Disability and Technology
A Critical Realist Perspective

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ABSTRACT

Assistive technology (AT) as a field explores the design, use and evaluation of computing technology that aims to benefit people with disabilities. The majority of the work consequently takes the functional needs of people with disabilities as starting point and matches those with technological opportunity spaces. With this paper, we argue that the underlying philosophical position implied in this approach can be seen as reductionist as the disabled experience is arguably richer and often more complex as can be projected from the functional limitations of people. Thinkers and activists in Disability Studies have conceptualised disability in various ways and more recently, critical realism was proposed as a philosophical position through which the many different facets of the disabled experience could be incorporated. In this paper, we explore the possibility of using a critical realist perspective to guide designers in developing technology for people with disabilities and thereby aim to contribute to the philosophical underpinnings of AT. After a brief review of historical conceptualisations of disability, we introduce the critical realist argument and discuss its appeal for understanding disability and the possible roles technology can have in this context. Subsequently, we aim to translate this philosophical and moral debate into a research agenda for AT and exemplify how it can be operationalised by presenting the OutsideTheBox project as a case study.

Keywords

disability studies; philosophy of science; critical realism

Categories and Subject Descriptors

K.4.2 [**Computers and Society**]: Social issuesâĂŤAssistive technologies for persons with disabilities

1. INTRODUCTION

Our collective and individual conceptualisation of disability significantly shapes which kinds of assistive technologies are being designed. When Mankoff et al first used Disability Studies as a lens to critically reflect on work in assistive technology (AT), they demonstrated through their case studies how taking a particular stance towards disability changed the way they created and evaluated technology [12]. They state that through their exposure to the disability studies literature, they were able to develop a more nuanced understanding of the concept of "assistance" and came to critically reflect on the value of AT projects that *"may have technical merit, and may solve observable problems, but still fail to address the complex interplay of issues at work"*.

With this paper we want build on this argument and use the most recent thinking in Disability Studies to contribute to the philosophical foundation of AT and evolve its future research agenda. In particular, it is the turn to *critical realism* that we draw on. It was introduced to the discourse in Disability Studies with the promise to help dissolve the dichotomy between the medical model and social model of disability, i.e., the polarising debate whether disability is determined in the biological condition or exists purely as a social construct in the environment. What is at its core a philosophy of science, critical realism offers Disability Studies a coherent basis on which the many, often equally valid perspectives on disability could be reconciled, thus leading to a multi-facetted view of the disabled experience [21].

We argue that this approach has great appeal for the field of AT too. As we will further elaborate on below, the philosophical position towards disability designers take, implicitly or explicitly, changes the way they motivate, design and evaluate technology. Consequently, we have seen assistive technologies that focus on individual support or change the environment to make it more inclusive by removing barriers. A multi-layered and interactional conceptualisation of disability, such as the critical realist perspective offers, however would allow us to think about technologies in a different way: can technologies work across the multiple layers that all together shape the disabled experience? Can it consider the physical, the biological, the psychological, the psychosocial and emotional, the socio-economic, the cultural and the normative at the same time in meaningful ways? Can it be non-reductionist?

We argue that AT has two good reasons for wanting to ask these questions. Firstly, as Mankoff et al also highlighted, too narrowly conceived efforts to "do good" are potentially misleading in terms of the overall complexity of the disabled experience. Furthermore, as they point out *"it is important to acknowledge that there may not even be a 'right' problem to tackle "* [12]. Secondly, the increasing pervasiveness of

ASSETS'15, October 26–28, 2015, Lisbon, Portugal.

ACM 978-1-4503-3400-6/15/10 ...$15.00.
DOI: http://dx.doi.org/10.1145/2700648.2809851 .

technologies means that they play an ever greater part in experiencing and interpreting our lifeworlds. Consequently, it becomes ever more difficult to solve any problem in isolation as its solution always interacts with many other aspects of our life. The field of human-computer interaction (HCI) has responded to this challenge by recognising the need for a situated, value driven and participatory approach—what came to be termed 3^{rd} paradigm HCI [9].

In the following we provide a brief, semi-historical account of the main approaches to conceptualise disability, including references to how those were manifested in the technologies that were created within these concepts. We then introduce the critical realist argument and discuss what this means for understanding the disabled experience. Based on this discussion, we develop a non-reductionist, future research agenda for AT and investigate its implications on methodology, evaluation, ethics and knowledge. We then briefly introduce the OutsideTheBox project to exemplify how this agenda can shape AT research. We close by recapping our argument and discussing its implications for the field of AT.

2. CONCEPTS OF DISABILITY AND ASSISTIVE TECHNOLOGIES

For the most part of the 20^{th} century, the dominant concept society had about disability was rooted in **biological determinism** [5]. Disability was heavily medicalised and consequently inherently "a-normative", i.e., disability was conceptualised as deviation from the norm in terms of biological functions and the resulting societal responsibility is expressed in terms of "curing", "caring" or, in the best case, "supporting" disabled people to elevate their burden. This perspective firmly places the "cause" of disability in the individual and is thus providing the basis for segregation, e.g. like in traditional special needs education. We still encounter this underlying perspective on disability in much assistive technology work. Like Mankoff et al state [12], the medical model, as this view has become known in Disability Studies, has proven useful for developing assistive technology as it pragmatically provides specific requirements for design, based on the functional limitations of its users. And while many of these efforts have to be applauded as they address many real-world issues people with disabilities encounter, we also should acknowledge that designing technology in this mindset reinforces a societal concept of disability that is one-sided as it places disability solely in the individual.

The medical model has been opposed by a growing number of disability rights activists during the 1970's which culminated in the publication of the policy statement of the the Union of Physically Impaired Against Segregation (UPIAS) and the subsequent report on a meeting held with the Disability Alliance on the Fundamental Principles of Disabilities [14]. In the spirit of union activism, they verbalised the perceived oppression of people with disabilities and demanded full participation in society. They postulated *"Disability is something imposed on top of our impairments, by the way we are unnecessarily isolated and excluded from full participation in society. Disabled people are therefore an oppressed group in society."* A crucial, conceptual distinction was introduced between impairment as biological circumstance and disability as social and environmental construction—the core feature of the social model of disability. The causality of disability has been shifted from the individual into the society. The field of Disability Studies further developed the theoretical underpinnings for this approach. Oliver coined the term **social creationist** approach to signify a materialist emphasis on the construction of disability, i.e., it is factors such as physical barriers in the environment or inadequate access to the labour market and precarious income situations that disable people [15]. The materialist view has led to seeing the main task of assistive technologies in making aspects of our life accessible; barrier removal equals inclusion. Accessibility standards for the Web are a good example that embodies this philosophy.

In contrast to materialism, a **social constructionist** perspective focuses on the cultural and socio-historical context that defines disability as a category of difference. Deeply rooted in a post-modern tradition, this perspective looks closely at language and social practices to identify what makes people to be viewed as "disabled". Distinctively, this has wider implications as the social creationist approach in that it is ultimately not the economic, physical or political barriers that disable people, but ideology, social representation and the public discourse and its language that disables people. Consequently, no amount of barrier removal would lead to truly inclusive societies, because the distinction between people with disabilities and those without is inherent in the way we think and talk about them. In Disability Studies, this has led to research into terminology, imagery of disability in public discourse or media, embodiment and phenomenological perspectives; and, in a post-structuralist tradition, into the deconstruction of the category of disability. This, essentially, concerns the question "What is normal?" and the more rhetorical version "Aren't we just all different?". At this point Disability Studies found itself making very similar arguments to researchers concerning themselves with the (de)construction of gender, race and sexuality. Like post-modern feminism, the cultural disability approach seeks to destabilise categories by foregrounding the processes through which we implicitly construct them. In the design of technology, a good example of this approach being applied is the adoption of the neurodiversity stance in HCI which seeks to reframe conditions as alternative, cognitive processing styles [6]. Thus, design aims to shift its focus to the strengths of users[1] and rejects normative assumptions (see also [1]).

None of the above concepts of disabilities is without its problems when trying to describe disabled experiences. The medical model is deeply oppressive and leads to segregative societies [21]. Technology designed with this mindset is at least complicit in fostering this segregation. The social model of disability, i.e. a social creationist approach, has proven useful in activism, but is ultimately equally one-sided. There are many aspects of disabled experiences that no amount of barrier removal can extinguish and equally, no level of accessibility to technology will make disabled people fully integrated in digital societies. A post-modern approach, i.e., the cultural, social constructionist view, denies people with disabilities their individual experiences in similar ways, but for different reasons. When the disability category is dissolved, there is no room left for the sometimes

[1]While on the surface of it there are parallels to ability-based design [26], it stops well short of challenging the defining categories and therefore could not be described as a social constructionist approach.

difficult and painful experiences of an impairment. If we are all just different, why do we find it amoral to painlessly alter a baby so that they could no longer see? (Harris used similar provocative statements in his critique of post-structuralist Disability Studies [8]). Furthermore, while the knowledge of the social construction is useful, they hardly yield actionable consequences to support people with disabilities. Thus, all of these models and approaches can be seen as reductionist in one way or another.

3. THE CRITICAL REALIST PERSPECTIVE

Critical realism is a philosophy of science that was predominately shaped by the British philosopher Roy Bhaskar. He initially used the terms transcendental realism and critical naturalism to describe his ideas, but eventually those were shortened into the now widely used term "critical realism" [4]. Like any philosophy of science, critical realism is concerned about what is (ontology) and how we can know about it (epistemology). And like the variety of post-modern philosophies, it has developed as a reaction to the empiricist, more specifically the positivistic philosophy or practice of science that has so significantly shaped, and in some way still does shape, our understanding of what "doing science" means. However, while they share some features, critical realism and post-modern thought arrived at quite different standpoints.

A common point of departure for both lines of thought was to reject the (post-)positivistic idea that there is an absolute truth about things that we can find out about in an empirical way. Particularly in the social sciences, there was growing recognition that we cannot know about people in the same way that we can know about atoms. In what became known as the "linguistic turn", the post-modernist answer is that understanding social reality is much more *"akin to understanding a language than a machine"* ([11], p8), i.e., it is irreducibly complex, situated, socially constructed and interpreted. Reading Kuhn's work about scientific traditions and revolutions [10] in a post-modern way, quickly expands this argument to the natural sciences: ultimately all we accept as scientific knowledge can be seen as constructed by social agents within their respective cultures. However, continuing this line of argument further, directly leads into radical relativism in which scientific progress is reduced to an arbitrary variation of an entirely constructed reality.

Critical realism rejects this notion and starts ontologically with a quite different position: there exists a reality that is independent of our description. *"Things exist and act independently of our descriptions, but we can only know them under particular descriptions"* ([2], p250, as cited in [21]). Thus, in contrast to many post-modern traditions, it rejects that reality is a social construct itself, but acknowledges that we can only know about reality in ways that are preliminary, culturally situated and most importantly multi-facetted. Thereby, it also rejects positivism for reducing reality to what can be empirically known. Positivism infers the actual from the empirical (actualism, see [4], p7) and reduces things to observable causal events and generates knowledge by generalising invariances in these causal relationships. Critical realism argues that this is not exhaustive and that things have potentiality and mechanisms that might not have been realised ([4], p7). It focuses on the underlying structure rather than the observable surface. This also allows it to see "things" as a broader category: they maybe powers, forces or relations [2]. *"Things possess characteristics which have tendencies to interact in particular ways with other things"* ([11], p11). These tendencies are not invariant, but are better understood as properties of mechanisms of which we can know of to a certain degree. Reality, thus, exists of things that interact through mechanisms which have certain tendencies. These real things are *intransitive objects*, and humans aim to understand the nature of the real mechanisms that connect them. Their understanding of these mechanisms is fallible, interpretative and socially constructed, and hence their models and theories are *transitive objects*. Scientific progress, therefore, becomes improving one's transitive objects, and (re)building these requires more than empiricism, but human reasoning on multiple levels.

For the concept of disability, this means that it allows a non-reductionist perspective, taking into account multiple layers that make up the disabled experience (a concept that is known as stratification in critical realism). Arguing from a critical realist position, Shakespeare proposed an approach that conceptualises *"... disability as an interaction between individual and structural factors"* ([21], p74). Individual or intrinsic factors include the nature of the impairment, their own attitude towards it or their personality. Structural or extrinsic factors are for example attitudes of others, the environment, support systems or social or economic issues. It is the interplay between these factors that make up the disabled experience, or in short *"people are disabled by the society 'and' their bodies"* (ibid. p75). This holistic approach is similar to the perspective that the International Classification of Functioning, Disability and Health (ICF) published by the WHO takes [16], although critics have pointed out that the ICF seems to take the biological for granted and objective, while a critical realist approach would deny that [24].

Such an interactional approach[3] makes room for a broad range of disabled experiences, for example regarding aspects of personal attitudes, chronic illnesses, the diversity and severity of impairments or social disadvantages. But it also points very pragmatically to different ways in which the lives of people with disabilities can be improved. Integration of disabled people in the labour market, for example, can be addressed on a structural level (e.g., anti-discrimination legislation, access to healthcare) and on an individual level (e.g., training, coaching, pain management). None of these interventions is per se preferred over the other, but their impact has to be assessed through their interaction on multiple levels.

4. A CRITICAL REALIST AGENDA FOR ASSISTIVE TECHNOLOGIES

The above has reflected on the evolution of concepts that are being applied to make sense and describe the disabled experience within our society. We argue that these underlying philosophical positions fundamentally shape the tech-

[2]Exactly what things are and what their causal powers would be, is a central debate within critical realism ([11], p22 ff.)

[3]Interactional with respect to facets of the disabled experience, not in terms of interacting with technology.

nologies that are being designed for people with disabilities. Thus, the following aims to develop a future research agenda for the field of AT that is inspired by a critical realist perspective on disability.

4.1 Multi-facetted and interactional

In Disability Studies, it is the possibility to incorporate different perspectives on the central questions into one ontological and epistemological frame that makes critical realism appeal. The disabled experience is multi-facetted and Shakespeare's interactional approach allows for these very different aspects to all contribute to a holistic understanding.

To investigate what that means for AT, we must first concern ourself with the question: "What is the purpose of the technology we design?" The medical and the strong social model had pragmatic answers to this: "mitigate the functional limitation of the individual" and "remove the social barriers" respectively. But, as the disabled experience is made up from a multiplicity of mechanisms, it becomes clear that the possible roles of technologies can be equally diverse. And as Shakespeare points out, it is not only different mechanisms, but it is their interaction that determines experiences. While currently we have a great variety of technologies that serve specific purposes in the lives of people with disabilities, what we lack, is a holistic, integrative and interactional approach. To illustrate the point with an example: we might design navigation aids for the blind walking streets, but do not consider how other people are necessarily part of the experience, be it negative as the source of stigmata or positive as possible part of the solution (asking directions is very often not merely a request for help, but a natural entry point to a social encounter). Shinohara and Wobbrock make a similar point by stating *"technology use does not happen in a social vacuum"* and provide further examples from their interview study across different disabilities [23]. We also do not consider the internal, psychological state of mind. A blind person might be experienced and self-confident wit respect to how people react to his presence, or anxious and insecure about their impairment. All will effect the way they interpret the situation and the technology.

This also demonstrates the dangers of limiting the scope of design in this context. Technologies always do interfere with the system of mechanisms as a whole and interact on an individual and societal level. So if we design for the individual, the technology will also interact with the environment and vice versa. Thus, we argue for an approach that cuts across the different levels from which disabled experience is made up. We need technologies that recognise the multiple mechanisms and the way they interact. Can we design technologies that consider the physical, the biological, the psychological, the psychosocial and emotional, the socio-economic, the cultural and the normative in meaningful ways ([21], p74)? Even if the motivation for creating a technology might not be addressing all of these perspectives, it is important to be mindful of the interaction between them, to not fall into the trap of meaning good, but realising unintended consequences.

4.2 Methodology

The next question is "How can we design such technology?" Again, the reductionist models of disabilities had relatively straight forward answers as their standpoints allowed the elicitation of specific requirements for developing technology. A critical realist approach is inherently more complex. Into the many mechanisms that interact to make up the disabled experience, we seek to inject yet another one: technology. While we cannot predict by nature, with any certainty what will happen in an open system, our understanding of tendencies and mechanisms provides us with suitable targets. We cannot, however, make the mechanisms we introduce interact with a single, well-understood mechanism, but it will always effect the whole system to different degrees, i.e., technology will shift the disabled experience, on some levels in possibly unintended ways. It becomes a truly "wicked problem" [18].

Consequently, choosing an appropriate methodology has two aspects: firstly, in order to identify and understand the mechanisms that technology will interact with, a diverse mix of methods is needed to probe into the disabled experience at different levels. This can, for example involve quantitative, lab-based studies to establish medical boundaries (e.g., the mechanisms that limit the range and accuracy of physical movement for controlling an input device) and design interventions with the aim to provoke social responses when technology is introduced into a context (e.g., when groups of children with cognitive disabilities are given smart objects to create video diaries).

Secondly, the understanding gained needs to meaningfully inform design and we argue that two qualities are quintessential in this respect: participation and reflection. Critical realism cautions us about the provisionality of the understanding we can have of mechanisms in open systems. Constant reflection and short development cycles is thus key to repeatedly verify and refine that understanding. There are moral arguments to be made about participation, which we will briefly discuss below, but we argue that just from a methodological standpoint PD has much to offer as a critical realist approach. The inclusion of different stakeholders allows designers to work with experts on different levels, each interpreting our understanding of the mechanisms in different ways. People with disabilities have unique insights into the complexity of the disabled experience that are invaluable, as have carers, parents, policymakers and others. PD also effectively dissolves design-evaluation cycles and puts concepts and ideas to the test while they emerge. As such, PD becomes not only a way to catalyse knowledge to inform design, but it becomes a form of enquiry in its own right. By co-designing, we deepen our understanding of disabled experiences and their mechanisms.

4.3 Evaluation

The way we evaluate technology as it is used by people has also undergone a radical change. In the traditional paradigms, HCI conducted controlled evaluation studies that were extrapolated into the wild, or it fitted lab-based evaluation criteria onto real-world studies. The inadequacy of this approach for today's technologies goes hand in hand with the diversification of purposes technology serves, not only in the lives of people with disability. It is consequently not necessarily clear anymore what it is that should be evaluated which, in the context of this paper leads to the more fundamental question of: "What does it mean for technology to work well for people with disabilities?"

A critical realist perspective highlights the need for assessing the impact of a technology on the whole interacting

system of mechanisms. So, it might be insufficient to prove that some assistive technology is delivering on what was the initial motivation (e.g., way finding, accessing information etc.) unless it becomes clear how it interacts with all other levels of the disabled experience. This, however, creates the challenge of defining a meaningful scope for evaluations. For example, we might discover that a rehabilitation device changes the social peer pressure on an older adult to do their exercises, which in evaluating the technology is more significant than any design aspect of the actual system. Evaluating assistive technologies thus, relies on including those mechanisms of the disabled experience that significantly shape it and this can be far from obvious a priori.

Another challenge is to interpret and value the change we observe, in other words, it is not always obvious what is desirable or an improvement. This also might depend on the perspective: what is positive change for policymakers might not be so positive for individuals. This is a similar issue that participatory design has grappled with in trying to define what "successful" PD work might be (compare [19, 7]).

4.4 Ethics and Morality

A conscious ethical and moral position has to be an integrative part of designing technology, even more so in the context of people with disabilities. From a critical realist perspective, it becomes clear that such a position is never achievable in advance. The complexity and multiplicity of perspectives that the critical realist conception of disability implies, requires us to constantly reflect on our position while we improve our understanding of the mechanisms that interact to make up disabled experiences in the given context of a project. Such in-action reflection has been theorised about in design to capture knowledge [20], but equally we need in-action ethics embedding the development and refinement of ethical positions deeply into our practice.

4.5 Knowledge

As a scientific field, the aim of AT is to improve our understanding about how technologies are designed, used and evaluated in the context of people with disabilities. This improved understanding is translated into a shared body of knowledge by the virtue of being re-used, re-interpreted and built upon. As control in studies of technologies "in the wild" increasingly disappears, the generation and transfer of knowledge becomes equally more challenging. Studies that are highly *relevant*, i.e. true to the given context, are often criticised for their *rigour* as they cannot generalise. Vice-versa, strictly controlled, lab-based studies are highly rigorous, but criticised for being irrelevant in real-world use – seemingly a *rigorous-or-relevant* dichotomy. Recognising this, HCI has embarked on a transformation, which is still ongoing, to redefine the way it describes and creates technologies that humans can interact with, and the way we can know about it [9].

A critical realism perspective offers to potentially resolve the *rigorous-or-relevant* dichotomy. To be *relevant*, knowledge produced has to relate to everyday life and thus acknowledge the openness and uncontrollability of the system as well as the fallibility of the process of enquiry. Equally, though, scientific outcomes have to be able to be *rigorous*, or in other words, we need to be able to objectively say that we have improved our understanding of reality by doing science. The concept of stratification in critical realism (layers of mechanisms, where lower explain higher ones) allows to enquire into the *same* reality by very different means. For example, it becomes possible to meaningfully integrate knowledge that was gai ned by understanding how the visually impaired interpret spatial auditory cues, how technology can support them to navigate unknown environments and how this new practice fits into their social patterns. Improving our understanding, i.e. generating knowledge, in this context can therefore be done either horizontally or vertically. So, either a) gaining better understanding on each level, e.g. about spatial hearing, or b) gaining better understanding how one level interacts with the another, e.g., how navigation relates to social behaviours. While the horizontal way (a) might be closer to traditional science practice, we argue that AT specifically would benefit from the vertical (b) kind of integration of knowledge.

4.6 Similarities and differences to other approaches

Recent work in AT has recognised the dangers of one-sided perspectives on the disabled experience. Shinohara and Wobbrock, for example, have studied how the use of AT is affected by social contexts and vice versa. They conclude that AT commonly provokes two misperceptions, firstly that AT is eliminating a person's disability and secondly, that this consequently makes them functionally equivalent to a person with no disability [23]. This has led Shinohara to propose a new approach for the design of AT, one that integrates designing for social acceptance [22]. While this very rightly makes the point that a strictly medical view ignores key social factors that contribute to the disabled experience in relation to technology, Design for Social Acceptance is still limited in scope, ignoring many other facets of the disabled experience, for example personal state-of-mind questions. It also carries a normative notion that rests uneasily with the proposed agenda here, in that design needs to be "accepted" by society and should be incorporated into mainstream technology to be less vulnerable to cause stigmata.

Pullin points to another important aspect, the role of æsthetics in AT, which also relates to the interaction between the medical and the social [17]. Amongst other examples, he describes the change in how we stopped regarding eyeglasses as medical aid, but a fashion accessory. It is certainly the case that AT can become a statement of choice when designed with care and intent, but the danger is that it might lead to the misunderstanding that disability can be turned into something entirely positive by choice, if only the aids are pretty enough. No matter how extravagant the glasses, one is still not able to see well without them.

Ability-based design has aimed to make a stance that focuses on what people with disabilities are good at and shift the effort of adapting for access from the user to the system [26]. The underlying ethos of the approach is laudable, but it seems to only side-step the problematic implications of the traditional philosophical stances. Focusing on functional abilities as starting points to model users for adaptable systems is equally reductionist and shifting responsibility for access from the user to the system has similar limitations as classical social creationist approaches.

Methodologically, User-Sensitive Inclusive Design [13] might be seen as the closest approach embodying a critical realist agenda. Its emphasis on participatory methods

to make designers *"consider the whole person, not simply their physical characteristics"* is in the same vein of arguments made here. Being pragmatically focused on methods, however, makes Newell et al sparing out the theoretical and philosophical underpinnings of their approach.

5. OUTSIDE THE BOX

"OutsideTheBox - Rethinking Assistive Technologies with Children with Autism"[4] is a three year research project that explores new, meaningful roles of ubiquitous computing (UbiComp) technologies in the lives of children with autism. In a deep, participatory design process, we engage children 6 to 8 years old and invite them to co-design their very own smart object. The design brief is deliberately under-specified: the resulting artefacts should realise the potential of UbiComp technologies to a) afford positive experiences, and b) support children with autism in sharing those experiences in their social environment. By realising a series of case studies we demonstrate that such open participatory processes are possible and lead to designs that would have been unimaginable for adult, neuro-typical researchers. Grounded in these case studies, we populate a conceptual space with evaluated design methods that aims to provide transferable design knowledge for others to build on.

At the time of writing this project is one year old. We have engaged 4 children over a period of 7 months, meeting them approximately every second week for a one hour workshop and succeeded in co-designing a smart object with each of them. Each process involved a phase of contextual enquiry followed by concept design, crafting and prototyping. A common strategy was to take the special interests of the children as a starting point[5] and lead the child out into a creative exploration phase. More detailed results about the processes, outcomes and evaluations will be published in due time. In what follows, we want to discuss in which ways this project aims to embody aspects of the research agenda that we have laid out above.

5.1 Multi-faceted

The design brief, while deliberately open ended, speaks to two different levels of the disabled experience: firstly, the focus on positive experience, fun and meaningful engagement takes a radical first-person and outlooking perspective. It aims to construct a human-centred understanding of experience of which the disability and the technology are necessarily part of, but not as the defining features. They are part of a holistic notion of experience and play their roles as mechanisms which interact. Secondly, the goal to scaffold the sharing of these positive experiences probes into a specific feature of the condition of which we know that it is often a great challenge for children with autism. The question how we can support such sharing has a different quality as it is directed towards the child, i.e. it is ultimately an intervention that addresses a specific aspect of an impairment.

A critical realist perspective allows us to see these two angles as complementary, rather than contradictory. The vertical integration of these two goals naturally raises different kinds of design challenges, for example, how do we get from the typically narrow interests to sharable experiences? What are positive experiences and is sharing them still positive from a child perspective? As such, the design brief makes it necessary to closely investigate the interactions between intrinsic and extrinsic aspects of the disabled experience.

5.2 Methodology

The methodology in Outside The Box is radically participatory. As argued above, this enables us to do two things: firstly, we gain understanding about the lived, disabled experience. When meeting a child every second week over the course of a school year, the quality of insights into their lifeworld is very different to what could be elicited traditionally when focused on requirements. Through our interactions with the child, the parents and the teachers, an empathic understanding from different perspectives is emerging. Which leads to the second point: this understanding needs to translate into the design of technology. A critical realist perspective alerts us that this understanding is provisional, biased and maybe misjudging the mechanisms at work. The participatory approach in Outside The Box aims to respond to this by involving children in the development so that this understanding is constantly refined and adjusted in a reflective process. The boundaries between design and evaluation are blurred as the child and the researchers develop and test their ideas at the same time.

The resulting smart objects (see figure 1) are testimony to how different the directions were in which each of the design processes evolved. Their design was inspired not only by the direct input from children, but by the empathic and mindful interpretation of their lifeworlds by designers, the views of parents and teachers, and by the project's underlying values and intentions.

5.3 Evaluation

Assessing the impact of the smart objects developed on the lived experience of children is at the heart of the evaluation work being conducted in Outside The Box. We therefore take a holistic approach looking, in critical realist terms, at all the different mechanisms that interact to shape that experience. This has led us to the question of how we can conceptualise and assess experience and on which data sources we could draw on.

We are in the process of developing such a framework for experience that brings together intrinsic and extrinsic perspectives and their interaction. We therefore draw on self-reporting methods like diaries, targeted questionnaires for the family or school context, interview data from children, parents and teachers, and usage data from the smart objects. It is unclear yet, however, whether the data sources will suffice to capture all relevant interactions between mechanisms of the (disabled) experience in this context. Further work will show whether novel forms of data gathering are needed or which impact the time-frame for evaluation has on what can be captured. It will be furthermore interesting to see how the picture we draw about the experience, is interpreted by different stakeholders. For example, will parents or teachers judge the experience in similar ways as the child?

5.4 Ethics

Moral and ethical considerations in Outside The Box go beyond the concern for the physical and mental wellbeing

[4] `http://outsidethebox.at`

[5] Special interests are a hallmark feature of autism, often very narrow and pursued with compulsory passion (cf. [25]).

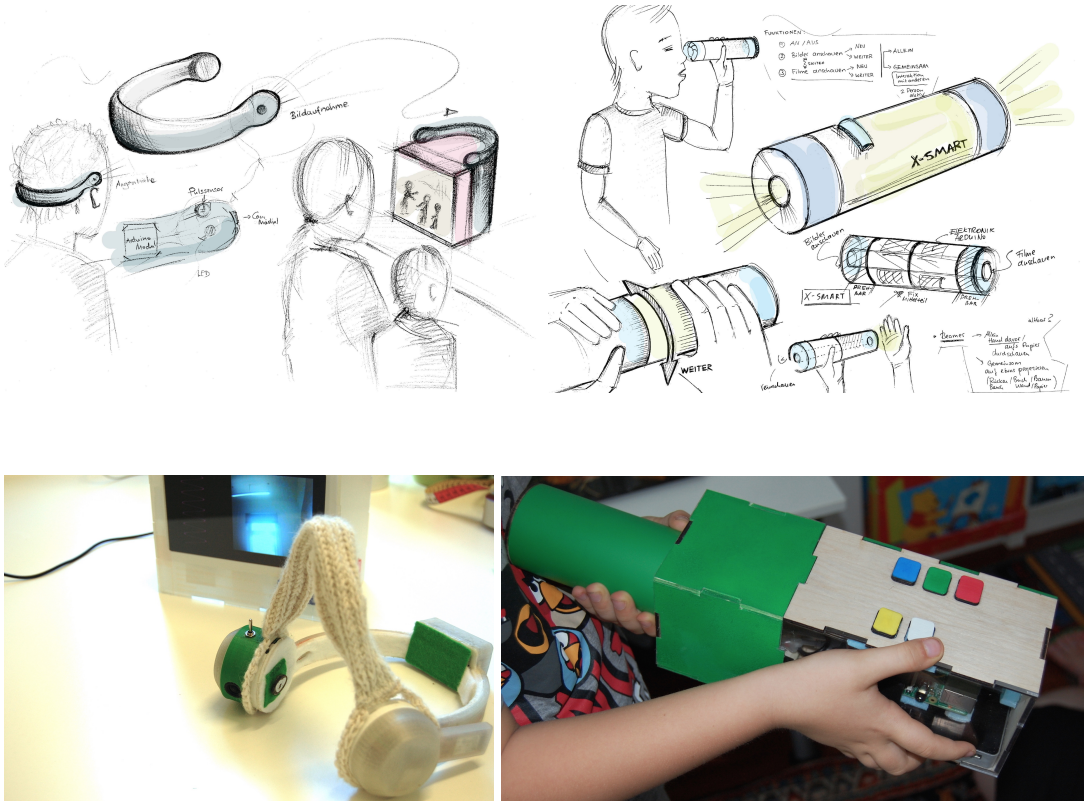

Figure 1: Initial sketches and their corresponding final prototypes of ThinkM (left, a memory machine for capturing and reflecting on difficult social situations) and XSmart (right, a story telling machine projecting cues into the hand of the child). Two examples of smart objects co-designed with children in OutsideTheBox (sketches ©Julia Makhaeva)

of our participants and thus, beyond the traditional anticipatory ethics processes formally required. By arguing for an open design process that focuses on a participant centred conception of wellbeing, the project makes a strong value statement that transparently shapes its moral standpoint. A number of technologies have been developed for children with autism, but, with very few exceptions, they match functional limitations with technological opportunity spaces, i.e., specific intervention goals drive the technological development. While, as argued throughout this paper, such perspectives have their purposes, they are also reductionist as they reduce the needs of children with autism to what they struggle with. In contrast, Outside The Box makes a point about putting wellbeing in the centre of design and starts with the often narrow interests of children with autism. Functional limitations and their effects are undoubtedly a part of this notion of wellbeing, but not their defining features.

This moral standpoint serves the project as guiding principle in planning and conducting workshops or studies in an ethically and morally responsible way. The open-ended and unpredictable nature of the work makes it necessary to constantly reflect on our decisions and whether they still embody the principle ethos of the project. We call this "in-action ethics".

5.5 Knowledge

The project generates knowledge on different levels: firstly, methodological in that new methods and techniques are developed to enable children with autism to lead on design processes. Secondly, technological know-how is generated in the way concepts and ideas are implemented as ubiquitous computing artefacts. Thirdly, knowledge in a socio-technical context is generated in terms of assessing experience in the context of the smart objects that were developed and how they support the sharing of such experience.

In Outside The Box we capture this knowledge mainly through annotated portfolios [3] which allows the construction of a synopsis across the different levels and thus is a first step towards vertically integrating knowledge.

6. CONCLUSION

With this paper we have argued that critical realism can contribute to the philosophical underpinnings of the field of AT. We have briefly discussed the various conceptualisations of disability and then introduced the critical realist perspective in Disability Studies. Inspired by the appealing features of both, the resulting multi-facetted, interactional model of disability, and the original philosophy of science, we have made the case for a critical realist perspective on designing technology for people with disabilities. The result is a proposal for an agenda for future research into AT that is non-reductionist and equally multi-facetted with respect

to its motivations, methodologies, evaluation criteria, epistemology and ethics. The last section introduced OutsideTheBox as a case study to exemplify how this new agenda could be approached.

Future work will need to further investigate the implications of different philosophical positions on the practical work in AT. We believe that, in particular the vertical integration of knowledge generated on different strata is an area that will require more attention. Relatedly, Roy Bhaskar has written extensively about the centrality of experiments in scientific enquiry, albeit, his conception of experiments being rather different from empiricism. However, the contribution of this paper lies in progressing this debate and fostering a culture of critical reflection in AT.

7. ACKNOWLEDGMENTS

This work has been funded by the Austrian Science Fund [P26281-N23].

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