Introduction

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> *My years of experience at Dr. Reijntjes School for the Deaf, Sri Lanka made me realize that sensory impairment has nothing to do with intellectual ability. For instance, the deaf children at this school, were able to communicate over much longer distances with sign language and make beautiful computer graphics. In fact, they had such a developed special skill that I felt like the odd man.*
>
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Our senses are the dominant channel for perceiving the world around us. With impairments and lack thereof, people find themselves at the edge of sensorial capability. Some excel and use their impairment as a gift. Prominent examples are Evelyn Glennie, a percussionist with hearing impairment, and Ben Underwood, whose eyes were removed when he was 5 years, taught himself echolocation. Some seek assistive or enhancing devices which enable a "disabled" user to carry out a task or even turn the user into a "superhuman" with capabilities well beyond the ordinary. The overarching topic of this volume is centered on the design and development of assistive technology, user interfaces and interactions that seamlessly integrate with a user's mind, body and behavior in this very way–providing enhanced physical, sensorial and cognitive capabilities. We call this "Assistive Augmentation".

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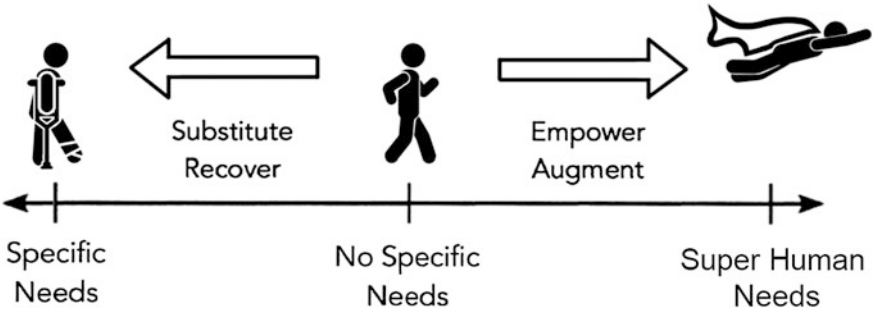

Fig. 1 Assistive augmentation continuum, a guideline for developing cross-domain assistive technology

Assistive Augmentation finds its application in a variety of contexts, for example scaffolding people, when they feel their innate senses are inadequate or, to support development of desired skillsets. We wish to put sensorial capability on a continuum of usability for certain technology, rather than treat one or the other extreme as the focus (cf. Fig. 1).

We therefore follow the design rationale of [1], stating technology should be socially acceptable, work coherently for disabled and non-disabled alike, and support independent and portable interaction. The latter requirement challenges both user interface and interaction design in particular, as Jones and Marsden point out: "*the test comes when it [the device] is deployed in the complex, messy world of real situations […] when it has to be used in the wild, as it were, in tandem with the world around it, the usability can break down quickly*" (cf. [2] p. 51). In the following, we depict challenges for the field of assistive augmentation and outline the objectives and the structure of this volume.

1 Challenges for Assistive Augmentation

The design, implementation and deployment of assistive augmentation technology faces a variety of challenges due to its cross-disciplinary nature. Emerging technologies for human augmentation continuously change how we perceive and interact with our surroundings, as well as ourselves. They strive to augment our sensory abilities for increased well-being, e.g. by stimulating our motor system [3] or even the gustatory perception [4]. At the same time, assistive technologies emerge that promise e.g. to scaffold sensory disabilities, e.g. to improve reading capabilities of the blind through technologies such as BrailleTouch [5] or UbiBraille [6].

Existing ethnographic research sheds light on stigma and misperceptions people face when using assistive technology in social situations [7], such as being publicly marked as a disabled person, or that technology can effectively eliminate disability.

Augmenting technology also harbors ethical implications, as it breaks the conception of an even playing field for all, once certain people start augmenting their natural-born senses with technology [3].

This triggers more higher level questions such as what is a good assistive augmentation, what is its quality and when can it be considered successful? Also, can we build on well-established research and evaluation methods that are effective in the assistive technologies and accessibility communities? How can technology be designed to discourage stigma, self-consciousness or social asymmetry in its users?

2 Objectives and Structure of This Volume

Research on Assistive Augmentation is spread across many different communities, depending on the targeted part of the usability continuum sketched above. Accessibility and assistive technologies are topics pertinent to academic conferences such as ACM ASSETS, and also widely disseminated at the CHI main conference. On the other hand, human augmentation is a primary topic at conferences such as Augmented Human or the International Symposium on Wearable Computing. The idea of Assistive Augmentation is also emerging in the field of sports, with the vision of reinventing sports that anyone can enjoy regardless of the ability.

Addressing this disparity, the Assistive Augmentation community initially met at an interdisciplinary workshop at the 2014 International Conference on Computer Human Interaction (CHI 2014) in Toronto, Canada [8]. The community is comprised of researchers and practitioners who work at the junction of human-computer interaction, assistive technology and human augmentation. This edited volume is the first tangible outcome of this very workshop.

The goal of this edited volume is to illustrate core areas of Assistive Augmentation and to stimulate discussion around challenges within those. As a first step, this volume explores (i) Sensory Enhancement & Substitution and (ii) Design for Assistive Augmentation. Implemented research within these areas directly caters to the continuum depicted in Fig. 1, investigating specifically:

- Development of novel technologies or extension of available technologies to synthesize desired augmentations or enhancements
- Understanding perceptual, sensorial, cognitive, and behavioral capabilities of users and discovering sensory substitution strategies
- Exploration of the interaction design space with proof-of-concept prototypes

The remainder of this volume contains comprehensive reports on case studies that focus on either of the core areas. The studies serve as lighthouse projects, each of them contributing to a sub-issue and challenge of Assistive Augmentation. Clustered into respective areas, these also map to the structure of this volume:

Part 1: Sensory Enhancement & Substitution

Chapter 3: Contributes sound-to-vibrotactile sensory substitution systems for deaf people in the application areas of music listening and music making.
Chapter 4: Describes an Augmented Reality system that focuses assisting human workers in flexible production environments.
Chapter 5: Reports on narrative text augmentations with sound effects to provide embodied experiences to readers.

Part 2: Design for Assistive Augmentation

Chapter 7: Discusses how technologies and domestic environments need to be designed to support ageing in place.
Chapter 8: Contributes a design process of a responsive sensory environment that augments social communication between autistic children and their parents.
Chapter 9: Illustrates the extensive design process of a finger-worn device equipped with a camera that assists users with visual impairments in accessing printed text.

Both parts of this volume are prefaced by introductions to the respective area of research. The volume concludes with a summary and an outlook upon the future of Assistive Augmentation.

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