Marketers Understanding Engineers and Engineers Understanding Marketers: The Opportunities and Constraints of a Cross-discipline Course Using 3D Printing to Develop Marketable Innovations

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Products exist to solve customer needs.
Points to take away from presentation today

1. The geometric model of a design begins with the customer in mind. Products exist to solve customer needs.

2. Low-fidelity prototyping allows all members of a design team to communicate their ideas without specialized training, CAD skill, to create geometry.

3. Fused deposition modeling creates alpha prototypes on non-trivial products within a one semester course.

4. Alpha prototype provides authentic feedback from customers and thus creates an authentic design experience for the student: one in which a product is designed, then built, and then tested by a customer.
A brief history of the collaboration between Dr. R Technology and Dr. K Marketing

• 2009 Dr. R. told by TEC graduate at major company that “having TEC students interact with students outside their program” would be very beneficial.

• 2009 - 2011 Drs. R & K collaborate: guest speaking, their undergrad TEC and Marketing classes collaborate on short term projects.

• **Spring 2013 and 2014** New Product Design and Development (NPDD) course taught with Senior TEC students and MBA Marketing students.
New product development is a **synthetic process** where customer **needs** (marketing) are converted into **solutions** (geometric model) to meet needs.

- **Marketing Focus**
- **Technology Focus**

- **Voice of the Customer** (the Plan)
- **Customer NEEDS**

- **Concept generation**
  - **2-D Hand Rendering**
  - **3-D Low Fidelity Prototype**

- **Brainstorming**

- **Synthesis of Plan and Solutions**
  - **Patents** (external search)

- **Geometric Model**
  - FDM prototypes,
  - cost analysis,
  - stress analysis,
  - authentic feedback,...
Design is an **iterative process**: Customer Needs are the measure of how well a solution is working.

- Concept generation
- **3-D CAE Model**
- **2-D Hand Rendering**
- **3-D Low Fidelity Prototype**

**Customer NEEDS**

- **Voice of the Customer** (the Plan)

**Synthesis of Plan and Solutions**

- **Patents** (external search)

**Geometric Model**

- **Technology Focus**

- **Marketing Focus**

**Release for Production**

- GOOD FIT?
  - NO
  - YES
Product Development as done in the NPDD course

**THE PITCH**

*Market Potential?*

**THE VOTE**

*resumes*

**TEAM FORMATION**
- Mutual Interest
- Complementary Skills

*Alpha Prototype in 10 weeks!*

**VOICE OF THE CUSTOMER(s)**
- We have this idea...
- Smaller.
- This and that...
- Strong but not too stiff.
- Some weight but not too heavy.

**Customer NEEDS**

**Concept Generation**
*(customer needs as guide)*

- Brainstorm
- Patents
- Prototypes
- External & Internal

**Week 7**

**Concept Selection**

*Best Concept Screen & Score*

**Week 10**

**Concept Testing**

*What do you think?*

*Well... ok here, great there, not so good here...*

*Would you buy? At what price?*

*Purchase Intention 1 2 3 4 5 Week 12*

**Week 12**

**Finalize Alpha Prototype DUE**
*(customer feedback)*

*Workshop*

*Just right!*

**Week 14**

**Prototype Testing**
*(customer needs as guide)*

*The same*

**Weeks 15 & 16**

**Final Prints & Financial Model**

*Sales + Unit Cost 5-D CAD Model Week 13*

**Week 13**

Customer Needs drive the design process: define the boundary of good and not so good solutions.

<table>
<thead>
<tr>
<th>Criteria No.</th>
<th>Focus</th>
<th>Final Customer Need Statement</th>
<th>Weighting Factor</th>
<th>Metric (Measure)</th>
<th>Metric Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy to carry</td>
<td>Easy to carry in and out of stores</td>
<td>30%</td>
<td>Dimensions and Weight</td>
<td>Girth (LxWxH) and Weight (lbs) of the unit</td>
</tr>
<tr>
<td>2</td>
<td>Size</td>
<td>Support the shopping materials I need</td>
<td>25%</td>
<td>Surface area</td>
<td>Usable surface area for storage (in^2)</td>
</tr>
<tr>
<td>3</td>
<td>Easy to attach</td>
<td>Will quickly attach to the cart</td>
<td>25%</td>
<td>Time</td>
<td>Seconds to attach</td>
</tr>
<tr>
<td>4</td>
<td>Security</td>
<td>Will stay attached securely during use</td>
<td>10%</td>
<td>Pounds force</td>
<td>Resistance to pulling of the cart (lbf)</td>
</tr>
<tr>
<td>5</td>
<td>Price</td>
<td>Will be priced economically</td>
<td>10%</td>
<td>Dollars</td>
<td>Price point</td>
</tr>
</tbody>
</table>

A POSITIVE attribute of the product that addresses a need.

Objective Measure to assess how well need is being met.

The number of NEEDS is relative few. Fewer constraints facilitate solutions.

Used to score alternative designs

Relative importance of need

Customer Needs from representative NPDD class project: Dashboard
Low fidelity prototype made with foam core to perform concept testing with customers.

Well... ok here, great there, not so good here...

What do you think?

Would you buy?

At what price?

Price Point: $, $$, $$$?

Purchase Intention

1 2 3 4 5

Week 12
Computer-aided design of product used to create FDM and perform cost analysis.

STL files for FDM

Component data for financial model of product
Many but not all components of alpha prototype are made with fused-deposition modeling.

Red parts are made with Fused Deposition Modeling (FDM) (rapid prototyping).

Acrylic sheet stock used for flat areas.

Lower costs materials are used when appropriate such as acrylic sheet stock.
Some part geometry was sourced from on-line vendors and incorporated into designs.

A self-locking hinge allows adjustable pitch and storage mode for product.

1. Assembly model of hinge saved from vendor site as a STEP file.
2. Edits made to integrate features of hinge into dash board design.
Dashboard product in use during prototype testing

3D models help develop products and Product design develops innovation skill in team members.
Conclusions – important lessons learned.

• Technology students learn that marketing data drives design: products do not exist because a “constraint-based” problem was solved.

• Marketing students gain exposure to the software and hardware used for prototype development.

BOTH groups

• Learn that products exist that meet customer needs which can be made at an economical price point,

• Gain experience collaborating on a significant project with people of diverse backgrounds.
Acknowledgement and follow-up question

• Does the cross-discipline design activity develop innovation skill within team members?

• The work Drs. Reifschneider & Kaufman have done to assess development of innovation skill while engaged in a design activity is beyond the scope of this talk.

• Research about how design develops innovation skill was conducted during the Spring 2014 offering of the NPDD course. This study was supported by the Illinois State University Scholarship of Teaching and Learning (SoTL) Small Grant Program sponsored through the Office of the Cross Chair in SoTL.
Questions?

THANK YOU