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A Technical Note

Racing wheelchair rear wheel alignment

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Abstract—This technical note describes a time-saving device for aligning the rear wheels of a racing wheelchair. The newly-developed analog alignment device is compared to the now standard discrete alignment device. The analog alignment device is found to reduce the time needed to align the rear wheels by nearly 75 percent, while increasing the accuracy of the alignment. The device does not noticeably alter the performance of the racing wheelchair and, if installed properly, the device is sufficiently resistant to fatigue.

Key words: *racing wheelchairs, wheelchair alignment mechanism, wheelchair athlete.*

INTRODUCTION

Wheelchair racing has become a very popular sport among the mobility-impaired population (2). Recently, more attention has been paid to the factors which effect racing wheelchair propulsion (1,5-9,11-14). Wheelchair athletes have been quite innovative in their solutions to many of the problems associated with wheelchair racing (3); however, much of what remains to be understood requires more means than are available to the average wheelchair racer.

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PROBLEM STATEMENT

The purpose of wheelchair racing is to propel a wheelchair as rapidly as possible over a predesignated course under arm power (10). Many factors affect the efficiency with which the race is completed. One such factor, which has been a particular source of grief for wheelchair racing athletes, is the alignment of the rear wheels. Improper alignment of the rear wheels significantly increases the friction between the tires and the road surface, causing premature tire wear. Moreover, it requires the athlete to exert more energy to maintain the same speed that would be needed for properly aligned rear wheels. When properly aligned, the rear wheels are parallel and of equal distance from the racing wheelchair's center line (**Figure 1**), (3). The analog alignment mechanism would be located in the center of the front crossmember.

Most racing wheelchairs are manufactured with rigid axle mounts (4), which allows for rigidity while reducing the weight, and are sold with the rear wheels in proper alignment. The problem stems from the alignment changing over time. The alignment may change for several reasons: use of another set of wheels or hubs than was originally used, repeated removal of the wheels, natural settling due to use, and unnatural changes due to travel or abuse. Racers can often be observed using many novel means to set the proper alignment on the evening before a major race. This has prompted

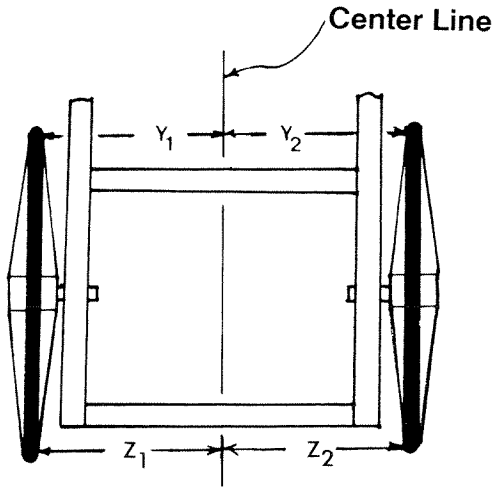

Figure 1.
Top view of proper rear wheel alignment for a racing wheelchair.

some manufacturers to sell an alignment setting mechanism especially made for their rigid axle racing wheelchairs (**Figure 2**) (3). These alignment mechanisms are helpful, but awkward, because they rely on adding and subtracting spacers in order to align the rear wheels. Thus, alignment is affected by the thickness of the spacers (3).

SOLUTION

The author has developed an analog alignment mechanism that has proven to simplify aligning the rear wheels of racing wheelchairs (**Figures 3a, 3b**). This device relies on the small changes in the angle made by the frame member with respect to the center line of the racing wheelchair (**Figure 4**) to take advantage of the natural spring qualities of the "horseshoe" type main frame design. Fortunately, the horseshoe type main frame is used by nearly all racing wheelchair manufacturers.

The nuts on the ends of the analog alignment mechanism are welded into the crossmember in front of the rear axle mounts (**Figure 5**). The rear wheels are aligned by loosening the jam nut and turning the alignment device with a wrench until the wheels are parallel. The wheel alignment can be

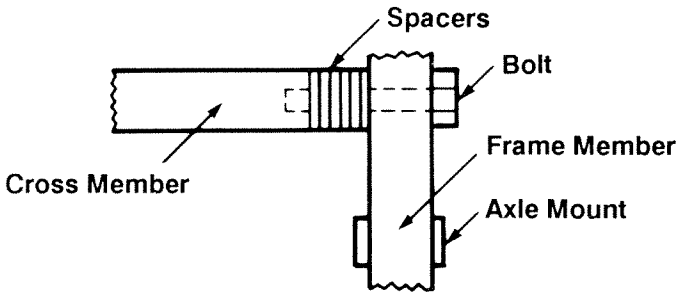

Figure 2.
Discrete alignment mechanism based on spacers.

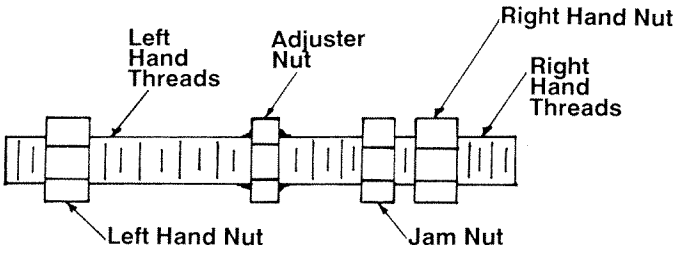

Figure 3a.
Cooper analog alignment device.

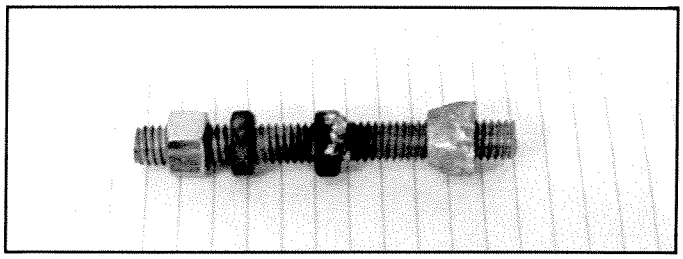

Figure 3b.
Photograph of Cooper analog alignment device.

checked with a simple tool (**Figure 6**) which is used to measure the difference between the rims at the back of the rear wheels (Z) and the front of the rear wheels (Y). The rear wheel alignment is correct when the distance at the front and rear are the same ($Z - Y = 0$).

SUMMARY

The analog alignment mechanism has been tested on 5 racing wheelchairs and has proven to

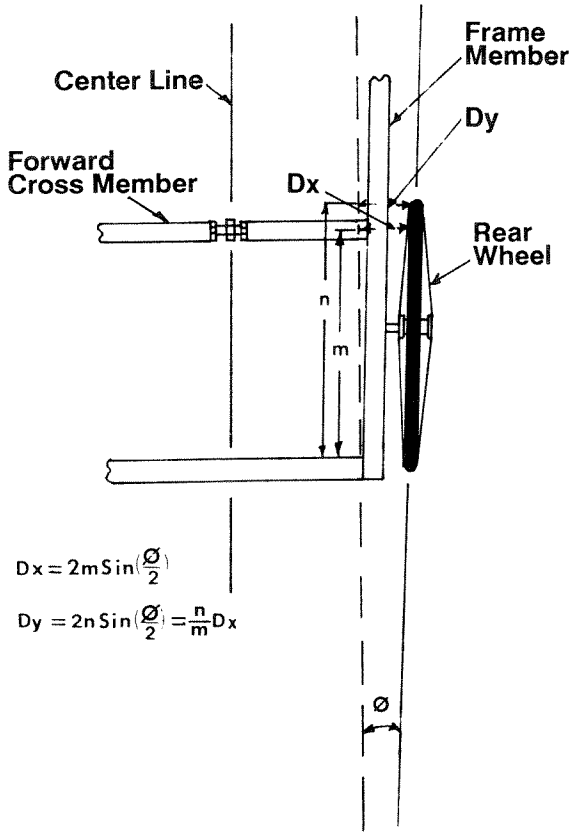

Figure 4.
Principle of rear wheel alignment. *(The rear wheels are aligned by lengthening/shortening the front crossmember which causes the angle made by the rear wheels with respect to the center line [misalignment angle] to change. The alignment device is used to make the misalignment angle zero. The alignment mechanism need only make small changes in displacement because of the amplification [n/m].)*

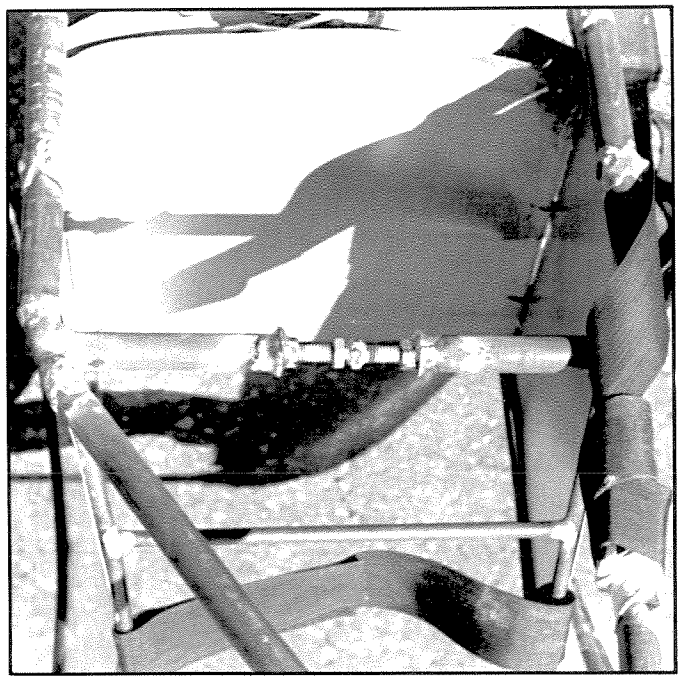

Figure 5.
Cooper analog alignment device in place. *(Device as viewed from the front of the chair looking towards the back, with the frame upside down.)*

reduce the time required to align the rear wheels by more than three-quarters of an hour over other methods (from an estimated 2 hours to less than one-half hour). The rigidity of the frame is maintained and none of the athletes noticed any difference in the response of the racing wheelchair after installing the device. The device offers the additional advantage of fitting onto most fixed-axle racing wheelchairs; it can be welded in place after removing about a 3-inch piece of the main frame crossmember. Of course, modifications to any racing wheelchair should be performed by an experienced welder.

The device should be inspected periodically, as should the entire frame, for signs of fatigue. It is subjected to some bending moments, as is the entire frame, due to the weight of the individual and the reaction forces of the wheels. The threads of the alignment mechanism are particularly susceptible to fatigue. The analog alignment device has been used for over 1,600 miles, at the submission of this note, without showing signs of fatigue.

CONCLUSION

The analog alignment mechanism effectively reduces the time required to align the rear wheels of racing wheelchairs, and improves the accuracy with which the rear wheels can be aligned. This device in whole or in concept should be incorporated into future racing wheelchair designs.

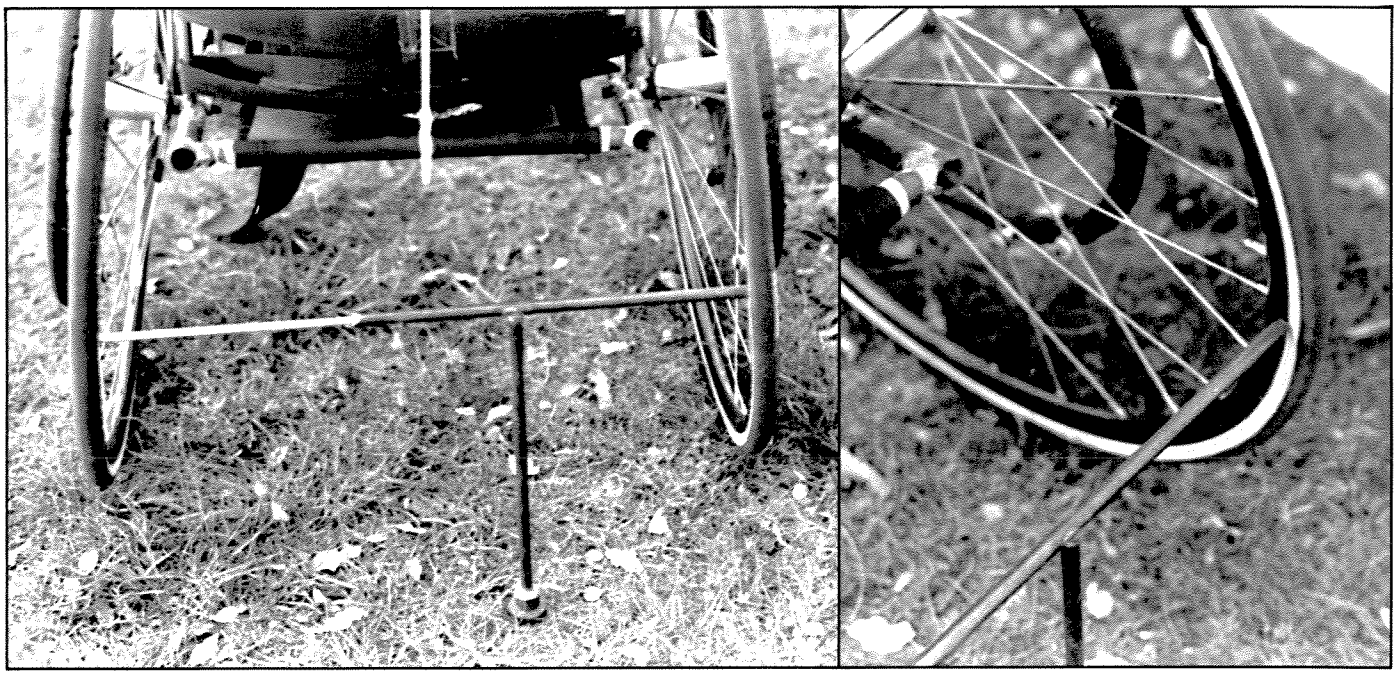

Figure 6.
Alignment tool in proper place for alignment. *(The alignment is best measured on a smooth, flat surface with the measurements made parallel to the surface. The tool is placed at the interface of the rim and the tire, on the rim).*

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