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Title
Parametric design can facilitate the design of 3d printed bespoke aids for daily living

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Summary
Nowadays, patients who have difficulties performing activities in daily life (ADL) are mostly equipped with prefab aids. The use of new techniques such as 3D printing, 3D scanning and parametric design could enable occupational therapists (OT) to make truly bespoke ADL aids at an affordable price.

Introduction
Persons with disabilities, for example as a result of stroke, rheumatoid arthritis or patients with mental disabilities often need occupational therapy aids to help them perform ADL tasks. Currently most of these patients are provided with prefabricated aids. Quite often these prefab aids are not adapted well to the needs of a specific patient. In this case the OT will often make small adaptations to these prefab devices to improve the functionality.
The use of 3D printing and 3D scanning for the production of personalized aids for daily living can eliminate the need for these time consuming adaptations.
The fact that most OT have no experience with these new techniques and CAD is still a major hurdle for the implementation of this new way of producing personalized devices into clinical practice.
In this abstract we propose the use of parametric design combined with an online platform that allows clinicians to adapt existing parametric models.

Methods
For the development of the parametric designs, different cases are elaborated involving patients, occupational therapists and orthopedic companies with the support of 3D manufacturing companies.

The parametric designs were made in Rhino Grasshopper. At the start of each case, the patient and OT where interviewed to determine the exact requirements of the occupational therapy aid. Once a first prototype of the design was finished, the digital design was sent to the OT and patient for verification and input. Since the patients were involved during different steps of the design process their specific needs are incorporated in the design.
Depending on the required properties of the devices, they were printed with different additive manufacturing techniques such as laser sintering, fused deposition modeling or DLP. In order to evaluate these newly developed designs, each design will be used by a patient for at least 3 weeks. After this period the D-QUEST questionnaire will be taken.

Results

Some of the parametric designs will be made available on the projects website.
The evaluation of the 3D printed aids is not yet finished. On one hand the results will be used to improve the new designs. On the other hand, the feedback on the implementation process will be used to improve the digital designing process for the OT.
At this moment, 7 pilot cases have been identified, including 1) assistive products for eating and drinking such as a knife holder for a person with only functional feet, a tool for fixing straws to several recipients, a device for increasing the height of a plate, 2) sports aids such as a device to place boccia balls on a wheel chair, and 3) aids to improve activities of daily living such as a tool to tie hair one handed and a tool to help clipping nails.
First digitals designs are developed together with the patient, the OT and engineers. For some of the cases, the first prototype devices are printed and used in a preliminary test. Next, the designs will be updated, and tested out for a longer period of time. The first feedback from the patients is positive, yet several suggestions were made to improve the designs.
When this project is finished, 35 cases will have been examined where patients are fitted with a new 3D printed bespoke aid.

Conclusion

The implementation of parametrized digital designs in combination with 3D printing is promising. 3D printing can be especially useful in the domain of bespoke aids, as it makes the production of small series or even unique products affordable to produce products in low numbers.

Making designs that are tailored to one patient, however, requires specific expertise. But with the use of parametrized models, the threshold is lowered to design models that are really adapted to the needs of one patient.

References

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