Collapsible Lawn Cart

Objective

- General Need for Product
  - Towable Cart that transports heavy cargo around the home or farm
- Area of Improvement
  - Storage space is a premium
  - Market lacks heavy-duty collapsible cart
- Maryland Market Estimation
  - 276 lawn/garden stores, $450 million revenue
  - 1.875 billion ft³ of public storage (US)
- CTQ Customer Requirements
  - Holds a half a cube of bricks (1000 lbs), two bales of hay, and 14 ft³ of mulch
  - Loads and unloads quickly and easily
  - Can be collapsed and stored with one person
  - Lasts lifetime of mower (10-15 years)

- Constraints
  - No loose parts
  - Must have a quick-dump feature
  - One person can collapse and store cart

- Physics
  - Used FBD to find dynamic forces on components

- Engineering Characteristics
  - Load before failure (1000 lbs)
  - Cart dimensions & collapsed envelope
  - Transformation time (less than 5 min)
  - Number of high-wear points

Concept Generation

- Customer Requirements
  - [in×10^2]
  - Transformation time (less than 5 min)
  - Maintained primary final design functionality
- Prototype and Testing
  - Folds nicely
  - Low load capacity
  - Stresses/deflection in bed
  - One person can collapse and store cart
- Physics
  - Used FBD to find dynamic forces on components

Similar Products

<table>
<thead>
<tr>
<th>Tipe® Alum. Cart</th>
<th>Craftsman® Steel Cart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collapses around wheels into box</td>
<td>Folds up from bed centerline</td>
</tr>
<tr>
<td>External Forces on System</td>
<td></td>
</tr>
</tbody>
</table>

Alternative Concepts

<table>
<thead>
<tr>
<th>Turtle</th>
<th>Scissors</th>
<th>Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion prone</td>
<td>Low load capacity</td>
<td>High load capacity</td>
</tr>
<tr>
<td>Low load capacity</td>
<td>Corrosion prone</td>
<td>High load capacity</td>
</tr>
<tr>
<td>Dump feature maintained</td>
<td>Ease of transport to storage</td>
<td>Ease of collapsing (one person)</td>
</tr>
</tbody>
</table>

Decision Characteristics

<table>
<thead>
<tr>
<th>High load capacity</th>
<th>Corrosion resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>28%</td>
<td>10%</td>
</tr>
<tr>
<td>Collapsed envelope</td>
<td>Ease of transport to storage</td>
</tr>
<tr>
<td>28%</td>
<td>6%</td>
</tr>
<tr>
<td>Dump feature</td>
<td>Ease of collapsing (one person)</td>
</tr>
<tr>
<td>25%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Final Concept

- Highest Capacity
- Small Collapsed Envelope
- Best Corrosion Resistance

Prototype and Testing

- Description
  - Modified used cart with hinges, sliders, and latches
  - Maintained primary final design functionality
- FEA Testing
  - Stresses/deflection in bed
  - Stresses in axle/suspension

Results and Future Work

- Product Design Process
  - Designed heavy-duty collapsible lawn cart
  - Developed alternative concepts
- Recommendation for Future Design
  - Optimizing dimensions of components and material selection to minimize weight and cost
  - Perform DFM & DFA to minimize cost and complexity
- Process Reflection
  - Concept generation allowed for initial familiarization with the product and for creative solutions
  - Morphological study allowed for best combination of ideas to be identified
  - Embodiment and detail design revealed component configuration options, requirements, and restrictions
  - Initial prototyping allowed team to visualize and confirm mechanical functionality and identify physical interferences

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- Decision Characteristics
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  - Corrosion resistance 10%
  - Collapsed envelope 28%
  - Ease of transport to storage 6%
  - Dump feature 25%
  - Ease of collapsing (one person) 6%

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