THE USE OF OPEN-SOURCE PLATFORMS AND ADDITIVE MANUFACTURING IN ASSISTIVE TECHNOLOGY PRODUCTS

Raquel Cañete Yaque (raqcanyaq@alum.us.es*), María Estela Peralta Álvarez (mperalta1@us.es)

1. INTRODUCTION

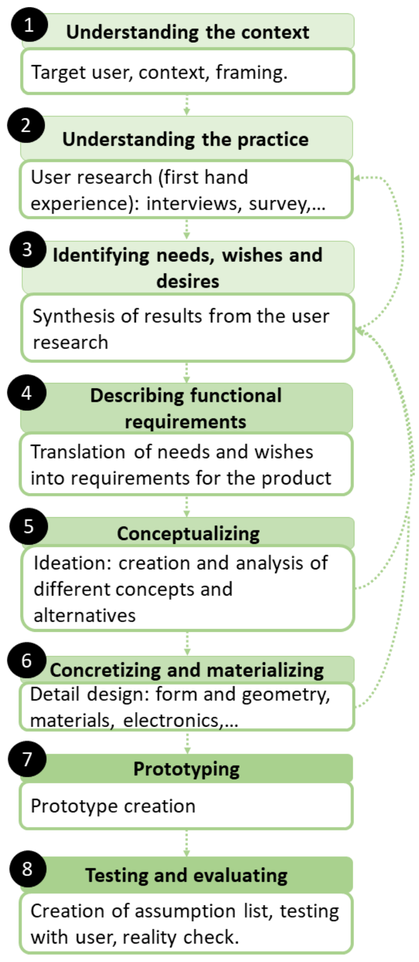
In his book *PLATFORM DESIGN*, David Cuartielles, states that open-source technology and free software are "a great contribution to human kind". Although a broad statement, it is known that this kind of resources have been a key element in promoting universal design, as the use of open-source electronic platforms has made it possible to create products available to everyone. As argued by Professor Powell (UC Berkeley), open-source platforms have established "new set of opportunities for democratization of knowledge" that "even affect the production of industrialized products". This is especially interesting when looking at products aimed at people with accentuated needs. The development of quality assistive technology, its universal design and its accessibility (supply and price) is one of the main research challenges identified by the WHO .

Technology has been proven to be extremely beneficial when integrated in products for people with accentuated needs, as it allows for adaptability. This results in products which adapt their behavior to the needs and preferences of the users to progress with them as they develop. However, these technological products are usually very expensive. To solve this problem, open-source electronic platforms, together with additive manufacturing, are now making assistive technology affordable, replicable in an agile way and with reduced costs. This is a great advantage for users (associations, training centers, therapy centers, etc.), as they have completely personalized and adapted products at their fingertips. In this way, open-source electronic platforms such as Arduino, are giving a new layer of accessibility to industrialized products. They allow users to create their own prototypes using a great variety of sensors by providing them not only with a coding platform, but with the knowledge of a whole community that is shared in it. Because of this, it is essential to stress the potential of open-source platforms and additive manufacturing to its fullest in the field of assistive technology to embrace accessibility and universal design in technological products.

These projects explore a use centered methodology created to develop concepts which embrace open-source coding and additive manufacturing to satisfy the needs and wishes of children with autism.

2. METHODOLOGY

The core of designing for accentuated needs, and more specifically assistive technology, lies on putting the focus on user experiences, needs, and wishes. For this research, we used a linear methodology based on use-oriented design approaches to design for children. This would also entail testing the product with children with ASD, as additive manufacturing, together with open-source platforms give us the opportunity to rapidly prototype and test the product. In this way, the project was developed using the following methodology:

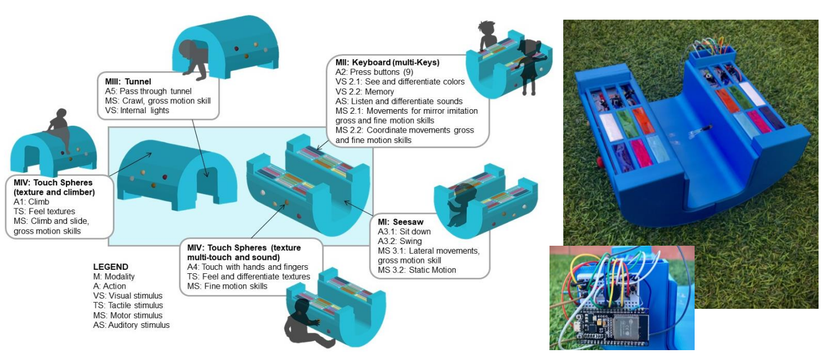


3. RESULTS

KEYme: multifunctional smart toy for children with autism

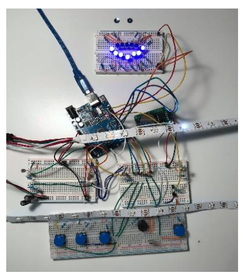
KEYme is a multifunctional smart toy developed as a reinforcement system for multiple needs. It is adaptable to different kinds of autism for therapies, educational centers or family environments. This approach involves the knowledge transfer from the latest neuroscience, medicine and psychology contributions to the engineering and industrial design field. The project uses a specific design framework for adaptive assistive technology that makes it possible to cover the set of needs included in the ASD classification. Using this methodology, a multifunctional toy with interactive and smart properties is developed. The combination of multiple functional elements allows the creation of game modes adaptable to different autism pictures and contexts of use.

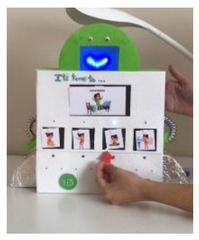
It is developed with an opensource electronic platform (Arduino), with versatile and easy-to-use software and hardware. The use of additive manufacturing allows the reproduction of any geometry, the manufacture of completely customized parts in a short period of time and at a low cost, easy product maintenance, and more environmentally sustainable results. In this way, the KEYme project contributes to the improvement of products and their accessibility in the field of human development and social sustainability (equity).



Pepe: an adaptive robot that helps children with autism to plan and self-manage their day.

Pepe is an adaptive robot that helps children with autism to plan and self-manage their day, with the end goal of becoming more independent. It combines traditional and computational elements to make the most out of the experience. It suggests a routine to the parents for the next day through an app, including main activities and subtasks that are grounded on the performance of the child. By collecting information from the performance of the kid and parent´s input, it is able to adapt its behavior to the child´s (and parent´s) needs. It is also able to change the level of support. Therefore, the robot and its functionality will progress together with the child, supporting children until they become more independent.





Arduino, together with sensors and actuators were used to rapidly prototype and test the different functions of the robot in different ways and forms. For the last prototype, materiality and the look and feel elements were combined with the electronic skeleton.

In this way, different materials and textures were integrated to test not only the functionality but the implementation at a deeper level. This prototype was tested with children with ASD.

CONCLUSIONS

- The results show two examples of assistive technology designs which demonstrate de potential of open-source platforms and additive manufacturing.
- Open-source platforms allow designers to quickly prototype different products which can be easily programmed and changed at any given point to test the product functions.
- Open-source platforms allow all users to easily replicate an electronic circuit, as all the needed knowledge is already embedded in the platform.
- Open-source platforms allow users to easily change an adapt the program to the specific needs they are trying to satisfy (personalization).
- Additive manufacturing allows fast and economical reproduction of any geometry, custom parts, easy maintenance, short series manufacturing and more environmentally sustainable results.
- Additive manufacturing allows users to easily replicate any product at low cost and rapid speed, optimizing material, time and manufacturing costs.
- Additive manufacturing allows the user to change and modify different aspects of the shape, colors, materials,.., to better adapt it to preferences and the needs they are trying to satisfy (personalization).
- The use of open-source platforms and additive manufacturing promotes universal design and accessibility.
- It is important to work on developing a methodology that helps not only designers but users to create their own products according to their needs.

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Design Engineering Department_Universidad de Sevilla
RESEARCH GROUP: tep022 Industrial Design and Project Engineering and Innovation