West Coast Forum Research Work Group Topic 2 – Product Design and Packaging

Summary of Research Findings and Gap Analysis

Topic 2: How we design, make and package products as a new focus of materials management strategy

RESEARCH QUESTION(S)

- Which government programs, policies, and strategies are the most effective: tax incentives, taxes, zoning, permitting, sales restrictions, subsidies, education, etc.?
- How much greenhouse gas (GHG) reductions could be achieved by focusing on changes to the design, manufacturing, and packaging of products as a materials management strategy?
- How do GHG reductions achievable by changes to product design compare to those achievable by increasing reuse, recycling, landfill diversion and similar end-of-life approaches?
- Where and how have product stewardship programs, such as extended producer responsibility and take-back programs, been effective (U.S. and international) at bringing about product design changes that have reduced GHG emissions?
- How do the GHG reductions compare to those associated with recycling, diversion, reuse, etc.?
- What have these programs cost and what are the lessons learned?
- How effective are various government approaches at influencing product design?

SUMMARY OF KEY FINDINGS

Identifying GHG Emissions throughout the Life Cycle

The literature highlights the importance of understanding at what stage during the life cycle do GHG emissions occur at the greatest magnitude. Different products will have vastly different GHG footprints for the various stages of the life cycle. Below is a list of products reviewed and the most important life cycle stage to focus on in order to reduce GHG emissions:

- *Apparel:* Single most important factor determining a garment's life-cycle GHG emissions is use-phase care (laundering accounts for 40-80% of total life-cycle GHG emissions for garments) (Business for Social Responsibility, 2009).
- *Large Scale Milk Production:* The agricultural stage contributes most to the total consumption of energy (Eide, 2002).

Importance of the Design Phase

Palousis et al. (2008) and Yarwood and Egan (1998) identify the design phase as a critical leverage point in reducing and mitigating the environmental impacts of products. According to their work, 70% of the life-cycle costs (including some environmental impacts – not clarified which) of development, manufacturing, and use is determined in the design phase for a typical product. Given the importance of the design phase, Palousis et al. (2008) recommends that governments focus on working with producers to integrate existing design methodologies that asses environmental impact (LCA) and cost impact (LCC – life cycle costing) across the product's life-cycle in order to achieve product sustainability.

Roper proposes a design for building material use and reuse using a waste management hierarchy and life cycle materials management. He concludes that significant money and resources can be saved and that knowledge is the key to success. He argues that the fear of the unknown is precluding opportunities, and that better understanding waste components, disposal options and service providers would be a big step.

Additional research points to the importance of the design phase, but a significant challenge is lack of know-how to design environmentally friendly products, especially products adapted to recovery strategies like reuse, remanufacture and recycle. Gehin et al. (2008) identify the remanufacturing phase as having substantial opportunity to reduce the environmental footprint of products. Remanufacturing reduces the raw materials component, can decrease the price of products and lower disposal costs. It can also improve regulatory compliance and create jobs.

Byggeth, et al. (2006) evaluate and discuss eco-design tools that can be used in both product development and purchasing, for example, to prescribe design alternatives, assess environmental impacts or to compare environmental improvement alternatives. The authors concluded that using a comprehensive eco-design tool required that trade-offs are made. Those tradeoffs often occur in one of the following three ways: material and material, material and energy and material and cost. Those tradeoffs are determined, in part, by what perspective is being considered, customer, company or environment.

Packaging (Food)

Marsh and Bugusu (2007) provide an in-depth overview of issues surrounding food packaging and its role, materials, and environmental issues. They found that food packaging accounts for 2/3 of all packaging waste by volume. Marsh and Bugusu focus on potential source reduction opportunities to minimize packaging and its environmental impacts, which include:

- Light-weighting packaging materials,
- Purchasing durable goods,
- Purchasing larger sizes (which use less packaging per unit volume),
- Refillable containers, and
- Purchasing toxic-free products.

While they identify source reduction as an important strategy to reduce the environmental impacts of packaging, Marsh and Bugusu note that source reduction efforts and convenience are often opposing pressures on food packaging design. Consumers tend to demand convenience in purchasing food, and typically improving convenience requires the use of more packaging materials. Source reduction efforts could be accelerated if consumers were willing to accept losses to convenience by modifying their buying habits accordingly.

Marsh and Bugusu also discuss that containers and packaging are often recovered through recycling at about 40% of what's generated.

Extended Producer Responsibility

There is general agreement that extended producer responsibility (EPR) programs have increased the recycling rates and led to safer handling of toxic materials (Walls, 2006; van Rossem, Tojo, & Lindhqvist, 2006). Only a few studies that have examined the effects of EPR policies on product design changes. Naoko Tojo's (2004) research on the product stewardship policies for electronics and automobiles in Japan and Sweden offers the most in-depth (and oft-cited) analysis, and it does present some qualitative evidence that product stewardship policies can drive design and manufacturing changes (Tojo, 2004). In his evaluation, however, it is not clear which types of product stewardship policies have been most influential for specific changes because several policies were implemented at similar times. Additionally, company representatives cite both various product stewardship policies and other legislation and voluntary standards, among other factors, that have been influential in driving design and manufacturing change (Tojo, 2004). The most clearly identified correlations between product stewardship and upstream design changes were found in the following areas:

- The reduction and elimination of restricted or banned substances (e.g. lead via WEEE and RoHS);
- The use of product impact assessments (e.g. LCAs) based on guidelines from the government (e.g. in Japan's 1991 Recycling Promotion Law); and
- Improving product reusability and/or recyclability and available recycling infrastructure in response to reuse and recycling rate requirements.

In particular, Tojo (2004) says that materials restrictions and recycling requirements have directly affected manufacturers' undertaking of upstream actions, with the main outcomes being reduced use of hazardous substances and increased product recyclability. However, the impacts of these actions are largely concentrated on the downstream section of the product's life-cycle.

Margaret Walls' (2006) research on EPR programs and their impact on design for the environment offers another look at the impact of products stewardship on upstream changes in the product life-cycle. Walls reviews a range of EPR policies in her analysis and finds that some design changes – especially reductions in material use and product downsizing – can be achieved with most EPR policies, including producer take-back mandates and combined fee/subsidy approaches. However, none of these alternative policies as they are currently implemented are likely to have a large impact on other aspects of design change. She draws this conclusion from evaluating a range of EPR policies currently in effect. She found that there is no empirical evidence about the current Maine EPR legislation on electronics to support the state's goal of having impacting the design of electronic devices for the environment. The relatively low cost of handling Maine's e-waste ($0.66 kg) does not represent a significant price signal for producers to redesign their products given the overall cost of an electronic good and market indifference in the consumer demand for electronic device recyclability. In her conclusions, Walls indicates that:

> Different types of EPR policy instruments may all be able to achieve relatively high recycling rates. Whether it is a fee/subsidy approach or a more traditional producer take-back approach, recycling is likely to increase with EPR. Changes to product design, on the other hand, are not as obvious and are difficult to attribute to the policy even when they do occur. The policies in place affect design only indirectly and this makes design changes difficult to trace out in practice.

STATE OF KNOWLEDGE AND INFORMATION GAPS

- Individual support tools for eco-design are insufficient to provide a sustainability framework and can lead to a suboptimal path. Tools must be used with together in a complementary nature.
- While LCA is often considered a starting point for environmental policy, no one standard exists for designers to use.
- There seems to be general agreement on the importance of product design in establishing the life-cycle environmental impacts of products. Additionally, some work has been done to identify actions that producers could take to reduce product impacts. However, there is a large gap in understanding how effective these actions have been and identifying effective leverage tools to promote such actions.

BIBLIOGRAPHY

Byggeth, Sophie & Hochschorner Elisabeth. "Handling trade-offs in Ecodesign tools for sustainable product development & procurement." Journal of Cleaner Production, 14:15-16, 2006.

Gehin et al. "A tool to implement sustainable end-of-life strategies in the product development phase." Journal of Cleaner Production, 16:5, 2008.

Eide, M.H. "Life cycle assessment (LCA) of industrial milk production." International Journal of Life Cycle Assessment, v7, n2 (115-126). 2002.

Marsh, K., Bugusu, B. "Food Packaging—Roles, Materials, and Environmental Issues." Journal of Food Science, v72, n3 (R39-R55). 2007.

Palousis, N., L. Luong, K. Abhary. An integrated LCA/LCC framework for assessing product sustainability risk. 6th International Conference on Computer Simulation Risk Analysis and Hazard Mitigation, Risk Analysis 2008. WIT Transactions on Information and Communication Technologies, v39 (121-128). 2008.

Roper, W. "Strategies for Building Material Reuse and Recycle," International Journal of Environmental Technology and Management v6, n3-4, p313 (33).

Tojo, N. *Extended Producer Responsibility as a Drive for Design Change – Utopia or Reality?*. International Institute for Industrial Environmental Economics, Lund, Sweden. 2004.

van Rossem, C., Tojo, N., T. Lindhqvist. *Lost in Transposition? A study of the implementation of individual producer responsibility in the WEEE directive.* Green Peace. 2006.

Walls, M. *Extended Producer Responsibility and Product Design*. Resources for the Future, Washington, DC. 2006.

Yarwood, J.M. and Eagan, P.D. Design for the Environment Toolkit: A Competitive Edge for the Future, Minnesota Office of Environmental Assistance: Minnesota, 1998.