the major importing nations who banned the use of tropical species.
- No information is available in regards to what it 'costs' to grow trees:
  - Forest economists know about the amortisation of land versus other uses.
- Reasonable data is available dealing with issues inclusive of the log to final application:
  - There is little information after this on maintenance and recycling issues;
  - Before this, the forest is under debate.
- The forest debate requires that humans form part of the equation.
  - Forests changed considerably before human contact occurred.
- Weyerhauser undertook a comprehensive study in which they built several warehouses: one out of steel; one paper; one masonry; and, one timber. In the study they assessed the energy costs to make and transport the materials, and to erect them on site. However, the results would be entirely different if a life cycle concept was used instead of simply energy.

CASE STUDY 25:

WWPA
(WESTERN WOOD PRODUCTS ASSOCIATION)

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	clarsen@wwpa.org
Internet:	**http://www.wwpa.org/default.htm**

'Because it does not laugh our kind of laughter or cry our kind of tears - we sometimes forget the earth is alive. And that the earth is at risk. Like us it is open and vulnerable, but also vigorous and resilient. And like us, it has the power to multiply, to be reborn, to regenerate. But there is a delicate balance between the power of the earth to continually give and the power of human beings to continually take. By our choices, individually and collectively, we influence the earth's ability to maintain its natural balance.'[195]

BACKGROUND

The Western Wood Products Association (WWPA) have been representing the Western United States softwood lumber industry for nearly a century. As a trade association, WWPA provide services for member companies, composed mainly of manufacturers, and also national and international purchasers of Western softwood lumber products. Funding is provided to WWPA by revenue collected on lumber shipments made by association mills. Member company representatives serve on the Association's standing committees and Board. In this capacity the member companies are active in developing policies and determining the scope of WWPA activities and programs.

The services WWPA provide include, quality standards, technical services, business information services and international marketing services. WWPA have worked very hard in the international arena

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[195] Western Wood Works (1994) 'Choices in Building Materials', WWPA, November, p. 2, The Delicate Balance.

to get their products recognised and they now have, offices are spread throughout the world, including an office in Australia.[196]

There has been a strong interest in environmental issues and member companies have requested the investigation of life cycle assessment. An initial LCA analysis has been undertaken in order for the industry to have a competitive market edge. The recent downsizing in the WWPA, however, has meant a reduction in staff, specifically in the areas focusing on environmental and LCA issues.

GOALS

The goal of WWPA is to represent Western Lumber manufacturers and to provide information that aids the Western Lumber Industry to compete in the national and international market place.

LCA-RELATED PROJECTS AND PUBLICATIONS

In 1992 Member Companies directed WWPA to focus their 'attention on product related environmental issues, in order to communicate factual information from credible sources on the environmental profile of wood products relative to alternative materials.'[197] They undertook a consumer report and established that 27% of consumers believed they were 'actually harming the environment by using wood (softwood) products,' 71% indicated that 'scientific information on the environmental impacts of wood versus other building materials would be helpful,' and another 70% wanted to see 'lumber products from an Envi-certification program, endorsed by a third party scientific audit company.'[198]

WWPA commissioned SCS[199], to conduct a life cycle assessment of western lumber, that was to be undertaken according to ISO and SETAC guidelines. This study was the first of its type ever conducted, and it resulted in a benchmark life cycle inventory study on Western lumber. The study quantifies the inputs and emissions for Western lumber system from the point of harvest through its primary distribution points. Resource renewability, products in use over time and recycling, including the diversion of end-of-life lumber disposal from land fills, have not been addressed in this report.

- SCS (1995) 'Eco-Profile of Lumber Produced in the Western United States: Life Cycle Inventory of WWPA Western Lumber,' conducted on behalf of WWPA.

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196 John Keith heads the WWPA office in Australia. Contact details are:
PO Box 695,
PYMBLE, NSW 2073
Telephone: 02 9144 2898
Facsimile: 02 9144 5125

197 WWPA and SCS (1995) ' Questions and Answers about the WWPA LCI Study of Western Lumber'.

198 IBID.

199 See **Case Study 26: SCS.**

The study is limited in scope and does not attempt to deal with impact assessment issues. At the time the study was undertaken resources were not available and the procedures needed to be more fully resolved in scientific circles and within the ISO 14000 standardisation process. Only basic input and emissions information were gathered and 'dealt with in a scientifically credible manner and applied in a materials selection consideration.'[200]

Papers relative to this study have subsequently been produced.

- Wolf, M. and Hershberger, S. (1996) 'Case Study - Life Cycle Inventory of WWPA Western Lumber,' Proceedings for TAPPI, NCASI, AF&PA's LCA Symposium: Methods and Applications for the Forest Products Industry, Atlanta, GA, January 24 - 26, 1996.
- WWPA and SCS (1995) ' Questions and Answers about the WWPA LCI Study of Western Lumber.'

The recent downsizing within WWPA has meant that follow up investigations into LCAs, expansion of the inventory, and a report that was planned, can not now be undertaken. The follow up report was intended to focus on specific issues that were felt to be under-examined in the first report, including the transportation issue which would have subsequently been split into sections.

Other WWPA publications, relate to environmental issues, and are often used as marketing tools.

- Western Wood Works (1994) 'Choices in Building Materials,' WWPA, November.
- Western Wood Works (1995) 'Life Cycle Assessment and Building Materials,' WWPA.
- Western Wood Works (1996) 'Wood vs. Its Alternatives,' WWPA.

ISSUES DISCUSSED

Life Cycle Assessment

- Europe is much more advanced in LCA development than the US.
- LCAs need to be incorporated in environmental design. The connection between architects and industry is important.
- Interest in LCA is still primarily at an academic level. There are a number of people undertaking Doctoral studies in this area.
- It will take a long while to get all the issues worked out.
- The Inventory process of LCA is very well worked out and SETAC, ISO and US Environmental Protection Agency (EPA) have produced standards and guidelines.
- LCA is a very expensive undertaking at present:
    - There needs to be effort to simplify the process in order to make it easier for small industries to deal with.
- The WWPA report looks at the issues from the point of harvest to the primary distribution point.
    - It is considered that a product cannot be tracked to the 'final retail spot let alone a job site.'

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200 Western Wood Works (1995) 'Life Cycle Assessment and Building Materials', WWPA.

- The whole resource discussion is very controversial, however, good progress is being made though.
- There is a need to understand in an inventory process:
    - What is and what is not included;
    - How, if transportation burdens, for example, are factored in, will this affect things? Forintek, for example, splits the transportation burdens
- Jim Boyer of CORRIM II,[201] has graduate students working to try and reconcile the differences between lumber inventories undertaken in different parts of the world. The numbers are not coming out the same.

Forestry

- Forestry Laws : There are tough regulations, especially in the West.
- Environmental Performance Laws: The laws are strong in USA.
- Forestry ownership:
    - In the West 30% of the forests are privately owned and 70% are publically owned;
    - In the rest of the US, 70% of the forests are privately owned and 30% publically owned.
- There is cooperation between the public and private sectors. Early on industry and government devised regulations on forestry, and since the early 1940s regulations have been implemented. These regulations seem to work now because of the cooperation which occurred while they were being introduced.
- Far more wood is being recycled in the US now than ever before:
    - Scrap and debris from construction sites are collected;
    - Wood from demolition sites is being diverted out of the waste stream.
- Data on recycling of wood is not available yet. It is not known:
    - How much wood is recycled;
    - Where the wood is going;
    - What the volumes are;
    - Distances being hauled.

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201 See **Case Study 24: APA - The Engineered Wood**

CASE STUDY 26:

SCS
(Scientific Certification Systems)

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E-mail: **eweidman@scs1.com**

'Life-Cycle Stressor-Effects Assessment (LCSEA) is the first technical framework and methodology directly integrating life-cycle impact assessment with other environmental assessment techniques. This integrated impact assessment framework has been developed with the specific purpose of addressing a broad range of environmental labelling, performance evaluation and management identified within the ISO 14000 standards.'[202]

BACKGROUND

Scientific Certification Systems (SCS) were established in Oakland, California, USA in 1984, as an independent, inter-disciplinary, scientific body. The organisation originated with the premise of forming a detached, third party company in order to encourage sustainable practices within both public and private sectors. SCS have retained their independence by avoiding outside ownership interests. That is, they have no external connections with the companies they certify, for example, and remain an impartial body.

There is a large focus on the objective nature of SCS. They employ a neutral Scientific Advisory Board to oversee all programs and certification guidelines. Further, all programs, before they are implemented, undergo 'extensive public and stakeholder review.'[203] This undertaking has lead to international

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202 Scientific Certification Systems, Inc., Swedish Environmental Research Institute, and Soil and Water, Ltd. (1997) 'Life-Cycle Stressor-Effects Assessment (LCSEA): A framework for integrating Life-Cycle Impact Assessment with Environmental Assessment Techniques - Practitioners Manual', Working Draft 1.2, Prepared for Distribution to ISO TC207/SC3/TG3 - Subcommitte on Environmental Labelling Task Group on Type III

203 McLeister, D. (1996) 'Product Report: 'Green' Certification Starts To Grow', Professional Builder, September, p. 81

recognition. SCS are currently Americas most senior and extensive environmental certification organisation, and in this capacity they have instigated certification initiatives, performance evaluations and eco-profile labelling. These initiatives are intended to aid 'business managers, product design engineers, consumers and government policy makers' in making 'better informed decisions.'[204]

SCS work both nationally and internationally. They have completed projects in countries including Sweden, and other Scandinavian countries, Korea, Japan, New Zealand and they have also worked with Boral in Australia to help implement and train the company in the use of Ian Boustead's LCA Model.[205]

GOAL

SCS were founded with the aim of strengthening and promoting 'environmentally sustainable policy planning, product design, management systems and production operations,'[206] within all sectors. In their endeavour to reach this goal a number of programs have been implemented, which include:[207]

1. Environmental Claims Certification;
2. Compliance Evaluation Program;
3. Life cycle Assessment and the Environmental Performance Evaluation;
4. Certified Eco-Profile (ISO Type III) Labelling;
5. Forest Conservation Program; and
6. Food Inspection and Certification.

LCA-RELATED PROJECTS AND PUBLICATIONS

Of most concern to this report are the Life Cycle Assessment projects within the area of 'Life-Cycle Assessment and the Environmental Performance Evaluation.' To the extent that they are affected by LCA, the 'Environmental Claims Certification'[208] and the 'Certified Eco-Profile Labelling,'[209] are also

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204 Scientific Certification Systems (Undated) 'Harnessing the Power of Science and the Marketplace for a More Sustainable Future'.

205 See **Appendix 1: Contacts List**

206 Scientific Certification Systems (Undated) 'Certified recycled content: SCS Environmental Claims Certification.'

207 As taken from, Scientific Certification Systems (Undated) 'Harnessing the Power of Science and the Marketplace for a More Sustainable Future.'

208 'Environmental Claims Certification', developed in 1990, is an independent, scientific system for verifying the accuracy of environmental claims made by companies about their products. This is the only such claims verification service available in America, and it verifies claims such as the 'recycle content' and 'biogradability' of products.

209 The 'Certified Eco-Profile Labelling System' is the only Type III labelling system available in the USA. This label is considered Type III by the draft ISO standards and as such is

of interest. Originally SCS's 'Eco-Profile Label' was based on life cycle inventory, recording only inventory results. This meant that the environmental impact or performance of a product was not necessarily communicated, which was inherently a problem as far a SCS were concerned. Out of this problem the Life-Cycle Stressor-Effects Assessment (LCSEA) manual developed. Pioneered by Stanley Rhodes[210] and developed in conjunction with IVL[211] and the Jacko Poyry Group in Finland, the LCSEA guide was designed primarily for use by practitioners.

This manual is still in a state of constant change and improvement and Ms Weidman stated that no sooner is the new version published than it is going out of date. Although based on SETACs LCA framework, this technical manual is quite different, being an advanced 'impact model.' The manual grew out of the need for an assessment method for the environmental certification of products, which is the focus of most of SCS's projects. At the time of visiting two LCA studies were being conducted. The first was a comparative study between steel and wood in residential framing, and the second a comparison between rockwool and polystyrene insulation materials.

Other relevant projects include the 'Eco-Profile of Lumber Produced in the Western United States: Life Cycle Inventory of WWPA Western Lumber' report commissioned by Western Wood Products Association (WWPA)[212] and completed in 1995, and the Forest Conservation Program (FCP), established in 1991. The WWPA report examines the 'solid sawn, lumber-production system, including all energy, materials, inputs and emissions associated with tree harvesting.'[213] Accredited by the Forest Stewardship Council, the FCP provides a third party certification program to identify and accredit forest management practices that fulfil three major requirements ensuring :[214]

1. Timber products are produced in a manner that sustains the timber resource;
2. The forest ecosystem is maintained; and
3. Financial and socio-economic criteria are met.

SCS are also using the Type 2 ecolabel to certify single attributes or specific claims, such as recycled content or biodegradability. Many building construction products have been given specific claim labels

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'specifically design to include both the process and the product, thereby presenting the total environmental profile.' [Hughes: 1996] This labelling system has been designed as a simplified tool for conveying LCA findings. It utilises 15 indicators to explain the environmental performance of a product. See Certified Eco-Profile Chart over.

210 Dr Stanley Rhodes is the president of SCS. He is also one of the principal authors and editors of the LCSEA manual as well as being an important player in LCA development.

211 See **Case Study 12: IVL**

212 See **Case Study 26: Western Wood Products**

213 McLeister, D. (1996) 'Product Report: 'Green' Certification Starts To Grow', Professional Builder, September, p. 81

214 As taken from, Scientific Certification Systems (Undated) 'Chain of Custody Certification Guidelines for the SCS Forest Conservation Program'

which maybe certify the content, say 25% recycled content. There are several studies being undertaken in the building construction field which are as yet incomplete, looking at insulation materials, such as fibreglass and cellulose, both steel and wood for residential framing, etc.

An interesting study currently underway with the North American Steel Industry, is focussing on human health effects. Human health issues cannot be quantified with scientific methods at present, so SCS is going as far as to record the emission and give relative indicators as to what effect this may have on the health of people.

ISSUES DISCUSSED

Certified eco-profile

- Reports must present the findings of the life cycle assessment graphically in a label form, in order for it to be available on the product, materials, service, etc.:
    - Should include the net resources used and emissions.
- A 'use profile' can be provided for any product, including, garbage-bags, residential wood, framing, automotive steel, power plants, etc.
- Not only products, but also facilities, packaging and services, for example, can receive an eco-profile.
- The labels are more industry than consumer oriented. That is the label is for use generally between industries, or between industry and government, or for a more sophisticated audience.
- For the consumer market there needs to be a simplified target message.
- For retail claims a 'certified environmental improvements' and 'certified environmental advantages' can be used:
    - If a product is in the top 20% for a specific product category then it can receive a label.
- This Independent third party certification gives a product, etc. more market credibility.
- Industry receives a technical life cycle study and an 'Executive Data Summary Sheet'(EDDS) which gives a text summary of the environmental performance, a system description, an example of profile, and any other applicable information. The EDDS can be:
    - Useful for communicating to other industries;
    - Summarises the full technical study undertaken;
    - A useful communication tool;
- The Certified eco-profile is recognised by ISO 14000 as a Type three label, which is the most sophisticated label.
- It uses site specific data rather than averages.
- The Type 3 ecolabel is in the process of being standardised within ISO.
- The Type 3 profile evolved as alternative as it:
    - Doesn't create trade barriers;
    - Is non discriminatory;
    - Is open to all products;
    - Has no restrictive or prohibitive criteria;
    - Allows any company get to obtain the label

- Depends on how good company turns out on whether or not they choose to use label. That is, all companies receive a label, and the products is certified whatever the standard.
- A company can keep the label until such time that they change something in their manufacturing processes, etc.
- There is much interest from architects for an electronic version of eco profile.

Life Cycle Stressor Effects Manual

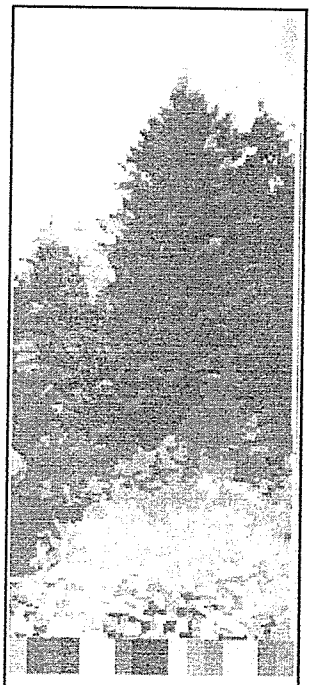
- This is a technical manual, to be used as a guide for LCA practitioners.
- It is not a traditional life cycle, rather a more advanced impact model. That is it does not simply deal with the inventory:
    - Inventory study figures do not necessarily communicate environmental impact or performance and the consequences of emissions to receiving waters, local environment, etc. are not necessarily provided
    - Inventory numbers may be deceiving, that is the numbers in a traditional LCA of 1000 tonnes may look bad, but the actual results might be negligable and no impact is caused to the environment.
- Equivalency factors have been developed. That is, effects are recorded and when there are no effects, No Significant Impact (NSI), nothing is recorded.
- There is much benefit for industry with this model.
- Traditional life cycle inventory model gives only a worst case scenario.
- Each indicator is calculated differently and has its own set of technical calculations.
- The assessment procedures are very thorough. Calculations have been developed with input from environmental groups, experts in particular areas, government experts, industry experts, etc.
- The model uses ISO 14000 guidelines.
- If a company wants to make a claim in the market place then the executive summary would have to be made public.
- Often companies use information internally:
    - As a performance benchmark, for management purposes:
    - As an internal communications device;
    - For product development.

  Many companies never make a public claim, so the reports are never made public.
- All information is confidential unless the company authorises the release of the results.
- All studies must undergo a peer review process.
- Studies can take from months to years.
- This model does not require all conceivable data to be looked at, such as with the traditional LCA. Only significant data is of interest once an overview has be undertaken, that is, the data collected is tailored to specific questions.
- It is a much more cost effective process to streamline data:
    - Less time;
    - Less resources;
- Data from other sources, such as government sources, can be incorporated, including risk assessment and environmental impact assessment.

- Data collected is specific to the local receiving environment.
- The indicators do not change, although some may be added for specific systems. There is, however a core set of indicators which are included in all assessments. In the future extra indicators, such as human health indicators, may be added.

6.0

KEY ISSUES AND FUTURE AREAS



Picture 6

6.0

KEY ISSUES AND FUTURE RESEARCH AREAS

6.1 AIMS

Sustainable Development is one of the most critical concepts being discussed today. This is a large and important issue, and eventually people will need to accept responsibility by taking part in a world-wide movement addressing environmental issues. One way for industry to address the implications of their practices on future sustainable development is by implementing LCA procedures. LCA, it is considered, will be an appropriate tool for industry to assess the environmental issues in regard to its products and processes. The work done to date has evolved rapidly and the standards emerging provide a background and framework to an LCA structure. This model is very large in scope, however, and it will be difficult to currently implement on a comprehensive basis. It has also been developed mainly within Europe and therefore does not address Australian Industry conditions. However, the ISO 14000 structure has been developed by the leading European LCA researchers and thus will provide an appropriate frame to work from to develop a model suitable to industry here. In order to do this, the ISO model, other relevant models (such as the Nordic Guidelines and the Dutch model) and their implications will require thorough analysis and further research will need to be conducted

The aims of this section are to summarise the key issues that are pertinent to further study and to briefly introduce the authors proposed study in terms of the doctoral work. This doctoral work will focus on possible ideas and strategies that are relevant to the implementation of LCAs within the plywood industry.

6.2 BACKGROUND

The following key issues have been interpreted from the Literature studied and the Case Studies. They are presented in two parts, separating the issues from the Case Studies and the Literature. The issues from the different sections do overlap and in numerous cases focus on parallel points. Within the two sections the issues are introduced in alphabetical order, rather than in any order of importance. The key points detailed relate specifically to the report. They are thus issues which the timber industry need to be made aware of when endeavouring to implement LCA within industry, and will require future development..

6.3 KEY ISSUES FROM LITERATURE

6.3.1 Development Process

LCA methodology is still in the process of development and therefore requires much additional research. It is important that industry becomes involved in this process, in order for LCA to better

reflect its needs. The development process needs to be well understood and assumptions need to be stated. Because much input is required from different organisations into the development process, it is a long and slow operation. Another problem is that developments in the LCA methodology are being based on consensus rather than scientific research. The connections between organisations in the LCA arena reflects this statement. There are also positives in such a tight knit community, including the rapid transferral of information. In many cases, however, LCA has been overrated, which has caused problems because the tool is not fully developed.

6.3.2 Economic Benefits

There is a perception that due to the fact that LCA is an expensive undertaking, the cost expenditure outweighs the cost benefits. The economic incentives should be stated, however, as savings are likely. '...Smaller companies have shown limited interest so far, but that could change as managers realise the standard can help them save money. A company that is generating less waste is more efficient and more profitable.'[1]

6.3.3 LCA Process

It is important to realise that the process of conducting an LCA is 'at least as useful as the results, because the company begins to develop a much better understanding of its own products.'[2] In order for industry to gain a better insight into products and practices it has to be involved in the whole process. Practical applications of LCA where a consultant undertakes the majority of the work, often defeats the purpose of conducting an LCA. All of an industry's employees from the ground up need training and knowledge to understand LCA, and hence, involvement from the outset. 'When mapping the environmental performance of a product, knowledge of the product's environmental performance increases significantly. We have noticed that this learning effect is usually very motivating for the employees of the client.'[3]

In this respect, environmental benefits can be realised from each component in the process and it makes it unnecessary to go through the entire process before making decisions on improvement. It has to be understood that LCA is only a tool for decision making[4] and the decision making itself has to be undertaken by the organisation. In the future, it is predicted that LCA will become a 'routine way to

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1 Bauer, Lesley [ed.] (1997) 'ISO 14000: the promise of a new environment for business,' CONSENSUS, Canada's Newsmagazine of Standardization, Vol. 24, No. 3, May.

2 SustainAbility, SPOLD and Business in the Environment (1993) 'The LCA Sourcebook: A European Business Guide to Life Cycle Assessment.'

3 CIT Ekologik (undated) CIT Ekologik - Consultants in Environment Management and Product Ecology', Brochure.

4 See **Section 6.4.1: Decision Making Tools.**

support environmental decision making.'[5] If it has been heavily involved in the process, the position for decision making is strengthened by the ability to utilise the knowledge gained during the LCA study. This also allows for the process to become automatic and part of the education and general mentality.

6.3.4 Product Comparison and LCA Use

Many practitioners and users of LCA consider the primary function of LCA to be product comparison. This is very problematic at present, due to the under development of current LCA tools. 'The imprecision and uncertainty of data in an LCA inventory is commonly so large that meaningful comparisons between different products or time periods are difficult or impossible to make in most cases.'[6] In the future when LCAs are more fully understood and a standard framework for comparisons has been developed, product comparison may be viable.

Currently it is within our scope to put LCA to use in 'identifying the dominant stages in the life cycle of a product and indicating main directions towards environmental improvement.'[7] Industry can use LCAs internally in order to identify environmental 'bottle necks' in the product's processes and hence develop products and processes that have less detrimental implications on the environment. The knowledge gained within the company from an LCA undertaking is empowering. 'Some of the most promising applications for life cycle assessment are for internal use by corporations...'[8] Its main use should be to focus attention on sustainability rather than to use complex results for comparative purposes. In this respect LCA 'could play a crucial role in helping to restructure and re-programme industry in pursuit of longer term sustainability.'

Rather than comparisons, a 'zero alternative' model could be used where the baseline is the product not being used. That is, a comparison to not producing or using the product. Issues ranging from the alternatives needed, to the need for the product, should also be addressed in this case.

6.3.5 Regulatory Instruments

In an effort to try and standardise LCA the International Organisation for Standardisation has developed the ISO 14040 Environmental Management standards on Life Cycle Assessment. This set of standards is a basic framework for LCA and is beginning to influence a life cycle management

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5 Vignon, B. [ed.] (1997) 'LCA News', SETAC Foundation for Environmental Education', Vol. 17, No. 1, January.

6 Grimstead, B. (1997) 'Life Cycle Assessment (LCA) Quo Vadis?' Book Review, The International Journal of Life Cycle Assessment, sourced from Internet, http://www.ecomed.de/naturw/bereiche/titel/life_ca/welcome1.htm

7 CIT Ekologik (1996) 'Life Cycle Assessment.'

8 The Institute for Environmental Toxicology (undated) 'Life Cycle Assessment,' sourced from the Internet, http://www.iet.msu.edu/GreatLakes/lifecycl.htm

paradigm. The standards are simply guidelines to LCA procedures, they should not be adopted as the exclusive LCA methodology. ' ISO 14040 provides a stake in the ground to help people understand what life cycle assessment is, including its potential application as well as its limitations.'[9]

6.3.6 Simplified LCAs

Most small firms have yet to respond to the need for comprehensive environmental assessments of their products and processes. Small and medium firms, often do not have the time and resources to conduct a full scale LCA. ' LCAs can be costly and time consuming, thus limiting their use as analysis techniques in both the public and private sectors.'[10] Industry has criticised the developments in LCA as being 'too complex, too difficult to perform, and insensitive to cost and performance trade-offs.'[11] Resources such as cost and time need to be reduced in order to encourage a broader use of LCA, especially within industry.

In general 'a detailed effect analysis is preferable over a less detailed one,'[12] but, there are problems in taking this approach. A tool that is appropriate for use by smaller organisations is required. 'Surprisingly little attention has been paid to the development of LCA methods that would be appropriate for SMEs (small and medium sized enterprises). This is an area where governments, industry federations and green business networks will need to invest a great deal of effort in the coming years.'[13]

The development of a simplified LCA needs to be a compromise between scientific rigor and a reduced scale. There are a number of circumstances which can be changed in order to simplify LCA studies, for example:

- The boundary can be limited by eliminating or decreasing up and down-stream stages, however, the decreased scope needs to still provide a balance between the data required and the accuracy of results;
- Several parameters of specific concern can be focused on;
- The impact assessment can be limited;

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10 Research Triangle Institute (1996) 'Streamlined Life-Cycle Assessment Model Development and Demonstration', sourced from Internet, http://www.rti.org/publications/cea/6059-01.html

11 MCC (1996) 'Business-driven Life Cycle Assessment,' MCC's Requirements Advisory Board Study.

12 Finnveden, G. and Lindfors, L.-G. (1997) 'LCANet Theme Report Life Cycle Impact Assesment and Interpretation,' IVL, LCANet, CML.

13 SustainAbility, SPOLD and Business for the Enmvironment (1993) 'The LCA Sourcebook: A European Business Guide to Life Cycle Assessment.'

- Data from data sources, such as developed data banks, can be used, however, at present quantitative scientific based information is not obtainable for all environmental effects;
- 'Screening' methods (such as those used by CIT Ekologik) and methods of only collecting data for specific concerns (such as EPEA's approach) are other alternatives.

6.3.7 Stakeholders

There are a variety of stakeholders that need to be included in an LCA study in order to conduct a holistic and credible study. Many organisations can be involved in this process, for example in the case of a wood product study the following players may be important:

- Forest Industry, including forest owners and investors;
- Manufacturers and their employees and trade unions;
- Industrial operators including suppliers and sub contractors;
- Government and Regulators;
- Non-Government Organisations (NGOs) including environmental groups such as WWF, Greenpeace, Wilderness Society;
- Architects;
- Consumers and suppliers; and
- Other Legitimately Interested Parties which may include neighbours.

It is important to get these players involved in the process of developing a framework for the timber industry and also in challenging current practices. The stakeholders expectations will have a significant effect on the structure, scope and level of detail in an LCA study. However, it is important to be aware that there needs to be a balance between incorporating and responding to stakeholders concerns and the workability of the model.[14] It is also important that stakeholders understand industry operations.

6.3.8 Structure

'The strategic environmental principles and goals of an organisation should guide the use of LCA and other techniques, so that these are consistent with an organisations' philosophy.'[15] The 'Goal and Scope Definition' stage is the defining stage of an LCA procedure. If this is properly described and all assumptions are made clear, then a study can basically be done according to the organisations requirements within the principles of LCA. Industry and stakeholders,[16] for example, have to determine exactly what they want out of the LCA study in order to develop the 'Goal and Scope Definition.'

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14 See **Section 6.3.6 and 6.4.6: Simplified LCAs.**

15 Vignon, B. [ed.] (1997) 'LCA News', SETAC Foundation for Environmental Education', Vol. 17, No. 1, January.

16 See **Section 6.3.7 and : Stakeholders.**

This phase must be clearly focused in order to 'acquire meaningful data.'[17] If all assumptions and limitations are carefully stated, subsequent studies can later be undertaken. That is, once more resources become available and the LCA process is further researched, then the organisation can include these new issues within their environmental management plans. LCA does not simply consist of carrying out one report and finishing there. It is an iterative process, and ideally will become part of a companies philosophy and be carried through as LCA becomes more complete.

A problem at present is the availability of data, especially within Australia. Overseas data is really not relevant to Australian conditions and research is needed within Australia to establish this type of information. LCA works best with quantifiable data, but, in many cases this is not feasible and limitations have to be understood. Data definition and collection needs to be done in a systematic way as part of the inventory preparation. Unfortunately, database research has been overshadowed by software development.

6.4 KEY ISSUES FROM CASE STUDIES

6.4.1 Decision-Making Tool

It should be recognised that LCA is not a replacement for decision making, rather it is a tool for aiding that process. It allows the systematic collection of results which should be interpreted in order to draw conclusions and make positive environmental changes.

There are no set rules and regulations as to what should be done with the results. Generally they should be used to identify where efforts need to be prioritised in order to minimise environmental impacts. How decisions are drawn from the information is unspecified.

Choices and trade-offs have to be made, for example trade-offs between greenhouse gas emissions and acidification. Often the decisions come down to simply the biases of the decision maker. As long as all the information is presented, then decisions can be made.

Decisions will not be determined on LCA alone. Other tools for determining economic, social and technical performance criteria, will need to be used in conjunction with LCA, in order for industry to weigh up and make decisions.

6.4.2 Economic Benefits

LCA needs to be sold to industry on the basis of economic benefits, rather than just for environmental advantage. If there is no market advantage in conducting an LCA study, industry will avoid it until the process becomes mandatory, or until there is some economic incentive. It has been shown through case

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17 Stone, K. (1997) 'What EPA Means When it Says, "Life Cycle Assessment",' National Risk Management Research Laboratory, U. S. Environmental Protection Agency.

studies and general statistics that reduction in areas such as energy and mass flows relates to a reduction in cost. This concept needs to be stated as an important benefit of the whole LCA procedure.

Many companies have admitted that they have used the same products and processes without having ever ascertained energy and mass flows, for example. LCA can be used for specific improvement options, such as the optimisation of flows and minimisation of processing steps. An LCA study not only increases the manufacturers' knowledge of their product and processes but also improves efficiency, thereby providing economic benefit.

6.4.3 Forestry Industry Issues

The forestry industry does not seem to be interested in utilising LCA for forest management at present. Most of their concentration is currently focused on forest certification. Forest certification does not address specific conditions, such as land-use issues, and avoids having to deal with scientific concerns. It is not currently possible to define criteria or standards on land-use issues, and there is a lot of work required in order to develop such a tool.

Certification of forestry and LCA are two different things and since discussion is being dominated by certification it is very hard to discuss other approaches to forest evaluation.

People remain sceptical as to whether a forest is actually sustainably managed. There is a lack of confidence in the ability to verify a sustainably managed forest despite the concentration in this area.

There are differing thoughts as to whether raw materials need to first be assessed before products can be analysed using an LCA method. It is considered, that for the present areas where an environmental difference can be made should be the ones that are concentrated on. Eventually a way to deal with the forestry issues will be ascertained, in the mean time, change and improvement can be made in the industrial and manufacturing areas for wood products.

There are two differing schools of thought in relation to the land-use issue. The first is dominated by forestry people who do not believe land-use should be included in assessment processes. The second believes that land-use should be an integral part of any analysis.

6.4.4 Product Comparison and LCA Use

Many LCA models are being developed with product comparison in mind. However, this is problematic in the current LCA climate. Problems are occurring due to false claims being made on the basis of LCA studies. This is dangerous since LCAs are not developed sufficiently and to compare two separate LCA studies is fraught with complications.

The main focus should realistically be placed on the benefits of the internal use of LCAs. There are possibilities for product development, communication, economic benefits and also possibilities to gain

vast knowledge about the product and its processes.

6.4.5 Regulatory Instruments

There is no one methodology that is 'the' LCA tool. This concept is still under development and ISO has developed their set of criteria in an effort to try and 'clean up' the development of LCA tools. The ISO standards therefore, should not be considered the defining rules on LCA, more a framework for LCA procedures, in which many options can be explored according to specific requirements.

There are differing schools of thought on the development of the standards. Some think that they have been developed too early, since the LCA methodology has not been properly defined. The standards will need to be under constant change if they are to keep abreast of the developments. Others, however, consider that ISO has given a seal of approval to LCA, and thus will aid its development.

If LCA becomes more regulated it will be hard for smaller companies to compete in the market place unless simplified versions[18] of LCA are established and introduction of LCA into industry starts now.

LCAs are being developed especially for ecolabelling purposes. Ecolabelling is the foremost in environmental marketing tools in Europe.

6.4.6 Simplified LCAs

Generally industry bodies are interested in simplified ways to implement environmental management programs, including LCA. There are many implications for small and medium firms, who do not have the time and resources to conduct a full scale LCA, including possible trade restrictions.

Practitioners and LCA developers tend to believe that if the tools become simplified, especially in the case of LCA, then important issues will be omitted. At present, most LCA work is being undertaken by practitioners, so little input is obtained via industry involvement.

The use of LCA within industry is the most promising application. This means that LCA will be focused more and more on industry in the future. Industry will need to have a greater input into the developments and application of LCA. The requirements of the smaller industry players need to be considered.

6.4.7 Stakeholders

LCA developers cannot be isolated while developing LCA methodologies. Many parties should be involved in order to obtain a holistic and realistic picture. A convergence of ideas is paramount to the concept of life cycle assessment and industry especially is a vital stakeholder.

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[18] See **Section 6.3.6 and 6.4.6: Simplified LCAs.**

The process needs to be critiqued and examined at all stages, and stakeholders are required in order to satisfy this undertaking. If many stakeholders are involved, the process gains a greater credibility and validity.

Involving many stakeholders, however, may succeed in greatly slowing down the process.

6.4.8 Structure

The initial boundary setting is a significant part of the whole LCA process. It is considered imperative that the boundary be set and all assumptions acknowledged and the process be undertaken. This needs to be done in order to make a productive start within industry and actually apply LCA knowledge. It is acknowledged that LCAs are not fully developed, however, the intrinsic values of LCA can be applied and a tool developed to begin the assessment process until a more comprehensive tool is made widely available.

There are many problems in the collection of data, including the problems with establishing a database with a common framework and set of collection criteria, and industry's hesitancy to give away data. It would make the LCA process much more simple if general information could be obtain from a databank. Site-specific data, however, is much more reliable and preferable to averaged data or that obtained from a databank, though a much greater amount of resources, time and effort is needed to collect this data.

6.5 FUTURE RESEARCH

Some Australian architects and industry bodies have shown interest in environmental developments. Generally though, professional design organisations and industry in Australia have lagged behind their European and Canadian counterparts in accepting environmental considerations as an integral part of decision making. There has been some work done in Australia in the LCA arena and this needs to be expanded and developed, in particularly within industry.[19]

The Plywood Association of Australia and the Timber industry have shown interest in the environmental developments for material assessment. Interest in methods for assessing the sustainability of their products and processes is increasing due to broadening knowledge and demand from consumers. The plywood industry in particular is interested in methods that will assess their products environmental

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[19] For example:
- Bill Lawson, based at the University of NSW, has been doing work in this area;
- The Forest and Wood Products Research and Development Corporation, in cooperation with the Tasmanian Forest Research Council Inc. sponsored an initial Life Cycle Assessment report by Todd, J. and Higham, R.;
- RMIT is using Sima Pro LCA software in some of their endeavours; and
- BHP has developed a data base including over 1200 different materials.

'soundness.'[20] The author is currently undertaking a Doctoral Thesis focusing on Life Cycle Assessment (LCA) as a tool for determining the impact of architectural plywood products.[21]

This report constitutes part of a wider doctoral study, and as such has aided these endeavours.

6.5.1 Doctoral Study

It is the purpose of the doctoral research to evaluate the role of life cycle assessment within the plywood industry and to determine how environmental results can be provided to architects and other product consumers in order for them to make ecological decisions. It is considered that the issues will be investigated through a cooperative study within the plywood industry.
The aims of the thesis are:

1. To examine the developments in the Life Cycle Assessment (LCA) field and analyse existing LCA models;
2. To develop a simplified model based on ISO's LCA framework with the ability to be implemented within a small plywood mill;
3. To define a suitable model boundary for a plywood architectural product and to determine an appropriate life cycle inventory of processes and impacts;
4. To assess the tools relevance and effectiveness in determining 'environmental bottle necks' and in product development; and,
5. To assess the capabilities of the tool in providing useful and understandable information regarding environmental impacts to industry and consumers.

The Gottstein report has focused on the first aim and investigates the findings of overseas research into LCAs. It forms a greater part of the doctoral study, however, as a basis has been determined for further development within the research field. In undertaking the Gottstein report, relevant information regarding LCA development and methodologies has been collected. The report has aided in focusing the doctoral thesis by this collation of material and information and has provided a way forward as a consequence of the outcomes.

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20 The Plywood Association of Australia (PPA) is showing their interest in this project by contributing financial support as the industry partner for the Australian Postgraduate Award - Industry (APA-I)[See Note 7 below] They are committed to furthering research into concepts of LCA as they affect product development and processing.

21 The author has obtained an Australian Postgraduate Award - Industry (APA-I) in order to undertake this Doctoral study.

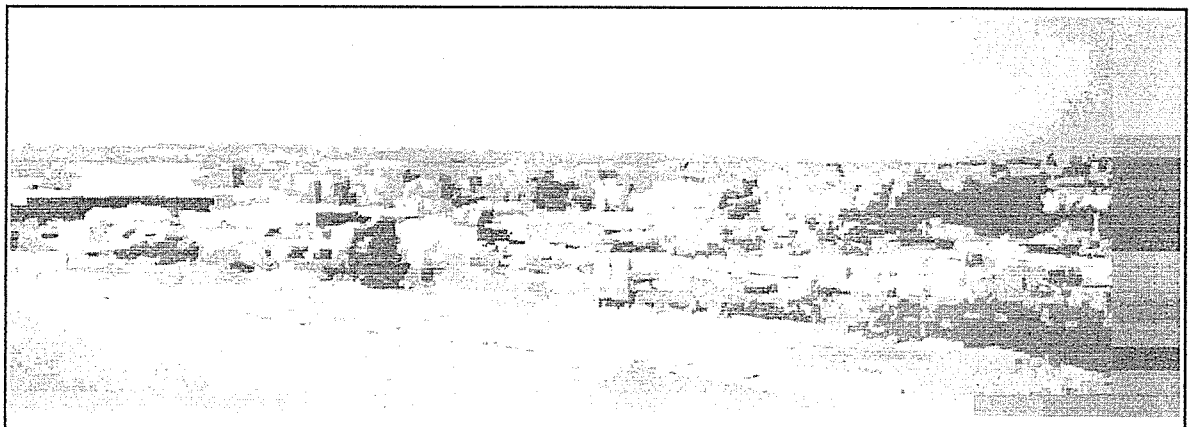
6.5.2 Possible Issues and Strategies

The future research for the plywood industry will need to question how LCA can best be implemented into industry, and eventually (long term) make the LCA concept a routine way of thinking. At present, LCA needs to become useable, and this may mean reducing the inclusiveness of the model and simplifying it. In order to develop an appropriate tool for implementation within the Plywood industry, information has to be delivered to them in a simplified manner in regard to LCA issues.

The next stage of the authors doctoral work will include an analysis of the models discussed here. This will be presented in the form of simplified charts which will make explanation to industry parties, who in many cases know little about LCA, easier. This will allow industry to be able to input to the process relatively early on. Next a test model will be developed and work-shopped with relevant stakeholders in order to determine its relevance. The model will also be given to LCA experts for scrutiny and comments.

It is consider that a simplified model such as this will need to be developed in order to determine if this type is appropriate to work from, at this stage in the development of LCAs within Australia. If the concept is introduced to industry, so that it has knowledge and understanding, it may eventually develop a credible LCA tool. It is recognised that this is a long slow process that will see an appropriate model being developed over years. However, the advantages of being involved at the outset is great, and voluntary measures will be of benefit to industry.

APPENDICES



Picture 7

APPENDIX 1:

CONTACTS LIST

Following is a list of contacts that includes many relevant LCA organisations. A considerable amount of the web sites listed have links to other LCA or environmental management sites. Many of the publications detailed also have contact names, for example, 'The LCA Sourcebook,'[1] and, in relation to forest and forest product related organisations, 'Life-Cycle Assessment for Forestry and Wood Products.'[2]

1 SustainAbility, SPOLD and Business in the Environment (1993) 'The LCA Sourcebook: A European Business Guide to Life-Cycle Assessment.'

2 Todd, J.J. & Higham, R.K. (1996) 'Life-Cycle Assessment for Forestry and Wood Products: Review and Discussion; Bibliography and Contacts, and; Data Base and Manual,' Tasmanian Forest and Research Council Inc. and Forest and Wood Products Research and Development Corporation

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
ADEME - French Agerncy for the Environment	**Nadia Boeglin** **Vincent D. Wilkes**	27 Rue Lois Vicat 75015 PARIS	p. 0033 14765 2061 p. 0033 14765 2000 f. 0033 14645 5236		~ Environmental criteria from a life cycle perspective ~ Specialists LCA field **~ See Case Study 20**
AFNOR	**Patricia Proia**	Tour Europe 92049 Paris La Defense Cedex FRANCE	p. +33 1 42 91 5926 f. +33 1 42 91 5686	communication@email.afnor.fr Certification@email.afnor.fr http://www.afnor.fr/english/welcome.htm	**~ See Case Study 20**
AFR - Naturvardsverket	**Sverker Hogberg** **Kirsten Jansbo**	Blekholmsterrassen 36 10648 STOCKHOLM SWEDEN	p. +46 8 698 1453 f. +46 8 698 1655	Sverker.Hogberg@environ.se Kirstin.Jansbo@environ.se http://www.environ.se/www-eng/enghome.htm	**~ See Case Study 16**
APA - The Engineered Wood Association	**Mike O'Halloran** Director, Technical Services Division **Ed Elias** Director, International Marketing Division	7011 South 19th Street Tacoma, Washington 98411-0700	p. +253 565 6600 f. +253 565 7265	mike.ohalloran@apawood.org http://www.apawood.org/ Ed.elias@apawood.org	**~ See Case Study 24**
Arthur D. Little		Acorn Park Cambridge MA 02140 USA	Canada p. +416 361 1051 USA p. +617 498 5777 Belgium p. +32 2 762 0731		~ Developed 'Environmental Performance Index' with Nortel
Atlantic Consulting	**Eric Johnson**	15 Whitehall Park LONDON N19 3TS	p.+44 171 281 4900 f.+44 171 281 0966	ejohnson@ecosite.co.uk http://www.ecosite.co.uk	~ Ecosite - World wide resource for LCA
BASF				http://www.basf.de	~ Looking at Sustainable Development
Benchmark Environmental Corp.	**Jeff Weinrach**	4501 Indian School Rd NE Suite 105 Albuquerque, NM 87110 USA	p. +505 262 2694 f. +505 262 2698	jbweinrach@aol.com	~ Environmentally Conscious Design and Manufacture Including LCA

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
BFH - Federal Centre for Forestry and Forest Products	**Jorge Schweinle** **Mohammad Schaari-Rad** **Arno Fruhwald**	Leuschnerstr. 91 21031 HAMBURG - BEREGDORF, GERMANY	p. +40 739 62305 f. +40 739 62480 p. +40 739 62617		~ **See Case Study 9**
Boustead Consulting Ltd.	**Ian Boustead**	2 Black Cottages West Grinstead Horsham, West Sussex RH13 7BD UK	p. +44 14038 64561 f. +44 1403865284		~ LCA Practitioner ~ Model and Database for LCIs
BRANZ - The Research Centre for Building Excellence	**Roman Jaques** Building Technologist	Moonshine Road Judgeford Private Bag 50908 PORIRUA CITY, NZ	p. +64 4235 7600 f. +64 4235 6070	branzraj@branz.org.nz http://www.branz.org.nz	~ Energy and Building Research
British Standards Institution	**Neil Kirkpatrick** Chair **Ms Senabulya**	389 Chiswick High Road GB - LONDON W4 4AL	p. +44 181 9969000 f. +44 181 9967400	info@bsi.org.uk	~ Responsible for coordinating BSI's participation in ISO/TC 207 Environmental Management and its subsidiary bodies
Business in the Environment	**Anthony Cleaver** Chair	8 Stratton Street LONDON W1X 5FD UK	p. +44 171 6291600 f. +44 171 6291834		~ Devise and promote practical tools for business ~ 'LCA Sourcebook'
BUWAL -Swiss Environmental Agency	**George Karlaganis**	Baudesamt fur Umwelt Wald und Landschaft, 3003 BERN SWITZERLAND	p. +41 31 322 9311 f. +41 31 322 9981		~ LCA Expertise
CAU - WG Assessment of Chemicals, Products and Systems	**Walter Klopffer** **Isa Renner**	Daimlerstrasse 23 D-63303 Dreieich GERMANY	p. +49 61 039 8328 f. +49 61 039 8310	061039830-0001@t-online.de	~ Editor in Chief of 'The International Journal of LCA'* ~ Walter Klopffer on SPOLD and SETAC board.
Canadian Plywood Association	**Art Kempthorne** Director Technical Services	735 West 15th Street North Vancouver BC V7M1T2 CANADA	p. +604 981 4190 f. +604 985 0342	kempthor@canply.cofi.org	~ **See Case Study 22**
Carneigie Institute of Technology Green Design Initiative	**Lester Lave**	GSIA 317A Carnegie Mellon Univesity 5000 Forbes Avenue Pittsburgh PA 15213 3890	p. +412 268 8837 f. +412 268 5229	lave@andrew.cmu.edu	~ Economic models for Environmental LCA

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
Carter Holt Harvey Plywood	**Hank Bier**	Private Bag TOKOROA NEW ZEALAND	p. +64 7886 2100 f. +64 7886 0068		~ "Ecoply" - What criteria?
CEC - European Commission	**Olivier Lluansi** DGXI **Johnathon Parker** DGXII **Graham Morrison** DGXIE4	Avenue de Beaulieu 5 B-1160 BRUSSELS BELGIUM Rue de la Loi 200 B-1049 BRUSSELS BELGIUM	p. +32 2299 0526 f. +32 2296 6995 p. +32 2299 2507 f. +32 2296 3024	olivier.lluansi@dg11.cec.be http://europa.eu.int http://europa.eu.int/comm/dg12/index.html	~ **See Case Study 3** ~ Mr Lluansi contributes to the Group des Sages. ~ Dr Busing is an observing member on the LCANet board.
Centre for Environmental Strategy, University of Surrey	**Roland Clift**	Guildford SURREY, GU 5XIT	p. +44 1483 259271 f. + 44 1483 259394	R.Clift@surrey.ac.uk	~ LCA methodology development inclusive of social and economic factors ~ R. Clift is on the LCANet board and member of Group des Sages.
CIT - Ekologik	**Elin Eriksson**	Chalmers Industriteknik Chalmers Teknikpark S-41288 GOTEBORG SWEDEN	p. +46 31 772 4000 f. +46 31 82 7421	info.ekologik@cit.chalmers.se http://www.ekologik.cit.chalmers.se	~ **See Case Study 12**
Clean Air Society of Australia and New Zealand	**Brian Winch**	9 Murphy Street Richmond VIC 3121, AUST.	p/f. +61 39421 0310		
CML - Centre for Environmental Science, Section Substances and Products Leiden University	**H.A. Udo de Haes** Director **Nico van den Burg** **Gjalt Huppes** **Jeroen Guinee** Senior Researcher/ Project Leader Nicole Wrisberg **Reinout Heijungs**	Einsteinweg 2, 2300 RA LEIDEN THE NETHERLANDS PO Box 9518 2300 RA LEIDEN THE NETHERLANDS	p. +31 71 527 7477 f. +31 71 527 7434	udodehaes@rulcml.leidenuniv.nl huppes@rulcml.leidenuniv.nl guinee@ rulcml.leidenuniv.nl http://www.leidenuniv.nl/interfac Heijungs@rulcml.leidenuniv.nl	~ **See Case Study 7** ~ Udo de Haes is on Editorial Board for 'The International Journal for LCA'* Thesis: 'Development of a Methodology for the Environmental Life Cycle Assessment of Products' ~ N. Wrisber is secretary for LCANet and Group des Sages. ~ R. Heijungs is on Editorial board for 'The International Journal for LCA'*

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
Concordia University	**Bernice Goldsmith**	1455 bou. de Maisonneuve Ouest Montreal, QUEBEC H3G 1M8	p. +514 848 3071 f. +514 848 4528	bernice@vax2.concordia.ca	~ LCA expertise and research
Consltancy and Research for Environmental Management (CREM) - Department "Product, Trade and Environment'	**Victor de Lange** Director **Karen Looye** Green Procurement	Spuistraat 104d 1012 VA AMSTERDAM THE NETHERLANDS	p. +31 20 6274969 f. +31 20 626 6539		~ Consultants in Environmental Management ~ Specialists in LCA ~ Knowledge of Environmental Policy Instruments of EU ~ Established Database on environmental management
Consoli Consulting Company	**Frank Consoli**	619 Nth Heilbron Drive Media PA 19063	p. +16 10 892 1981 f. +16 10 892 3950		~ LCA methodology development **~ LCA Practitioners** ~ On Editorial board of 'The International Journal of LCA'*
Cooperative Resaerch Centre for Waste Management and Pollution Control (CRC)	**Leanne Philpott** **LCA Research Project Leader**	University of NSW NEW SOUTH WALES AUSTRALIA	P. 02 93855038 F. 02 931 38624	l.philpott@unsw.edu.au	~ Developing a scientific basis For LCA in Australia.
CSIRO - Forestry and Forest Products	**Harry Greaves** Chief Research Scientist	Private Bag 10 Clayton South MDC VICTORIA 3169 AUSTRALIA	p. +61 3 95452241 f. +61 3 9542 223	Harry.Greaves@ffp.csiro.au	~ Beginning work in LCA research field
Department of Chemical Engineering, University of Texas	**David Allen**	CPE2.802 AUSTIN, TEXAS 78712			~ LCA Research
dkTeknik	**Allan Jensen** Head Department	Gladsaxe Mollevej Soborg, DK-2860	p. +45 39 69 6511 f. +45 39 69 6002	aajensen@dk-teknik.dk	~ LCA Consultants ~ On Editorial board of 'The International Journal of LCA'* ~ On LCANet board and member of Group des Sages.
DuBo Centrum - Nationaal Centrum voor Duurzaan Bouwen		Catharijnesingel 59 Postbus 19084 30501 DB UTRECHT	p. 030 239 3000 f. 030 233 1868		
Earthsystem				http://earthsystems.org/	~ Website

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
East Meets West (EMW)	**Anneke van Waesberghe** President	p/a mevrouw D.Heijl - Dings 554 NL VALKENSWAARD THE NETHERLANDS	p. +31 40 204 5197 f. + 31 40 206 1900	eastmeets@aol.com	~ Design for environment Competition - promoting development of products that are less harmful to human health and the environment.
Ecobilan	**Phillipe Osset** **Pierre F. Baisnee** **Laurent Grisel**	Immeuble Le Barjac 1 Boulevard Victor 75015 PARIS FRANCE	p. +33 1 53 78 2379 f. +33 1 53 78 2379	posset@ecobilan.com	**~ See Case Study 21** ~ On Editorial board for 'The International Journal for LCA'* ~ L. Grisel is a meber of Group des Sages and is on LCANet board.
EMPA - Swiss Federal Laboratories for Materials Testing and Research	**Klaus Richter** Wood Scientist	EMPA Dubendorf Uberlandstrasse 129 CH-8600 DUBENDORF SWITZERLAND	p. +41 1 823 5511 f. +41 1 823 4007	klaus.richter@empa.ch http://152.88.1.13/index_e.htm	**~ See Case Study 19**
ENET		PO Box 142 3000 BERN 6 SWITZERLAND	f. +41 31 352 7756		~ Published ' Environmental Life Cycle Inventories for Energy Systems' and ' Swiss Framework for Integration of Waste Disposal in LCA'
Environment Canada **Waste Prevention Division** **Hazardous Waste Branch**	**Kevin Brady** **Andie Paynter**	Ottowa ONTARIO CANADA KIA 0H3	p. +819 953 1112 f. +819 953 6881 p. + 819 997 3060 f. + 819 953 6881	kbrady@synapse.net apaynter@synapse.net	~ Produce 'Ecocycle Newsletter' http://www.ec.gc.ca/ecocycle 'newsletter on life cycle tools, management and product policy
Environment Research Group **School of Architecture** **University of British Columbia**	**Raymond J. Cole**		p. +604 822 2779 f. +604 822 3808		~ Green Building Challenge ~ Building Environmental Performance Assessment Criteria (BEPAC)
Environmental Building News		RR 1 Box 161 BRATTLEBORO VT 05301 - 9911 CANADA		ebn@ebuild.can	~ Major Environmental Building Periodical
Environmental Resources Management	**Karen Raymond**	21 South St David Street EDINBURGH EH2 2BW	p. 0131 539 8882 f. 0131 539 8886	sjh@ermuk.com	~ Developing ecolabel criteria ~ Environmental LCA initiatives

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
European Design Centre (EDC)	**J. M. Bor** Manager Applied Research, Consultancy and projects	PO Box 6279 5600 H. G. Eindhoven THE NETHERLANDS	p. +31 40 246 6350 f. + 31 40 246 6850	box@edc.nl	~Publication: 'Introduction Environmental Product Development.' ~ LCA for Designers
EPEA - Environmental Protection Encouragement Agency	**Jens Soth** Managing Director	EPEA Internationale Umweltforschung GmbH Feldstrasse 36 D-20357 HAMBURG GERMANY	p. +40 439 2081 f. +40 439 2085		**~ See Case Study 10**
ETH-Zentrum	P.Hofstetter R. Frischknecht	CH-8092 SWITZERLAND	P. +41 1632 4978 F. +41 1632 12832	hofstetter@iet.mavt.ethz.ch frischknect@iet.mavt.ethz.ch	~ On LCANet Board.
Finnforest - Kerto Division	**Matti Kairi**	Finnforest Oy PO Box 2A FIN 08101 LOHJA FINLAND	p. +358 123 6011 f. +358 123 601222		~ Working on LCA of LVL with G. Wegener, University of Munich
Finnish Forest Industries Federation	**Hanuu Valtanen** Director	PO Box 316 FIN 00131 HELSINKI FINLAND	p. +358 9 132 6610 f. +358 9 654 724		~ Forest and Wood Product Management
Franklin Associates	**Robert Hunt** **William Franklin** Vice President	4121 West 83rd Street Suite 108 Prairie Village, KANSAS 66208 USA	p. +19 13 649 2225 f. +19 13 649 6494	franklin@qni.com	~ Developed LCI in 1970s ~ Actively involved in LCA development
Fraunhofer Institut fur Bauphysik (IBP)	**Klaus Sedlbauer**	Postfach 800469 D 70604 STUTTGART	p. 0711 970 3407 f. 0711 970 3385		~ LCA development ~ LCA software
Forintek Canada Corp.	**Jim Dangerfield** Vice President **David Plackett** Manager Composite And Treated Wood Products **Christopher Gaston** Forest Products Market Economist	Western Division 2665 East Mall VANCOUVER BC V6T 1W5 CANADA	p. +604 224 3221 f. +604 222 5690	jim@van.forintek.ca Plackett@van.forintek.ca Gaston@van.forintek.ca	**~ See Case Study 23**

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
GEN - Europe (Global Eco-Village Network)	**Declan Kennedy**	Ginsterweg 5 D-31595 Steyerberg GERMANY	p. +49 57 649 3040 f. +49 57 649 2368	even@lebensgarten.gaia.org http://www.gaia.org	~ Ecobalance Publications Ecobalnce@gaia.org ~ Kennedy, M & D [eds.](1997) 'Designing Ecological Settlements', Dietrich Reimers Verlag, Berlin
Global Business Network		PO Box 8395 EMERYVILLE CALIFORNIA 94662 USA	p. +1510 547 6822 f. +1510547 8510		
Griffth University Environmental Studies	**Mark Bennett** **Ian Lowe**	Kessels Road, Nathan Queensland, 4111, AUST.	p. +61 7 3875 7110 f. +61 7 3875 7459		~ LCA
HPH Consultancy	**Harald Huter**	Marialaan 10 6541 RL Nijmegen THE NETHERLANDS	p. +31 24 378 0560 f. +31 24 378 0560	hph@telebyte.nl	~ One person organisation
IFW	**Stefan Schardt**	Am Kollnischen Park 2 D-10179 BERLIN	p. +49 30 27 56220 f. +49 30 27 562212	ifw@TBX.berlinet.de ifw@berlin.snafu.de	**~ See Case Study 17**
ILV - Fraunhofer Institut Lebensmitteltechnologie und Verpackung	**Mrs Goldhan** Head Department, System Analysis **Annette Diers** Computer Scientist LCA Software and Project Manager	Guggenhauserstrasser 35 D-85354 FREISING	p.+49 81 6149 1304 f. +49 81 6149 1333	diers@ilv.fhg.de	~ LCA for complex product systems ~ Developing methodology, data and software tool for conducting LCAs in Architecture, ecological design of components and complex constructions
Imperial College	**Richard Murphy**	**UK**	p. +44 171 5945389		
Institute for Applied Environmental Economics (TME)	**Joram Krozer**	Grote Marktstraat 24 2511 BJ's-Gravenhage THE NETHERLANDS	p. +31 70 346 4422 f. +31 70 362 3469		~ PIA Computer Program for Product Improvement Analysis
Institute for Wood Science and Wood Research University of Munich	**Gerd Wegener**	Winzererstrasse 45 80797 MUNICH GERMANY	p. +89 30 63 0913 f. +89 30 63 0911		**~ See Case Study 18**
Institut fur Umweltinformatik	**Dr Hauslein** **Andreas Muller**	Im Winkel 3 20251 HAMBURG	p. +0049 40 462033 f.+00494048000922		

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
					~ Authorities on LCA
International Energy Agency (IEA)	**Mr Keppler** **Mr Wiederkehr**	Nouveau Batiment Rue Andre Pascale 2 75775 PARIS			
International Institute for Environment and Development (IIED)	**Maryanne Grieg-Gran**	3 Endsliegh Street, LONDON WC1H ODD	p. +44 171 3882117 f. +44 171 3882826	leecuk@gn.apc.org iiedagri@gn.apc.org http://www.oneworld.org/iied	**~ See Case Study 2** ~ Publication with SGS Forestry
International Journal of Environmentally Conscious Design Manufacturing (ECDM)	**Andrew Spicer**			http://ie.uwindsor.ca/ecdm/ journal/	
International Organisation of Standardisation (ISO) **ISO Central Secretariet**	**Orban Johnson** **K.-G. Lingner** Assistant Director Technical Programme Manager	Box 3295 STOCKHOLM 10366 SWEDEN 1 Rue de Varembe CH-1211 GENEVE 20	p. +46 8 610 3000 f. +46 8 307 170 p. +41 22 749 0111 f. +41 22 749 7349	http://www.iso14000.com/ http://www.stroller.com/iso.htm http://www.iso.ch	~ Other Links include: http://mindlink.net/mgmt/ http://www.quality.org/qc/html/iso14000.html Http://deming.eng.clemson.edu/pub/tqmbbs/
International Research Group on Wood Preservation (IRG)	**Joran Jermer**	Drottning Kristinas vag 67 S-114 86 STOCKHOLM SWEDEDN	p. +46 8 101453 f. +46 8 108081		~ Forestry and Wood Product Research
INTRON	**Agnes Schuurmans**	Onderdoor 19 Postbus 226 3990 GA HOUTEN			
IVAM Environmental Research University of Amsterdam	**Peter Fraanje** Project Manager Building and Environment	Plantage Muidergracht 14 1001 ZB AMSTERDAM THE NETHERLANDS	p. +31 20 525 5080 f. +31 20 525 5850	pfraanje@ivambv.uva.nl http://www.ivambv.uva.nl	**~ See Case Study 8**
IVL - Swedish Environmental Research Institute	**Hakan Pleijel** **Hakan Stripple** **Lars-Gunner Lindfors**	Dagjamningsgatan 1 PO Box 470 86 SE-402 58 GOTEBORG SWEDEN	p. +46 8 729 1500 f. +46 8 318 516	infomanager@ivl.se http://www.ivl.se/index.html	**~ See Case Study 11** ~ On Editorial board for 'The International Journal for LCA'*
JKM Associates	**Jamie Meil**	8 Granville Avenue Ottawa, Ontario CANADA K1Y 0M4	p. +613 722 8075	jkmeil@fox.nstn.ca	~ Athena Project with Forintek
KCL (The Finnish Pulp and Paper Research Institute)	**Tiina Pajula**	Tekniikautie 2 SF 02151 ESPOO FINLAND	p. +358 943 711 f. +358 946 4305	tiina.pajula@kcl.fi	~ LCA study recycled paper ~ KCL-ECO: LCA software

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
LCANet		C/o CML PO Box 9518 2300 RA LEIDEN THE NETHERLANDS	p. +31 71 527 7477 p. +31 71 527 7434	lcanet@rulcml.leidenuniv.nl http://www.leidenuniv.nl/ Interfac/cml/lcanet/hp22.htm	~ Describe state-of-the-art LCA methodology ~ Input to EU ~ Members from EU Countries - see Appendix 5
Life Cycle Assessment Society of Japan (JLCA) **Department of Geosystems Engineering,** **University of Tokyo**	**Hisashi Ishitani**	3-1 Hongo 7-chome Bunkyo-ku TOKYO 113 JAPAN	p. +81 3 38 12 2111 f. +81 3 38 18 7492		~ On editorial board for 'International Journal of LCA'*
Nordic Council of Ministers	**Stig Hirskak1** Secretariat, Committee on Cleaner Technologies	Suomen Valtuuskunta Aurorankatu 6 Eduskunta, 00102 DENMARK	p. +45 33 115711 f. +45 33 960202		~ Developed Nordic LCA Guidelines
Nortel				Http://www.nortel.com/habitat.html	~ Environmental Performance Index - with Arthur D. Little
Pacific Northwest National Laboratories	**Ken Humphreys**	PO Box 99 RICHLAND WA 99352-0999 USA	p. +509 372 4279 f. +509 372 4378		~ Life Cycle Data Project
Pira International	**Michael Sturges**	Randalls Road Leatherhead SURREY KT22 7RU UK	p. +44 1372 802000 f. +44 1372 802238	publications@pira.co.uk http://www.pira.co.uk	~ Environmental Research and consulting
Pre Consultants	**Mark Goedkoop** Director **Marcel Collignon**	Plotterweg 12 3821 BB AMERSFOORT THE NETHERLANDS	p.+31 33 455 5022 f. +31 33 455 5024	info@pre.nl http://www.pre.nl/	~ Product Ecology Consultants ~ Use LCA approach ~ Expertise in Methodology development ~LCA software and database - SimaPro
Prepare/ Euroenviron Secretariat (Preventative Environmental Protection Approaches in Europe)	**Marcel Crul**	Grote Marktstraat 24 2511 BH Den Haag THE NETHERLANDS	p.+31 70 346 4422 f. +31 70 362 3469		~ Stimulate use of Cleaner production and Environmental Management Systems ~ LCAs, quick LCAs and design oriented analysis.

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
Proctor and Gamble	**Mrs de Smet** Environmental Quality Manager **Nick de Oude** **Peter White** Environmental Science **P. Hinde**	Temelaan 100 B-1853 Strombeek Bever BELGIUM PO Box Forest Hale 2 Newcastle-upon-Tyne NE12 9TS UK	p. +32 2 456 2393 f. +32 2 456 3248 p. +44 1912792000 f. +44 1912792088	WHITEPR@PG.COM	~ Works with LCA ~Associated SETAC & SPOLD ~ On Editorial board for 'The International Journal for LCA'* ~ On LCANet board.
Research and Consultancy Centre on Chemistry, Labour and the Environment (Chemiewinkel) University of Amsterdam	**J.C. van Broelchuizen**	PO Box 20242 1000HE AMSTERDAM THE NETHERLANDS	p. +31 20 525 5607 p. +31 20 525 5615 f. + 31 20 525 5615	chemiewinkel@chem.uva.nl	~ Environmental effects, health risks, screening of life cycle of products. Focus on chemical products ie detergents, paper and building materials
Research Triangle Institute	**Keith Weitz** RTI Project Manager	3040 Cornwallis Road North Carolina 27709 USA	p. +919 541 6973 p. +919 541 6000	kaw@rti.org listen@rti.org http://www.rti.org/publications/cea/6059-01.html	~ Streamlined LCA model development
RMIT - Royal Melbourne Institute of Technology, Department of Building and Construction Economics Centre for Design	**Chris Ryan** Director **Peter Graham** **John Gertsakis** **Marjolein Demmers** **Helen Lewis** Project Manager	City Campus 124 La Trobe Street Melbourne, VIC. 3000 AUSTRALIA GPO Box 2476V Melbourne, VIC. 3001 AUSTRALIA	p. +61 3 9660 2364 f. +61 3 9639 3412 p. +61 3 9660 1936 p. +61 3 9660 3902 f. +61 3 9639 3412	cryan@rmit.edu.au cfd@rmit.edu.au pgraham@edc.rmit.edu.au gertsakis@rmit.edu.au http://www.cfd.rmit.edu.au mdemmers@rmit.edu.au	~EcoReDesign ~ Using Sima Pro as developed in The Netherlands by Pre Consultants.
Schauman Wood Oy	**Paavo Ojanpaa** Managing Director **Eija Simonen** Research and Development	PO Box 203 Niemenkatu 16 FIN - 15141 LAHTI PO Box 13 FIN 57201 SAVONLINNA FINLAND	p. +358 204 15113 f. +358 204 15112 p. +358 204 15183 f. +358 204 157345		
School for Resources and Environmental Studies	**Raymond Cole**	Halifax Nova Scotia B3H 3E2 CANADA	p. +902 494 1344	rcote@ac.dal.ca http://quasar.sba.dal.ca:2000/sres/BURN/home.html	~LCA research work

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
SCS - Scientific Certification Systems	**Elaine Weidmen** LCA Projects Coordinator	Park Plaza Building Suite 400 1939 Harrison Street Oakland CALIFORNIA 94612 USA	p. +510 832 1415 f. +510 832 0359	eweidman@scs1.com	**~ See Case Study 26**
SETAC - Europe (Society for Environmental Toxicology and Chemistry)		Avenue E. Mournier 83 B-1200 BRUSSELS BELGIUM	p. +32 2772 8377 f. +32 2770 5386		~ Leading LCA Organisation
SETAC - USA		101 North 12th Avenue Pensacola FLORIDA 32501-3370 USA	p. +904 469 1500 f. +904 469 9778	setac@setac.org http://www.setac.org	~ Work with SETAC - Europe in LCA development
SkogForsk - The Forestry Research Institute of Sweden	**Yvonne Aldentun** **Staffan Berg**	Glunten S-751 83 UPPSALA SWEDEN	p. +46 18 18 8500 f. +46 18 18 8600	staffan.berg@skogforsk.se http://www.skogforsk.se	**~ See Case Study 13**
SGS Forestry, Oxford Centre for Innovation	**Christopher Upton**	Mill Street OXFORD OX2 0JX	p. +441865 202345		~ Publication: 'The Forest Certification Handbook', & IIED
SPOLD - Society for the Promotion of LCA Development	**Anita van Schaardenburg** **Claude Fussler** President	Avenue E. Mournier 83 B-1200 BRUSSELS BELGIUM	p. +32 2772 8377 f. +32 2770 5386		**~ See Case Study 4** ~ Claude Fussler, Vice President Environmental, Health and Safety, Dow Europe
SustainAbility	**John Elkington** **Julia Hailes**	49-53 Kensington High St.	p. +44 171 3882117 f. +44 171 3882826	elkington@sustainability.co.uk http://www.sustainability.Co.uk/index.html	**~ See Case Study 1**
Sustaianable Materials Group Centre for Innovation & Design, Deakin University		GEELONG, VIC. 3217 AUSTRALIA			
Swedish Forest Industries Association (Skogsindustrierna)	**Agneta Lindstedt**	PO Box 5518 11485 STOCKHOLM	p. +46 8 783 8400 f. +46 8 661 7306	agneta.lindstedt@forestindustries.se http://www.forestindustries.Se/defaulte.htm	
Technical and Environmental Planning, Chalmers University of Technology		Sven Hultins Gata 8 S 412 96 GOTEBORG	p. + 46 31 772 2170 f. + 46 31 772 2172	enviroron@vsect.chalmers.se http://www.tep.chalmers.se	

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
Technical Centre for Wood Application (CTBA)		10 Avenue de Saint Monde 75012 PARIS	p. 01 40 19 4950		~ Working with LCA with Ecobilan
The Centre for Sustainable Design	**Martin Charter**		p. +44 1252 732229 f. +44 1252 732274	cfsd@surrat.ac.uk	~ Sustainable product design ~ Publish 'The Journal of Sustainable Production'*
The International Journal of LCA (Subscription Service)	**Walter Klopffer** **Editor in Chief**	Rudolf-Diesel-Strasse3 D-86899 Landsberg GERMANY	p. +49 81 91125500 f. +49 81 91125600	http://www.ecomed.de	~ Available on Internet
The Journal of Sustainable Production				http://www.cfsd.org.uk	~ Economic, environmental, ethical and social aspects of product design and development
The Natural Step	**Karl-Henrik Robert**	Amiralitetshuset Skeppsholem S 111 49 STOCKHOLM SWEDEN	p. +46 8 678 0022 f. +46 8 611 7311		~ Focussing on consensus within Scientific arena
TimberBuilt Pty Ltd	**Bruce Hutchings**	Suite 1 Wadhurst Drive BARONIA, VIC. 3155	p. 03 9887 2200 f. 03 9887 2056		~ Timber Engineering Specialists
TNO Building Construction and Research	**Petra Esser**	Lange Kleiweg 5 Rijswijk 2600 AA DELFT THE NETHERLANDS	p. +31 15 284 2360 f. +31 15 284 3979	P.Esser@bouw.tno.nl http://www.tno.nl/	**~ See Case Study 5**
Tratek - Swedish Institute for Wood Technology Research	**Britt-Inger Andersson** **Joakim Norem** **Ralph Nussbaum**	Drottning Kristinas vag 67 S-114 86 STOCKHOLM SWEDEDN	p. +46 8 14 5300 f. +46 8 11 6188	tratek@tratek.se http://www.tratek.se/eng/index.shtml	**~ See Case Study 14**
TUD-TB	**Hans be Bruijn**	Postbus 5015 2600 GA DELFT THE NETHERLANDS	p. +31 15 278 3422 f. +31 15 278 3422		
TUDelft - Section for Environmental Product Development	**Han Remmerswaal** **Martin van Hees** Faculty for Industrial Design Engineering	Jaffalaan 9 2628 BX DELFT THE NETHERLANDS	p. +31 15 278 5041 f. +31 15 278 2956	J.A.M.Remmerswaal@IO.TUDelft.NL M.F.M.vanHees@IO.TUDelft.NL http://www.IO.TUDelft.NL	**~ See Case Study 6**

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UK Ecolabelling Board	**Paul Jackson** Senior	7th Floor Eastbury House 30-34 Albert Embankment LONDON 5E1 7TL	p. +71 820 1199 f. +71 820 1104		~ Expertise in LCA
Umweltbundesant (Federal Environmental Agency)	**Stefan Schmitz** **Harald Neitzel** **Mrs Hagenah** Environmental Management Systems **Mrs Fritz** Environmental Management Systems	Fachgebeit III 1.3 Seecktstrasse 8-10 D-13581 BERLIN Fachgebeit I 3.1 Mauerstrasse 52 10117 BERLIN-MITTE	p. +49 30 23145703 f. +49 30 8903 3099 f. +49 30 8903 3336 p. +49 30 23145789 f. + 49 30 231 5638	stefan.schmitz@ubu.de http://www. umweltbundesamt.de	~ LCA beverage packaging ~ Expert product evaluation methods and environmental labels ~ On Editorial Board of 'The International Journal of LCA'*
United Nations Environment Programme - Industry and Environment	**Jon Hobbs** Coordinator Cleaner Production Programme **Jacqueline Aloisi de Larderel** Director	Tour Mirabeau 39 - 43 Quai Andre Citroen 75739 PARIS CEDEX 15 FRANCE	p. +33 01 4437 1450 f. + 33 01 4437 1474	unepie@unep.fr http:..unepie.org	~ 'Profiler' - software for environmental information management ~ Cleaner product issues focussing on environmental issues and LCA
United Nations Environment Programme - Working Group on Sustainable Development (UNEP-WG-SPD)	**Dr Hans van Weenen** Chair **Dr Yorrik Benjamin** Senior Researcher **Anne Elsen** Network Coordinator	3rd Floor J. H.Van't Hoff Institute Building 'B', Nieuwe Achtergracht 166 1018 WV AMSTERDAM THE NETHERLANDS	p. +31 20 525 6268 f. +31 20 625 8843 p. +31 20 420 3961 f. +31 20 488 451	HvWeenen@unep.frw.uva.nl ybenjamin@unep.frw.uva.nl unep@unep.frw.uva.nl http://unep.frw.uva.nl	~ Promotes development of equitable and environmental products, systems and services ~ Publish 'Way Beyond'
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Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
University of Canterbury Department of Civil Engineering	**Andrew Buchanan** Associate Professor				~ LCA Forestry and Wood Products
University of Michigan National Pollution Prevention Centre for Higher Education (NPPC)	**Greg Keoleian** School of Natural Resources	Dana Building 430 E University Ann Arbour, MICHIGAN 48109 1115	p. 313 764 1412 f. +313 936 2195	gregk@michigan.edu	~ Published with US EPA Life cycle design manual
University of New South Wales School of Architecture	**Bill Lawson**	SYDNEY 2052 AUSTRALIA	p. +61 2 9385 4801 f. +61 2 9662 1378	B.Lawson@unsw.edu.au	~ Developed 'The Building Material Ecological Sustainability Index', with Partridge Partners
University of Surrey Environmental Strategy	**T. Jackson**		p. +44 1483 300800		~ Development of non-linear optimisation in the LCA of material 'cascades'.
University of Sussex, Science Policy Research Unit	**F. Berkhout**		p. +44 1273 606755		~ Materials LCA and industrial Innovation
University of Tennessee Centre for Clean Production and Clean Technologies	**Gary A. Davis** Director	327 South Stadium Hall Knoxville, TENNESSEE 37996-0710 USA	p. +615 974 8979 f. +615 974 1838		~ Environmental Design and LCA work
University of Toronto Centre for Biomaterials	**Steve Young**	Toronto, ONTARIO M 55 1A1	p. +416 978 7138 f. +416 978 1462	young@ecf.utoronto.ca http://www.trentu.ca/ faculty/lca	
University of Victoria Department of Chemistry	**Martin Hoking**	PO Box 3055 Victoria BC V8W 3P6	p. +604 721 7165 f. +604 721 7147		~ LCA
University of Waterloo Environmental Studies	**Murray Haight**	Waterloo ONTARIO N2L 3GI	p. +519 885 1211 f. +519 725 2827		
University of Windsor Environmentally Conscious Design and Manufacturing Lab	**Michael Wang**	Department of Engineering & Manufacturing Systems Engineering	p. +519 253 4232	http://ecdm_lab@ ie.uwindsor.ca	~ Publish 'International Journal of Environmentally Conscious Design Manufacturing'* (ECDM)

Organisation	Contact Name	Address	Phone/Fax	E-mail/Internet	Comments
US Environmental Protection Agency - National Risk Management Research Laboratory	**Kenneth Stone** LCA Team Leader **Mary Ann Curran** LCA Research Program Manager	26 West Martin Luther Cincinnati, OHIO 45268 USA	p. +513 569 7474 p. +513 569 7837		~ Emphasis on development and Implementation of LCA based Tools ~ On Editorial board for 'The International Journal for LCA'*
Victoria University of Wellington **Faculty of Architecture** **Centre for Building Performance Research**	**George Baird** Associate Dean (Research) **John Storey** **Nigel Isaacs** **Mike Dunn**	139 Vivian Street PO Box 600 WELLINGTON, NZ	p. +64 4 802 6231 f. +64 4 802 6204	George.Baird@vuw.ac.nz mail@vuw.ac.nz ruruku@vuw.ac.nz	~ Completed major work for NZ Institute of Architects - consists of series of 20 charts covering life cycle impact of common materials
VTT	**Jyrki Mali** **Arja Merra** **Pertti Soyrila** **Allan Johansson**	Puumiehenkuja 2A SF-02150 ESPOO 15 FINLAND	p. +358 0456 5553 p. +358 0456 5533 p. +358 0456 5491 f. +358 0456 7027	Jyrki.Mali@vtt.fi Arja.Merra@vtt.fi Pertti.Soyrila@vtt.fi allan.johansson@vtt.fi	**~ See Case Study 15** ~ Sustainable Forestry
Wayne Trusty and Associates Ltd.	**Wayne Trusty**	PO Box 189 Merrickville, Ontario CANADA K0G 1NO	p. +613 269 3795	wbtrusty@fox.nstn.ca	~ Athena Project with Forintek
Wuppertal Institute	**F. Schmidt-Brek**	Doppersberg 19 D-42103 WUPPERTAL GERMANY	p. +49 202 2492132 f. +49 202 2492138	bio@mail.wupperinst.org	~ On LCANet board.
WWPA - Western Wood Products Association	**Shelley Hershberger** Manager Technical Publications **Craig Larsen** Director International Marketing	Yeon Building, 522 SW Fifth Avenue Portland, OREGON 97204-2122 USA	p. +503 224 3930 f. +503 224 3934	shershberger@wwpa.org http://www.wwpa.org/default.htm clarsen@wwpa.org	**~See Case Study 24**

APPENDIX 2:

PAA LETTER OF INTRODUCTION

kjl:vr:pene2614

February 28, 1997

Dr. Staffan Berg,
Skogforsk,
The Forestry Research Institute of Sweden,
Glunten,
UPPSALA, S-75183
SWEDEN,

Dear Dr. Berg,

re: **INTERNATIONAL STUDY BY PENELOPE MITCHELL ON LIFECYCLE ANALYSIS**

The Plywood Association of Australia, together with the J.W. Gottstein Trust and the University of Queensland have awarded Ms Penelope Mitchell a scholarship to study internationally to gather information for her Ph D thesis. Ms Mitchell's specific interest is in 'Whole of Life Cycle Analysis' on glued structural veneer composite products i.e. structural plywood, LVL and composite products.

Through the University of Queensland's international contacts, Ms Mitchell has arranged to visit a number of European and North American Universities known for their expertise in developing models for lifecycle analysis. A major part of the thesis will be to investigate all of the models available, assess their relevance and suitability for the products in question, and if necessary make modifications.

To ensure that the exercise is not academically dominated, the PAA has recommended that Ms Mitchell visit a number of laboratories, organisations and corporations in Europe and North America who we believe have an industry perspective towards the environmental aspects, including lifecycle analysis, of marketing and manufacturing reconstituted glued structural wood products. The Australian industry is hopeful that through Ms Mitchell's research we will be in a stronger position to address the environmental issues affecting our products. We would appreciate your support in this project and of course would make the findings available to those organisations who contributed.

Ms Mitchell will contact your organisation directly, with firm dates for her proposed visit to your facility, approximately two months ahead of the visit. In the meantime could you please advise the PAA of your willingness to assist in this project.

Yours sincerely,
PLYWOOD ASSOCIATION OF AUSTRALIA LTD.

Kevin J. Lyngcoln,
CHIEF EXECUTIVE OFFICER.

APPENDIX 3:

LETTER OF INTRODUCTION

ANITA VAN SCHAARDENBURG
Avenue E. Mournier 83,
B-1200 BRUSSELS, BELGIUM

15th March, 1997

PENELOPE MITCHELL
Department of Architecture
University of Queensland
ST. LUCIA, QLD, 4067

Dear Mrs van Schaardenburg,

re: International Study on Life Cycle Assessments

I am currently undertaking an international study tour gathering information pertinent to my postgraduate study on Life Cycle Assessments (LCAs). I am particularly interested in their effectiveness as tools for aiding product development and in promoting environmental architecture through the use of correctly specified materials.

It is proposed that from this investigation a suitable LCA tool will be developed for the use within the Australian Plywood Industry. The Plywood Association of Australia (PAA) and the J. W. Gottstein Trust, have given industry support to this project. Together they have awarded a travel scholarship which will help fund some of this trip. The University of Queensland is also supporting this project, and an Australian Postgraduate Award - Industry (APA-I) has been awarded. The project is being supervised by Dr. Richard Hyde, Senior Lecturer in the Department of Architecture.

I am endeavouring to establish contacts involved in the Life Cycle Assessment field and the Forest and Wood Products Industry. The acceptance of LCAs by Australian Industry has so far been limited. It is considered a report of this type will focus industry attention on the benefits of LCAs. As a graduate architect, I will also be investigating LCAs from an architectural perspective. Thus, the reporting of LCA results is an important issue.

I would appreciate any assistance you can give me in this undertaking. I will be in Brussels around the 4th and 5th of June, and would appreciate any time you may be able to accommodate. I would be grateful if you could advise on your ability to aid in this project.

Yours Sincerely

Penelope Mitchell
Postgraduate Architecture Student
University of Queensland

APPENDIX 4:

OVERSEAS ITINERARY

DAY	ACTIVITY	ORGANISATION	TIME	TRAVEL
March				
Sun 30th	Depart Brisbane Arrive Sydney Depart Sydney Arrive L.A. USA		1: 40pm 3:10pm 4:35pm 12:15pm	Air NZ
Mon. 31st	Depart L.A. USA Arr. Vancouver Dept. Vancouver		10:35am 1:20pm 2:50pm	Air Canada
April				
Tues 1st	Arrive London		8:50am	
Wed 2nd - Sun 6th	Rest, Orientation and Organisation			
Mon 7th April - Fri 16th May	Work	Martin Centre, Department of Architecture, Cambridge University		
May				
Sat 17th \ Sun 18th/	Rest and Organisation			
Mon 19th	Work Dept. Cambridge Arrive London	Martin Centre	3:14pm 4:06pm	WAGN Rail
Tues 20th	Meeting	John Elkington **SustainAbility (Case Study 1)**	1:30pm	
Wed 21st	Meeting	Maryanne Grieg-Gran **IIED (Case Study 2)**	10:00am	
Thurs 22nd	Depart London Arr. Cambridge		1:45pm 2:34pm	WAGN Rail
Fri 23rd - Fri 30th	Work	Martin Centre, Department of Architecture, Cambridge University		
June				
Sat 31st \ Sun 1st \ Mon 2nd /	Preparation and Organisation			
Tues 3rd	Depart London Arrive Brussels		12:27pm 4:44pm	Eurostar

DAY	ACTIVITY	ORGANISATION	TIME	TRAVEL
Wed 4th	Meeting	Oliver Lluansi, **CEC DGXI (Case Study 3)**	9:00am	
	Meeting	Jonathon Parker and Dr. Busing **CEC DGXII (Case Study 3)**	1:00pm	
Thurs 5th	Meeting	Anita van Schaardenburg **SPOLD (Case Study 4)**	10:00am	
	Depart Brussels Arrive Delft		2:10pm 3:30pm	Eurail
Fri 6th	Phone Calls	Franz Corten **Centre for Energy Conservation and Environmental Technology** Joram Krozer **Institute for Applied Environmental Economics (TME) PRe Consultants**		
	Meeting	Petra Esser **TNO (Case Study 5)**	12:30pm	
Sat 7th \ Sun 8th /	Rest and Organisation			
Mon 9th	Meeting	Dr Remmerswaal and Maarten van Hees **TUDelft (Case Study 6)**	9:00am	
	Depart Delft Arrive Leiden		12:30pm 12:45pm	Eurail
	Meeting	Nico van den Burg **CML (Case Study 7)**	2:00pm	
	Depart Leiden Arrive Delft		6:00pm 6:15pm	Eurail
Tues 10th	Depart Delft Arr. Amsterdam		7:40am 8:30am	Eurail
	Meeting	Peter Fraanje **IVAM (Case Study 8)**	10:00am	
Wed 11th	Phone Calls	**International Research Group on Wood Preservation (IRG)** Dr Weenen **UNEP** Dr Hauslein **Institut fur Umweltinformatik** **Friends of the Earth**		

DAY	ACTIVITY	ORGANISATION	TIME	TRAVEL
Thurs 12th	Dept Amsterdam Arrive Hamburg		9:14am 2:07pm	Eurail
Fri 13th	Meeting Meeting	Jorge Schweinle **BFH (Case Study 9)** Jens Soth **EPEA (Case Study 10)**	9:00am 1:00pm	
Sat 14th	Depart Hamburg Arrive Goteborg		7:30am 5:30pm	Eurail
Sun 15th	Rest and Organisation			
Mon 16th	Meeting	Hakan Pleijel and Hakn Stripple **IVL (Case Study 11)**	9:00am	
Tues 17th	Meeting Depart Goteborg Arrive Uppsala	Elin Eriksson **CIT - Ekologik (Case Study 12)**	9:00am 4:05pm 8:30pm	 Eurail
Wed 18th	Meeting	Yvonne Aldentun **Skogforsk (Case Study 13)**	9:00am	
Thurs 19th	Depart Uppsala Arr. Stockholm Meeting	 Joakim Noren **Tratek (Case Study 14)**	8:30am 9:30am 11:00am	Eurail
Fri 20th		Swedish Mid-Summers Eve		
Sat 21st	Dept. Stockholm		9:15pm	Viking Line
Sun 22nd	Arrive Turku Rest and Organisation		7:00am	
Mon 23rd	Depart Turku Arrive Espoo Meeting	 Jyrki Mali **VTT (Case Study 15)**	9:00am 11:00pm 1:00pm	Eurail
Tues 24th	Phone Calls	**International Standards Organisation (SIS)** **The Finish Standards Institute** Frieder Rubik **Ecological Economics Research Institute**		

DAY	ACTIVITY	ORGANISATION	TIME	TRAVEL
Wed 25th	Depart Helsinki Arrive Turku Depart Turku		2:34pm 5:00pm 9:45pm	Eurail Silja Line
Thurs 26th	Arr. Stockholm Meeting	 Sverker Hogberg **AFR (Case Study 16)**	8:00am 11:00am	
Fri 27th	Dept. Stockholm Arrive Malmo		3:18pm 9:30pm	Eurail
Sat 28th	Depart Malmo Arrive Berlin		7:00am 4:00pm	Eurail
Sun 29th	Rest and Organisation			
Mon 30th	Meeting	Stefan Schardt **IFW (Case Study 17)**	10:00am	
July				
Tues 1st	Depart Berlin Arrive Munich		3:43pm 11:07pm	Eurail
Wed 2nd	Meeting Depart Munich Arrive Zurich	Professor Wegener **Institute for Wood Science and Wood Research (Case Study 18)**	9:00am 2:02pm 6:23pm	 Eurail
Thurs 3rd	Meeting Depart Zurich Arrive Geneva	Klaus Richter **EMPA (Case Study 19)**	10:00am 6:03pm 9:01pm	 Eurail
Fri 4th	Phone Calls	**Battelle Europe** **World Business Council for Sustainable Development** Neil Cook **International Standards Organisation**		
Sat 5th July - Sun 20th	Rest, Travel and Architectural sightseeing Phone Calls	 Vincent Denby Wilkes **ADEME** Jacqueline Aloisi de Larderel **UNEP IE**		

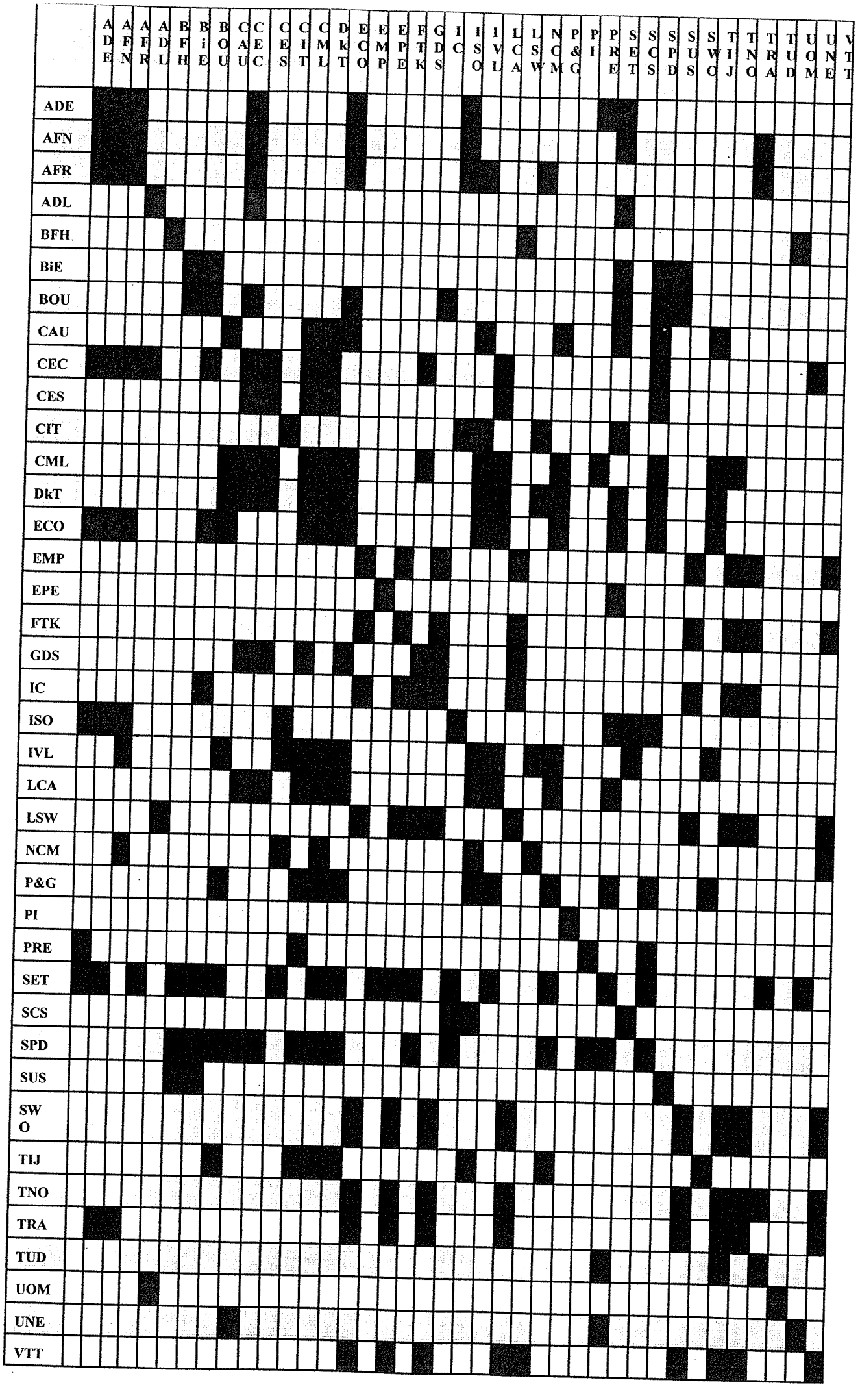
DAY	ACTIVITY	ORGANISATION	TIME	TRAVEL
Mon 21st	Meeting	Patricia Proia **Afnor (Case Study 20)**	9:00am	
Tues 22nd	Meeting	Phillipe Osset **Ecobilan (Case Study 21)**	9:00am	
Wed 23rd	Depart Paris Arrive London		3:19pm 5:13pm	Eurostar
Thurs 24th July -Sun 10th August	Work	Martin Centre, Department of Architecture, Cambridge University		
Mon 11th\ Tues 12th/	Rest and Organisation			
Wed 13th	Depart London Arr. Vancouver		1:30pm 2:50pm	Air Canada
Thurs 14th	Rest and Organisation			
Fri 15th	Meeting Phone Calls	Art Kempthorne **Canadian Plywood Ass. (Case Study 22)** Raymond Cole **Environmental Research Group Council of Forest Industries, BC**	10:00am	
Sat 16th \ Sun 17th /	Rest and Organisation			
Mon 18th	Meeting	David Plackett **Forintek Canada Corp. (Case Study 23)**	9:00am	
Tues 19th	Dept. Vancouver Arrive Tacoma			Amtrak
Wed 20th	Meeting Phone Call	Mike O'Halloran **APA (Case Study 24)** Weyerhauser	10:00am	
Thurs 21st	Depart Tacoma Arrive Portland			Amtrak
Fri 22nd	Meeting Visit to	Shelley Hershberger **WWPA (Case Study 25)** World Forestry Centre 4033 SW Canyon Road Portland OREGON		9:00am

DAY	ACTIVITY	ORGANISATION	TIME	TRAVEL
Sat 23rd	Rest and Organisation			
Sun 24th	Depart Portland		10:00am	Amtrak
Mon 25th	Arr. S. Francisco		7:00pm	
Tues 26th	Meeting Phone Call	Elaine Weidman **SCS (Case Study 26)** **Consortium for Green Design, University of California**	9:00am	
Wed 27th	Dept S. Francisco Arr Los Angeles			Amtrak
Thurs 28th	Phone Call	**Centre for Clean Technology, UCLA**		
Fri 29th	Rest and Organisation			
Sat 30th	Dept Los Angeles Arrive Sydney		11:00pm	Air NZ

APPENDIX 5:

ORGANISATION CONNECTIONS WITHIN THE LCA ARENA

ADE	ADEME
AFN	AFNOR
AFR	AFR - Naturvards...
ADL	Arthur D. Little
BFH	BFH
BiE	Business in the Envi.
BOU	Boustead Counsult...
CAU	CAU - WG Assess.
CEC	European Commiss.
CES	CES - Centre for ...
CIT	CIT Ekologik
CML	CML - Centre for ...
DkT	Dk-Teknik
ECO	Ecobilan
EMP	EMPA
EPE	EPEA
FTK	Forintek Canada
GDS	Group des Sages
IC	Imperial College
ISO	International Org.
IVL	Swedish Envi. Research
LCA	LCANet
LSW	Life-Sys Wood
NCM	Nordic Council of ...
P&G	Procter and Gamble
PI	Pira International
PRE	Pre Consultants
SET	SETAC
SCS	Scientific Cert...
SPD	SPOLD
SUS	SustainAbility
SWO	Schauman Wood Oy
TIJ	The Int. Journal of
TNO	TNO - Netherlands ...
TRA	Tratek
TUD	TUDelft
UOM	University of Munich
UNE	UNEP - United Nat...
VTT	VTT - Technical Res..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GDS
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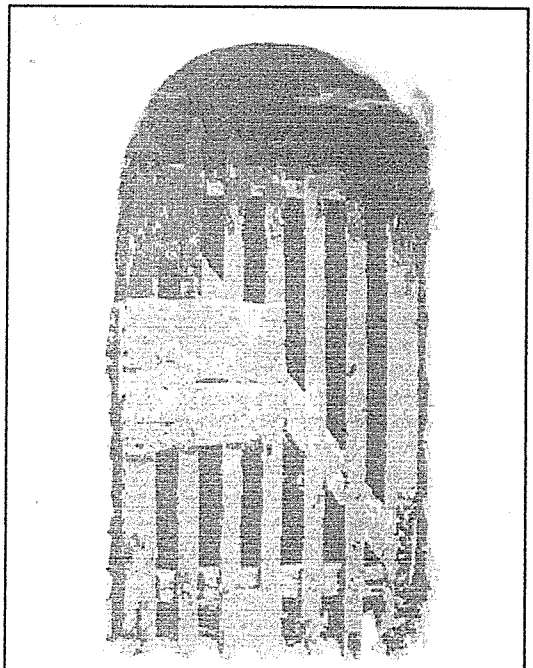

Picture 8

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