### Project Title: Communicating and Modeling Sustainability in Design

#### Research Team:
- Erin MacDonald (ME)
- Jinjuan She (ME)
- Ping Du (ME)
- Jingnan Zhao (ME)
- Seda Yilmaz (ID)

#### Thrust Area: New Design Paradigms and Processes, Design Optimization

### Need and Industrial Relevance

- Engineers spend much effort on designing sustainable products, but if this may be wasted if customers do not value this work
- Models of environmental impact need to include customer decisions in order to have predictive power
- Sustainable products need to communicate with the customer through design

### Project Goals

- Improve the manner in which sustainable design is addressed in engineering research by exploring seven cognitive concepts related to sustainable design and using optimization of interdisciplinary design models
- Motivate all customers to think about sustainability when they purchase and use products

### Approach and Methods

#### Cognitive Concepts

<table>
<thead>
<tr>
<th>Concept</th>
<th>Design Recommendations for Successful Sustainable Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsibility</td>
<td>R1: Build a sense of control with active customer participation</td>
</tr>
<tr>
<td>Complex decision-making</td>
<td>R2: Simplify decision criteria/industry standards</td>
</tr>
<tr>
<td>Decision behavior</td>
<td>R3: Design with interaction incentives</td>
</tr>
<tr>
<td>Attention-sacrifice link</td>
<td>R4: Use educational feedback</td>
</tr>
<tr>
<td>Trust</td>
<td>R5: Address customers’ sustainability concerns</td>
</tr>
<tr>
<td>Cognitive dissonance and guilt</td>
<td>R6: Design with simplified emotional messages</td>
</tr>
<tr>
<td>Motivation</td>
<td>R7: Identify and use perceptual products cues</td>
</tr>
</tbody>
</table>

#### Examples: Customer Decision Modeling in Sustainable Design

- **Design for Consideration**

#### Objectives

- Forge a new line of customer-(and manufacturing) engineering design research: design for consideration
- Create design methods focused on sustainability using the “Seven Cognitive Concepts for Sustainable Design”
- Use mathematical models to represent customer decisions and the changes that can be made to these decisions through engineering design improvement

### Impact

- Increase the demand for sustainable products
- Increase R&D resources devoted to the design of sustainable products
- Establish sustainable design as both a customer- and product-driven field

### Project Duration

- Two Years

### Proposed Budget

- $30,000 per year

### Outcome/Deliverables

- New design methods and models that promote the purchase and use of sustainable products

---

**Example:** Priming Designers to Communicate Sustainability

- **Recycled Paper Content:** 0 to 1 (= 100%)
- **Examples:** Customer Decision Modeling in Sustainable Design

---

**Example:** Optimization with Customer Decisions

- **Hard-power boiler:** using high efficiency hand-power energy instead of electricity
- **Hard-power boiler:** using high efficiency hand-power energy instead of electricity
- **Test Conditions**
  - 10 minutes
  - 100% power
  - 0% power

---

**Legend:**
- **Test Enhanced**
- **Test Reduced**

---

**Examples:** Priming Designers to Communicate Sustainability

- **Graphs:**
  - Colored graphs showing the number of features and percentage of good features
  - Bar graphs showing the number of respondents and percentage of good respondents

---

**Examples:** Customer Decision Modeling in Sustainable Design

- **Table:**
  - Comparison of design task, deliberation, and final decision
  - Number of features and percentage of good features
  - Number of respondents and percentage of good respondents