

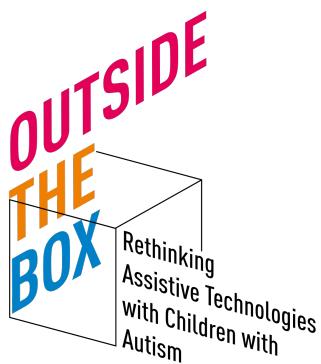
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# Exploring Future Technologies Through Digital Fabrication With Autistic Children

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FabLearn

June 16 2014, Aarhus, Denmark

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## Abstract

In this paper, we will discuss the potential and the challenges of using Digital Fabrication to involve children with autism in a participatory design process. We will introduce the *OutsideTheBox* project that aims to explore new technological opportunity spaces with children with autism, re-thinking future roles of technology in their lives. Digital Fabrication is one of the co-designing approaches that the project will implement to exemplify this paradigm shift.

## Introduction

Digital fabrication is promising to allow people with little specific training to design and create physical objects in all shapes and forms. The advances in 3D printing particularly, have created a thriving sub-culture that has changed our relationship to physical objects. Not only can physical objects be copied in similar fashion as digital media, the barriers to designing have been lowered to allow people express their creativity and prototype physical objects with comparatively low effort, but a high level of production quality [4]. This also allows a much more personalised approach to objects than would be possible in a mass market.

Participatory Design (PD) has its origins in the scandinavian labour movement, which aimed to allow

**Autism** is extraordinarily diverse in its manifestations, but there are three hallmark features that define Autism Spectrum Disorders:

- 1) The development of **social skills** is impaired which may include, for example, the ability to read other people's emotions or seeing the world from other people's perspectives (Theory of Mind).
- 2) Impaired **communication** which can range from being completely non-verbal to having problems with using body language appropriately.
- 3) Autistic people often have a tendency for **repetitive behaviours** or **narrow interests** (Monotropism).

workers to participate in the shaping of their future working environment [1]. Since then, PD has greatly diversified and is now incorporated into a multitude of design processes, be it to create technological artefacts or social service design. Whatever flavour of PD, there is a broad consensus emerging that involving people who are affected by a technology or service in its design leads to more meaningful outcomes. This is in line with the paradigm shift we see more generally in Human-Computer Interaction (HCI) which continues to move from designing technology with an engineering mindset, focusing on tasks and performance, towards a situated, embodied and value driven design approach that involves the potential users [5].

Participatory Design has consequently developed a variety of methods to allow people who are not necessarily trained as designers to participate in design processes, contributing their tacit knowledge as experts in their own life [7]. In fact, the overwhelming part of research reported in the academic field of PD is concerned about finding ways to elicit this knowledge and enable participants to creatively express their ideas. It is at this point, where the needs of PD meet the potential offerings of Digital Fabrication. Can Digital Fabrication offer a new way of allowing participants to envision alternative, technological futures? Can it scaffold creativity and highlight an opportunity space for design? Can Digital Fabrication provide a design space for personalised and thus more meaningful objects for children with autism?

In this paper, we want to discuss these questions within a specific context. In the research project *OutsideTheBox - Rethinking Assistive Technologies with Children with Autism* we aim to create technologies with children with autism in a radically different way. Instead of focusing on

tailoring the technology to the deficits related to their disability, we invite children with autism to envision new roles of technology in their lives. We leave them the space and freedom to design the technology they want and shift our focus towards wellbeing, positive experiences and building bridges between their lives and that of their social environment. Involving children with autism in such a participatory design process is challenging, however, and Digital Fabrication will be one of the approaches that *OutsideTheBox* will implement to achieve its goals.

## OutsideTheBox

Autistic people, particularly children, often have a natural affinity to technology which they regard as being less complex than other beings. Their need for structure and predictability is well served by computers and thus computer-mediated interventions have been seen as a highly promising route for intervention. However, the focus on designing technology for intervention has meant that exploring other roles for technology in the lives of children with autism has been ignored. With *OutsideTheBox* we want to move away from the traditional deficit model for designing technology for people with disabilities. Technology enriches our lives in many different ways and limiting ourselves to seeing technology as a means to overcome the effects of a disability means limiting the lives of people with disability. This preoccupation with "fixing" people, embedded in our thinking about assistive technology, has long been questioned by the field of Disability Studies. Many scholars and thinkers in this field have advocated to move away from the dominating medical model of disability to a social model or post-modern model which carefully differentiate between the impairment (the physical or cognitive limitation) and the disability (the disadvantage experienced in our society), e.g., [8]. However, a paradigm

shift in technology design is on the horizon and researchers begin to critically question traditional approaches [6]. With *OutsideTheBox* we want to demonstrate that the life-worlds of children with autism are rich design spaces that afford radically new, and empowering roles of technology.

To explore these new meanings of technology and to unlock new application spaces, design has to be guided by the intimate knowledge and expertise children with autism have of their own life-worlds. However, facilitating design processes that meaningfully involve them in leading roles is very challenging [3]. In *OutsideTheBox* we implement 6 different approaches to co-designing technology with children with autism with the design brief being deliberately open with only two requirements: a) applications afford meaningful and positive experiences within the life-worlds of children with ASC and b) they support children in sharing these experiences with their social environment.

While one of the approaches to be implemented will focus exclusively on Digital Fabrication as a way to involve children with autism, all approaches incorporate elements of "making" and collaborative prototyping. We believe, that this expressing-by-doing is particularly important with a participant group that struggles with communication and finds expressing themselves creatively—thinking outside the box—difficult. The embodied interaction has the potential to reduce the social pressures of design situations which children with autism find difficult to cope with [3].

### Challenges

There is few related literature on children and Digital Fabrication. Eisenberg [2], for example, identifies five

major challenges for 3D printing to truly become available for children: a) expanding the range of physical media available for printing, b) incorporating ideas derived from "pick-and-place" mechanisms into 3D printing, c) exploring methods for creating portable and ubiquitous printing devices, d) creating tools for hand-customisation and finishing of tangible printed objects, and e) devising software techniques for specifying, altering, and combining 3D elements in the context of printing. Posch and Fitzpatrick [9] are describing their experiences with introductory workshops in a FabLab for children and observe that while it is possible to lower the barrier to Digital Fabrication to an extent so that children will have good first experiences, there is still a long way to go to support children's self-directed interaction with Digital Fabrication.

In the absence of prior work on children with autism and Digital Fabrication, we can only speculate about the specific challenges that lie ahead in *OutsideTheBox*. However, drawing on the observations from above and extrapolating from Frauenberger et.al. [3] in terms engaging children with autism, some broad areas of difficulties can be anticipated:

**Imagination:** Children with autism often have very narrow interests and it is difficult to guide them to think outside the world they are used to and feel safe in. Consequently, while the technology of Digital Fabrication might appeal to them, they might end up wanting to produce familiar objects in minor variations.

**Interaction:** Using Digital Fabrication tools requires the ability to link abstract concepts in softwares with the physical outcome. This might be a barrier for many children with autism, so interfaces will have to be developed that not only are highly usable in terms of

hiding the complexities of Digital Fabrication, but also narrow the gap between the abstract concept and the physical artefact.

**Expectations:** Managing the expectations of children with autism is a key issue to help avoid frustration and potential social distress. Equally, opportunities have to be provided for children to emotionally regulate their excitement and the amount of sensory input has to be managed as many children have some form of hypersensitivity.

**Customisation:** As mentioned above, narrow interests are a hallmark feature of autism and this results in children loosing interest quickly of anything falling outside this interest. A common strategy to deal with is to customise the experience to an extent that allows the child to stay engaged, while exploring novel aspects.

**Interpretation:** Due to impaired social skills, aspects of the processes or outcomes often remain inaccessible to other people than the child. Mindful interpretation is a process that tries to mitigate for this effect, building on a strong, empathetic understanding and relationship that allows the designer to look beyond the visible.

## Conclusions

In this paper, we have explored the potential of Digital Fabrication in the co-design of technology with children with autism. The *OutsideTheBox* project has been introduced and first challenges are identified.

Participating in this workshop will give me the opportunities to further develop my ideas and concepts for implementing a Digital Fabrication approach in *OutsideTheBox*. Exchanging thoughts with colleagues who are more experienced with working in Digital Fabrication environments will provide invaluable input for developing an appropriate co-design process.

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