Sustainable Packaging for Global Sourcing

Ford Motor Company
Georgia Institute of Technology

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Introduction

- Ford Motor Company
  - Roger Huff
  - Plant Operations Manager, North America Truck
Team Leaders

Ford Motor Company
- Rick DeMuro, Plant Operations Manager, Powertrain
- David Shepps, 6-Sigma Black Belt, Material Planning & Logistics
- Marsiale Arbuckle, 6-Sigma Green Belt, Powertrain

Georgia Institute of Technology
- Chen Zhou, Associate Professor Industrial and Systems Engineering
- Leon McGinnis, Eugene C. Gwaltney Professor of Manufacturing Systems
Ford Motor Company’s Heritage

- Henry Ford reused wooden crates for the Model T production parts.
Ford’s Commitment to Sustainability

- Business Principles
- “ Improved sustainability performance is not just a requirement, but a tremendous opportunity. I want our Company to be a leader in driving the transition and be in a position to benefit from it.”

Bill Ford, 2003/04 Corporate Citizenship Report
Importance

- Ford’s Commitment to Sustainability
  - Ford Rouge Dearborn Truck Plant
  - Ford Escape Hybrid
  - Auto parts with recycled content

Green roof at Dearborn Truck Plant

Courtesy: Ford Motor Company
Project Charter

- More sustainable alternatives to conventional cardboard containers for parts sourced internationally
- Alternatives must meet Ford packaging specifications and part quality requirements
- Assessment with a common set of economic, environmental, social indicators (Triple Bottom Line approach)
**Current State**

International packaging logistics system

Emerging Market Suppliers
- boxes formed and filled

Third Party Logistics
- Parts shipped in cardboard and repacked into returnable containers
- Cardboard recycled
- Assembly plants

Cardboard rolls shipped from North American locations

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Ford Consumer Driven 6-Sigma
Case Study

From Shanghai, China → Longbeach, CA → Detroit, MI → Belleville, MI → Ford Assembly Plants
Case Study - Current State

Waste

- Poor environmental sustainability with cardboard
- Potential cardboard contamination of Powertrain parts

Damage on packaging

Part quality risk (rust)
Case Study - Current State

Waste

- Non-Value Added repack process at third party logistics

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Analysis

Alternatives considered for future state

- **Alternative A**
  - Recycle international packaging into Ford vehicle splash shields (example: Ford Maumee Stamping Plant).

- **Alternative B**
  - Recycle international packaging into shipping caps and plugs for Ford Powertrain (Plastic cap and plug supplier).

- **Alternative C**
  - Recycle international packaging into returnable domestic packaging (example: Ford Powertrain unique trays).
Solution

• Proposed packaging design
### Solution

- **Proposed packaging design**

<table>
<thead>
<tr>
<th>Packaging components</th>
<th>Material</th>
<th>Quantity/pallet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top cap/lid</td>
<td>Recyclable packaging polymers</td>
<td>1</td>
</tr>
<tr>
<td>Assembled spacer for parts partition</td>
<td>Recyclable packaging polymers</td>
<td>5</td>
</tr>
<tr>
<td>Die cut layer pads</td>
<td>Recyclable packaging polymers</td>
<td>5</td>
</tr>
<tr>
<td>Die cut tube/box</td>
<td>Recyclable packaging polymers</td>
<td>2</td>
</tr>
<tr>
<td>Bottom tray/pallet</td>
<td>Recyclable packaging polymers</td>
<td>1</td>
</tr>
<tr>
<td>Volatile Corrosion Inhibitor sheets between layers</td>
<td>Recyclable polyethylene</td>
<td>10</td>
</tr>
</tbody>
</table>
**Solution**

- **Selected solution for future state**

To recycle the packaging into automotive part (splash shields)

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**Regrind** → **Extrusion process**
Sustainability at Georgia Tech

- Dr. Chen Zhou
  - Associate Professor
  - Industrial and Systems Engineering

- Vision

- Strategy
  - Research
  - Education
  - Campus initiatives
Environmentally Conscious Design and Manufacturing

- Working with Corporate Partners
  - Interested in studying sustainability and manufacturing from a holistic perspective
  - Interested in participating in a long-term research agenda to promote more sustainable manufacturing practices
Performance Measures

- **Indicators**
  - **Economic**
    - Logistics costs (transportation, packaging, warehousing services, repack process)
    - Cost of Poor Quality
    - End-of-use value of packaging
  - **Environmental**
    - Supply chain impact on the environment
      - Waste generation
      - Energy consumption
  - **Social**
    - Worker’s health and safety
Environmentally Conscious Design and Manufacturing

- Multidisciplinary Team
  - Industrial Systems Engineering
  - Chemical Engineering
  - Mechanical Engineering
  - Management

[Image of a group of people in front of a building with a sign reading "Georgia Tech"]
Design Selection Process

System Models

- Decision Tree (Option set)
- Integrated Inventory Analysis
  - Total Cost Accounting (TCA)
    - TCA Report
  - Environmental Impact Analysis (LCA)
    - LCA Report
  - Energy Consumption Analysis (ECA)
    - ECA Report

Environmental Indicators

Sensitivity Analysis
Analysis Tool

Modeling Interface

Packaging Configuration
Part Configuration
Logistics Processes

Library

Economic & Environmental Analysis Report

Total Cost Analysis
Life Cycle Analysis
Energy Consumption Analysis
**Analysis Tool**

<table>
<thead>
<tr>
<th>Information Input Button</th>
<th>Material Flow Modeling</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Part #</th>
<th>Add</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplier</td>
<td>Supplier info</td>
</tr>
<tr>
<td>Quantity (Auto Fed)</td>
<td>1000</td>
</tr>
<tr>
<td>Price (Auto Fed)</td>
<td>cost x</td>
</tr>
<tr>
<td>Location</td>
<td>abc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In: Container #</th>
<th>Pallet box</th>
</tr>
</thead>
<tbody>
<tr>
<td>In: Pallet #</td>
<td>Wooden pallet</td>
</tr>
<tr>
<td>In: Wrap &amp;</td>
<td>Small mach</td>
</tr>
<tr>
<td>In: Damage #</td>
<td>cost y</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mode</th>
<th>Distance (Auto)</th>
<th>cost z</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Consolidation Center, China</th>
<th>Consolidation Center, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inventory (day)</td>
<td>cost x</td>
</tr>
<tr>
<td>Purchasing Cost (per part)</td>
<td>cost y</td>
</tr>
<tr>
<td>Inventory management required for production part requirements (per part)</td>
<td>cost z</td>
</tr>
<tr>
<td>Time (day)</td>
<td>1</td>
</tr>
<tr>
<td>Fee &amp; (piece)</td>
<td>cost x</td>
</tr>
<tr>
<td>Mode</td>
<td>Truck</td>
</tr>
<tr>
<td>Distance (Auto)</td>
<td>cost z</td>
</tr>
</tbody>
</table>

**Report Creation**

- Create Reports
- Activate Library

**Processes**

- Process Definition
- Basic Summary
- Cost Analysis
- Life Cycle Analysis
- Energy Consumption Analysis
Results

Total Cost Analysis (TCA)

Potential logistics cost reductions
(Alternative packaging design implementation)

- Packaging: -29%
- Transportation: -24%
- Third party services: -13%
- Packaging end of use: -41%
- Overall logistics: -34%
Results

Energy Consumption Analysis

- Baseline case vs. proposed alternative
  - Transportation
    - Energy to transport via truck, ship, and train
  - Package production
    - Energy to make packaging material from primary source
    - Energy saved in package production by recycling materials
## Energy Consumption Standards-Transportation

<table>
<thead>
<tr>
<th>Source</th>
<th>Energy consumption MJ/(kg x km)</th>
<th>Percent Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Train Image]</td>
<td>0.0003</td>
<td>0.0008</td>
</tr>
<tr>
<td>![Ship Image]</td>
<td>0.0003</td>
<td>0.001</td>
</tr>
<tr>
<td>![Truck Image]</td>
<td>0.0021</td>
<td>0.005</td>
</tr>
<tr>
<td>U.S. DOE Transportation Energy Data Book, Ed. 21</td>
<td>Danish Environmental Protection Agency &lt;www.mst.dk&gt;</td>
<td></td>
</tr>
</tbody>
</table>
## Energy Consumption Standards - Packaging Material

<table>
<thead>
<tr>
<th></th>
<th>Cardboard</th>
<th>Wood</th>
<th>Recyclable Plastic Polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy to make material from primary source (MJ/kg)</td>
<td>30.00</td>
<td>0.20</td>
<td>74.00</td>
</tr>
<tr>
<td>Energy to reprocess material (MJ/kg)</td>
<td>10.00</td>
<td>~</td>
<td>6.00</td>
</tr>
</tbody>
</table>

Source: Danish Environmental Protection Agency <www.mst.dk>
Results

Life Cycle Assessment Summary

Life Cycle Analysis of International Packaging Logistics
(Impact on the environment in millipoints)

7.7% Improvement

Cardboard packaging
Recyclable plastic packaging

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Consumer Driven 6-Sigma
Recycling Solution

Life Cycle Assessment Summary

Contribution of logistics components on environmental impact (Alternative Packaging)

- Packaging acquisition: 19%
- Transportation: 81%
Results

Finite Element Analysis

- Structurally capable for long transit
- Shown below, stress concentrations on D/C Pad
Results

Ergonomics

• Study completed by the University of Michigan
• Eliminate repack/double-handling
• Minimize reaching and lifting
Further Work

• Complete testing and trial shipments and implement sustainable international packaging
• Investigate replication opportunities
• Investigate additional packaging alternatives
Challenges Met

• Analysis
  - Quantifying social impacts
  - Multi-dimensionality of problem

• Sensitivity
  - Material availability
  - Impact of rising energy costs
Summary

System Models

Decision Tree (Option set)

Integrated Inventory Analysis

Total Cost Accounting (TCA)

Environmental Impact Analysis (LCA)

Energy Consumption Analysis (ECA)

Environmental Indicators

<table>
<thead>
<tr>
<th>Baseline</th>
<th>-</th>
<th>-</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative</td>
<td>34% cost reduction in overall logistics</td>
<td>7.7% reduction in the environmental impact</td>
<td>Similar in energy consumption</td>
</tr>
</tbody>
</table>

Note: Slight change from published proceedings
Takeaways

- Packaging in global supply chains
  - Costs are multi-faceted
  - Complexity of the environmental impact
  - Focus on major factors
    - Materials
    - Energy
- Innovation in global sourcing
  - Triple bottom line approach in global packaging