State-of-the-Art Report on Sustainability

The Fifth International Conference on Ecobalances

Practical Tools and Thoughtful Principles for Sustainability

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Introduction

The Fifth International Conference on Ecobalances (the 5th-ICEB) was held November 6–8, 2002, at the International Conference Center 'Epochal', Tsukuba, Japan, supported by the Ministry of Education, Culture, Sports, Science and Technology, Ministry of Agriculture, Forestry and Fisheries, Ministry of Economy, Trade and Industry, Ministry of Land, Infrastructure and Transport and Ministry of Environment of the Japanese Government. It was the fifth in a series of Ecobalance Conferences, which began in 1994 and has provided biannually a platform for international exchange for methodological and practical studies on Life Cycle Assessment (LCA). The main theme of the 5th-ICEB was 'Practical tools and thoughtful principles for sustainability' which was presented as the sub-title of the 5th-ICEB. This theme was based on the discussions in the concluding session of the past conference.

The 5th-ICEB attracted over 450 participants to the three-day event. In addition to large firms, which were in attendance in abundance, academics, consultants and representatives from private research institutes were present. There was also a sampling of small enterprises and government representatives as well as NGOs. The attendance included 93 foreign participants from twenty-one countries; the largest delegation comprising 17 persons came from Germany, followed by Korea, The Netherlands, China, Italy, Switzerland, USA, Canada, Australia, France, Belgium, India, Egypt, Finland, New Zealand, Philippine, Portugal, South Africa, Sweden, Thailand and The United Kingdom.

The specific topics of the 5th-ICEB were selected by the program committee, with the support of the international advisory board, from the viewpoint of the application of environmental management towards sustainability. These themes are shown in **Table 1** with the number of presentations and keywords used in the call for papers.

Table 1: Specific themes/key words and the number of presentations

Themes/Keywords	Oral	Poster
[Session 1] Life Cycle Assessment	51	60
Keywords: LCA methodology (Sensitivity/uncertainty analysis, Application of I/O table, Weighting method, etc.), LCA case studies/implementation (Manufacturing, Agriculture, Construction, Infrastructure, Technology system, Service, Life style, etc.), Database, Software		
[Session 2] Environmental performance indicators (product/company/industry/country)	14	5
Keywords: Environmental performance evaluation, Environmental efficiency, Resource productivity, Factor X, Indicators and Indices of Sustainability		
[Session 3] Applications of Life Cycle Thinking to product development/corporate management	16	17
Keywords: Eco-design, Design for Environment (DfE), Supply chain management, Life cycle costing, Life cycle management, Integrated Product Policy		
[Session 4] Environmental information of product/company and its use	19	11
Keywords: Eco-label, Environmental accounting, Environmental reporting, Eco-fund, Environmental indicator, Environmental rating, Green procurement, Environmental communication		
[Session 5] Industrial Ecology/Sound energy and material cycles	32	12
Keywords: Socio-economic analysis of energy and material cycles, Material flow analysis, Industrial symbiosis (Eco-industrial park, Zero-emission, etc), Sustainable regional/urban environmental planning and resource management, Energy supply-demand systems, Waste treatment and recycling systems, Co-production system		
[Session 6] Assessment and choice of environmentally sound materials	15	11
Keywords: Eco-material & processing, Material selection		

147 oral presentations in six parallel sessions and 116 posters, in a separate afternoon poster session, were presented at the Conference. Overall, approximately one-third of contributions were related to LCA (Session 1), with another quarter categorized as industrial ecology/sound energy and material cycles (Session 5). Indicators (Session 2) were the least subscribed area, though it drew very large audiences.

The conference was held in cooperation with the International Society for Industrial Ecology (ISIE); Session 5 was co-organized by ISIE. In addition, the conference was connected to the 2nd International Workshop on Ecomaterials (November 5–7), the International Symposium on Sustainable Material Cycles (November 5) and an AIST Workshop entitled 'Gateway to Life Cycle Impact Assessment for APEC Member Economies' (November 7), the latter in cooperation with the UNEP/SETAC Life Cycle Initiative.

This conference review paper introduces the plenary opening/closing sessions focusing mainly on the session summaries to illustrate the results of the conference. Detailed summaries of Sections 2 and 3 (environmental performance indicators and application of life cycle thinking to product development and corporate management) can be found in a separate report by Hunkeler et al. (see pp. 55 – 58 in the LCM-Section of this issue [1]).

1 Opening Plenary Session

RYOICHI YAMAMOTO of the University of Tokyo, the Chairman of the Organizing Committee, opened the Conference by noting that the year 2002 was a landmark for Japan with six new environmental laws, including a green procurement program which extends over hundreds of products. ITARU YASUI of the University of Tokyo, who chaired the Executive Committee, rationalized the main themes of the biannual conference. Following these opening addresses there were three keynote presentations.

MIKIO SHOJI of Kajima Corporation presented the first lecture on the approaches for a recycle-oriented society. Recently they have been examining their material and energy balance and seeking to improve recycling of materials, the reuse of heat and products as well as the identification of the most appropriate disposal methods. At present Japan has thirty-eight industries participating in voluntary actions related to environmental achievements. These include goals for a reduction in final waste disposal by 25% between 2000 and 2005, with the 2000 data already one-third of the same figure only two decades ago. As another example, CO_2 emissions are down significantly, in part due to the new controls on emissions and reduced idling time for heavy vehicles. Shoji noted that streamlining the waste management system, and reducing its cost, required a redefinition of waste. He proposed that the recycling of valueless materials be not treated as waste management, but rather handled under the legislation related to resource management. He generalized his argument by observing that a recycle-oriented society may require further legislation as well as a prioritization of existing laws, though he also called for industry to take the leadership.

HELIAS UDO DE HAES (Leiden University) discussed broadening the scope of life cycle approaches. He noted that LCA is

being incorporated into industry, in part due to economic reasons, though there are also legal drivers. In Europe, this includes, specifically, the waste management directives as well as the integrated product policy (IPP) framework. Nations can deviate from the well known 'reduce, reuse, recycle' hierarchy only if this can be rationalized, such as by LCA. In a similar vein, the IPP packaging directive will permit one-way packaging only if it is shown to be superior using environmental indicators or LCA. For Type III labeling, or EPDs (Environmental Product Declarations), approximately ten economic sectors are involved in a proposal to the EU to coordinate the schemes in individual countries. It is proposed to develop a harmonized EU Life Cycle data base. Udo de Haes summarized the scientific developments in LCA, including harmonization; many of those are now addressed by the new UNEP/SETAC Life Cycle initiative. Topics for the sophistication of LCA include an increase in spatial detail, dynamic and non-linear modeling, more sophisticated box models, the statistical treatment of uncertainties as well as the economic processes inclusion in LCI. From a scientific point of view, these developments are welcome. But it is not always clear how much they can contribute to Life Cycle Management[1] (LCM). If LCM is taken as a reference, there may be other priorities. Thus he suggested:

1. The development of Pass/Fail criteria for example concerning certification of types of land use. Such a pass-fail approach may well share the flowchart with LCA.
2. The use of a toolbox, for answering different types of questions in LCM.
3. Hybrid modeling, consisting of detailed modeling of a limited set of core processes (for instance by traditional process-LCA), connected with less detailed modeling of background processes (for instance by environmental IO-LCA).

Hybrid modeling could be seen as an optimum between fully integrated, complex modeling on the one hand, and the use of a toolbox of non-connected tools on the other hand. Udo de Haes concluded that, to support LCM, new research priority setting is necessary.

THOMAS GRAEDEL of Yale University followed up on Udo de Haes' comments and asked how we can best serve the needs of the environment and future society, as we refine our ecobalance tools and research. Graedel turned to an example of a kettle developed in England, several years ago, which could be disassembled by removing a single screw. This product fell into less than ten pieces, only two of which contained metal, with all the plastic made from the same material. However, according to Graedel, LCA is not able to address the advantages of this product[2]. Graedel also used examples of urban development, noting that we do not have tools to determine if they are sustainable. In terms of the industrial implementation of LCA, Graedel continues to advocate streamlined (simplified) methods which retain the

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[1] According to this definition, 'Life Cycle Management' includes not only the typical combination of economic and environmental data, within a product context, but also comprises a basis for government policy. The latter would more typically be defined as LCA in decision-making, for example by SETAC-Europe's Working Groups. Readers are encouraged to consult the various monographs, submitted to SETAC press, on the various definitions, as well as case studies, in LCM and decision-making.

[2] A debate following the presentation noted that if an LCA cannot account for end-of-life advantages, then one would question if the functional unit, system boundaries and the end-of-life model have been appropriately defined.

breadth of LCA though minimize the level of quantification and detail. He stressed the need to have environmental assessments which are easily and rapidly communicable to designers, many of whom have very limited periods of time to include any parameter, including environmental impacts, in development. To maximize the efficient utilization of resources and minimize the generation of wastes he cited the classic example of an ecoindustrial park at Kalundborg, near Copenhagen, and he emphasized the importance to learn from biological ecosystems in networks known as 'food webs' in order to optimize industrial chains. Metabolic investigation (i.e, the characterization of inputs and outputs) is a common tool to analyze human society at the level of cities or regions. Material Flow Analysis aims at analyzing the stocks and flows of a single resource in a specific region. For example, Japan, per capita and year, imports about 12 kg of copper, stores nearly 5 kg, exports 2 kg in products and 2 kg in scrap and semi-finished products, and disposes off 3 kg. Graedel concluded by listing a few issues which should be discussed, including:

1. A definition of what we wish to sustain (e.g. current situation).
2. A definition of for whom we wish to sustain the world[3].
3. For how long do we wish to sustain the globe.

Overall, Graedel sees ecobalance as more than LCA. He stressed that it must look for information from analytical tools, and must also address global issues and the future.

2 Closing Plenary Session

The Closing plenary session was organized by a group of relatively young members of the program committee. On behalf of the group, HIROKI HONDO of the Central Research Institute for Electric Power Industry, Japan, chaired the closing session. He introduced that the session consisted of three parts. The first was a ceremony for the Poster Prizes, followed by the session summaries and the panel discussion.

2.1 Poster prize

Amongst the overall 116 posters, eight posters were awarded by ITARU YASUI of Tokyo University on behalf of the Executive Committee. They were selected by anonymous voting based on content, explanation and presentation. Under the case study category in which there were 60 posters, the following posters were recognized with congratulations to the authors:

1. N. Koga, H. Tsuji and H. Nakano (Japanese National Agricultural Research Center for the Hokkaido Region) for 'Assessing Overall Environmental Issues of Arable Land Crop Production in Hokkaido'.
2. Y. Kato (Japan Science and Technology Corporation), A. Inaba and M. Sagisaka (AIST) for 'The CO_2 emissions for some metal resources from production country to Japan'.
3. E. Benetto, E. Popovici, P. Rousseaux (INSA, Lyon) and J. Blondin (CERCHAR-SNET) for 'Life Cycle Assessment of Coal by-Productions and biomass based electric power production'.
4. F. Cappellao, P. Masoni, A. Moreno, L.Naldesi and S. Scalbi (Italian National Agency for New Technologies) for 'Need for the Use of Standards for LCA data bases'.

In the 'non-case' category, the following posters were awarded certificates:

1. M. Funakoshi, K. Matsumura and I. Yasui (University of Tokyo) for 'Analysis of the change of the citizens' consciousness toward the environment by multi-agent model'.
2. Y. Yagita, Y. Aikawa (Ochanomizu University, Japan) and A. Inaba (AIST) for 'A proposal of the quantitative evaluation method for social acceptability of products and services'.
3. H. Tanikawa (Wakayama University, Japan), S. Hashimoto and Y. Moriguchi (National Institute for Environmental Studies, Japan) for 'Estimation of Material Stock in Urban Civil Infrastructures and Buildings for the prediction of waste generation'.
4. K. Nakajima, Y. Uchiyama (University of Tsukuba) and K. Halada (National Institute for Materials Science, Japan) for 'I/O Analysis for environmental effect of newly developing steel recycling technology'.

2.2 Session summaries

The closing plenary summarized the six parallel sessions of the Conference.

[Session 1] REINOUT HEIJUNGS (Leiden University) summarized the session Life Cycle Assessment beginning with the summary of seven presentations in the sub-session on LCAs in developing countries. There was a very large interest in emerging countries on the development and application of LCA. There was also a large focus on end-point modeling in life cycle impact assessment, with a focus on damage functions, rather than mid-points. There were also novel methods for weighting and incorporation in decision support. Heijungs noted that a problem of communication to decision makers in government and industry remained. For methodological issues, some hybrid and input-output approaches and methods for uncertainty and sensitivity analysis including Monte-Carlo-Simulation were presented. Heijungs mentioned that uncertainty/sensitivity analyses have been used until now mainly in the inventory phase, which might be one of the targets of the UNEP/SETAC Life Cycle Initiative. There were a lot of case studies in many industrial sectors (e.g. automotive, metals, machinery, waste-water treatment, mining) with good acceptance. Generally, these LCAs were partial with a cradle to gate analysis performed. The presentations in this session included dynamic system modeling, the optimization of processes and the evaluation of urban or local systems.

[Session 2] MARK GOEDKOOP (Pré Consultants) summarized the session Environmental performance indicators. He noted the involvement of stakeholders and the fact that many indicators were indeed ratios, even ratios of other indicators. There was a debate on simplicity and complexity, with a desire for a facile, LCA-validated, metric. Goedkoop noted that there were several, quite different, interpretations of eco-efficiency. Indeed, not all definitions could even be categorized as value generation per unit of environmental load. Eco-efficiencies defined by the cost per unit of environmental load and functionality of the products per environmental load were reported. The cases ranged from whole countries to a variety of products. Goedkoop noted that an important question was 'are we already there?', with an emphasis on who is 'we'.

RYOICHI YAMAMOTO showed that the sustainability targets for developing countries should leave room for less developed areas. Some firms were using indicators for the rating of staff and departments. Overall, Goedkoop concluded that the selection of indicators needs care. He also noted that there are micro, meso and macro indicators. Open questions include the issue if one can monitor countries and consumers. Transparency is, evidently, important if one uses simplified indicators for complex issues.

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[3] This touches on the intergenerational discount factor which is a value not at all agreed upon among the various stakeholders, such as NGOs, industry, governments and religious groups.

[Session 3] MATTHIAS FINKBEINER (DaimlerChrysler AG) summarized the session **Application of life cycle thinking to design and management**, which had both seventeen papers and seventeen posters. Interestingly, there were no presentations by NGOs or government, with a small number by consultants and an equal contribution by industry and academics. With almost 50% of the papers by industry, the session had the largest industry contribution of all sessions of the conference. Finkbeiner noted the use of LCA for product development was confirmed to be one major application, followed by corporate management. Some key messages of the session were:

1. There is no single solution or tool for the variety of products and companies. Therefore, there is no best practice or recommended practice. Simply, whatever is useful should be used.
2. A clearer separation of LCA science and LCA application might help to focus the future discussion. For application, the actual improvement of environmental burdens and relevance for decision-making are the main criteria, while for judging the progress of LCA science the criteria of good scientific practice have to be applied.
3. It remains difficult to prove the business case for environmental management. There also seems to be a lack of correlation between what is done in industry and what is reported, since new developments, environmental included, are kept in-house.
4. Market drivers are still weak, though the most effective, because some of the environmental legislation lacks the life cycle perspective and is therefore, at times, counterproductive.

[Session 4] CLAUDE SIEGENTHALER (Sinum AG) summarized the thirty papers of the session **Environmental information of product/company and its use**. The majority of papers were from non-profit organizations (36%), public-private partnerships (30%) and private firms (28%), with government at 6%. A broad variety of presentations were given and addressed mainly three key questions: First of all, for whom are we collecting or to whom are we addressing environmental information? Second, what kind of environmental information is needed and appropriate? And third: How to deliver it and how to make it effective (meaning leading to real effects and changes towards ecological sustainability)? Regarding the first question the presentations provided findings and concepts addressing mainly four target groups: Managers including non-environmental experts, investors, professional business to business customers or end-use consumers and citizens. For the second and third questions, the broad variety of tools for the collection, processing and communication of environmental information for several target groups were discussed, e.g., Environmental Accounting (EA), Environmental Reporting (ER), EcoRating and Environmental Product Declaration (EPD). For EA, DANIEL RUFER presented a comprehensive overview of the applicability and benefits of Ecobalancing for companies as the key-note presentation. A recent study presented by KENJIRO HIRAYAMA demonstrates that the governmental guidelines on EA have a clear empirical impact on the way companies conduct EA in Japan: from 245 reports investigated, the conformity rate was at an impressive 77%. It was also reported that Environmental Reporting has reached a high 20% of all of these 1474 Tokyo Stock Exchange listed companies. In Korea, 20 environmental posters were listed from the biggest companies (poster of Ecofrontier). As investors became one of the most important target groups for environmental information for the creation and monitoring of EcoFunds or risk management of assets in general, EcoRating methods and studies were of special interest. Beyond the inves-

tors focus, especially in Japan, there is a strong movement to provide EcoRating also to consumers and the general public. For EPD, the recent trends in Korea concerning the Type Three Labelling Scheme were reported as well as the impressive speed of implementation of the green purchasing law in Japan. Overall, session 4 made clear that the technical infrastructure in terms of methods, tools and governmental guidelines concerning environmental information of products and companies were now installed and also bound to continuous improvement. Thereby, the focus is shifting from method development towards application and how to create benefit and added value for its users in political and business decision-making.

[Session 5] TSUYOSHI FUJITA (Osaka University) summarized the fifty-four papers and posters in the session **Industrial ecology/ sound energy and material cycles**. Material flow analysis dominated the session with seventeen contributions, followed by eleven presentations of regional management and/or industrial parks, twelve on waste and nine on energy from a regional perspective. His summary started with the keynote of 'Extension for types of material flow related analysis' presented by STEFAN BRINGESZE of Wuppertaal Institute. In the field of material flow analysis, there were discussions on economic analyses, socio-economic and dynamic modeling, decision support indicators and case studies on copper and heavy metals. On the other hand, presentations on regional management and/or industrial parks discussed flows within narrower system boundaries. There were also talks on materials and their cycles, sound and local/ regional energy cycles, where many papers discussed LCA and material flow analysis methodology application. The discussion of which tools were most suitable for regional analysis was also important. Fujita pointed out three main discussion topics as a result of the session. The first was the big gap between macro and micro analysis, which was denoted as a missing hole by someone of the field. The second was the discussion on which tools were most suitable for regional management. The terminology of regional management includes different levels such as local, regional and national and different aspects such as environmental pollutants, resources and waste. Tools for decision-making are needed. The last topic addressed the problem that tools should be considered based on the decision factors for management, not data oriented. There are many factors for management such as environment, resources, infrastructure, space and land use and socio-economic issues. These heavily debated topics are continuing themes in the field of industrial ecology.

[Session 6] KOHMEI HALADA (Japanese National Institute for Materials Science) summarized the presentations of the session **Assessment and choice of environmentally sound materials**. One theme focused on alternatives for hazardous materials. The assessment of the improvement of processing and technology was discussed in cable recycling, plastics extrusion, can manufacturing and alloy-based case studies. Materials selection for sustainable habitation/building and mobility was also a topic. An example of the latter included the 1 L/100 km automobile. In the field of methodology, there was a proposal to use exergy analysis to count the value of output. There were several papers pointing out the misleading results of inappropriately simplified LCAs. It is important to consider how LCA should be used from the viewpoints of cost and accuracy of the study. Halada concluded that 'eco-materials' are not equivalent to labeled materials. He stressed that this concept includes the selection and use of materials based on environmental metrics or

indicators. A single criterion usually does not work, multi-criteria approaches are needed. The choice of criteria and their integration is discussed continuously in this field.

2.3 Panel discussion: Needs and outlook, views from the supply and demand side

Following the session summaries, the panel discussion took place. The target of the discussion was to identify the future needs and to create an outlook for the Conference, both from users and suppliers of LCA and related tools.

NORIHIRO ITSUBO of AIST in Tsukuba was the first speaker in the panel discussion, summarizing the pre-conference survey of participants regarding the future needs for ecobalance research and development. Five key areas were identified by the respondents (number of answers split equally between Japan and the rest of the world):

1. Establishing a state-of-the-art in the practice of LCA.
2. Linking LCA with other tools, in particular to those that are market related, such as green procurement.
3. Establishment of metrics for sustainable development.
4. Closing the gap between theory and practice.
5. Promotion of LCA in SMEs and in emerging/developing countries.

Following this overview, seven panelists, moderated by YUICHI MORI-GUCHI (NIES, Japan), discussed the future for LCA and related tools. A summary of the panelists' comments is included below.

REINOUT HEIJUNGS of Leiden University underlined the three-dimensional aspect of sustainability (economic, social and environmental) and posed the question if international meetings should focus on one of these aspects. He also noted that there was extensive literature on multi-criteria decision-making under uncertainty.

DANIEL RUFER from E2 Management Consulting in Zürich distinguished between environmental tools for products and for firms. He mentioned that LCA should not consist of research projects but rather be applied routinely, perhaps in a simplified form. Rufer also underlined that management requires measurement and that, for firms, ecobalances need a time dimension, such as a fiscal year.

DAVID HUNKELER of AQUA+TECH took up the theme of the differences, and complexity, in various environmental management approaches, noting the opportunity for simplicity and commonality. Quoting some work initiated in Latin America, Hunkeler mentioned that the risks associated with large firms in emerging regions are quite similar to those of northern SMEs. Specifically, the consequences of improper resource allocation not only influence the bottom line, but can be catastrophic to the firm and lead to bankruptcy. Therefore, the expansion of life cycle related methods presents an opportunity to the supply chain, which involves many SMEs, and for working with emerging countries. Specifically, those organizations which lack resources, though wish to carry out environmental management activities, require validated metrics which are based on systematic studies. The communication of these metrics or indicators, both through the supply chain and in the form of a North-South dialog, is required. Hunkeler also noted that the choice of specific tools will be dependent on the product at hand and the organization and is, therefore, management context dependent. He also pleaded for a distinction between private and public sector decision support methods.

SHIGEYUKI MIYAMOTO, from NEC, noted that sustainable development, for a private organization, needs to be profitable. The selection of methodology is critical and industry requires success cases to justify the costs incurred in environmental management.

JUNKO EDAHIRO, a Japanese Environmental Journalist now working for the recently founded NGO 'Japan for Sustainability', noted that the public interested in environmental affairs does not recognize the term life cycle assessment. She noted that the public seeks to understand environmental tradeoffs and recommended that environmental ambassadors be trained to interface with the population.

MARIAN CHERTOW of Yale University, formerly responsible for the waste management in one US state, began her discourse by mentioning that government requires Ecobalance's tools. She also mentioned that systemic approaches have limitations for policy makers since their decisions are incremental. 'Science (can) prove things false and politics is the act of compromise'. Therefore, given the fact that the results from different LCAs on the same product are often contradictory, Chertow believes that LCA, and related approaches, need to give policy makers 'a place to stand'.

THOMAS GRAEDEL of Yale University questioned how one would know the difference between changing something for the good and a change that is necessary for sustainable development. Sustainability may, therefore, require tools that do not exist at present. Graedel also pleaded for more interdisciplinary work, amongst practitioners themselves, specifically with social and environmental scientists.

YUICHI MORIGUCHI expanded on this, calling for collaborations between countries. ATSUSHI INABA (AIST, Japan) mentioned that Japan has begun this in the Asian region, though there was a strong desire, on all fronts, for stronger links between Europe, Asia and the Americas. MATTHIAS FINKBEINER (DaimlerChrysler) cautioned that scientific communities of one area, dedicated to LCA or other activities, cannot achieve sustainability on their own. They cannot achieve sustainability only by cooperating with other fields. They should make efforts also inside in their own community.

At the end of the closing session, ITARU YASUI (University of Tokyo, Chairman of the Executive Committee of the 5th-ICEB) completed the formal portion of the Conference by recalling that the 1st-ICEB was held in 1994. Over the past five Conferences the participants have confirmed that both practical tools and thoughtful principles have been discussed in relationship to sustainability. Yasui announced that the Sixth International Conference on Ecobalance, in 2004, will aim at improving the various assessment tools. The integration and linking of tools as well as a description of their function will also be important. KEN MORISHITA (Eco-Management Institute in Tokyo, Chairman of the General Affairs Committee of the 5th-ICEB) thanked all attendees for their participation.

Reference

[1] Hunkeler D, Rebitzer G, Inaba A (2003): Environmental Performance Indicators and Application of Life Cycle Thinking to Product Development and Corporate Management – A Detailed LCM-Related Excerpt of The Fifth International Conference on Ecobalances, November 6–8, 2002, Tsukuba, Japan. Int J LCA 8 (1) 55–58