Objective

Description of market
- Major car manufactures across the U.S.
- 7.5 Million cars sold in the U.S. this past year
- 237 million cars on the road

Engineering Characteristics
- Size
- Location
- Interior Space
- Exterior Styling
- Constraints of current car
- Assembly
- Manual override switch
- Lifespan of device
- Force required by user to open/close door
- Stopping distance of door
- Maximum force applied to stop door
- Door lock release in case of emergency
- Door open to the maximum angle without hitting any adjacent object while user is entering or exiting the vehicle
- Ability to prevent door digs on own car
- Ability to prevent door digs on other cars
- No change in resistance to open door
- Ease of operation
- Durability of system components
- Ease of maintenance
- Override feature for false obstacles

Constraints
- Robustness of sensing system
- Force required by user to open/close door
- Maximum force applied to stop door
- Stopping distance of door
- Door lock release in case of emergency
- Ability to prevent door digs on own car
- Ability to prevent door digs on other cars
- No change in resistance to open door
- Ease of operation
- Durability of system components
- Ease of maintenance
- Override feature for false obstacles

Physics of the Task

Concept Generation

<table>
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<tr>
<th>Selection Criteria</th>
<th>Reliability</th>
<th>Cost</th>
<th>Manufacturability</th>
<th>Safety</th>
<th>Maintenance</th>
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<td>0.139</td>
<td>0.492</td>
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Cable Actuated Brake
- Simple Actuation
- Withstand large forces
- Purely mechanical, Single unit, No fluids, Simple design

Passive Damper
- High stress concentration due to interlocking gears, Heavy weight

Final Concept: Self Locking Gear
- Need large amount of space for mechanical advantage, Slow reaction time
- Costly, Difficult to prototype and manufacture

Weight
- 0.285
- 0.185
- 0.161

Design

Additional Features
- Dual override system
- Automated control system

Prototype and Testing

Testing Results

FEA Analysis

Individual gear teeth were designed to withstand 500lbs

Initial Prototype

Although lightweight, aluminum housing is able to withstand over 6000lbs of clamping force from the 4 1/4"-28 bolts

Process Reflection
- Physics of the task allowed for the team to understand what forces were necessary to stop the door which influenced design
- Initial prototyping in plastic allowed for team to visualize the design
- Detail design allowed for team to further analyze how the system will operate and make small design changes

Future Design
- More robust sensing system with an ultrasonic range sensor and a larger sensing range
- Cost analysis for product and marketing
- Further analysis of DFM and DFA
- Pursue patents