# Adjustable Bulldozer Maintenance Platform

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RioTinto

## Introduction & Goal

In collaboration with Rio Tinto, our team is designing an adjustable lift for use on D10 and D11 bulldozers. During maintenance, these bulldozers often require engine removal, leaving a large hollow space in the center. Currently, mechanics must crawl underneath the bulldozer and use a step stool on a platform to access essential components. This method raises concerns about both safety and efficiency. To address these issues, Rio Tinto has requested a mechanically robust lift that can fit beneath the bulldozer, operate within the hollowed-out space, and lift to the necessary working height.


## Design and Engineering Decisions

| Required Specifications | Units | Value |
|---|---|---|
| Platform final height | ft | 5 |
| Weight capacity | lbs | 700 |
| Top platform area | ft x ft | 2x3 |
| Time to raise platform | sec | 60 |
| Max controller height | ft | 5 |
| Grip tape | Binary | - |
| Swivel wheels | Binary | - |
| Lockable wheels | Binary | - |
| No handrails | Binary | - |
| Max starting height | ft | 2 |
| Hieght adjusting increment | in | 1 |
| Max lift weight | lbs | 300 |
| Wheel diameter | in | 6 |

The requirements for the lift are that it must fit underneath the bulldozers when fully compressed (be under two feet in height), extend to a height of five feet, be adjustable while on the platform, and be safe for users to operate. To the left is a detailed table of all specifications.

The scissor lift is constructed from 1/4" thick steel and features two hydraulic cylinders actuated by a manual pump. This configuration was chosen to ensure a robust design that does not require an external power source to operate.

The lift uses a double-stacked scissor mechanism to maximize its range and achievable height.

## 3D Model

## Results & Capabilities

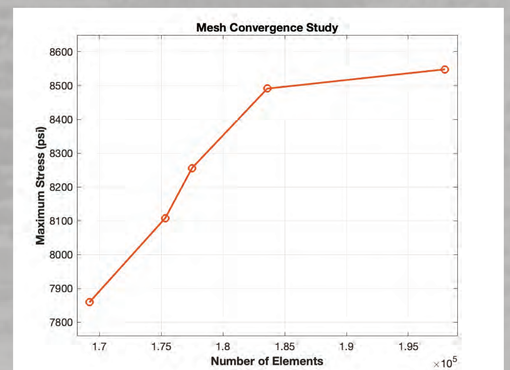
The scissor lift is capable of:

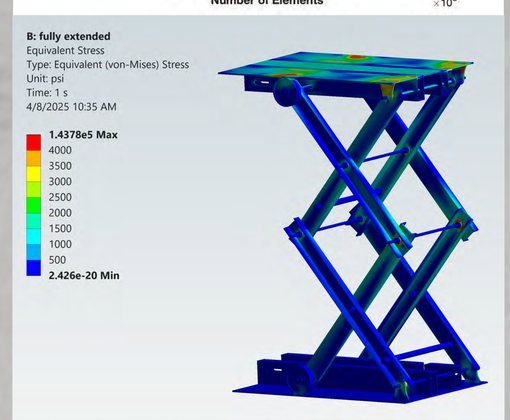
- Lifting users up 5ft.
- Collapsing to a minimum height of 2ft.
- Lifting users with a manual hydraulic pump within 60 seconds.
- Maneuvering easily with 360 degree caster wheels.
- Safe and stable operation.

## Analysis

A static structural analysis of the lift assembly was conducted utilizing Ansys Workbench. The objective of the finite element analysis is to evaluate the lift's ability to withstand the maximum weight of the user, 500 lbs, at a fully extended height. This analysis was used to assess the suitability of the selected material, determine the appropriate thickness, and identify areas that experience high stress.

To achieve this, a 500 lb load was applied to the top plate, while the bottom plate was fixed in place. Additionally, components of the assembly were meshed independently, to ensure optimal sizing and shape for more accurate results. A mesh convergence study was conducted on the linkages as seen on the plot below converging at 197,973 elements. The maximum Von Mises stress at convergence in the linkages was 8548 psi, giving a factor of safety of 4.




## Conclusion

Throughout both semesters, we went through various design iterations, each of which was validated through physical testing and finite element analysis. The first prototype used linkages with self-aligning bearings. However, these components caused instability, prompting further testing on the linkages under lateral forces and additional evaluation of the bearings. As a result, we switched to c-channels and weld-on pivot bushings, which significantly improved the lift's stability and durability. The integration of a hydraulic system into our machined lift resulted in a fully operational platform, which will be delivered to Rio Tinto.