

# Carriage Wheel Assembly Upgrades & Modifications

The carriage wheel assembly consists of an aluminum fork in which six skateboard wheels are connected. This allows for support in all directions to ensure stable, smooth motion. A fork is located at all four corners of the rectangular carriage.



*Figure 1. Fork Truck Assembly*

## Evaluation and Improvements

Once the forks had been removed from the carriage it was obvious that many improvements were needed to ensure accurate and reliable data could be collected test after test:

- Due to the degree of rust and corrosion found on the truck it was found that the proper hardware and components was not used in the original design. Stainless steel hardware, which is resistant to corrosion and rust, was installed to replace the existing. (Complete Hardware List)
- The carriage wheels were not free to rotate due to the fact that no spacers had been placed between the fork and the wheel bearing. New stainless steel spacers were added unbinding the wheels.
- The main reason the carriage was not running smooth was due to the main support wheels being totally bound. Upon removal it was found that a cantilevered 5/8" bolt supported the wheel. The bolt had been subjected to such great loads that it had yielded seen in figure 2, binding the wheel in place.

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

*Figure 2. Yielded Main Bolt*

The carriage is rated to 400lbs maximum load. This means that each truck was rated to carry a total of 100 lbs (if the load is distributed evenly). Each truck is equipped with two load bearing wheels. This means that each 5/8" bolt had to support 50 lbs . A Solidworks model of the fork was completed and a static Finite Element Analysis was performed yielding the following model shown in Figure 3:

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

### ***Figure 3. FEA Stress Model***

The analysis in figure 3, as expected, shows that the bolts yield where they enter the truck assembly. Surprisingly the F.E.A. model shows that this will only happen at twice the rated load of the carriage. This means that the carriage had been overloaded at some point in the past causing the damage seen in figure 2.

In order to ensure that this would not occur once new bolts replaced the old. A new FEA model adding a machined support at the free end of the bolt was performed.

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

### ***Figure 4. Modified FEA Deflection Model***

Figure 4 shows that the wheel with the new modification will be very rigid. With this new modification at the rated carriage load the bolt will have a factor of safety of 21 compared to about 2, which the bolt had before the modification. The modified piece was machined using a CNC Milling Machine at the Advanced Manufacturing

Center at the University of Maine Orono. A complete set of drawings for the modified truck can be seen here. ([Link to Drawings](#)).

## Modified Carriage

These modifications allow for the carriage to provide accurate and reliable data test after test for years to come. The completed truck with all the modifications is shown in the pictures below.



*Figure 5. Truck Machined Supports*



*Figure 6. Truck & Hardware*



*Figure 7. Complete Truck Installed On Carriage*