# Designing for Disability: Making Activities of Daily Living more Manageable through 3D Printing

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### INTRODUCTION

- The CDC defines physical disability as a multifaceted experience, in which impairments impose difficulty for the individual to engage in activities or interact with their environment
  - Physical disabilities to place limitations on one's physical functioning, mobility, dexterity or
  - stamina. Consequently, these restrictions hinder a variety of facets of daily living.
  - Encompasses a wide variety of conditions including, but not limited to, multiple sclerosis, epilepsy, stroke, spinal cord injuries, and amputation
- Despite significant strides over the years in improving accessibility for those with physical disabilities, many barriers still exist
  - Through the 2010 Americans with Disabilities Act (ADA): Standards for Accessible Design, a variety of enhancements have been made to ATMs, parking spaces, and speed bumps for example
  - However, large-scale alterations such as these are not quick to implement
- Now, with rapid advancements in technology especially in regards to 3D printing small-scale accommodations can be not only provided, but created, easier than ever before (Figure 1). Designs can be made open-source and hosted on sites such as Thingiverse and MyMiniFactory for persons around the world to benefit from.







Figure 1: (Left) Hackess Handy Holder by Eva Sbaraini, (Middle) Umbrella Holder attachment for wheelchairs by "Carlos", (Right) Plastic Bottle Opener for Hand Support by Luca Parmegiani

• The design process is not confined to scientists in laboratories any longer and can instead be affordably pursued by students in hackathons, hobbyists and even people with physical disabilities alike, all from the comfort of their homes.

### METHOD

As a part of my Capstone in Public and Population Health Leadership, I developed this design (Figure 2) that intends to support those with physical disabilities in getting into, and out of a bathtub. Muscle weakness caused by Multiple Sclerosis, Myasthenia Gravis, and even in the elderly can make this seemingly simple task quite difficult. Furthermore, repurposing household items (i.e., commercial step ladders) for climbing into bathtubs are not only cumbersome but pose numerous risks to the safety of those with physical disabilities.



Figure 2: Bathtub used for developing the model seen in Figure 3

- Photos and measurements of a bathtub's (Figure 2) height, depth, and thickness were taken and used for reference when modeling the assistive device in Autodesk Fusion 360.
- Bathtubs having other dimensions can certainly be accommodated; the model can be adjusted to reflect measurements of one's choosing in the software, prior to 3D printing.

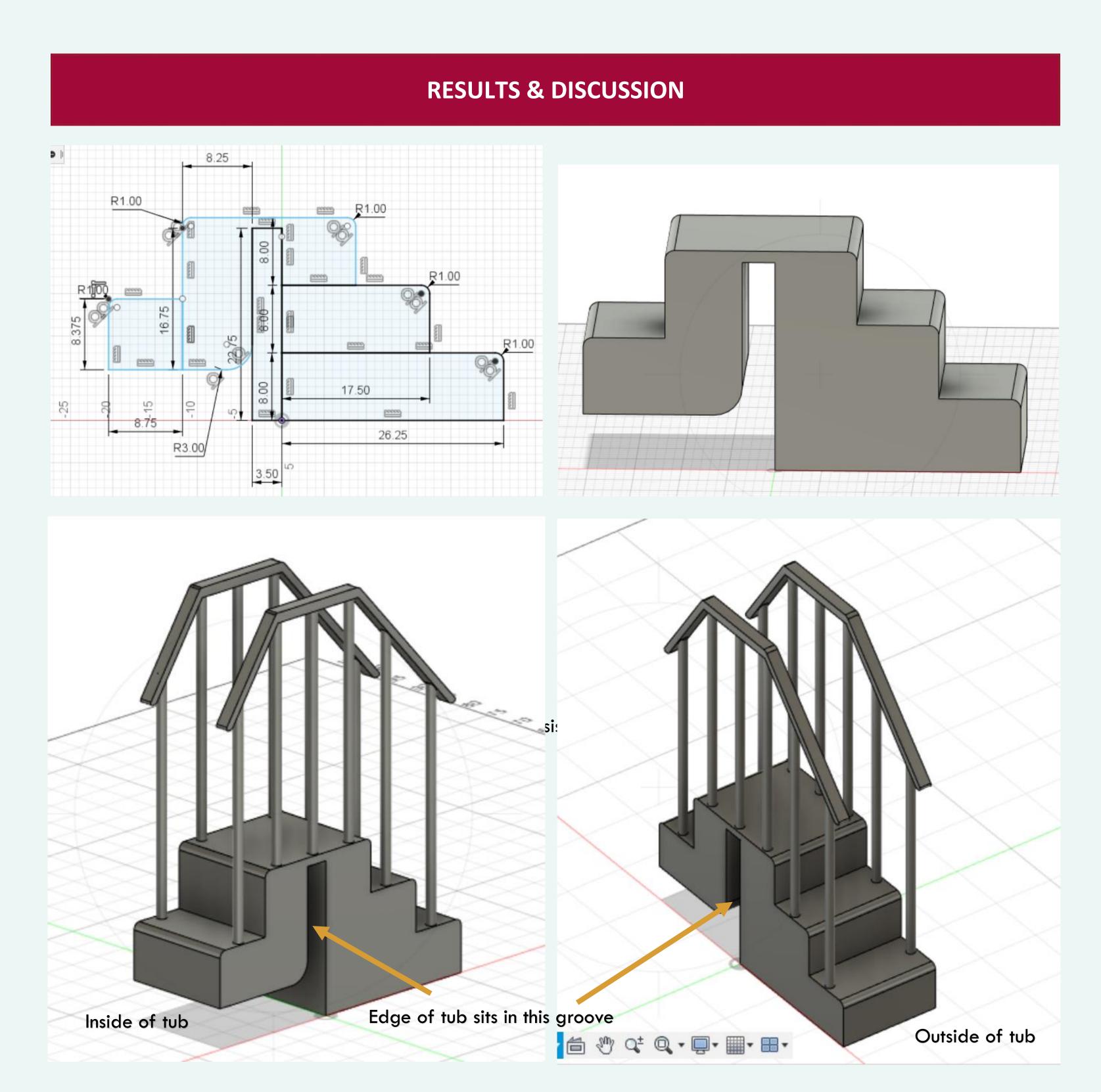


Figure 3: Proposed design by Mashaal Syed. (Top left) Initial draft with measurements taken from Figure 2, in the 3D modeling software Autodesk Fusion 360. (Top Right) Extruded model to span a width of 17 inches, a comfortable area for users to traverse up and down the steps of the printed model. (Bottom) Views of the model with both left and right sided railings, as well as a guard rail added for safety and ease of use; the view on the left depicts the portion of the design that would sit in the bathtub, while the view on the right showcases the part that sits outside the tub.

### **DESIGN SPECIFICATIONS**

The design is meant to be fitted along the edge of the bathtub, so that the individual can climb up the three steps from the outside, and then walk down two steps into the bathtub itself. It can be held by the railings when brought into the bathroom prior to use and lifted by the railings when fitting the edge of the tub in its groove. Of course, the main purpose of the left/right sided railings and guard rail are to provide the individual with the necessary support as they climb into and out of the tub. It also serves as a protective mechanism should the individual have a sudden bout of weakness and feel as if they would fall over.

All corners of the steps and railings have been rounded to prevent accidental injury that could arise had normal sharp corners been printed. Railing heights, as well as the step heights and widths were all chosen within standard ranges.

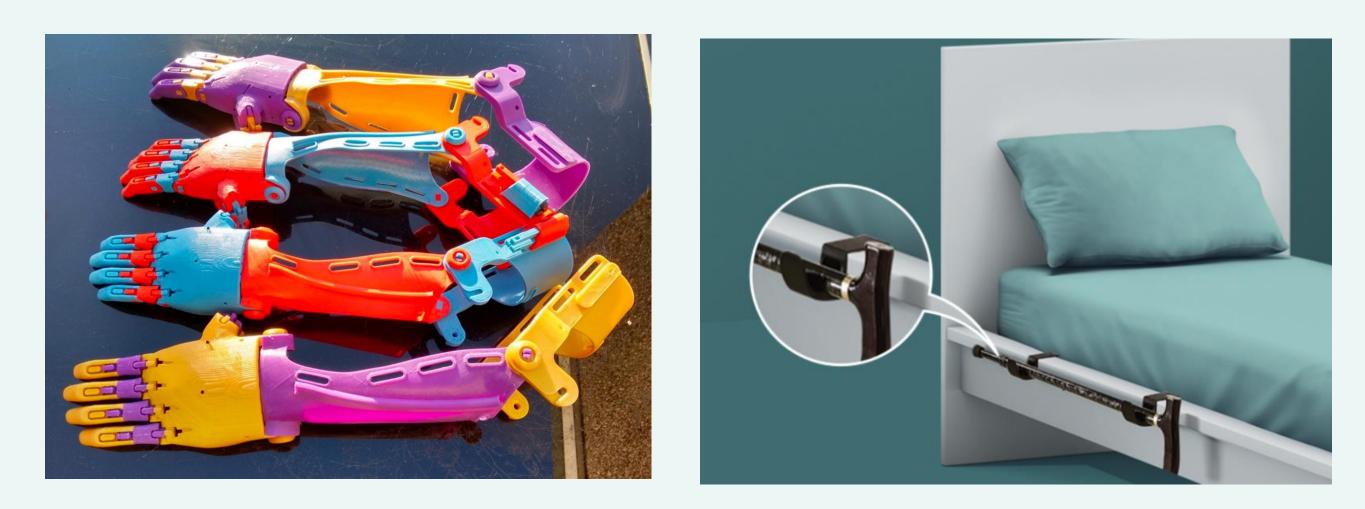
### **3D PRINTING SPECIFICATIONS**

Presently, this design is intended to be printed with an Afinia H800+ FDM printer in ABS plastic. Choosing a honeycomb infill pattern as well as an infill density of over 70% ensures a strong print that is best able to support the weight of the individual.

While there are many large-scale 3D printing initiatives to provide support for those with physical disabilities around the world (i.e., E-Nable and Ikea's ThisAbles - Figure 4) oftentimes there are opportunities to help those in our own communities ourselves through these new methods and technologies. We have the flexibility to make our designs as personalized as possible – meaning, our work can target their specific needs and circumstances in ways that commercialized devices may not be able to.

- physical disability

Sometimes it's the simple day-to-day activities that we take for granted, that require some innovation to become accessible for those with physical disabilities. By taking the time to listen to them and work with them, and by leveraging the capabilities of 3D modeling and 3D printing, we can develop solutions that have more of a multifaceted impact than we without physical disabilities could possibly understand.



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2.	Department of Homeland Secu
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3D Printing Designs from MyMiniFa	

 https://www.myminifactory.com/object/3d-print-hackcess-handy-holder-1651\* 2. <u>https://www.myminifactory.com/object/3d-print-umbrella-holder-for-wheelchair-version2-189</u> https://www.myminifactory.com/object/3d-print-plastic-bottle-opener-for-hand-support-5483

### CONCLUSION

### 3D printing is a cost-effective, completely customizable method of designing assistive devices to support those with physical disabilities.

• Having the ability to make modifications in 3D models is especially of value, since disabilities arising from various medical conditions have the potential to progress; future alterations to this design (and others) can reflect the changing needs of the individual

• Future iterations of this design could consider removable railings for increased ease of storage. It could also be designed to be foldable.

The choice of the 3D printing material is also impactful; printing with filament that is antimicrobial, or reinforced with carbon fibers would increase the longevity of the device

• Those with physical disabilities often have limited financial resources; 3D printing is comparatively more affordable than seeking to remodel one's home to account for their

Figure 4: (Left) Example of a 3D printable prosthetic arm from E-Nable, (Right) "Cane by Me" design from Ikea's ThisAbles program, which aims to supply printable modifications to their furniture for those with physical disabilities

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