Institution: University of Surrey

Unit of Assessment: UOA 15 General Engineering

Title of case study: Changing industrial practice through lifecycle modelling

1. Summary of the impact

Developing sustainable consumption and production policies and practices in industry requires analysis of technical, environmental, economic and social performance of supply chains delivering goods and services. In a programme covering the 20 years since its foundation, the University of Surrey's Centre for Environmental Strategy (CES) has played a major role in developing a systematic "whole system" approach to assessing and managing supply chains, starting from Life Cycle Assessment (LCA) and Life Cycle Management (LCM) and progressing to sustainability analysis.

This approach underpins current national and international standards and policy and is embodied in the corporate strategies of a number of major companies (for example Unilever and M&S); the approach is also starting to be adopted in guiding the development of new consumer products.

2. Underpinning research

Achieving sustainable consumption and production requires analysis of technical, environmental, economic and social performance of the supply chains delivering goods and services [1]. Since its foundation in 1992, CES has been a leader in developing a systematic "whole system" approach to the class of environmental system analysis tools for assessing and managing supply chains which started with the quantitative modelling approach of Life Cycle Assessment (LCA) and, through integration into general decision-making processes, developed into the use of LCA for Life Cycle Management (LCM) and wider sustainability analysis. Surrey's Research has been pursued with and for analysts and consultants using these tools and approaches to develop evidence-based policy and commercial strategy for selecting and designing more sustainable processes [2]; designing, making and certifying more sustainable products [3,4]; and managing resource use and waste [5,6].

This area of research was initiated by Professor Roland Clift (1992- present) and over the following two decades has been refined and applied by many other researchers, some of whom subsequently developed activities elsewhere based on their experience at Surrey. Current CES staff active in this area include Drs. Elghali, Lee and Sadhukhan and Prof. Murphy. Dr. Mila i Canals spent 5 years with Unilever embedding the approach within a global consumer products company; he now has a senior role in the LCA programme of the UN Environment Programme. Dr. Cowell now leads an active research group as Associate Professor in Life Cycle Management at Massey University (NZ). Dr Basson is now advisor on "green enterprise" to the Government of Western Cape Province (South Africa). Prof. Azapagic, now at the University of Manchester, leads a group applying the particular quantitative modelling approach on which she worked in CES. Prof. Clift was awarded the Royal Academy of Engineering's Sir Frank Whittle Medal in 2003 "in recognition of an outstanding and sustained engineering achievement contributing to the well-being of the nation", specifically for the programme of work referred to in this case.

A specific contribution of the research to LCA methodology has been the distinction between "Foreground" and "Background" sub-systems to delineate where primary data on the energy/resource inputs or pollution outputs of each stage in a supply chain are essential and where it is acceptable to use secondary data from quality-assessed databases [5]. Surrey's

current research focuses on the distinction between application of attributional [i.e. accounting] approaches used, for example, in product labelling and consequential [prospective] approaches for strategy and policy; this is particularly important in assessing the impacts of land-use change [4]. CES is one of the leaders in driving this research and is involved in the efforts of the European Commission and other bodies, including standardisation organisations, to develop clarified and standardised approaches.

Effective use of this kind of system analysis for decision support and supply chain management requires quantitative LCA to be combined with other approaches including multi-criteria decision analysis and other forms of stakeholder engagement based on understanding of behavioural change. Combining quantitative system analysis with more qualitative approaches is a key feature of the research. Assessing the sustainability of supply chains requires assessment of the distribution of social benefits as well as environmental and economic impacts along supply chains [1,3].

3. References to the research

1. Clift,R., Sim, S. and Sinclair,P. (2013) Sustainable Consumption and Production: quality, luxury and supply chain equity. In: Treatise in Sustainability Science and Engineering. (Ed. I.S.Jawahir, S.Sikhdar and Y. Huang), Springer Publishers.
2. Azapagic, A., & Clift, R. (1999) Life Cycle Assessment as a Tool for Improving Process Performance: A Case Study on Boron Products. International Journal of LCA, 4(3), pp.133-142.
3. Clift, R., & Wright, L., (2000) Relationships between Environmental Impacts and Added Value along the Supply Chain. Technological Forecasting and Social Change, 65, pp.281-295.
4. Cederberg, C., Persson, U.M., Neovius, K., Molander, S. and Clift, R. (2011) Including carbon emissions from deforestation in the carbon footprint of Brazilian beef, Env. Sci and Tech., 45, pp.1773-1779.
5. Clift, R., Doig, A., & Finnveden, G. (2000) The Application of Life Cycle Assessment to Integrated Solid Waste Management: Part 1 - Methodology. Trans IChemE (Process Safety and Environmental Protection), Special Issue: Sustainable Development, 78, pp.279-287.
6. Muñoz, I., Milà i Canals, L. and Clift, R. (2008) Consider a spherical man – a simple model to include human excretion in Life Cycle Assessment of food products, Journal of Industrial Ecology, 12(4), pp.521-538.

4. Details of the impact

The approach to LCA developed at Surrey (notably “Foreground” and “Background” analysis) is now standard practice in industry and amongst LCA practitioners: it is embedded in the tools used by local authorities for waste management planning and public engagement; it is embodied in industry-standard tools and software packages for LCA more widely; it provides the basis for “ecolabelling” of products and services to inform consumer purchases; it has shaped commercial efforts to improve supply chain sustainability and it underpins development of some innovative consumer products.

Surrey’s approach to LCA is embedded in the tools for waste management decision support developed by the UK Environment Agency for use by local authorities and waste management authorities, ‘WIZARD’ and ‘WRATE’. These tools are also used as a vehicle for public engagement in what can be highly contested local decisions. The Science Manager at the

Environment Agency who led this work says "*the CES approach of distinguishing between 'foreground' and 'background' in the system and the related processes and also between process- and material-related burdens was essential and provided one of the bases for the approach adopted by the government… The researchers at CES have been the academic leaders in the UK in developing sound but practical LCA methodology*." [a].

The approach has been embodied and extensively referenced in the world's first standard for carbon labelling of products and services: the British Standards Institute's (BSI) "PAS 2050: Specification for the assessment of the life cycle greenhouse gas emissions of goods and services", developed in 2008 and updated in 2011 [b]. PAS 2050 is the basis for the "carbon footprint" labels now carried by many consumer goods. Surrey's Professor Clift and Professor Jackson were key members of the group which developed and revised PAS 2050, at the specific invitation of Defra and the Carbon Trust. An extensive industry has also been spawned based on PAS 2050: for example Lloyds register promote environmental quality assurance and regulatory compliance services by implementing the standard and Arup and the Carbon Trust developed Footprint Expert™, a toolkit aimed at delivering PAS 2050 assessments to businesses. The Carbon Trust state that they are 'the world's leading certifier of organisational carbon footprint reduction' and 'global leader in product carbon footprinting certification for PAS 2050', with 650 organisations achieving the carbon Trust Standard in the past 5 years [c].

The International Standards Organisation (ISO) has now issued a technical specification for carbon labelling which embodies the CES and PAS 2050 approach, and ISO is developing a standard for the carbon footprint of products, ISO 14067: 'The document is currently at the stage of Draft International Standard (DIS) and is expected to be finalized for publication in March 2014'. 'ISO 14067 will be consistent with …BSI PAS 2050' [d]. In parallel, a business-NGO partnership called the GreenHouseGas protocol initiative launched in 1998 to develop accounting tools for government and business to understand and manage greenhouse gas emissions. More than 1,000 organisations internationally have used the GHG Protocol, including 63% of the Fortune 500 companies. The GHG Protocol built on the initial PAS 2050 method in development of its Product Standard.

This area of research continues to be taken up by industry-standard models and databases. Muñoz et al. [6] presented the first model to include human digestion and excretion in LCA. Surrey researchers agreed for it to be incorporated into the algorithms of 'EcoInvent v3', which is the industry standard life cycle inventory database tool. Future LCA studies of food supply and related agricultural land use undertaken by researchers, industry and policy-advisers internationally may thus be extended and improved, based on this piece of research.

The approach to analysing and managing supply chains and consumption has also been applied to help develop industry-leading initiatives such as Marks and Spencer's "Plan A" and Unilever's "Less Environmental Impact", which consider social benefit as well as environmental impact.

The impact of this research is truly international. Among the growing LCA community worldwide, there is a particularly active group in New Zealand (LCANZ), motivated by the need to establish environmental credentials for international trade; every one of the founding officers of LCANZ is a CES alumnus, including Prof. Cowell. LCANZ is one of the leading bodies outside Europe providing accredited carbon labels, which are changing the practices of producers and changing purchasing practices of consumers.

The International Council on Mining and Metals commissioned a report (2013, in press) on the application of life cycle approaches in the primary resource sector, written by Prof. Clift and Dr. Basson with Prof. J.G. Petrie (now Energy Advisor to the Government of the Western Cape,

South Africa, and a Visiting Professor in CES).

One specific piece of work applying consequential LCA to land-use change was an analysis of the carbon footprint of Brazilian cattle farming [4]. Surrey's research had impact internationally, resulted in it being quoted in BSI's PAS 2050 and prompting more than 60 secondary articles and provoking a specific defensive press release by the Brazilian beef industry [e].

The approach developed by Surrey is now also being applied to specific product and service innovation. It underpinned development of a new type of beverage packaging, delivering chilled drinks without refrigerated storage. The packaging was developed in the US by the Joseph Company with the benefit of saving energy for refrigeration and emissions of refrigerants (which are potent greenhouse gases) from poorly-maintained soft drinks dispensers [f]. The initial product, cooled by refrigerant release, was banned by the then UK Department of the Environment (DoE) in 1998 because of its disproportionate contribution to climate change. A more environmentally benign form, chilling through release of carbon dioxide adsorbed onto activated carbon produced from organic waste, was then proposed by the company. DoE agreed to lift the ban on the express condition that an LCA was undertaken, by Surrey researchers, that showed it to be no worse than conventional refrigeration. Surrey researchers have subsequently worked with the Joseph Company applying LCA and systems methods to re-design the chilling system and the supply chain. ChillCan was launched in Spring 2012 as an environmental "disruptive technology", winning two major industry awards: Editor's Choice Award for Packaging Design at Supply Side West (the leading international food and beverage exposition in Las Vegas) and Best Package 2012 by the beverage industry's stalwart publication, The Beverage Industry [g].

5. Sources to corroborate the impact

[a] The then Science Manager at the Environmental Agency affirms Surrey's role in the development of WIZARD and WRATE. Provided Statement.

[b] Details of PAS 2050: http://www.bsigroup.com/en/Standards-and-Publications/How-we-can-help-you/Professional-Standards-Service/PAS-2050/PAS-2050/

[c] Carbon Trust and PAS2050 certification http://www.carbontrust.com/client-services/footprinting/footprint-certification

[d] Development of the ISO standard http://www.iso.org/iso/home/news_index/news_archive/news.htm?Refid=Ref1643

[e] Carbon footprint of Brazilian beef: listing available on request of more than 60 media and other articles following publication of paper [4]

[f] Article describing Chillcan http://www.dailymail.co.uk/sciencetech/article-2165903/Now-men-longer-need-fridges-First-self-chilling-beer-sale-UK.html

[g] See http://chillcan.com/self-chilling-vending-machine-debuts-at-the-university-of-surrey/