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**

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<th>Shape Capture</th>
<th>Rectification</th>
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<td>Capture the geometry of the residual limb with plaster bandages</td>
<td>Manually modify the positive model &amp; design the socket</td>
<td>Produce a socket by laminating over the positive model</td>
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**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

**Transradial Prosthetic Socket**
- Shape Capture
- Rectification
- Fabrication

**Scanning**
- Plinth
- Black drape & floor mat

**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**
- 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

**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**

**Conventional**
- Well-established
- Reduce plaster & material waste
- Collect and store digital data

**Digital**
- No established guideline/recommendations for scanning, rectification, and fabrication procedure

**CONS**
- Labour-intensive
- Waste of material
- No quantifiable data
- Outcomes are highly dependent on the skills and experience of prosthetist

**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