Ergonomically Sound Design of a Bottom Dishwasher Rack

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Agenda

- Initial Groundwork
- Preliminary Designs
- Design I - Pulley System
- Design II - Four-Bar, Spring-Assisted System
- Prototype Demonstration
- Conclusion and Recommendations
Project Problem

- Design a lifting mechanism for the bottom rack of a specific whirlpool dishwasher model
- Purpose: To prevent lower back strain for consumers during the loading and unloading process
- Fulfill design specifications
Dishwasher Model:
- GU1500XTK Gold Tall Tub
- Adjustable upper rack
- 13 inches of clearance
- Bottom rack dimensions: 21 in x 21 in x 6 in.
- Rack material: steel wire coated with nylon
- High tech, large capacity
Project Motivation

- Whirlpool Survey Results:
  - Convenient to use
  - Limit potential lower back strain
  - Smooth rack operation
  - Prevent dish damage
Design Specifications

- AHAM load standard: 40 lb
- Smooth operation with sturdy feel
- Material that is non-corrosive
- Avoid pinch points
Design Specifications (cont.)

- Include locking mechanism
- Keep rack level throughout motion
- Design for high volume manufacturing
Current State of Technology

- No lifting mechanisms currently available in dishwashers
- Researched products that reduce lower back strain
- Researched tables with height adjustment
Current State of Technology (cont.)

Lifting Tables incorporating the adjustable height option

Foot-Pedal Hydraulic System

Electric “Scissor” Arrangement

Cocktail Table with Lifting Surface
Preliminary Designs

- Hydraulic Cylinder
  - Hydraulic Cylinder (collapses into door)

- Ramp
Preliminary Designs (cont.)

- Linkages
- Pulleys
Pulley Design

Turn Crank

Basket Lifts
Pulley Design (cont.)

- Maximum height: 6.9 inches
- No pinch points
- Weight reduction
- Crank / Locking Pin
Pulley Design Analysis

Forces Applied
Pulley Design Analysis (cont.)

Deformation of Top Frame

Nylon Plastic

Max. = 2.605 in

Stainless Steel

Max. = .0285 in
Four-Bar, Spring-Assisted Design
Four-Bar, Spring-Assisted Design (cont.)

- Maximum height: 8.4 inches
- Spring
- Locking Pin
Four-Bar, Spring-Assisted Design (cont.)

- Pinch points: 6
- Anchor

= Pinch Point
Four-Bar, Spring-Assisted Design Analysis

Kinematic Analysis Using Working Model

Level Rack Analysis

Vertical Position vs. Time
Four-Bar, Spring-Assisted Design Analysis (cont.)

Deformation

Max. = 0.00345 in.

Nylon Plastic

Max. = 3.7e-5 in.

Stainless Steel
Four-Bar, Spring-Assisted Design Prototype
Conclusions and Recommendations

Conclusions
- Designs met specified requirements
- Obtained understanding of design process

Recommendations
- Material reduction
- Lock pin hole adjustment
- Further prototype testing
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Questions???