Embedding a Carbon Footprint Project into an Undergraduate Class

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California Higher Education Sustainability Conference:
Curricular Inroads to Advanced Vehicle Technologies and Carbon Footprint Reduction

July 2015
Outline

- Background
- Goals
- Implementation
  - Partnership
  - Tool
- Results
- Lessons Learned
Background: the Class

- Definition: Supply Chain Management “provides goods and services to fulfill customer demand **responsively, efficiently and sustainably**”
- Sustainable Supply Chain Management (DS655)
  - A pre-existing senior-level elective for undergraduate Decision Sciences concentrators
  - I had developed the class in 2012 and previously taught it twice
A Sample Supply Chain: Nintendo Wii
Background: Carbon Footprints

- A Product Carbon Footprint (PCF) accounts for the resultant Greenhouse Gas emissions associated with providing a good or service
  - Transportation is only a component, but it is a universal and typically substantial portion
- Caveats:
  - PCFs are not likely to be very accurate
  - How much of the supply chain do we include?
    - Do we have the necessary data?
    - Do we have decision power to make or influence changes?
- Idea is not to say product X emits 2.3456 kgCO$_2$e, but to show that logistic choices may impact resultant emissions
Background: Campus as a Living Lab

- “Provides funds ... to develop or redesign of a course that ties elements of sustainability into opportunities for learning using the campus physical plant.”
- My proposal was funded for the 2013-2014 Academic Year at <$3K, solely for hiring student assistants for:
  - Data gathering, benchmarking and enhancing the underlying toolkit
  - Grading assistance to offset the time spent in developing and implementing the project (did not request a course release)
Goals

- Have students work with actual campus clients to perform a carbon footprint analysis for an existing campus process
  - Real world projects more motivating than those based only on secondary sources
  - Let students develop client handling skills
  - Provide benefits for clients
- Improve student skills:
  - Analysis
  - Oral and written communication
  - Teamwork
- Embed project into existing course without displacing material
Implementation: Project Partners

- 3 organizations involved
  - Office of Sustainability
  - SF State Bookstore
  - Outside food vendor: Café Rosso/Station Café/Village Market

- Fall 2013: Met with stakeholders from each organization to vet 3 potential PCF projects
  - Also determine if enhancements to the underlying carbon calculation tool would be needed

- Spring 2014: Partners’ planned contributions during course
  - Provide a point of contact for students to learn about the process, collect data, ask questions
  - Attend final presentation, provide feedback to teams
# Implementation: Potential Projects

<table>
<thead>
<tr>
<th>Client Partner</th>
<th>Potential Process/Product for Carbon Footprint</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFSU Bookstore</td>
<td>1- Electronics/Computer product</td>
</tr>
<tr>
<td></td>
<td>2- Logo clothing sourced from Asia</td>
</tr>
<tr>
<td></td>
<td>3- Textbook sourced from Europe</td>
</tr>
<tr>
<td>Office of Sustainability</td>
<td>4- Virgin paper vs. 100% recycled content paper</td>
</tr>
<tr>
<td></td>
<td>5- Organic food item vs. non-organic version</td>
</tr>
<tr>
<td></td>
<td>6- Hand dryer vs. paper towels in restrooms</td>
</tr>
<tr>
<td>Cafés</td>
<td>7. Juicing Oranges</td>
</tr>
<tr>
<td></td>
<td>8. Bananas</td>
</tr>
<tr>
<td></td>
<td>9. Melons</td>
</tr>
</tbody>
</table>
Implementation: CarbonCalc

- A spreadsheet I had previously developed
  - Simple to use
  - Easy to understand
  - Free
- Only Data, product weight and the following 4 inputs for each transportation link
  - Distance
  - Transport Mode, selected from a preset list
  - Utilization Rate (how fully packed is the vehicle?)
  - Backhaul Rate (are we returning empty?)
- Outputs: Carbon emissions for each link and the overall supply chain that can be assigned to that particular product
Which Link Has the Largest Carbon Footprint?

Port of Shenzhen

Manufacturer's Warehouse

20 km

Port of Long Beach

10000 km

Best Buy DC

80 km

Best Buy Retail Store

675 km

Consumer

10 km dedicated trip
### The Carbon Footprint for Transporting a Wii according to CarbonCalc

<table>
<thead>
<tr>
<th>Link</th>
<th>Departing from</th>
<th>Arriving at</th>
<th>Transportation Mode</th>
<th>Distance (km)</th>
<th>Vehicle Weight Limit (kg)</th>
<th>kg CO2e per 100 km, full utilization</th>
<th>Utilization Rate (%)</th>
<th>Backhaul Rate (%)</th>
<th>Item's Share of Vehicle (%)</th>
<th>Item's share of CO2e (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shenzhen factory</td>
<td>Port of Shenzhen</td>
<td>Midsize_Diesel_Truck</td>
<td>20</td>
<td>6,250</td>
<td>0.015</td>
<td>90%</td>
<td>100%</td>
<td>0.1%</td>
<td>0.011</td>
</tr>
<tr>
<td>2</td>
<td>Port of Shenzhen</td>
<td>Port of Long Beach</td>
<td>Ship_LargeBulk_Carrier_Bunkerfuel</td>
<td>10,000</td>
<td>N/A</td>
<td>0.001</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.238</td>
</tr>
<tr>
<td>3</td>
<td>Port of Long Beach</td>
<td>Chino DC</td>
<td>Midsize_Diesel_Truck</td>
<td>80</td>
<td>6,250</td>
<td>0.015</td>
<td>90%</td>
<td>0%</td>
<td>0.1%</td>
<td>0.089</td>
</tr>
<tr>
<td>4</td>
<td>Chino DC</td>
<td>Colma Store</td>
<td>Midsize_Diesel_Truck</td>
<td>675</td>
<td>6,250</td>
<td>0.015</td>
<td>90%</td>
<td>10%</td>
<td>0.1%</td>
<td>0.717</td>
</tr>
<tr>
<td>5</td>
<td>Colma Store</td>
<td>Pacifica Home</td>
<td>Midsized_Car_Gasoline</td>
<td>10</td>
<td>38</td>
<td>0.677</td>
<td>9%</td>
<td>0%</td>
<td>9.0%</td>
<td>5.117</td>
</tr>
</tbody>
</table>

**Key Outputs:**
- **Total Distance:** 10,785 km
- **Total CO2e (kg) Associated with Item:** 6.172 kg

- **The last link is the most emissions-intensive... Why?**
Results: Spring 2014 Launch

- In late February students self-selected into 7 teams and picked from the nine projects available.
- They had nearly half the term to meet with their clients, collecting data and asking questions.
- Mid May- the end deliverables: document the carbon footprint associated with supporting a current product/process and suggest changes for improvement.
  - Executive summary
  - Final presentation to fellow students, clients and professor.
Results: Mixed Success

• Students seemed to pick what they felt would be the easy projects (hah!)

• Partner participation varied:
  • Office of Sustainability – the perfect partner!
  • One partner effectively went AWOL, had to allow those teams to make massive assumptions and/or switch to backup projects

• Student help was not always available as needed
  • Side benefit for Campus As a Living Lab? Spent less than $500 out of budgeted $2900, yet still had a project in production!
Conclusions and Lessons Learned

- My judgment: students did a better job on these real world projects than on prior ones based only on second sources.
- The majority of students seemed to have favorable perceptions of the project.
  - Some didn’t, and end-of-term evaluation scores and comments reflected this.
- Implementation takes more time than you think it will.
  - Are your partners truly involved? (have backup plans)
  - Can you hire the student help that you need when you need it? (budget for a course release or two)