3D Prosthetics for Rojava (Northern Syria)

Objectives of the Project

Support the prosthetics laboratory based at Qamishlo through the transfer of skills for 3D printed production of upper limbs and the integration of the current lower limb production process.

The Context

In Rojava (Northern Syria), after many years of war against ISIS, many people have suffered amputations, including many women and children. A prosthesis laboratory has been operating for several years which employs 5 people and an expert coordinator who, using standard components purchased on the local market, produce and customise the prostheses for patients.

The laboratory is unable to fulfill all the local demand, with an estimated backlog of about 1000 people waiting for upper limb prostheses and 1500 for lower limb prostheses. This is also due to production times (from 6 to 10 days for the upper limbs and 10 days for the lower limbs) and costs ranging from 1500 USD to 4000 for the upper limbs and from 2500 to 6000 for the lower limbs.

The proposal by Staffetta sanitaria and project Partners

The primary aims of the project are to aid the Qamishlo laboratory in starting the production of complete 3-printed upper limb prostheses (hand, wrist and elbow), and if the first phase is successful, to start the production of 3D-printed sockets for lower limb prostheses.

As one of the primary objectives of the Project is to keep the production costs as low as possible, it important to note that while the production of a complete upper limbs does not present any particular difficulties, as in fact someone in the laboratory group is already working on it, the production of complete lower limbs at a low cost is not practicably achievable. For this reason, at this stage of our technological capability, we will only experiment with the production of lower-limb sockets, to be adapted by integrating the 3d-printed sockets with commercially manufactured prosthetic components (such as semi-active or passive knee and ankles) already used in the Qamishlo laboratory.

The objectives of the project are therefore to transfer the skills acquired during an experimental phase (to be carried out in Italy), to the employees of Qamishlo's laboratory, in order to produce locally-produced upper limb prosthetics and if the first stage is successful, to eventually integrate 3D-printing of lower-limb sockets with the current production process of prosthetics for the lower limbs. This would make it possible to drastically reduce production times and costs and respond more effectively to the needs of Rojava citizens.

Main steps

- Definition of an "experimentation protocol"
- Implementation of the protocol within an operating laboratory aimed to verify the details of the production process and writing a "User Manual";
- Transfer of skills to Qamishlo operators.

Advantages of the proposal: a) reduction of time and costs; b) the lower limb in 3D allows mechanical mobility; c) considering the models are standard (S / M / L measurements tailored for children and adult) it is not necessary for the patient to visit the laboratory in person before the lower limb is ready for adaptation.

Critical requirements sufficiently long learning time for local workers, local availability of required equipment and materials .

The production process in 3D

Phase 1: Patient visit with measurements with 3D scanner (phase that is not necessary for the upper limbs)

Phase 2: Modeling
a) 1: 1 scale modeling;
b) export in STL format, an extension, binary or ASCII,
c) uploading files to software (eg Cura/Slic3r),
d) output file in GCODE and send it to the printer

Phase 3: Print;

Phase 4: Assembly (especially for the upper limb)

Phase 4: Adaptation to the patient.

Example of upper limb

Example of socket (lower limb)
https://www.3dwasp.com/wp-content/uploads/2018/09/oggetto-in-modellazione.jpg)

Main Equipment and tools

It is necessary to have available on site:

a) 3D scanner

b) Software

c) 3D printer

d) Wire

For this purpose, we have identified models with a good quality/price ratio. The same has to be identified local to the laboratory, especially for the availability of spare parts. Alternatively, you are asked to know which models are available on site so that we can find and operate with the same models in Italy.

For the *scanner* we suggested to use the *3d Systems 350470 sense2 3d scanner (price 500 €) (Note: it is unknown if this scanner produces sufficiently high quality 3d models at this moment)*

Technical features:
2nd generation three-dimensional mobile scanner. The software for Sense2 makes the refinement of the collected data very simple. The digitized model can be saved as STL, PLY, WRL or OBJ file. The models can be reprocessed or printed immediately Advantages: Good scanning quality 3D scanning even in color Ease of use No calibration or configuration Simple finishing Export in various formats: OBJ, STL, PLY, WRL

Software : (free software- https://ultimaker.com/en/products/ultimaker-cura-software

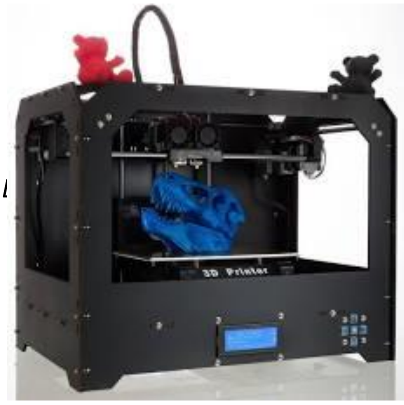
Printer: Technical Specification – 3D Printer

- FDM printer (Fused Deposition Modelling), that can print from 1.75 or 3mm ABS-plastic filament
- Build volume - minimum 300x300x200mm size
- Printing accuracy (x- and y-axis) – 0.1mm
- Layer height (z-axis) – 0.2mm
- Build speed - 100mm/s (will mean 5-6 hands can be printed per day)
- Fully enclosed printing area for temperature management (can be retro-actively fitted)
- Heated Bed – up to 100 Celsius (or 100-200 watt)
- Extruder nozzle temperature – 240 Celsius

Example models:

1) Ultimaker Original Plus, 1000 EUR

2) CTC 3D Printer, ~400 EUR)



3) Creality CR-10, Tevo Tornado, XYZ Makerbot, 200-300 EUR

(Chinese copies of the Prusa Researchi 3 Prusa, original price 600-700 EUR).

These are the most highly recommended printers to use for this type of project, as they have the best print-quality to price ratio

Filament Material

Upper limbs: ABS-plastic filament (15-28 € per KG)

Lower limbs PLA (20-25 euros per kilogram) or Nylon (much better but more difficult to print (30-50 euros per kg), depending on the brand and quality.

(example of ABS-plastic filament)

Activities chronogram

1) Completion of the working group with the integration of an orthopedic technician

2) Definition of the “experimentation protocol”

3) Training on assembly and use of the 3D printer (1-2-3 activities to carry on in February)

4) Laboratory for the production of upper limbs in Italy (on March) and writing an Instruction Manual

5) Laboratory for the production of lower limbs (in Italy (in March/ April) and completing the Manual

6) Laboratory in Rojava to transfer the skills to Quamishlo employees by using the instruction the Manual (from May onwards).

The main operational phase is based on Laboratory activities, also aimed to define in detail:

- The preparatory phases for production (installation of the instrumentation);

- The activities to be done and the tools for each phase (modeling, production, adaptation)

- Production of the user manual with the times, inputs, results and costs.

Working group

In Italy: people by Staffetta sanitaria, A.S.C. - Association of Solidarity and Cooperation (Trieste), Engineers Without Borders (Roman section), Avana Group (Rome), FabLab Buridda (Genoa). The Project is carried on also by the coordination with UIKI e MezzaLuna Rossa Kurdistan Italia Onlus.

At a local level: in addition to the employees of the Qamishlo orthopedic laboratory, it would also be necessary to have an expert printer technician and / or able to handle technical problems related to machinery.