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APPLYING AN INTERIOR VR CO-DESIGN APPROACH FOR THE MEDICAL DEPLOYMENT VEHICLE OF THE FUTURE

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ABSTRACT

Designing the cabin of future rescue helicopter concepts is characterized by a high level of complexity. Besides the technical and mission-specific requirements of the helicopter system, new cabin designs must particularly meet the individual requirements to provide a high level of functionality and usability for all user groups. In addition, the prototyping, planning and execution of user tests is enormously time-consuming and costly, which increases the complexity of the development process. The implementation of a user-centered design approach in conjunction with an optimized prototyping and feedback process can provide an effective solution in this context. Therefore, this paper aims to present the applied Co-Design process for the design of a novel rescue helicopter cabin using an immersive prototyping and feedback process. As part of this approach, the focus is on conducting and evaluating user workshops with a particular emphasis on medical crew and pilots with experience in air rescue. The first phase of each workshop initially involves exchanging experiences, challenges, and problem scenarios from daily operations through a discussion among participants. The second workshop phase involves brainstorming and idea exchange for a novel concept using a digital concept board and notes. With the help of a moderator, these ideas are then transferred to the virtual reality mockup using the Gravity Sketch tool and reevaluated and optimized by participants in real-time.

This approach provides a significant contribution to the development of a future emergency medical deployment vehicle concept for the DLR project Chaser in course of the DLR guiding concept 4 “Rescue Helicopter 2030”. Moreover, the combination between the Co-Design process and the immersive prototyping and optimization approach in virtual reality offers new and effective opportunities for a more efficient and user-centered cabin design.

Additionally, this approach can be applied to the design of further and future cabin concepts, making them more tangible and evaluable for end-users.

INTRODUCTION

The early arrival of qualified medical personnel at the scene of an accident is essential for a successful and effective first-aid treatment of emergency patients. Due to an increasing shortage of emergency medical personnel, as well as a decreasing hospital density in Germany, the continuity of medical care will be more challenging in the future. [1] [2]

According to a study by the Bertelsmann Foundation in the summer of 2019, the density of hospitals and clinics in Germany could be reduced from the current number of 1900 to 600. This immediately leads to the concentration of healthcare centers, making hospitals no longer equally accessible to the entire population. [3]

The resulting and extended time of arrival at the place of an accident immensely affects the adherence of the prehospital time and help time, which can seriously affect the health condition of the emergency patient. [1]

To ensure emergency medical care in the future, especially in structurally weak or densely populated regions, the DLR (German Aerospace Center) has set itself the goal of the "Rescue Helicopter 2030", to develop the aircraft of air rescue in Germany under the aspects of the future rescue service and to present new concepts.

Currently, research is being conducted on the concept of a medical deployment vehicle. This vehicle aims to transport medical professionals to the accident site in the shortest possible time to provide on-site initial care until the ambulance arrives for further transportation.

To maximize flight speed and range, this future rescue helicopter has been significantly reduced in size and weight.

The design of a tailored cabin concept for this purpose is characterized by high complexity in all aspects. In addition to the technical and mission-specific requirements of the helicopter system, new cabin designs must meet the individual needs to provide a high level of functionality and usability for all user groups. Furthermore, prototyping, planning, and conducting user tests are extremely time-consuming and costly, which increases the challenges in the development process [4]. To develop novel and highly complex cabin concepts that closely align with user requirements, the combination of user-centered design thinking methodology [5] and an immersive prototyping and feedback process has proven to be an effective approach [6] [7]

According to Burkett et. al., the concept of Co-design offers an approach that engages consumers and product users in the design process, aiming to foster enhancements and drive innovation. [8]. Furthermore, co-creation is widely acknowledged as "practices where a design practice and one or more communities of practice participate in creating new desired futures" (Lee, 2018) [9]. Co-design involves the empowerment of individuals, granting them the opportunity to exert substantial influence over designs. User groups are regarded as central experts, uniquely positioned to contribute their expertise and insights throughout the entire process. [10]

The focus of this approach is on implementing a VR Co-Design process through the execution and evaluation of user workshops, with a particular emphasis on medical personnel and pilots with experience in air rescue.

METHOD

In the initial development phase, information regarding general experiences and challenges in air rescue were gathered from practicing pilots and emergency physicians. In addition to a subsequent description of the medical deployment vehicle concept, participants had the opportunity to familiarize themselves with the project and list initial requirements for the concept based on their own experiences. [10]

Participation in an online questionnaire and an initial engagement with the concept, as well as raising awareness about the topic, were fundamental prerequisites for attending a collaborative online workshop.
The following section will describe the structure of the study and the key findings of the second phase.

PARTICIPANTS

The online survey was completed by 25 participants from the air rescue sector,[1] including four pilots, six emergency medical technicians (HEMS TC), and 15 doctors. The age of the participants ranged from 22 to 60 years, with a mean age of 39.4 years.
After 37.5% of the online questionnaire respondents expressed interest in participating in a Co-Design workshop, a total of two workshops were conducted, each with three participants.

Special attention was given to the composition of the participants, aiming to bring together different user groups to combine diverse perspectives in the collaborative development process. The composition of the groups was as follows:

- Group 1: Person A (emergency physician), Person B (pilot), Person C (medical technician)
- Group 2: Person A (emergency physician), Person B (pilot), Person C (engineer)

PROCEDURE

At the beginning of the Co- Design workshop, the participants were presented with the requirements and mission scenario for the medical deployment vehicle. The interactive online tool *Conceptboard* was used for this purpose. Subsequently, all participants were asked to

[1] The online survey was internally circulated among the employees of ADAC (Allgemeine Deutsche Automobil-Club e.V)

conceptually design an initial cabin layout based on their own requirements within ten minutes.

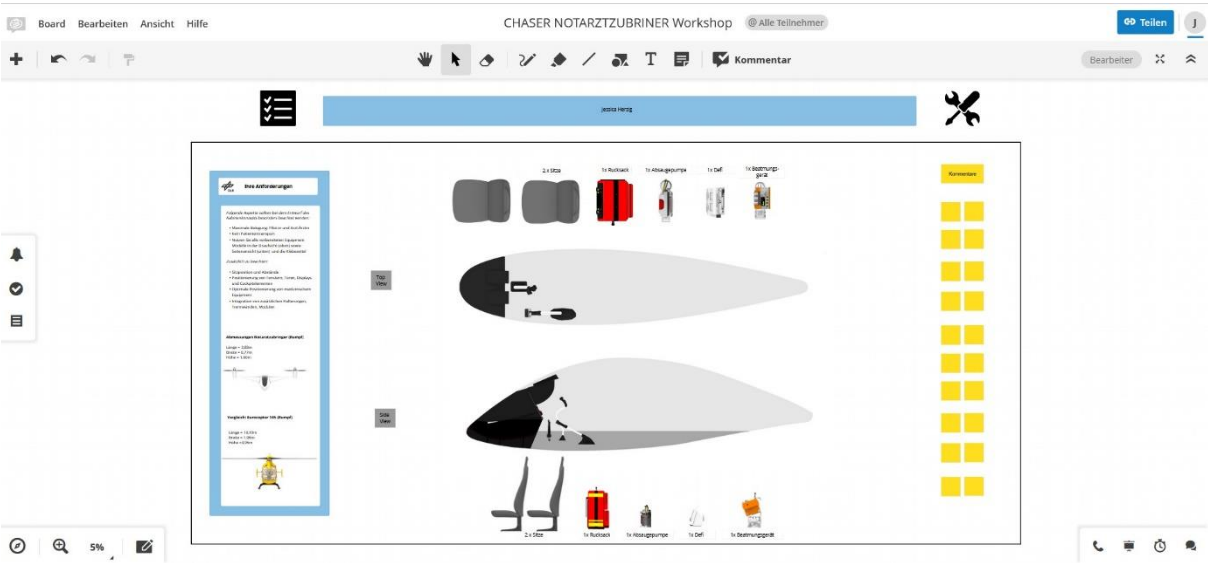

Figure 1: Example of the concept board work space for each participant including a description of the scenario, requirements and mission (left), the layout in two perspectives including interior parts and equipment (center) and notes for ideas (right)

Each participant received their own model where they could place objects on the helicopter floor plan. Additionally, there was an option to use post-it notes to add missing objects and include comments (see Figure 1). After presenting their concepts, the participants' designs were photographed and imported into the VR modeling program *Gravity Sketch*.

The 2D concepts created by the participants were placed in *Gravity Sketch* alongside the 3D model of the helicopter to provide an overview of the concepts and allow for a collaborative immersive incorporation of selected designs into the model.
A 3D cabin concept developed by the DLR cabin design team was positioned alongside as a comparative reference to the corresponding 2D solution approaches. Participation in the virtual reality session was facilitated through screen sharing of the collaboration app of *Gravity Sketch*.

After the participants were taken through the model via the shared screen, concept proposals could be expressed and implemented in real-time within the VR design model. With the aid of the newly gained spatial perspective, the concepts could be collectively reviewed, reevaluated, and optimized from the viewpoints of the three different professional groups regarding the usability of functions and positioning of modules (see Figure 2).

Figure 2: VR design concept as baseline for participants evaluation and further development process

RESULTS

The workshop participants evaluated the Co-Design process of the medical deployment vehicle concept in virtual reality as an efficient and effective design method. The VR representation provided participants with an enhanced spatial awareness, making sizes, distances, and positions more comprehensible. This enabled immersive and rapid prototyping and efficient facilitated the evaluation of potential use cases.

The combination of the Co-Design process with immersive prototyping and optimization in virtual reality enables new and more effective design possibilities for user-centered and targeted cabin design.

This method allows for time and cost savings, as initial concepts can be developed in a short period. Additionally, it facilitates the direct implementation of experiences and requirements from different user groups into a virtual product, integrating the feedback and optimization process directly into the product. The findings of this paper provide a basis for adapting the method to other concepts with an expanded range of requirements. In addition to involving a higher number of participating stakeholder groups, direct integration into virtual reality is also conceivable.

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