Redesign of the current orthosis

'The integration of a therapeutic Feature in the current seating orthosis to reduce spasticity'

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Perteon Seats is a company in Oldenzaal, that is expert in complex problems in the field of orthoses. An orthosis is a device that helps to prevent deformities and thus ensures a good posture. Perteon Seats focuses on seating orthoses (Perteon Seats, 2017). The company aims at adding functionality to the current seating orthosis in order to increase its value. Given that many of its users suffer from spasticity, it is interested in the consequences of spasticity related to the seat. Perteon Seats desires to figure out if it can design a seating orthosis that helps its clients to manage their spasticity. Hence, the purpose of this research project is to design a preliminary layout of a seating orthosis, which helps in managing the spasticity of Perteon Seats' users in order to answer the following research question:

To what extent is it technically feasible to include a therapeutic feature in the current orthosis that helps to reduce the passive problems caused by spasticity?

The design method of Pahl and Beitz has been used as the orientation for the approach of the project (Eger, Bonnema, Lutters & Van de Voort, 2013). Therefore, the first phase after the definition of the aim has been the planning and clarification. A wicked problem approach has been used, that means the problem to be solved has been defined during the design process. Therefore, a user-centred methodology has been approached to identify the real problem and needs of the user of Perteon Seats, because spasticity "is a lived experience" and thus difficult for other people to understand (Bhimani & Anderson, 2014). Hence, the user and other stakeholders have been included in every step of the design process. To get a better understanding of the target group and their problems, semi-structured interviews with users, therapists and revalidation doctors have been executed at the beginning. The gained information has been analysed in terms of a PACT-Analysis. That answers the sub-question what causes the passive problems, and what the clients currently do to solve it. The results of a market research indicate that several technologies reduce the spasticity, but that heat and cold treatment, neurorobotics, and vibration stimulation are the only technologies that are suitable for the approach in a seating orthosis. Finally, a function analysis has shown that vibration stimulation reduces more passive problems than the rest, so it has been made the decision to design a seating orthosis with the function of vibration.

Literature research yields that vibrations at a frequency of 50Hz-100Hz and an amplitude of 0,5mm-1,5mm inhibit the monosynaptic reflex and thus relax the muscles. Additionally, the work of the muscles is reduced by decreasing the activation of the muscles. Therefore, the passive problems, pain, and fatigue are reduced by vibrations in the aforementioned range. Furthermore, the approach of vibration stimulation in the seating decreases the reflexes in the hamstrings. That is expected to prevent the user from thrusting out of the chair. As a result, wearing a confining hip belt can be avoided. The analysis phase yields the program of requirements that is used as the basis for the conceptual design. This is updated later because new insights are gained during the design process due to the wicked problem approach.

In the conceptual design phase, a concept for the controlling of the vibration feature and for the construction for the realization of it have been generated based on morphologic charts. A remote-control with physical buttons enables the user to control the intensity and the activation of the vibration based on a limited number of modes. The solution for the construction is to integrate voice coil transducers into the hard shell of the seating orthosis to generate a linear vibration.

The concepts have been combined to one total concept. This has been worked out more in detail in the embodiment design phase. Crucial information for the construction of the orthosis has been figured out in a brainstorm session with the different experts of Perteon Seats. Besides, necessary technical components for the chosen concept have been identified in collaboration with electricians and technicians. Moreover, a paper mock-up of the remote-control has been made to execute a little user test. It has been indicated that the designed interface is too complex for some users. Therefore, recommendations have been worked out for a redesign in the future.

Figure 1: Paper mockup

The result of the design project is a preliminary layout of an orthosis that can generate controllable vibrations in the seating. Therefore, the conclusion of the thesis is that it is technically feasible to design an orthosis that helps the users of Perteon Seats to reduce the passive problems caused by the spasticity. Nevertheless, a prototype would be necessary to test some critical points of the concept. Also, a clinical test is relevant to test the effect on spasticity over a longer time.

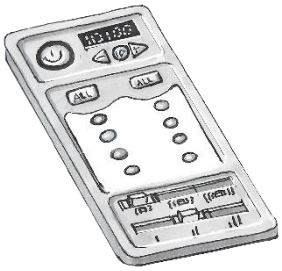

Figure 2: Remote-control.

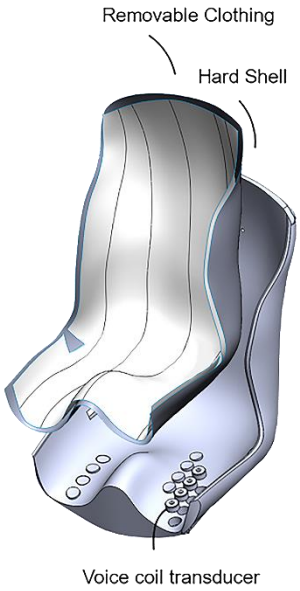

Figure 3: Redesigned orthosis.

References

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