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Design and manufacturing of children's remote control for child viewing

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ABSTRACT

This paper presents a child-centred product design development process to produce a customized fingerprint-activated remote control for children using additive manufacturing technology. The paper is centered on the idea of using children's input in a design process using the imagination of the child. The My Remote manages television viewing content for children, restricts inappropriate content, controls viewing time and helps maintain a safe distance from the television screen. A finger-shaped design inspired by children based on the fingerprint recognition and the action of pointing at the television was adopted which demonstrated a synergy of functional and aesthetic design. The design process considered 4D elements: such as interface design, navigation, mood lighting and sounds, and 3D representations using Solid Works showing various colour schemes. Prototype models were produced using SLA (Stereolithography) and FDM (fused deposit modelling) techniques, allowing for ergonomic testing and visualisation. The study found that including children's input allowed subtle adaptations in the design requirements of the children because they were able to ergonomically test the remote control. The research culminated in a prototype model finger-shaped design, which fulfilled the criteria that it had to be innovative, inspired and liked by children, be comfortable and demonstrate functional requirements.

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1. Introduction

Some television programmes are rife with content that is unsuitable for children and which can have damaging effects. The consequences are varied and can have a detrimental effect on children's attitudes, behaviour and beliefs, as well as being an impediment to their development, influencing how they interact with others. Moreover, the act of actually watching too much television has similar negative effects. It has been proven that control over the content of television viewing has many benefits for children, including their health.

It would be unreasonable, however, to expect adults, who are responsible for children, to monitor all their viewing, given the vast amount of inappropriate content, and taking into account the busy lives of adults. Therefore, there is a need for a device that can protect children from such content.

The results from the primary research conducted as part of this project suggested a more general need for controlling and managing content and, additionally, more specific function and

usability needs to be provided by parents and children. It was found that a remote control should have an access security function, controlling viewing content and time and distance from the television, affecting individual user profiles to cater for different viewing needs, intended to be educational and fun, and to be comfortable for children, be safe, and finally, to be designed to withstand the physical rigours of daily use by children. In addition to the needs identified in the primary research, there was a need for the design to be inspired by children.

The My Remote project fulfils these needs and develops a concept for a remote control designed with children's design input reflected in the aesthetics and the functionality. More specifically, the shape of the My Remote was the result of a design process, which incorporated ideas on the functionality of the remote, i.e. pointing at the television and being fun for children to use. The designer considered a number of themes with children, including insects, dolphins and the human finger, the last which was chosen for the final design.

The My Remote has interactive elements, which are designed to praise children for correct choices and warn them against bad choices, as well as being fun. This is achieved through an interactive interface which includes voice instructions and warnings as well as mood lighting which reflects their behaviour. The My Remote will also incorporate a fingerprint-recognition system for security reasons and user-specific management of content and viewing time.

The My Remote was the brand developed to inspire a feeling of personal belonging in the child to encourage them to use it.

A prototype of the My Remote was modelled using the SLA (Stereolithography) and FDM (Fused Deposition Modelling) techniques; Acrylonitrile butadiene styrene (ABS) was chosen as it is robust and safe.

2. Preliminaries

The detrimental effects of inappropriate television content on children and the benefits of controlling such content have been extensively discussed in the literature [1, 2, 3]. Television does have a significant impact on children generally [3] agree that television affects children's attitudes, behaviour, beliefs and knowledge. Similarly, [1] state that too much television affects the way children interact with their peers, their world view and general behaviour. Other detrimental effects from watching television include negative effects on learning development [2], an increase in aggression in children [4] and childhood obesity [5, 6].

This study presents a remote control device for children as a solution to the aforementioned problems. Therefore, work related to this study also includes the psychology of toys and the design of remote controls. Although expensive electronic toys have been shown to improve children's intelligence, there has been some research showing that simpler toys are better for child development, as they encourage children to engage their imaginations [7] and to make a bridge between imagination and reality [8]. However, the introduction of electronic toys has produced the notion of rewards. With more traditional toys, the learning was enhanced through the activity itself, but, with electronic toys, children are stimulated by sound and colour and the opportunity to gain rewards [8].

However, there is very little related work about devices that control content. In the United States, there is the V chip, which automatically protects children from unsuitable content and, in the United Kingdom, unsuitable channels for children can be blocked by cable TV receivers and set top boxes. These systems often use password protection but offer no personalised management systems that can be pre-programmed by adults.

Much related work that has been done concerning this project and this has been in the area of the design of remote controls. Specifically, the work of [9] found that there should be a limited number of buttons on a remote control and they should be grouped according to function. This idea was also supported by [10], who studied physical shortcuts for remote controls, and concluded that usability had reached 'overstraining complexity', thus there was a need for simplification.

Children's input in design is important in the design process and the creativity and intelligence of children should not be ignored [11]. There are different levels of participatory design;

there is informant design – where the child informs the adult about their needs, balanced design – where designing involves equal participation of the adult and the child, and facilitated design – where the child is the designer and the adult is only the facilitator [12]. Moreover, there is a real need to involve children in the design of technology intended for use by children because adult-led processes may properly consider the needs of the child [13].

3. Methodology

The methodology was aimed at creating a solution to the problem of inappropriate content, and answering the needs of users by adopting a user-centred approach. User's needs were ascertained through interviews and questionnaires of parents and children initially, and through feedback generally and using focus groups during the design process. A total of 10 children, 5 girls and five boys, aged between 9 and 12 years took part in focus group discussions about various aspects of the design and ergonomic testing. Because feedback was engaged throughout the design process it allowed the designer to move from two-dimensional concepts through to three-dimensional models.

The use of additive manufacturing in rapid prototyping allowed the development of prototype models in the same proposed materials of the final product, this allowed children to experience both the aesthetic and feel of the remote control and these processes also allowed changes to be made in response to user feedback during the focus groups with the children.

For the shape of the My Remote, particular attention was paid to the required elements of fun, and with the incorporation of the children's input this resulted in an innovative finger-shaped design, which was ultimately reflective of the My Remote's function and use.

4. The design process

With the requirements established, the designer began to sketch ideas. In keeping with the need for the remote to be a toy and have a fun element, a number of ideas were conceived which were inspired by the children. These concepts included a watch strap, insects, fruit and the dolphin design as shown below (Fig. 1).

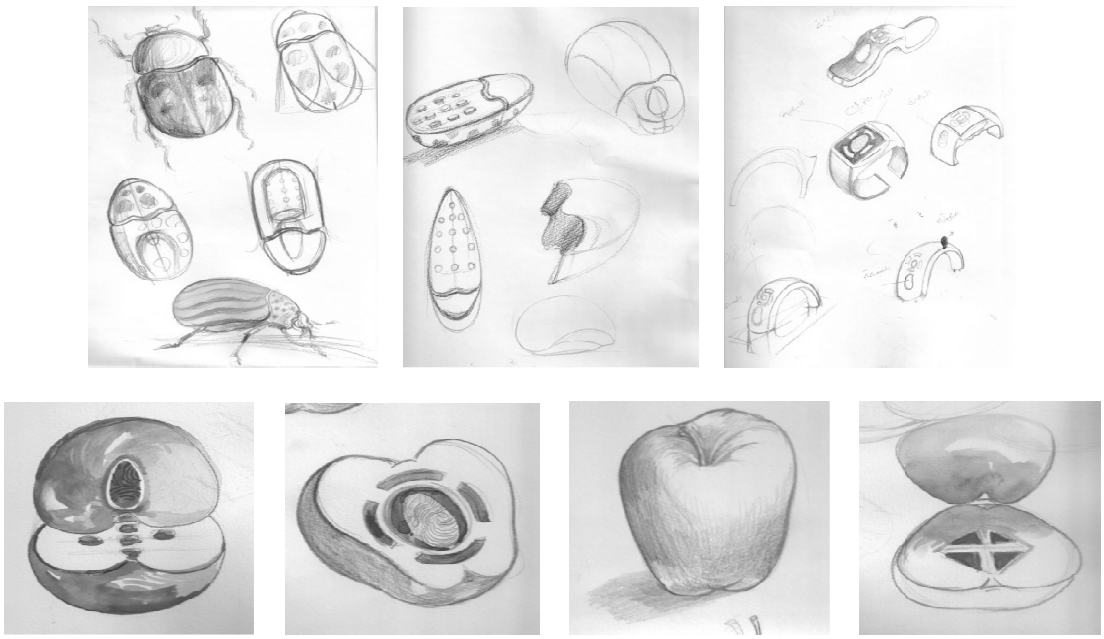

Fig. 1 Early sketch design

Fig. 2 Three-dimensional designs

Three dimensional designs (Fig. 2) based on these concepts were produced, in order to assist visualisation and gain feedback from children. Overall, the children criticised these two-dimensional designs; the watch strap was too thin, the dolphin looked uncomfortable and the ladybird was too wide and would wobble.

4.1 Finger-shaped design

The next significant development was the introduction of the finger-shaped design. The design ideas shown above were unacceptable to the users. Moreover, the designer wanted the shape of the My Remote to be innovative and incorporate the functionality of the remote control as an idea in the physical design.

From interactions with children and discussion about using television remote controls, the idea arose that a remote control is something that you point at the television, and this inspired the finger-shaped design. Moreover, this idea also incorporated the other functional aspect of the My Remote, the finger-print recognition system.

4.2 Early sketching

A sketch representation of the finger design was presented to some of the children involved in the study and the feedback was positive. They said that it looked fun and like a toy. During this stage the designer also considered the functional and usability requirements as shown in (Fig. 3).

Based on these sketches, an initial prototype model was made using modeling foam, to test the ergonomics of the design. Foam was chosen because not only was it malleable but also because other substances such as plasticine would have been too heavy. Primarily this device is to be used by children and should be comfortable. Moreover, the device had to be well balanced and held in a way that would not cause physical stress.

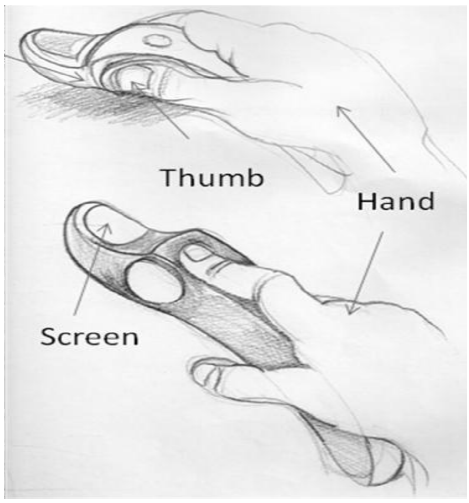

Fig. 3 Early sketch design – usability and functionality

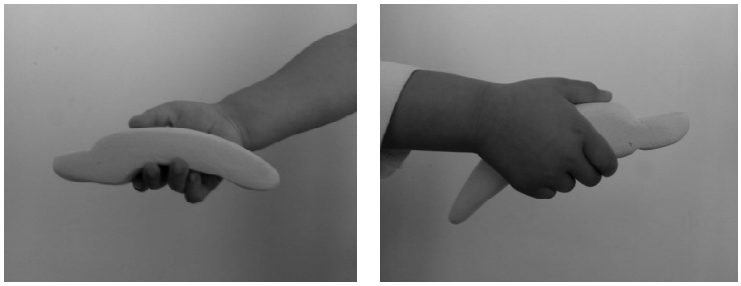

Fig. 4 Ergonomic testing

More specifically, the dimensions had to ensure that the remote was balanced when being held and that the child could use the functions and see the screen easily in a normal holding position. The ergonomic testing was conducted using a focus group and it was found that children preferred the design to be slightly slimmer and the shape was changed accordingly (Fig. 4).

There was positive feedback from the ergonomic testing about the finger-shaped concept, the children liked the concept and liked the feel of the shape, and they said it was comfortable and easy to hold. Subsequently, the designer created 2D dimensional aspects of the finger-shaped design as the next stage of the design process (Fig. 5).

Fig. 5 Two-dimensional aspects

The precise dimensions of the remote control were based on the ergonomic testing. The aforementioned requirements, i.e. holding the remote, using the buttons, pointing at the television and seeing the user interface at the same time, required an innovative design, illustrated in (Fig. 6). Here, the angle of the screen section is positioned to allow the user to see the screen and point it at the television at the same time, with ease.

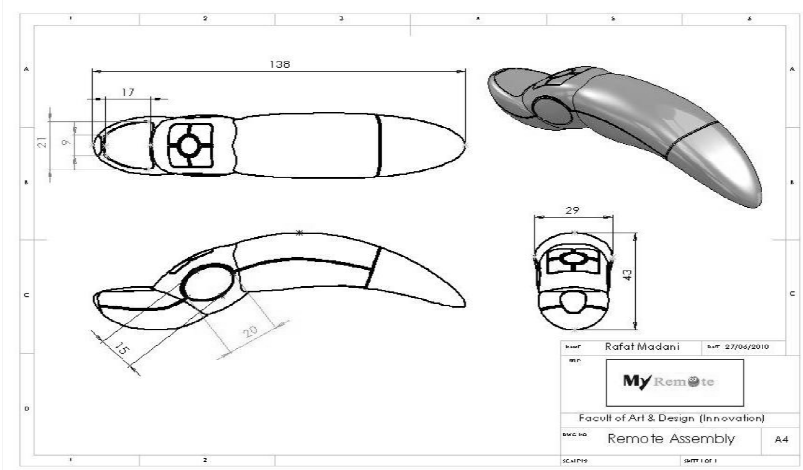

Fig. 6 Dimensions of remote control

4.3 Three-dimensional representation and modeling

Three-dimensional representations of the chosen design were produced using CAD (Solid Works), which clearly illustrated the overall aesthetics and various colour schemes, as shown in Fig. 7.

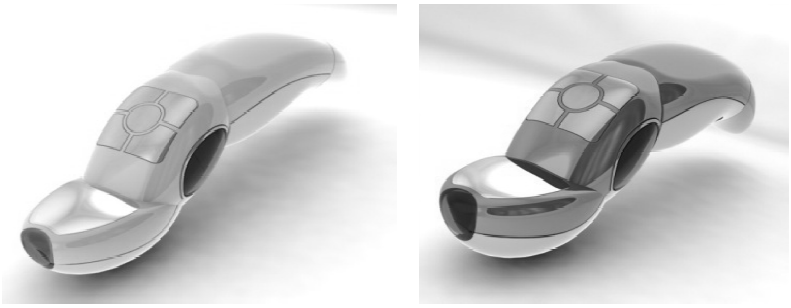

Fig. 7 Three-dimensional representation

This stage of the design process used CAD representations to show the internal design and components of the remote, including the integrated circuit board and the battery housing. These representations were later used for the production of the final prototype model using additive manufacturing techniques (Fig. 8).

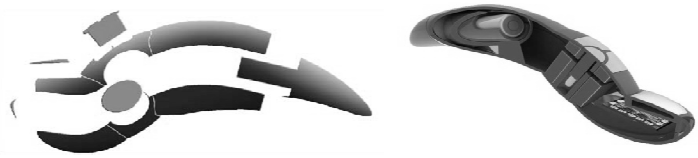

Fig. 8 CAD representation – internal design and components

4.4 Four-dimensional aspects

According to the needs of the users, that the remote control would have the required functionality, as well as fun and educational aspects, it was necessary to consider the four-dimensional aspects, which included interface design, mood lighting and sounds.

4.5 Interface design

The My Remote design includes an interface which fulfils the various needs of the device; such as programming by parents, user identification and profile saving. More importantly, for each action by the child, i.e. choosing a channel, sitting too close to the television or watching too much television, there is a specific interface response, which provides encouragement and discouragement, as well as fun and learning. Navigation through the interface screens was designed to be simple and various journey scenarios were tested with the children and they found the interface interaction easy to understand and navigate, instructions were clear and symbols were also understood (Fig. 9). Moreover, the children responded well to the fact that there were minimum controls, i.e. channel and volume.

Visual										
Sound		MY REMOTE	Welcome Jawharah	You are too Close to The TV Please Move Back	That is Much Better Now You Can Watch The TV	No No No you Not Allowed to watch this Channel	Yes This is a very good Channel	Please Turn Down The Volume	You Only Have One Hour Left	
Touch	**On**		—	—	**Channel** □	**Channel** □	**Volume** +	**Volume** -	—	**Off**
Action	Switch on the Remote	Finger Print	Automatic Distance Checker	Children Move Back	—	—	Make volume too loud	Watching Too Much TV (Alarm)	Log Out	—

Fig. 9 Navigation scenario

Other 4D elements of the My Remote included mood lighting and sounds, which were also incorporated as feedback mechanisms for the children, some of which through the interface itself. In relation to sound, the My Remote will advise children according to their actions with speech. This was considered to be aimed more at providing direct and clear feedback and also to be more motivating. Fig. 9 provides an example of a typical navigation and illustrates the different feedback that a child will hear, for example, 'please turn down the volume' or 'you only have one hour left'. The children in the focus group responded well to these ideas and found them to be fun and also provided additional input which included the idea of different lights for different 'moods' of the remote.

Although the device itself is designed to be unisex, there are two different interface styles, one for girls and one for boys because this is something that the children requested in the focus groups (Fig. 10).

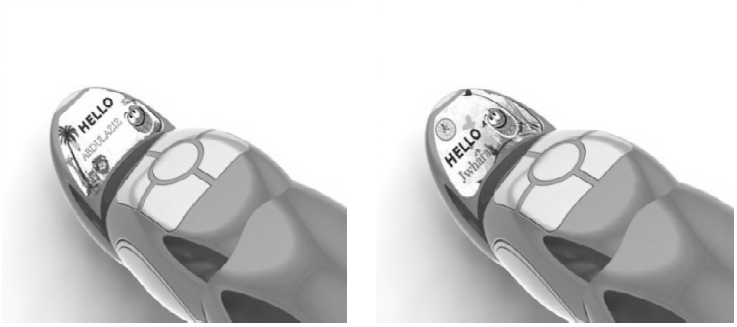

Fig. 10 Girls and boys interface design

The child-inspired mood lighting reflects the mood of the different feedback responses, for example, if a child tries to enter a prohibited channel, the My Remote will turn red, if they choose an appropriate channel then the device changes to an approving green and for general actions such as checking the time, it appears as a neutral yellow (Fig. 11).

Fig. 11 Mood lighting

4.6 Branding

The branding for the My Remote shows that it is fun, comfortable, provides security, is personal to the user, educational, caring and, above all, innovative. It is therefore essential to give the product strong branding so that it will inspire the ideas of safety, security and caring in the minds of the parents, make it a household name and be loved by children.

The My Remote logo reflects the ideas of caring, ownership and functional control by using the hand symbol and to illustrate the fingerprint function and an element of fun the 'O' is represented by a fingerprint with a happy face (Fig. 12).

Fig. 12 My remote brand

5. Manufacturing and materials

In order to visualise the final design and for the purpose of further ergonomic testing with children, models were produced using SLA (Stereolithography) and FDM (Fused Deposition Modelling) techniques (Fig. 13). This was the next stage of the design process where the design could be refined according to feedback from the children. Of these two rapid-prototyping techniques, it was found that stereolithography produced a smoother surface texture which was more comfortable for the children. However, FDM allowed for the use of ABS (Acrylonitrile butadiene styrene).

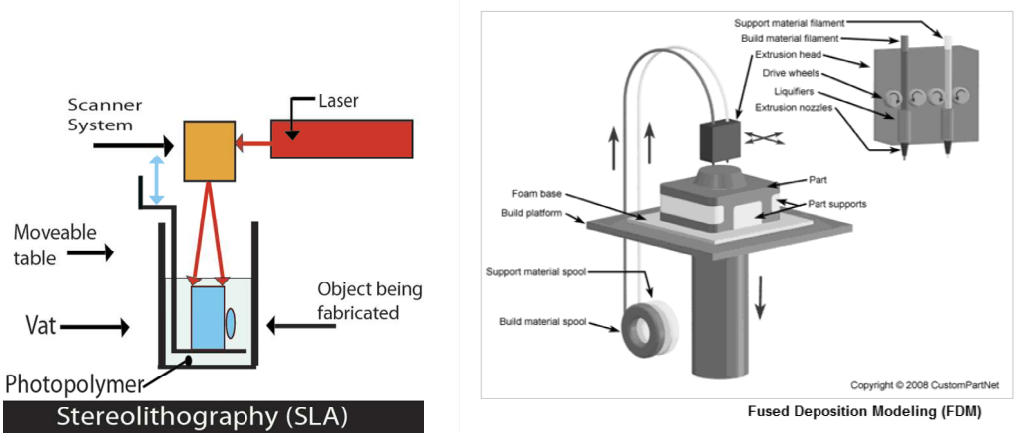

Fig. 13 Production techniques

ABS was chosen as the material for the My Remote, because it has strength and rigidity, is impact resistant, able to absorb shock and is resistant to corrosion from alkalis and acids. Moreover, it has electrical insulating properties, which offer additional protection from electrical faults. Moreover, it was easy to create a smoother surface after prototype production. ABS is already commonly used in toys such as Lego.

The model was the casing for the My Remote, which also included the battery compartment mechanism. The internal structure included the various compartments for housing the components, such as the fingerprint recognition system and the position of the integrated circuit boards, this stage was more detailed and technical and the children were not consulted about the internal mechanisms (Fig. 14).

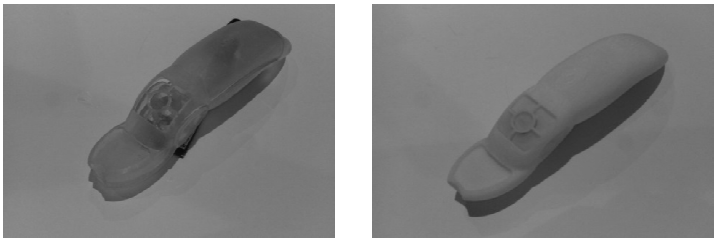

Fig. 14 Remote prototype

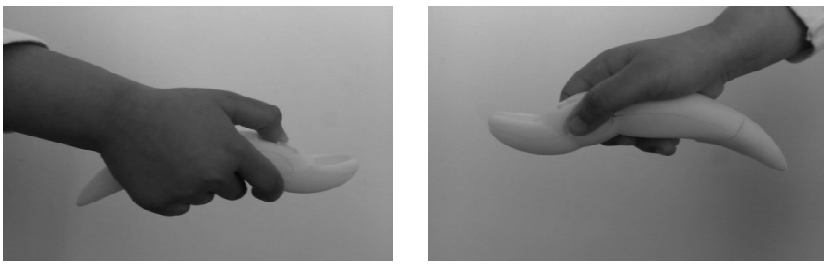

Fig. 15 Ergonomic testing

Both manufacturing methods produced the desired result. The children were again involved in providing feedback and it was found that the manufacture of the model was successful, which not only allowed for precise ergonomic testing in terms of the position of buttons and overall usability, but also demonstrated a functioning battery compartment mechanism, which worked according to user requirements. The children were able to reveal some issues about the angle and balance of the design. Subsequently, slight adjustments were made to the design and new models were produced, again this was an advantage of these rapid prototyping techniques.

The models allowed the final design to be visualised fully and the materials gave an indication of the feel of the remote control. These plastic models then allowed for further ergonomic testing with children (Fig. 15). The design was found to be comfortable, well balanced and the buttons were easy to reach.

The manufacturing was successful. The desired model was produced, the design of which was based on the needs of users, namely, the functional and usability needs, as well as ergonomic needs. Moreover, the model clearly represented the internal aspects of the design. ABS was found to be compatible with both manufacturing techniques and the material's properties were not compromised.

6. Conclusion

In conclusion, this project was initiated to resolve the problems associated with children watching television, by presenting a concept for a remote control that controls both content choice and children's viewing habits. The project did achieve these objectives, by creating a concept, the My Remote. The design was intended for use by children and the project was successful, because it introduced elements of education, encouragement and fun into the design in which children had a significant input. This was reflected in the innovative finger-shaped design, which responded to the needs and aspirations of the user.

The overall design process was child-centred and involved children's input and feedback throughout. It was found that using additive manufacturing for rapid prototyping facilitated not only the design but also the children's involvement in the design. Moreover, these techniques provided a model, made from materials intended for the final product, which answered additional needs that were identified, such as comfort, usability and robustness.

One of the limitations of the study was that it did not do enough to explore in more depth the different technologies available in the design process and how children could be more involved in the various stages using these technologies, for example, CAD could be used more extensively involving the children in input. Moreover, there could be more experimentation with different materials during the prototyping stage, such as using rapid prototyping to produce foam models which would reduce time spent on ergonomic testing and feedback.

This project was concept based and was primarily about the design process, design for children and design involving children and therefore there is opportunity to develop it further in a future project, either featuring the entire remote control capabilities or just certain aspects, such as the on-screen interaction using the same collaborative process. A full working model would allow complete testing and feedback. Only some aspects of the remote control were customised, however, in a future development aspects such as the interface design could be customised for the individual user.

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