Human augmentation: the role of design in the design of on-body interfaces for cognitive-sensorial wellbeing

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Abstract

Human Augmentation is the set of practices and disciplines that involve the use of technology as an integral part of the human body, aiming at assisting, substituting or augmenting human sensorial, physical and cognitive capabilities. Contributions in the field are mostly related to technology-centered perspectives, aiming at providing useful, safe and usable augmentations to address immediate needs, generally to improve and support performance. A human-centered approach on the topic offers new perspectives on the interpretation of human needs, going beyond functionality and usability. Investigating new emerging needs, desires and expectations of users willing to integrate augmentation technologies into their everyday life is essential in defining also novel design approaches. Therefore, involving Design Research and Practice in this field is important for the development of interactive on-body technologies that leverage a human-centered approach. Design-based approaches and tools such as Human-Centered Design (HCD), Design Thinking and Design Fiction can offer a viable basis for this exploration, while a reinterpretation and combination of these might be useful in future design developments in the research area of Human Augmentation. In particular, the topic offers interesting opportunities for design-based intervention with regard to the development of wearable and integrated interfaces that can restore or enhance cognitive and sensorial abilities that are not immediately associated with functional user needs, such as biological capabilities that are innate in humans and might be weakened or extinguished. Through theoretical research and practical experimentation, the intersection of Design Research and Practice and Human Augmentation will be investigated with the aim of offering a contribution to the discussion and development of the matter in the perspective of human-centered augmenting technologies.

Author keywords

Human Augmentation; Design Research; Design Science; Wearable Computing; Human-Computer Integration.

Introduction

Human Augmentation, also referred to as Human 2.0, is the set of practices and disciplines that focus on creating cognitive and physical enhancements as an integral part of the human body, aiming at assisting, substituting or augmenting human capabilities through technology. These interventions usually involve senses (e.g., vision and hearing), physical mobility (e.g., strength, speed and agility), and cognition (e.g., memory, creativity and learning ability) (Raisamo et al., 2019; Huber et al., 2018). Improving and enhancing human capabilities are practices that have been characterizing the evolution of human development since its early stages (Alicea, 2018), but today they are gaining new significance in a context of rapid technological advances.

Human Augmentation is a relatively novel area of research, with an ongoing discussion about its ethical and social implications (Oertelt et al., 2017, Caon et al., 2016), as well as its legitimacy in redefining the concept of the human body, particularly in relation to disability studies (Bose, 2014). The number of scientific contributions and technological development to Human Augmentation has been increasing over the years, with applications ranging from industrial to medical contexts (e.g., exoskeletons, supernumerary robotic limbs, advanced prosthetics, Brain-Computer Interfaces and Augmented Reality Head-Mounted Displays).

Current examples of human-augmenting applications are mostly resulting from a technology-centered perspective on Human Augmentation, with contributions to knowledge and development deriving especially from consolidated research fields such as Computer Science, Engineering and Robotics (Guerrero et al., 2022). With a market growth expected to reach $341.2 billion by 2026 (Markets and Markets, 2022), the increasing demand of human-augmenting products is leading to a consequently growing need for novel frameworks for designers and practitioners working on the design and implementation of these new product typologies (De Boeck & Vaes, 2021).

Human-human and human-environment (whether natural or artificial) interactions mediated by technology prove to be particularly important from the perspective of extending human perception and cognition (Schmidt, 2017). This deserves specific attention when this relationship is lacking (e.g., disorientation, decreased proprioception), is framed within new contexts (e.g., virtual reality environments) or surpasses the natural limits (e.g., sensing the magnetic north).

While substituting or assisting temporary or permanent impairments translates into addressing immediate user needs (such as functionality and usability), augmenting humanity beyond its natural limits could be separated from

solving everyday problems. With this assumption, design tools and methods encapsulating future-oriented approaches are needed (Kymäläinen et al., 2016). This involves redefining what is intended for "user needs", which can be not related to providing solutions to specific issues, but rather to building new ways of being human with cyborg sensing abilities (Ramoğlu, 2019).

Objectives

The research aims to find new design opportunities for Human Augmentation that improve users' sensorial and cognitive wellbeing. These will focus on enhancing human characteristics and rebuilding the relationship between humans and their natural abilities using technology, to facilitate human-human and human-environment communication and interaction.

The research will focus on the opportunity for advancing knowledge in the intersection of Design and Human Augmentation, with the aim to offer a systematization of findings about existing human-augmenting products from a design perspective (especially regarding processes and methods) by analyzing case studies, in order to support the development of the research area towards Human-Augmenting Product Design.

The dimensions of this research are both theoretical and applied. On the one hand, it will focus on the acquisition of theoretical knowledge in the disciplines of Design and Neuroscience through the survey of relevant literature and the direct involvement of target users, companies, research organizations, designers and communities of practice involved in the development and use of technological products for cognitive-sensorial augmentation. On the other hand, the knowledge gained will be subject to experimentation through the design and prototyping of wearables, with possible testing being carried out in relevant environments or scenarios of use. This is expected, consequently, to serve as a basis for the advancement of new knowledge useful to the construction of design guidelines for human-augmenting products.

Moreover, the research will involve users with limited sensory-cognitive abilities, following a participatory design approach, to identify possible needs and expectations. The study will include action-research moments through the involvement of designers and non-designers for brainstorming and prototyping. The goal is to provide designers with a tool for designing technological products that can improve human-human and human-environment interaction, with a view to scalability of the principles thus defined with regard to users with different cognitive-sensory abilities. The research work has the overarching goal of offering a contribution to the topic of Human Augmentation through Design Research and Practice, with the aim of establishing a conversation in a shared development perspective with research groups, universities and communities of practice in order to bring useful outcomes to end users, designers and companies operating in the field.

Methodology

Given the multidisciplinary nature of the research project, the investigation methodology will first be oriented towards desk research of Human Augmentation applications in the field of Product Design, for the construction of a mapping of existing solutions and their technological and User Experience characteristics. Next, the research will cover the field of Neuroscience aiming at building a solid knowledge base that can be useful to designers who are called upon to design increasingly immersive and user-friendly experiences. This will be followed by an action-research phase through moments of participatory design and rapid prototyping to analyze possible desirable future directions of Human-Augmenting Product Design.

In particular, the research will be structured in the following phases:

Phase 1

- Survey of the state of the art of Human Augmentation products (analysis of technological features, User Experience and design processes and methods) through a collection of case studies, experiments and practices;
- Review and analysis of Design Research contributions to the field;
- Mapping of domestic and foreign research centers and universities working in the field of Human Augmentation.

Phase 2

- Survey of scientific research in the field of Medicine and Health (and related) pertaining to diseases or conditions related to the impairment or lack of sensory and cognitive abilities;
- Benchmarking of medical rehabilitation companies and survey of technologies used.

Phase 3

- Design and prototyping of products dedicated to cognitive and sensory Human Augmentation according to a human-centered design approach;
- Experimentation of prototypes and construction of a report on the results.

Phase 4

- Building of guidelines and a framework for design intended for designers, companies and manufacturers operating or willing to operate in the field of Human Augmentation.

Expected outcomes

The methodology and phases of the research will serve for the production of deliverables that can crystallize the knowledge gained in each step, with the aim of sharing them in the form of multimedia materials, both digital and tangible.

In particular, the expected outcomes will involve the following results:

- Offering a comprehensive understanding of the state-of-the-art of Product Design for Human Augmentation, providing a review of the literature, case studies and experimentations, while building an international research network focused on the study and implementation of human-augmenting technologies;
- Offering an overall understanding of the needs and solutions related to cognitive and sensorial issues, providing a review of the literature in the matter of assistive technologies and a report of interviews and on-field observations;
- Applying the knowledge to guide experimentation in an international workshop for Human Augmentation Product Design;

» Transferring knowledge through guidelines and design frameworks.

In conclusion, this research work aims at supporting the involvement of Design Research and Practice in the field of Human Augmentation, with a focus on methods, tools and processes in the perspective of exploring and designing for the augmented needs of humanity.

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