

EXPO

engineering ▲ design

VERTICALLY OPENING FORKLIFT CAB DOOR WINDOW



ALEX BAILEY, CAMERON KAMINSKI, HUNTER HIGGINBOTHAM, KHALED ALAMOUDI

OBJECTIVE

Create an improved window design within the existing door geometry that provides a larger opening and better air flow for operators while still being easy to open and close.

BACKGROUND



Hyster H3.0A lift truck with previous window design

Interior view of previous window design

- Large visible area with upper, horizontally moving section and lower fixed window
- Panels cannot slide past each other causing less than a 50% opening of the total window area when fully opened
- Thin profile that does not protrude into the cab space
- Similar door design for various models of lift trucks

VALUE PROPOSITION

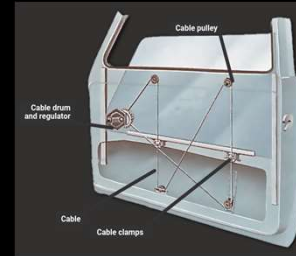
We will be building and testing a proof-of-concept design for a 2–3-ton pneumatic lift trucks, which can be scaled to higher and lower capacity models. Hyster-Yale believes it will provide more comfort for their customers and maintain and/or increase visibility for the operator.

REQUIREMENTS

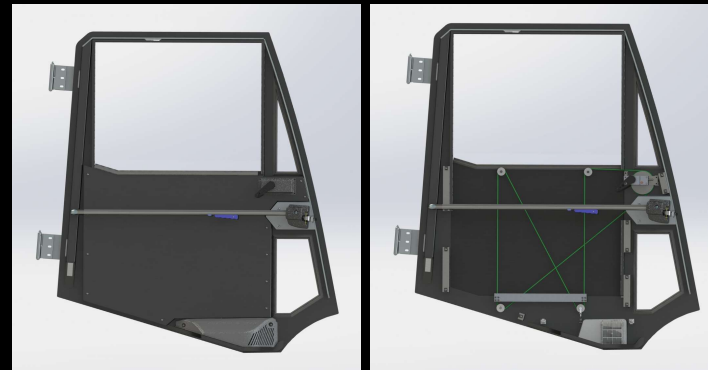
- Mechanically, vertically opening window
- Minimum of 80,000 cycles on design – moving window from fully opened to closed
- The window must hold at least 10-12 discrete positions without rattling due to vibration
- The new design must not protrude into the cab more than 35mm
- The window should be able to withstand the pressure of a standard garden hose without water ingress

CONCEPT DEVELOPMENT

- Design a hybrid of old mechanical systems and new pulley systems within automobiles
- Utilize worm gears to lock the window in any position
- Have a similar number of cranks comparative to an automobile with a mechanical system



FINAL DESIGN



With door cover

Without door cover

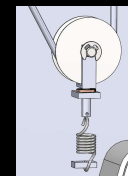
- Friction driven cable pulley system that moves the large window from a position to completely closed to over 90% open
- Fixed windows towards front of the cab to maintain necessary visible area
- Ten revolutions of crank handle to fully roll down or up the window
- Removable door panel to gain access to enclosed mechanisms for maintenance



Top view of the gear mech



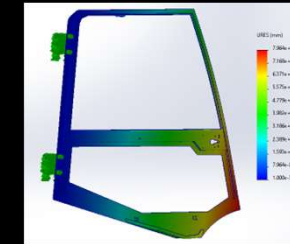
Bottom view of the gear mech



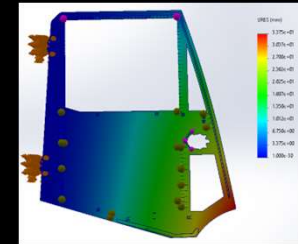
Pulley tensioner to combat cable elongation or shrinkage

VALIDATION

- Jury analysis conducted to get feedback on visibility, crank handle location, and ease of use by utilizing a pool of people of different genders, height, and strength levels.
- Water ingress test to ensure proper sealing.
- FEA Displacement test conducted where the door is fixed on the flat part of the hinged and a 20lb force simulating the operator closing the door is applied; over half as much deflection was observed.



Previous door design



New door design

RECOMMENDATIONS

- Utilize higher strength materials within the gear mechanism to increase weight capacity of the system.
- Create a formed plastic door cover to reduce weight.
- Replace annealed glass and plexiglass windows with code-compliant tempered glass.
- Redesign the gear mechanism for ease of replacing parts

ACKNOWLEDGEMENTS

We would like to thank our advisor at Hyster-Yale, Claire Linneman, our lead professor, Dr. Matthew Swenson, our graduate student mentors, Ty Sand and Ryan Sundberg, and machine shop manager, Brian Petty, for their contributions to this project.



University of Idaho
College of Engineering

2024 Capstone Project