



# *Informing Packaging Design Decisions at Toyota Motor Sales Using Life Cycle Assessment*

January 30, 2007

## **Student Proposers**

---

Claire Early  
[cearly@bren.ucsb.edu](mailto:cearly@bren.ucsb.edu)

Tim Kidman  
[tkidman@bren.ucsb.edu](mailto:tkidman@bren.ucsb.edu)

## **Faculty Advisor**

---

Roland Geyer  
[geyer@bren.ucsb.edu](mailto:geyer@bren.ucsb.edu)

## **Problem Statement**

---

Packaging 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 at least of a similar magnitude.

Often overlooked, however, are the environmental impacts associated with packaging manufacture and transportation. Both require significant 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 reusable and disposable packaging. Given the economic cost, environmental impacts and high volume of pre-consumer packaging, the TMS engineers are in a unique position to affect significant economic and environmental improvements. Unfortunately, packaging engineers at TMS presently lack the requisite tools for making informed decisions and evaluating the environmental and economic life cycle impacts of their 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. Even though the main motivation was economic, frequent additional benefits were reduced 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 a unique opportunity 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 life cycle 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 economic life cycle impacts 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 are the reductions in greenhouse gas emissions from shipping parts directly to a Vehicle Distribution Center instead of through the part distribution network?
  - What have been the environmental and economic life cycle impacts of TMS' increased use of reusable shipping modules?
- Develop a graphic user interface, such as Excel VBA macros or GaBi i-report, translating the model into a simplified 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 life cycle costs and life cycle 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 (reuse, recycling, incineration, landfill)

The project will illustrate the relationships between packaging decisions, environmental impacts, and economic costs. There is also the potential to provide a model to others in the industry who would like to make similar improvements. In the long term, this project has the potential to raise standards in the automotive industry for informed environmental and business decisions.

### **Approach and Data Availability**

---

- Conduct Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) of current packaging and logistics network using professional LCA/LCC software (GaBi4) and based on ISO 14044 standards. Assess environmental impacts of current practices, as well as recent and proposed changes to packaging design and distribution.
- Required data is either collected by TMS (available to Bren students under a non-disclosure agreement), or contained in GaBi4 databases or gathered from literature.
- 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

## Client

Ryan McMullan  
Environmental Resource Specialist  
Environmental Coordination Office  
Toyota Motor Sales  
(310) 468-4883  
[Ryan\\_McMullan@toyota.com](mailto:Ryan_McMullan@toyota.com)

## References

ISO (2006), *Environmental management – Life cycle assessment – Requirements and guidelines, ISO/FDIS 14044:2006(E)*

Bren School Request for Group Project Proposals  
Environmental Protection Agency, *Industrial Waste Management*,  
<http://www.epa.gov/industrialwaste> , accessed on January 30, 2007

Institute for Lifecycle Environmental Assessment, *Packaging*, *Tellus Institute*, 1992.  
<http://www.ilea.org/lcas/Tellus.html>

McMullan, et al (2005), *Environmentally Responsible Packaging: A Guideline and Certification Program for the Electronics Industry*, accessed on January 30, 2007

