Design of an Ergonomic Wheelchair Drive System for Improved Shoulder Biomechanics

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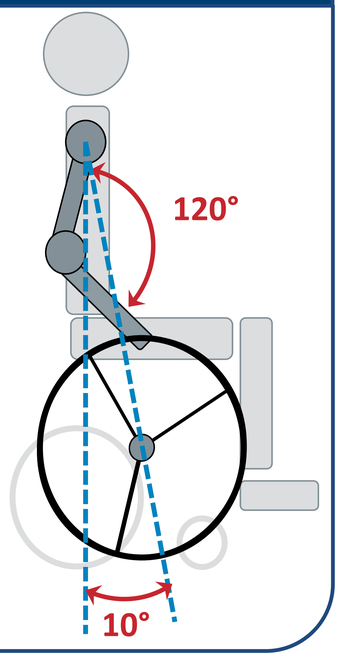
Problem

- There is a high prevalence of shoulder injuries in manual wheelchair users [1].
- Shoulder muscle stress, co-contraction, and metabolic cost are minimized when the hand rim axle is located anterior to the shoulders [2]. (See diagram below)
- Hand rims of current manual wheelchairs are affixed directly to the drive wheels.
- Drive wheels must be placed behind the user's center of mass to prevent tipping backward.
- Thus, current manual wheelchair designs do not allow optimal hand rim positions for shoulder health and function, potentially leading to chronic overuse injury and pain.

Design Criteria

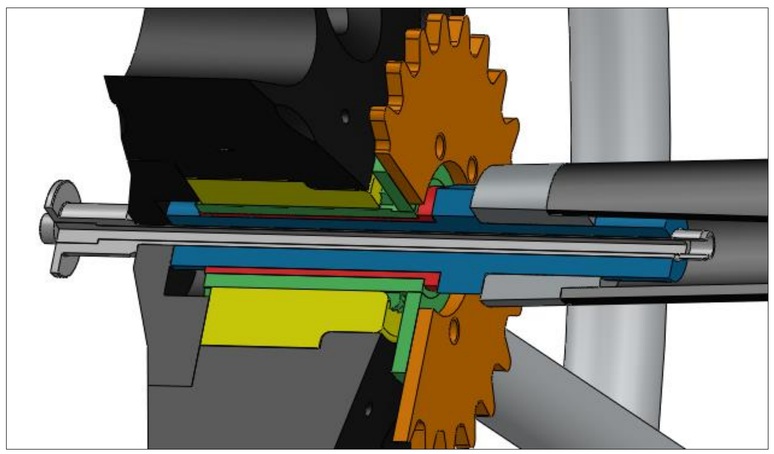
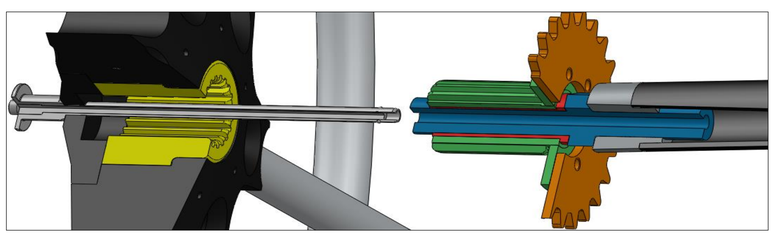
- Optimal positioning of hand rims (120° elbow angle at top dead center and hand rim axle position 10° anterior of the shoulders) [2].
- Direct coupling of hand rim motion to drive wheel motion.
- Removable hand rims to facilitate lateral transfers.



Design Overview





Discussion

- Chain drive coupling allows for optimal location of both the hand rim and the drive wheel
- Quick release removable hand rims for unobstructed lateral transfers
- Gearing options for patients of different functional levels
- Turnbuckles adjust the position of the hand rims and the tension of the chain.
- Less incidental contact with drive wheels means cleaner hands
- Multi-diameter hand rims can be used for "2-speed" propulsion
- Narrow width when both hand rims are removed

References/Acknowledgments

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