



Design of a Folding-Frame Ergonomic Wheelchair

Emily Hein^{1,2}, Gregory Voss², Andrew Hansen^{1,2}, and Gary Goldish^{1,2}

¹University of Minnesota, Minneapolis, MN

²Minneapolis VA Health Care System, Minneapolis, MN



U.S. Department of Veterans Affairs

Introduction

- Shoulder pain >50% in manual wheelchair users [1]
- Moving the hand rims forward reduces shoulder extensions
- Using a chain-driven system retains stability by keeping the drive wheels back [2]
- Commercial viability would be increased with a foldable, lightweight ergonomic wheelchair

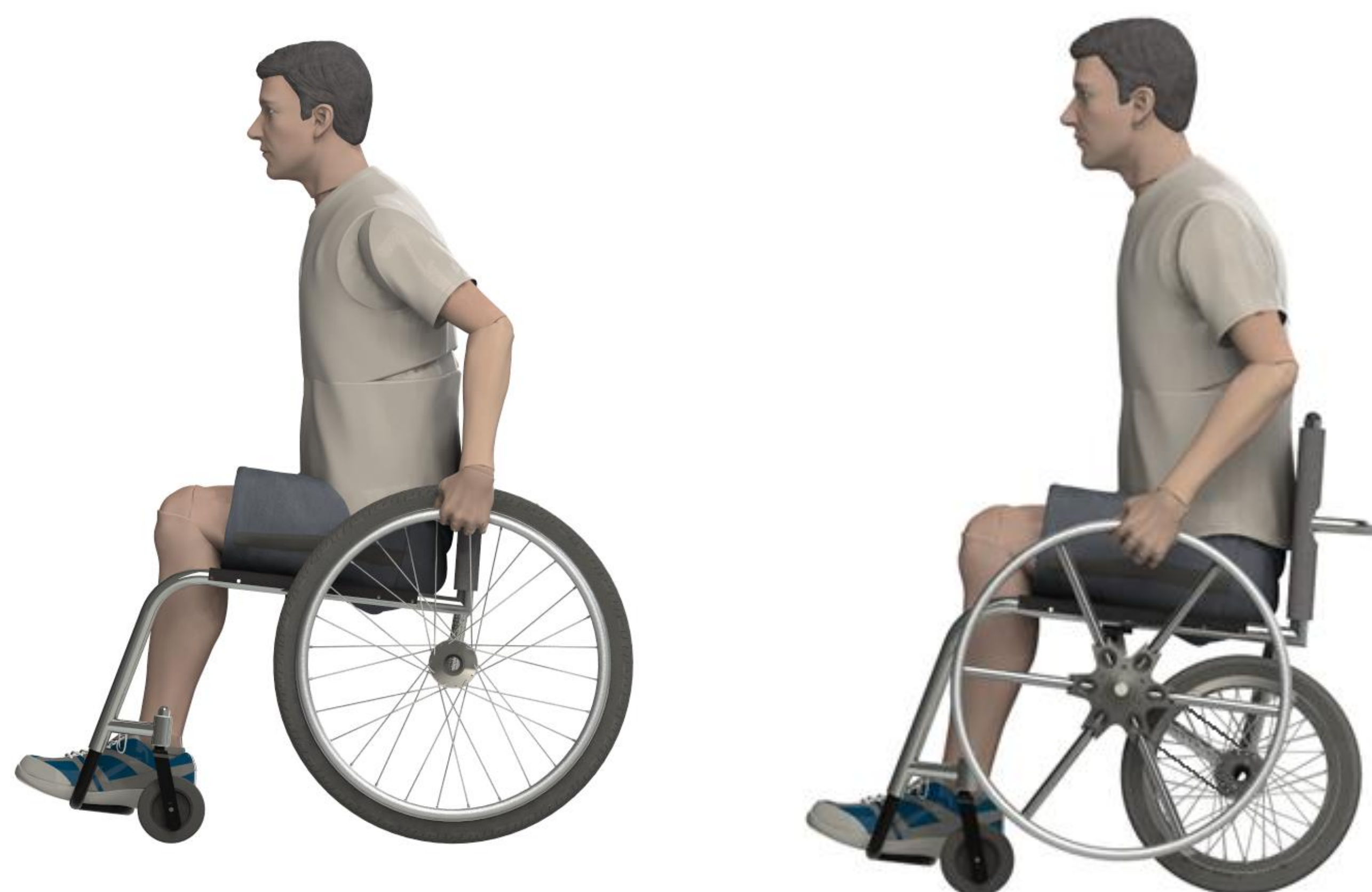


Figure 1. Demonstration of shoulder angle difference for traditional manual wheelchair (left) and ergonomic wheelchair (right).

Results



Figure 2. Final prototype in the unfolded (left) and folded (right) state.

Table 1. Weight comparison between chairs

Hand rims	Rigid frame (lb)	Folding frame (lb)
Attached	42.5	26.9
Removed	35.2	32.3

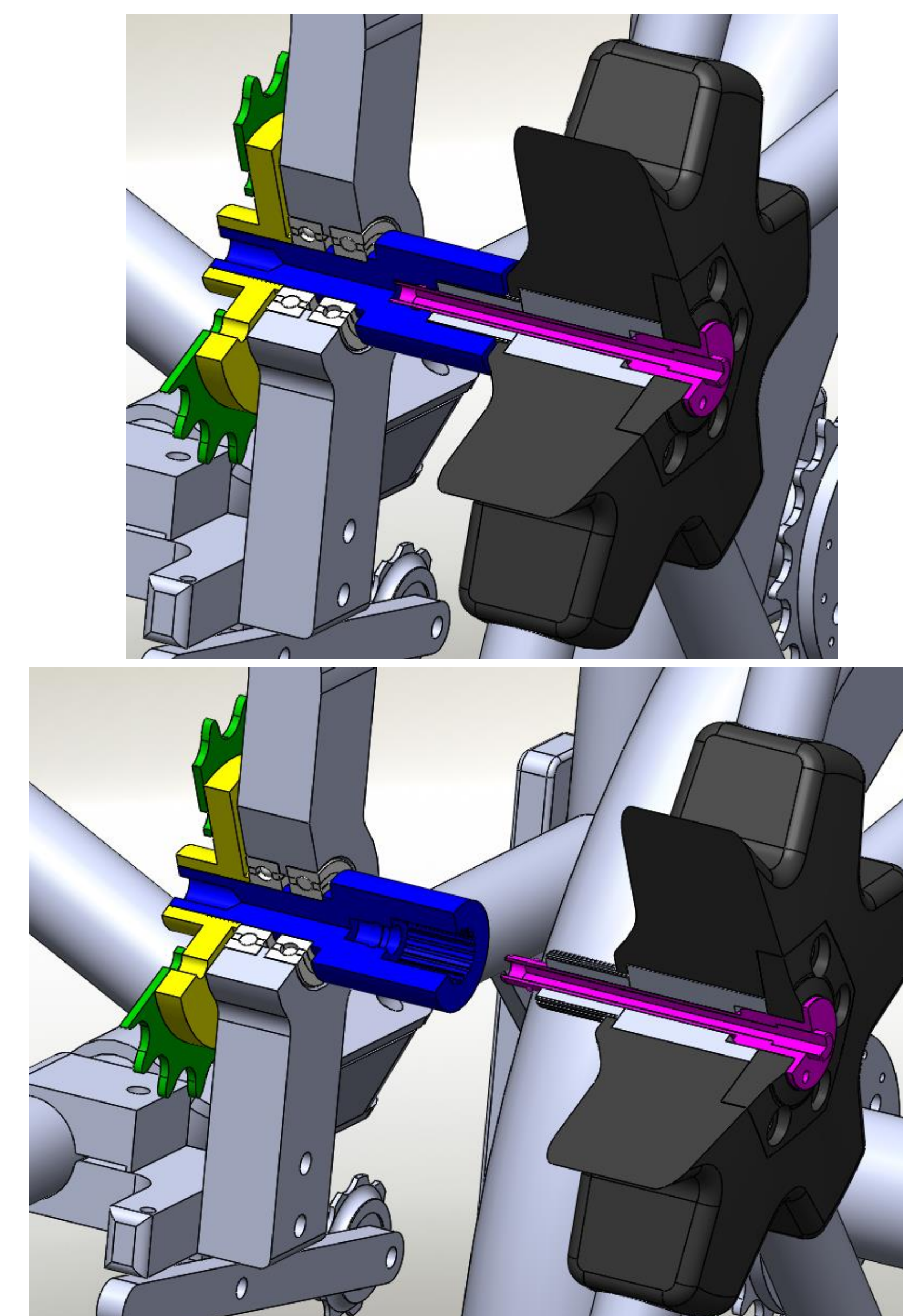


Figure 3. Hand rim mounting system in engaged (top) and disengaged (bottom) positions.

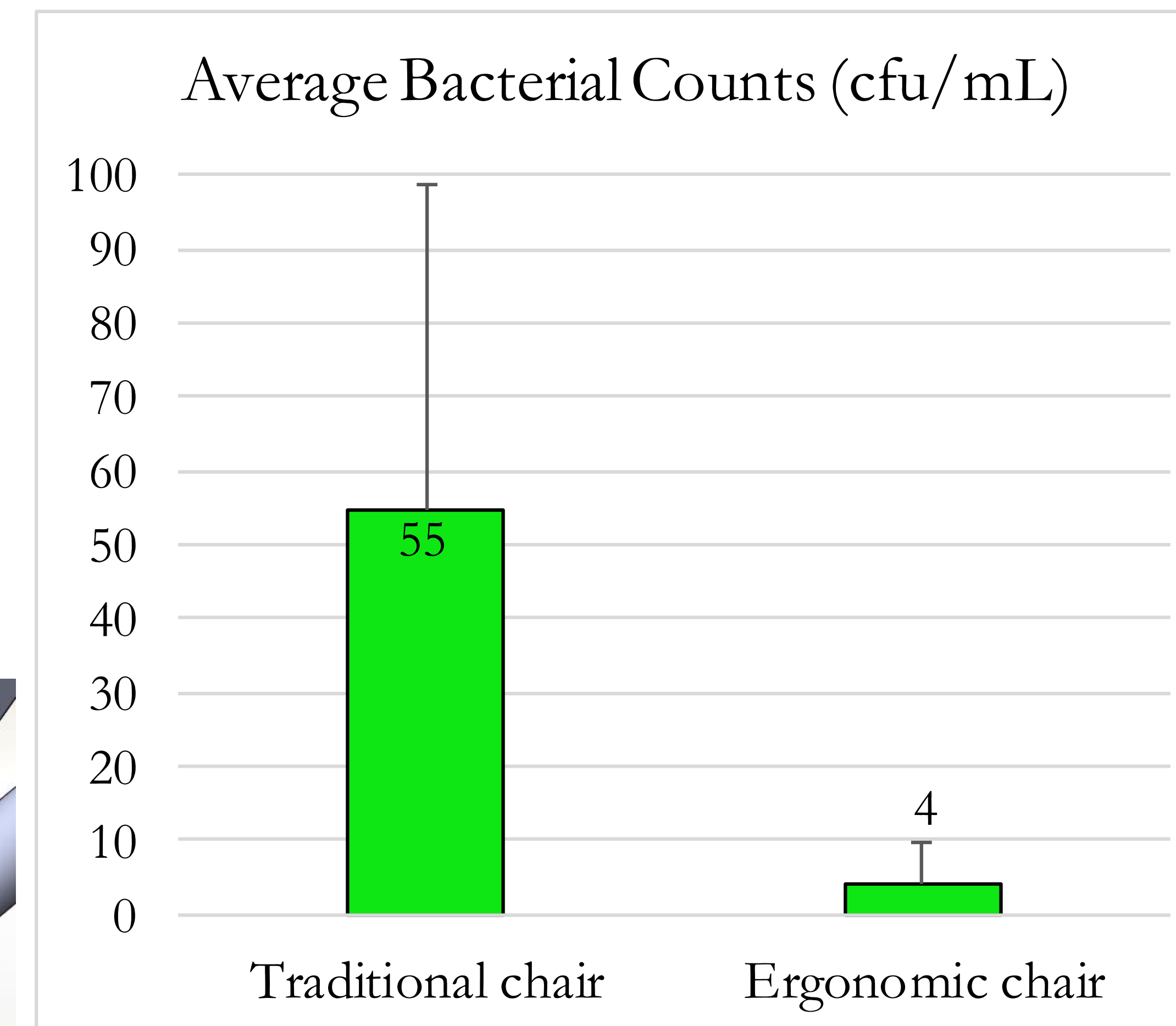


Figure 4. Average bacterial counts from a bacterial culture study [3]. Of note, since hand rims no longer touch the drive wheels, the users hands also stay cleaner.

Methods

- Iterative design using SolidWorks
- Rapid prototype fabrication using CNC laser cutting, 3D printing, and manual machining

References

- [1] P. Nichols, P. Norman, and J. Ennis (1979). *Scand J Rehab Med* 11:29-32.
- [2] S. Fairhurst, E. Nickel, S. Morin, G. Goldish, and A. Hansen (2016). *J Med Devices* 10(3):030952
- [3] B. Slater et al (2019). Reduced bacterial hand contamination with an ergonomic wheelchair [Abstract]. PVA Summit 2019.