Towards a Digitally-Made Transradial Prosthetic Socket

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Background

Transradial Prosthetic Socket

- Transradial = below-elbow
- Prosthesis = restore functions of missing limb
- Socket = arguably the **most important part** of the limb prosthesis = human-machine interface

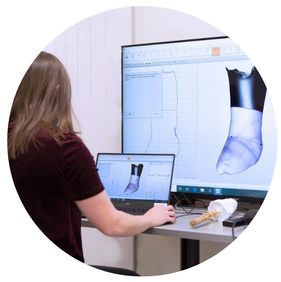
Socket Fabrication: Conventional vs Digital

Shape Capture
Capture the geometry of the residual limb with plaster bandages

Rectification
Manually modify the positive model & design the socket

Fabrication
Produce a socket by laminating over the positive model

Shape Capture
Scan client's residual limb with a handheld optical scanner



Rectification
Create a 3D socket model using Computer-Aided Design software

Fabrication
Use 3D printer to create prosthetic socket from digital design

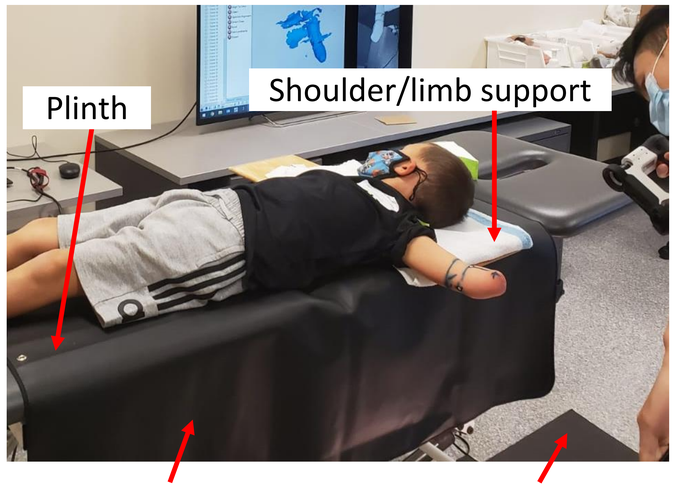
	Conventional	Digital
PROS	- Well-established	- Reduce plaster & material waste - Collect and store digital data
CONS	- Labour-intensive - Waste of material - No quantifiable data - Outcomes are highly dependent on the skills and experience of prosthetist	- **No established guideline/ recommendations for scanning, rectification, and fabrication procedure**

Rationale

The implementation of digital workflows in prosthetic and orthotic (P&O) care is increasing throughout healthcare. However, there exist challenges and technical barriers hindering the full adoption of digital workflows, especially for upper limb population. **A team of researchers and certified prosthetists has been investigating the feasibility to implement digital and additive technologies as routine practice for transradial prosthetic management – from digital shape capture to final fabrication.**

Things we have learned so far

Scanning



Set-up

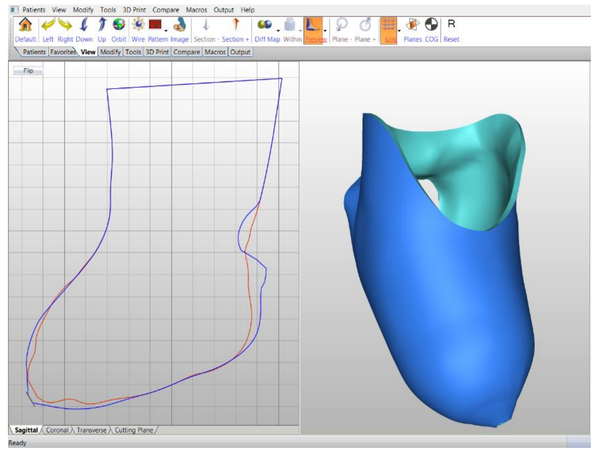
- Plinth = height adjustability for ease of scanning
- Black drape & floor mat = ↓ noise & ↑ contrast between background and residual limb
- Shoulder support = ↓ patient fatigue & ↑ stability

Client's Positioning

- Lay comfortably on the plinth
- Roll sleeve up to shoulder level
- Rest limb onto the support
- Remain still for the duration of the scan

Digital Rectification

- The most challenging aspect for prosthetists as it is a drastic change from conventional practice
- To help reduce the learning curve, we have begun developing a rectification protocol as a starting point for designing transradial sockets
- We have been working on automation tools that aim to simplify the rectification process.

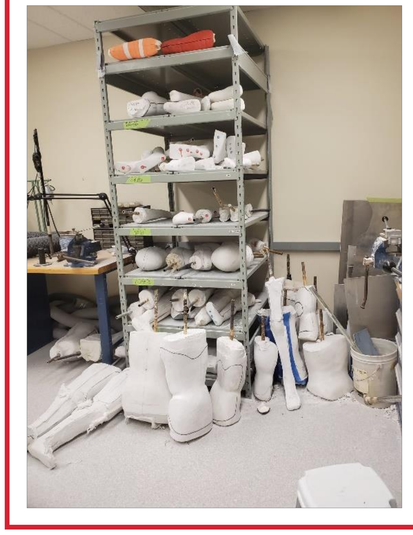


3D Printing

Challenges

- No material standards for diagnostic or definitive sockets
- Heat moldability of FDM printed parts is less than desired
- Transparency is insufficient to visually assess fit

Next steps and other applications



Next steps

- Fit 3D printed sockets on volunteer clients
- Train O&P staff to use digital technology
- Support digital rectification through research effort
- Expand application of digital technology to other populations such as lower limb populations and orthosis users
- Evaluate 3D printing materials

Other applications

- Eliminate existing plaster models and repurpose storage spaces by scanning and storing models digitally