Racks R’Us: Bike Rack 2.0

Objective

Customer Requirements
- Ease of Access and Use
- Bike Accommodation Density
- Security
- Ease of Installation and Maintenance
- Minimal Land Area
- No Damage to Bikes

Constraints
- Weight
- Size/Collapsed Size
- Manufacturing Costs

Engineering Characteristics
- Inlet Area
- Simple Latch
- Stability
- Compactness
- Universal
- Latch Strength
- Number of Racks

Physics

\[ F_1 = \frac{W \cdot L_1}{L_2} \]

\[ M_1 = \frac{W \cdot L_2 \cdot (1 + 2 \cdot \sin(30))}{2} \]

Market Size
- In Washington DC, a 2010 Bicycle Commuter Act required more businesses to accommodate for bike storage.
- In the next two years, there is a potential for 20,000 bike racks to be installed in the local area.

Key Similar Product

Cyclepod

(Uses a vertical design to store up to 8 bicycles circularly)

Concept Generation

Decision Characteristics

<table>
<thead>
<tr>
<th>Compactness</th>
<th>NoG Weights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21%</td>
</tr>
<tr>
<td>Number of moving parts</td>
<td>16%</td>
</tr>
<tr>
<td>Simple latch</td>
<td>14%</td>
</tr>
<tr>
<td>Inlet area</td>
<td>12%</td>
</tr>
<tr>
<td>Number of racks</td>
<td>12%</td>
</tr>
</tbody>
</table>

Concept Ratings Table

<table>
<thead>
<tr>
<th>Concept</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept 1</td>
<td>0.207</td>
</tr>
<tr>
<td>Concept 2</td>
<td>0.496</td>
</tr>
<tr>
<td>Concept 3</td>
<td></td>
</tr>
<tr>
<td>Concept 4</td>
<td>0.297</td>
</tr>
</tbody>
</table>

Concept 2 Rated Highest

Design

Operation
- (A) supports six bikes and rotates on a one-way bearing ratcheting mechanism (B) that attaches to the ground anchored platform (C)
- The rear rack (D) swivels around a bolt (E) and supports the rear wheel and bike weight
- The channel (F) guides and supports the front wheel when a detent pin (G) is inserted
- Security is assured when the bike is locked to the eye-hook (H)

Trade-offs
- Increased compactness
- Decreased stability
- More bike space
- Fewer total bikes

Key Functionality
- Supports multiple bikes
- Vertical Storage
- Space Efficient
- One-way Rotation

Prototype and Testing

Prototype made with available materials. Shaped similar to the final design

Testing
- 1) Full-scale operation (limited to two active sides), 2) Proper bike size ranges, and 3) Requiring end-users to complete field tests

Analysis of Test Results
End-users are satisfied with product, the design has proven to be durable through field tests and FEA

Prototype Performance
Prototype has passed all tests with high performance

Test Results and Future Work

Summary of PDP
- Interviewed bike retail store managers to gauge interest
- Surveyed end-users to define bike storage difficulties
- Generated and evaluated designs for bike storage
- Performed embodiment design to refine angled rack concept
- Ensured robustness of the bike rack with FEA
- Fabricated bike rack prototype to test the final design

Recommendations for Future Design
- Perform life-cycle tests to ensure design reliability and safety
- Perform Six Sigma and continuous improvement strategies on DFA and DFM
- Begin marketing to create customer awareness

Process Reflection
- Concept generation led to a variety of ideas, allowing for the selection of a strong design
- CAD modeling and the fabrication of a prototype illuminated DFA and DFM considerations

ENME472 - Integrated Product and Process Design and Development

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