Problem Statement

Package design has numerous environmental impacts throughout its life cycle. Part of this impact is well understood and appreciated: municipal solid waste in the U.S. topped 245 million tons in 2005, and of this as much as one third can be attributed to consumer packaging. Pre-consumer packaging from commercial or industrial sources is of a similar magnitude.

Often overlooked, however, are the environmental impacts associated with packaging manufacture and package transport. Both require enormous amounts of raw materials, energy, and other resources while generating various forms of pollution. According to the Tellus Institute, “…the environmental cost of production contributes 99% of the environmental harm….The problem of packaging facing the environment is not a problem related to disposal. It is a problem of production…”

Engineers at Toyota Motor Sales (TMS) are responsible for packaging and distributing over 110 million parts through their parts logistics operations every year, using both returnable and disposable packaging. Given the various environmental impacts and high volume of pre-consumer packaging, the TMS engineers are in a unique position to affect significant environmental improvements. Unfortunately, packaging engineers at TMS presently lack the requisite tools for making informed decisions and evaluating the environmental impacts of design options. This represents a significant information gap and opportunity for improvement, both financially and environmentally.

Background Information

Toyota Motor Sales has recognized the intimate connection between packaging design, distribution processes, and the resultant resource use. TMS has made changes to its packaging design aimed at improving and streamlining the logistics process. This has often had the additional benefit of reducing environmental impacts.

As TMS captures more of the American market each year, not only are overall vehicle sales growing but also the number of accessories installed per vehicle (12% per vehicle increase in 2006). For accessories installed at vehicle distribution centers, TMS controls all aspects of
parts manufacturing, packaging, distribution and disposal. As such, TMS is in a unique position to affect all aspects of this process. Such capacity to modify the process is rarely so controlled, and presents fantastic opportunities for improving efficiency. TMS’ past efforts to increase efficiency have included shipping certain accessories directly to vehicle distribution centers, bypassing parts distribution centers, using returnable shipping modules, and exploring the use of different materials. These efforts have also reduced greenhouse gas emissions, curtailed energy consumption, and diminished resource use. To date, however, that impact has not been adequately quantified and package designers lack the tools necessary to evaluate the environmental impacts of implemented changes, as well as the tools necessary to facilitate making informed decisions on design/distribution options in the future.

**Project Objectives**

This project will create decision support tools to be used internally by TMS design engineers specializing in the packaging and distribution of post production options (accessories installed at TMS-owned vehicle distribution centers).

Specifically, this project will:

- Build a robust model to assess the environmental and cost implications of potential design changes on an ad hoc basis.
- Use the model to answer the initial questions:
  - Is it environmentally preferable to design packaging with 5 pounds of cardboard with 100% recycling rate or 1 pound of plastic (LDPE) with a 50% recycling rate?
  - What is the reduction in greenhouse gas emissions from a supplier shipping parts directly to a Vehicle Distribution Center instead of through the part distribution network?
  - What have been the environmental benefits or costs of TMS’ increased use of returnable shipping modules?
- Develop a graphic user interface such as Excel Visual Basic for Applications or GaBi I-report, translating the model into a simple decision support tool (“calculator”) for use by a packaging engineer. Engineers must be able to modify the calculator in the future to incorporate emerging technologies and materials.
- Develop training and documentation materials to accompany the model and calculator.

**Project Significance**

Using the calculator, TMS will be capable of assessing the environmental impacts of packaging design; this capability can fundamentally change the way TMS packaging engineers approach design decisions. TMS will become more efficient and less resource consumptive with respect to packaging materials and distribution processes. This, in turn, will decrease the environmental impact of these operations.

Issues that may be affected include:

- Impacts from packaging materials (raw material extraction, refinement/manufacturing impacts, material cost/assembly cost, etc.)
- Effects of product transport (shipping cost, fuel consumption, GHG emissions, air pollution emissions, return transport of returnable containers/use of back-hauls, compatibility with returnable containers)
• Efficiency of inventory space use at distribution centers (utility usage, warehouse expansion needs, etc.)
• Waste Management Impacts (recycling, incineration, landfill)

The project should illustrate the linkages between packaging decisions, environmental impacts, and financial consequences. There is also the potential to provide a model to others in the industry who would like to make similar improvements. The long term benefits of this project have the potential to raise standards in the automotive industry for informed environmental and business decisions.

Approach and Data Availability
• Obtain GaBi software and execute Life Cycle Assessment and Life Cycle Costing of current packaging and logistics network based on ISO 14044 standards. Assess environmental impacts of current practices, as well as recent and proposed changes to packaging design and distribution.
• Use data collected by TMS and available to Bren students under a non-disclosure agreement.
• Tour salient facilities. Meet with packaging and distribution associates to understand the system and explore innovative materials, processes, and solutions to make the “calculator” a dynamic and accessible tool.
• Incorporate emerging low-impact materials and processes. These will be researched in the industry literature and through communication and information sharing with Toyota designers in Japan and Europe.

Deliverables
• An analysis of the three questions raised in the Objectives section in the form of an A3 document, summarizing the project findings most relevant to a TMS manager.
• A “calculator” that packaging engineers will use to compare different packaging designs and options, quantitatively showing both environmental and economic impacts of those options.
• A report on the calculator’s development providing transparency that will allow for future changes or improvements.
• Documentation and a training program on the use of the calculator.

Stakeholders
• Environmental Coordination Office: coordination, recycling
• NAPO Packaging: packaging design
• NAPO Logistics Operations: parts shipping
• NAPO NPO (NAPCC, LAPDC): parts warehousing
• TLS LBO: vehicle logistics support
• TLS VDC (LBVDC): accessory installation, vehicle logistics

Financial Needs
• $1,200 provided by the Donald Bren School of Environmental Science and Management
• Fuel reimbursement/travel costs for trips to TMS
• Meetings and meals for site visits paid for by TMS
Informing Packaging Design Decisions at Toyota Motor Sales Using Life Cycle Assessment

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References
Bren School Request for Group Project Proposals