Scenarios Addressing United Parcel Service’s Energy Acquisition:

* A methodology for performing a comparative analysis of alternative fuels

Megan Pease
Advisor: Tim Allen

_Nelson Institute Environment & Resources_

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Outline

Introduction
- United Parcel Service (UPS)
- Research Motivation & Questions
- Application of Systems Theory

Methodology
- Multi-Scale Integrated Analysis
- Stakeholder Matrix

3 Scenarios

Conclusion
Understanding UPS

Why UPS

- Essential role in society
- Demand increase
  - $19.7 billion increase in 7 years
- Dependent upon petroleum resources
- Elaboration of the system over time
  - Problem solving tool has been to increase efficiency

Today

- Present in 200 countries
- Control every aspect of the operation
  - 88,000 package cars (brown trucks)
  - Semi-truck fleet
  - Airline- 8th largest worldwide
  - Ocean Cargo Fleet
Research Question

- Why systems theory is necessary
  - Complex Problem
    - Uncertainty: changing context of resource acquisition
    - Lots of variables at multiple scales
    - Social values

- Alternative Fuels & UPS a Narrow Topic?
  - Multitude of replacement options
  - Multitude of perspectives about alternative fuels
  - Decision making process convoluted:
    - All alternative fuels have benefits and drawbacks
    - One choice doesn’t outweigh another

- How can UPS design flexibility in their system, allowing adaptation to a changing context?

Making Decisions about the System

- Bounding the system
  - Biological perspective
  - Investigate gradients
  - Comprehensive description of Alternative Fuels
  - Soft Systems Methodology: CATWOE Technique

- Need for a decision support tool to layer information

- Developed methodology and applied it to the case study of UPS

Allen, T. F. H., & Thomas Hoekstra; Checkland, Peter. 1981
Methodology Overview: Models

- Investigated the Options
  - 7 Alternative fuels and petroleum diesel
  - Biodiesel (BD20), Natural Gas (CNG & LNG), Synthesis Gas (FT Diesel & DME), Hydrogen (Compressed and Liquid)

- Multi-Scale Integrated Analysis (MSIA)
  - 4 Criteria
  - 20 Indicators

- Stakeholder Matrix
  - Matrix of questions
    - Quantify values
    - Developed by using SSM CATWOE

## Multi-Scale Integrated Analysis Criteria

<table>
<thead>
<tr>
<th>MSIA Criteria</th>
<th>Observed Scale of Alternative Fuel Choice Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Impact on the Environment</td>
<td>Global, Regional &amp; Local</td>
</tr>
<tr>
<td>Feasibility</td>
<td>Local</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Local</td>
</tr>
<tr>
<td>Strategic Relationships</td>
<td>Regional</td>
</tr>
</tbody>
</table>

- **Synthesizing Information**
  - Interdisciplinary Approach
  - Life Cycle Analysis Model (GREET), Primary Research, Databases
Criteria & Indicators

Fuel Impact on the Environment

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Cmprs Nat. Gas</th>
<th>Liquid Nat. Gas</th>
<th>Liquid H₂</th>
<th>Comprs H₂</th>
<th>FT Diesel</th>
<th>DME</th>
<th>BD20</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCA Emissions (GHG)</td>
<td>DI</td>
<td>6.10%</td>
<td>9.30%</td>
<td>-1003.10%</td>
<td>-518.30%</td>
<td>69.40%</td>
<td>-50.70%</td>
<td>58.80%</td>
<td>0%</td>
</tr>
</tbody>
</table>

## Criteria & Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Units</th>
<th>Cmprs Nat. Gas</th>
<th>Liquid Natural Gas</th>
<th>Liquid H₂</th>
<th>Cmprs H₂</th>
<th>FT Diesel</th>
<th>DME</th>
<th>BD20</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Constraints:</td>
<td>0=No</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Weather</td>
<td>1=Yes</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Criteria & Indicators

Infrastructure

- Union Employees
- Vehicle Maintenance
- Specialist Positions
- Engine Replacement
- Fuel Storage

**Table: Engine Replacement**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Units</th>
<th>Cmprs Nat. Gas</th>
<th>Liquid Natural Gas</th>
<th>Liquid H₂</th>
<th>Cmpres H₂</th>
<th>FT Diesel</th>
<th>DME</th>
<th>BD20</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Replacement</td>
<td>0-3 scale</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Chandler, Kevin, Walkowicz, & Clark. 2002
Criteria & Indicators

Strategic Relationships

- Fuel Price Coupled with Feedstock
- Potential for Scaling Up

Competition with Food system
- Control of Fuel Stream
- Tax Incentives

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Units</th>
<th>Cmprs Nat. Gas</th>
<th>Liquid Natural Gas</th>
<th>Liquid H₂</th>
<th>Cmprs H₂</th>
<th>FT Diesel</th>
<th>DME</th>
<th>BD20</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition w/ Food System</td>
<td>0=No 1=Yes</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>


**Stakeholder Matrix**

- **Stakeholder:** Group of people with a vested interest in UPS

- **Dissimilar points of view**
  - All observing the system
  - Different criteria for making a decision

- **Non-equivalent perspectives**
  - Groups observe UPS
  - Different perceptions

- **Weight in the model**
  - Equal importance as a necessary abstraction

Giampetro, Mario. 2004; Porritt, Jonathon. 2007.
## Explicitly Addressing Values

<table>
<thead>
<tr>
<th>STAKEHOLDER</th>
<th>QUESTIONS ASKED BY GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stockholders</td>
<td>Is this fuel considered a “green” fuel?</td>
</tr>
<tr>
<td>Customers</td>
<td>Will the cost of shipping a package cost more due to higher fuel and labor costs?</td>
</tr>
<tr>
<td>Employees</td>
<td>Is the safety of the alternative fuel comparable to petroleum diesel?</td>
</tr>
<tr>
<td>Outside Relationships</td>
<td>By forming a relationship with UPS will I benefit from economies of scale?</td>
</tr>
<tr>
<td>Regulatory Committees</td>
<td>Are regulations for fuel handling, storage and distribution already in existence?</td>
</tr>
</tbody>
</table>
Stakeholder Matrix Results

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Cmpress Natural Gas</th>
<th>Liquid Natural Gas</th>
<th>Liquid H₂</th>
<th>Cmprss H₂</th>
<th>FT Diesel</th>
<th>DME</th>
<th>BD20</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stockholders</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Customers</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Employees</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>External to UPS Relationships:</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Regulatory Committees</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total Yes Answers</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>
Three Scenarios

- **Business as Usual:**
  - Minimum Change
  - Wait for cost to drive decision: Reactionary
  - Not supported by Matrixes

- **Redefine the System: A new vision of UPS**
  - Maximum Change
  - Move People: Airline
  - Move Information: Supply-Chain Management
  - Move Financial Resources: Financial Lending
  - Package cars become symbolic
  - Unacceptable to existing employees
Three Scenarios

- **Flexibility Scenario:**
  - Intermediate change
  - Maintain identity
  - Integration of the MSIA & Stakeholder results shows:
    - Series of engine modifications
    - Relinquish control
      - Fuel varies based on each center’s needs
      - Local relationships with multiple fuel vendors
Conclusion

- Developed a methodology
  - Investigating persistence of an existing structure
  - Layering information
    - Biological perspective
    - Define the material system
    - Multi-Scaled Integrated Analysis
    - Stakeholder Matrix
    - Scenarios
  - Combined information from many disciplines
  - Methodology incorporates
    - Diverse values and scales
    - Environmental impacts
    - Economic pressures
References