PURDUE UNIVERSITY

CAPSTONE/SENIOR DESIGN EXPERIENCE 2019

Improved Door Latching Mechanism

Agricultural & Biological ENGINEERING

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1. Statement of Purpose

CNH and their customers need an improved door latching mechanism because with the existing latch it can be difficult to insure the second (final) portion of the latch is fully seated. If the second portion of the latch is not fully seated the door does not provide a proper seal allowing water ingress in the cab.

2. Background on Problem

- CNH magnum door has natural curvature to shut and seal correctly
- Curve in glass and air resistance in cab make the door difficult to shut
- Double rotor latch currently used for toughness
- Excess force is needed to make sure the door is in the final latch position
- Electronic powered design like that of van hatches and doors is desired
- No electronic powered mechanism on market in ag industry yet

Initial Latch Position

Final Latch Position

3. Criteria

- Cost needs to stay less than $400 additional to make it a feasible add-on for customers
- Mechanism must be reliable to hold up to thousands of cycles in rough environment
- Needs to be cross compatible to be put in use on other models
- Must maintain a water tight seal with no door slam needed

4. Alternative Solutions

1. Implement and test a mechanism designed by CNH's current latch vendor
2. Modify simple current door components such as door seal, latch, etc.
3. Use a pneumatic system (like used on automobiles in the 2000s) to cinch the door
4. Modify the door configuration so that there are less things to obstruct shutting the door

5. Influential Factors

Safety & Health

- Safety of the operator is of extreme importance
- Design eliminates hand and feet pinch hazards

Economic

- Startup price and cost for customer to add-on
- Mass production results in lower costs

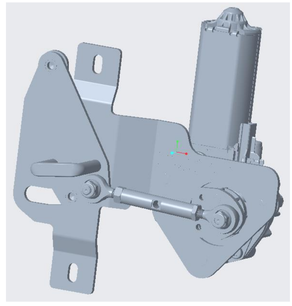
Global

- CNH products are shipped across the globe

6. Final Solution

- Cinching mechanism used to fully seal door
- Cinching mechanism is equipped with an anti-pinch reversal, tested and is functional after reassembly
- Mechanism required bracket to account for curvature in A-pillar of cab frame, which was designed on AutoCAD and 3-D printed

A-Pillar Bracket



Cinching Mechanism

- Mechanism is paired with a single rotor state sensing latch that has a more user friendly handle
- Latch required a new mounting plate to be welded on to door frame
- Wiring for latch sensor ran through door frame tubing, keeping wire unexposed
- Measurements made on clearance between door seal and cab frame in three places: top of the door (26.5 mm), by latch (24 mm), and on bottom (27 mm)
- Measurements matched after reassembly

State Sensing Latch

7. Failure Mode and Effects Analysis (FMEA)

Potential Failure Mode	Potential Effect of Failure	Severity	Classification	Potential Cause(s) of Failure	Occurrence
loss of power	door will not cinch	7	1	loose connector, bad wiring	3
sensor does not sense if door is shut or not	door will not shut, allowing dirt and water in cab	7	1	bad sensor, bad wiring/connection	6
door will not cinch	door cannot be closed properly	8	2	loose connector, obstruction to door or cinch	4
controller will not reverse for obstruction	operator appendages could be pinched	9	2	bad controller	1

- Severity and occurrence ranked on a scale of 1-10
- Classification – Rating of 1 is considered issue of Customer Dissatisfaction, 2 is a Safety/Regulatory Issue

8. Economic Analysis

Item	Price
Cinching Mechanism	$136
Controller	$118
State Sensing Latch	$36
Original Latch	$(8.00)
M8x1.25 bolt (4)	$3.44
Total Cost	**$285.44**

9. Deliverables

- Assembled, working prototype for CNH
- Mechanism seals door properly and does not allow water ingress
- Added customer comfort and peace of mind

10. Future Recommendations

- ROPS test on holes drilled in frame
- Explore different options for mounting bracket on a-pillar
- Attempt to relocate motor for improved operator line of sight

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