

Physicalisation to Support Graphical Content Access by Blind and Low Vision Users

Matthew Butler
Monash University
Melbourne, Australia
matthew.butler@monash.edu

Leona Holloway
Monash University
Melbourne, Australia
leona.holloway@monash.edu

ABSTRACT

Access to graphical information and content is compromised for people who are blind or have low vision (BLV). To support access to vital content such as that used in education, orientation and mobility, and the workplace, graphics are often converted into a tactile format. Traditionally this has been in the form of tactile graphics, but in recent times a greater focus has been placed on the use of emerging technologies such as tactile overlays on tablets and 3D printing, which is sometimes augmented with low-cost electronics to provide multi-modal experiences. This short paper supports the research agenda to explore physicalisation of data and information, but highlights the need to consider it through a lens of inclusion, in particular for those who are BLV.

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1 BACKGROUND

People are surrounded by visual information, and it is a cornerstone of education, orientation and mobility, and our general day-to-day engagement with the world. For people who are blind or have low vision (BLV), access to graphical information is severely compromised. In order to access this content, alternate representations need to be provided. This is done in many different forms, including written or verbal descriptions as well as sonification. Tactile representations, however, are one of the most important means in which to provide access. Unlike written descriptions, tactile representations support agency of the BLV user, allowing them to explore, draw their own meaning and identify areas of interest. Tactile representations are also important in opening up the authoring of data representations by BLV people [4].

As such, the physicalisation of visual information is crucial for BLV people. While the current standard is the use of swell paper based tactile diagrams, there is an increasing interest and use of emerging technologies such as 3D printing. Indeed, 3D printing

offers an exciting area of exploration, as early work [6], both fundamental research and practitioner-led, is revealing that 3D printing may have lower barriers to tactual understanding, more greatly facilitate the development of mental models for some content, and encourage greater collaboration between BLV users and their peers. There is considerable work yet to be undertaken, however, to understand for what use cases 3D printing could be most valuable, as well as what design guidelines are most appropriate for transcribers and materials providers.

2 RELATED WORK

2.1 Tactile Graphics

Graphical information is typically transcribed into an alternate format for BLV people, and usually presented using written or verbal descriptions or tactile graphics. Published guidelines recommend the use of tactile graphics for graphics in which spatial relationships are important, such as maps, plans and many STEM diagrams. The most common production methods are embossing with raised dots using a braille embosser or printing onto swell paper. There is also a rich history of the provision of 3D models to represent graphical information, commencing with wooden models and shifting toward new technologies such as 3D printing.

By providing tactile graphics rather than just written or verbal descriptions, BLV people have much greater levels of agency, being able to focus on areas of their own interest and make their own interpretations, rather than be beholden to the interpretations of a transcriber.

2.2 The Role of Emerging Technologies

A number of computer-mediated technologies for presenting accessible graphics have been developed in the last decade including sonification, haptic feedback, and multi-modal materials. While these technologies offer some advantages over tactile graphics, in general they are too expensive or require bespoke technology, as such tactile graphics remain the presentation medium of choice.

Over the last decade the widespread use of 3D printing has been the most influential technology for the provision of accessible graphics [2]. Holloway et. al. undertook one of the first studies to directly compare tactile graphics and their 3D printed equivalents, using the O&M context [6]. The study also sought to examine the touch reading strategies used. Both of these contributions would go on to influence design guidelines for 3D prints for providing accessible graphics. These design guidelines could have strong influence on any broader physicalisation guidelines to be developed.

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Figure 1: Series of 3D printed education materials

2.3 Education Context

Many learning theories emphasise the value of interaction with physical objects for active and concrete learning by all students, regardless of whether they have a disability. Hein proposed that interaction with real materials or objects enables students to engage with knowledge more fundamentally [5]. Object-based learning is now being adopted at all levels of education, including higher education [3]. 3D printing offers a new technique for creating artefacts that can be used for object-based learning, with particular resonance in STEM [7, 8]. With participation rates by BLV students in STEM being in some cases less than half of typical cohorts [1], by supporting increased use of objects and data physicalisation and designing for inclusion, barriers to STEM participation could begin to be removed.

3 KEY RESEARCH CHALLENGES

Given this context, the following would represent key research challenges regarding physicalisation that would be in particular support of BLV people:

- What areas of education would best suit physicalisation, with consideration of support of access by BLV people?
- How can design guidelines for BLV tactile materials (especially those relating to 3D printing) inform the key design considerations of physicalisation more broadly?
- How do we ensure that equity of access is a cornerstone of any formalisation of physicalisation design?

4 CONCLUSION

This short paper has described the important role that tactile graphics play for BLV people. It has also briefly introduced the role 3D printing has begun to play in providing more effective tactile materials that support independent access and agency. Having robust design guidelines for the use of 3D printing for BLV people has begun, and indeed these could play an important role for physicalisation more generally. It is also important that as physicalisation

becomes more widespread and formalised, that any design guidelines take into consideration access by the BLV community.

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