Design of the physical part of an arm-hand rehabilitation game

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A stroke has a large impact on the daily life of a patient, this includes the reduced functioning of the arm and hand. Different functional arm and hand movements are important for performing daily activities. Research has stated that the application of games in rehabilitation contributes to more motivated patients *(Flores et al., 2008)*. Roessingh Research and Development (RRD) has developed the HandsOn game to train the arm and hand function of stroke survivors. The goal of RRD is to help people with a disability, physical or cognitive, to live as independent as possible in society by use and application of new technologies *(Roessingh Research and Development, 2017)*.

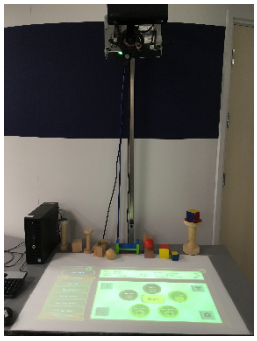

Figure 1. Current HandsOn prototype

The HandsOn is a low-budget game, developed by RRD for arm and hand rehabilitation. The virtual environment of the game is projected on a table, while the users place physical objects on the table to play the game. Patients train their arm and hand skills by reaching, releasing, rotating and manipulating objects.

The current HandsOn construction is still in a prototype phase (Figure 1). RRD wants to further develop the HandsOn construction into a product, to share it with other rehabilitation centers in the future. Therefore, the aim of the assignment was: *"Develop the physical part of the HandsOn into a professional product, upon which the low-budget concept is still applicable"*. The "physical part" included both the construction of the HandsOn and the physical objects used in the game.

During the start of the project, research was performed to get familiar with the HandsOn, the users and arm-hand rehabilitation exercises in general. Essential elements of the HandsOn game are the table, the projector that projects the game, the Kinect that registers the objects and the computer to start the game. It is concluded that these are essential parts of the HandsOn game that need to be kept within the re-design.

To examine how individuals interact with the HandsOn, a user study was performed during therapy sessions. The users were observed while playing the game to examine if present problems should be solved. Results showed that all users needed to be able to use the HandsOn, whether they were wheelchair-bound, needed an arm-support device during training or did not use any device. After the analysis, design requirements were set up for both the HandsOn construction and the objects.

During the design process, the HandsOn and the objects were examined separately. The design process started out with sketching ideas for both the HandsOn and objects on the basis of the requirements. The ideas for the HandsOn led to three different concepts, which were reviewed together with experts in the field. Eventually, a final concept was chosen, which was further elaborated in detail, including a 3D model, material choices and production methods. The ideas for the objects eventually led to six ideas for objects for the HandsOn. Some of these objects were realized in the workplace.

The final design of the HandsOn (Figure 2) consists of a simple and professional construction with a friendly appearance towards the user. The design has rounded corners and an open appearance. All essential parts for the game are still used within the re-design. The HandsOn was designed to be as compact as possible, with all parts integrated.
The design was optimized for all different users and the therapists. The computer is easy to reach and the design can be moved around if necessary. The low-budget concept is still applicable, as this was taken into account with both the choices for the material and production methods.
Due to time limitations, it was not possible to produce a prototype of the re-design. However, a costs estimation was performed in order to estimate how much a prototype would cost for RRD.

Figure 2. Final design of the HandsOn

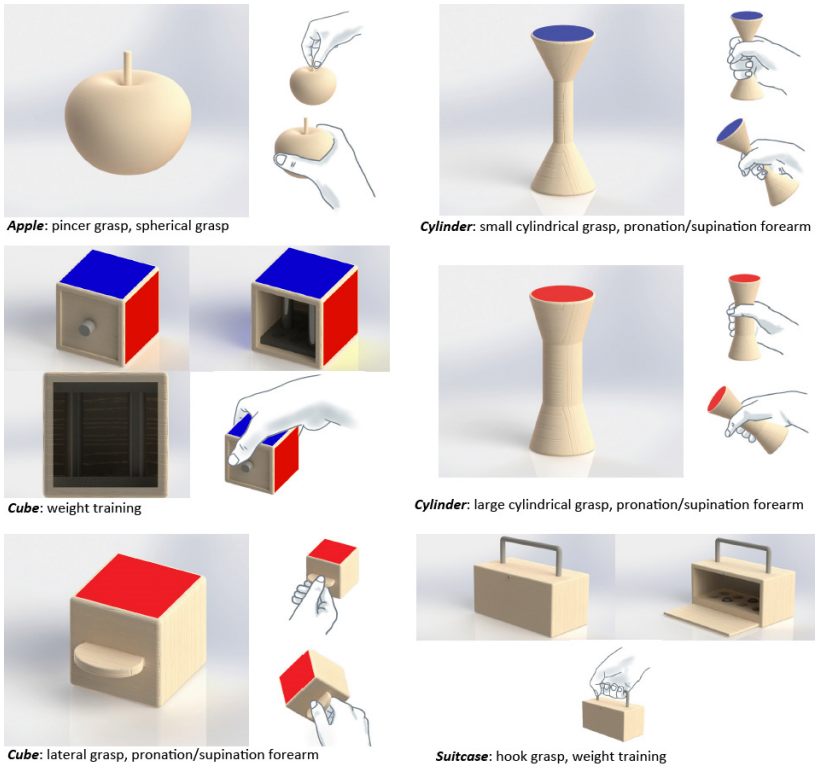

Figure 3. Models of the developed objects for the HandsOn

Objects were developed for the HandsOn, with different grasps for a varied training (Figure 3). Some of the objects were realized in the workplace. As the objects were realized, they can actually be used by the patients while playing the HandsOn game. A user test with the objects proved that most objects were grabbed as designed, except one: the object with the lateral grasp.

Further research is necessary for the realization of the design, including more detailed material- and production choices. It should also be tested whether the material of the HandsOn is able to carry the weight of the Kinect and the projector. Also, the object with the lateral grasp should be further designed, so the right grasp is provoked from the users.

The assignment resulted into a full re-design of the HandsOn into a product, with a low-budget concept. Next to the construction, objects were re-designed and developed for the HandsOn game. Although optimization is needed before manufacturing is possible, the assignment can be used as a design suggestion for further development of the HandsOn.

References

Flores, E., Tobon, G., Cavallaro, E., Cavallaro, F. I., Perry, J. C., & Keller, T. (2008). *Improving patient motivation in game development for motor deficit rehabilitation.* Paper presented at the Proceedings of the 2008 International Conference on Advances in Computer Entertainment Technology.

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