Looking Good, Feeling Good – Tac Map: a navigation system for the blind

CHAMBERLAIN, Paul <http://orcid.org/0000-0001-6643-3480> and DIENG, Patricia

Published version

CHAMBERLAIN, Paul and DIENG, Patricia (2011). Looking Good, Feeling Good – Tac Map: a navigation system for the blind. In: The role of inclusive design in making social innovation happen. RCA.

‘Looking Good, Feeling Good’ – TacMap - a navigation system for the blind’.

Professor Paul Chamberlain MDesRCA, Patricia Dieng MA.
Art & Design Research Centre, Sheffield Hallam University, UK

Abstract
This paper describes the research and development of a navigation system for the blind that provides a tactile and visual language that can be understood by both sighted and blind users. It describes key work and issues in the development of graphical symbols and in particular the pioneering work of Neurath’s ISOTYPES, as well as more specific communication systems for blind people. The paper focuses on the development of ‘TacMap’, a navigation system for the blind. User engagement has been fundamental in the research and the paper discusses the methodology, the research findings and product’s potential future opportunities and impact.

Keywords
tactile graphics, haptics, inclusive design, human-centred design, accessibility, co-design

TacMap

Overview
Traditional maps and plans use a combination of pictographs, ideographs, symbols and text to abstractly communicate space and the arrangements within it. The focus of our research explores how traditional graphics and architectural icons used in the design of maps and plans for sighted people are interpreted and understood by blind people through tactile translation. From this we hope to develop a series of optimum icons for use in the design of tactile maps that can also be understood easily by sighted people. The rationale for this is that the maps will often be created by people with sight and the maps are likely to be a communicative link between people with and without vision.

An initial search revealed an incomplete range of tactile icons and also established there is no single international standard. The Canadian National Institute for the Blind (CNIB) and the Braille Authority of North America (BANA) are working on guidelines in the hope of developing standards for the production of tactile graphics.

Our objective is to provide a system that can be adopted by non-experts to enable the creation of tactile maps for diverse locations of varied scales and customisable information. This will support autonomy, independence and safety to intended users through increased access to a variety of environments. There are many examples where ‘special’ facilities have become ubiquitous in our society, e.g. access ramps and textured footpaths. The TacMap navigation system has been developed to change and improve the way visually impaired people plan their journeys, travel and move around exterior and interior spaces. Our aim is for blind people to better understand how a space, e.g. a building, is composed before or at the time they visit and understand the arrangement of this space. Such places would include hotels, museums, theatres, civic buildings, university buildings, sports arenas, schools, bus and train stations, and buildings where they work.

Our research focuses on the development of the iconographic content of the maps as well as a system to create the tactile maps/plans. We have developed graphical software and the screen interface to enable the easy production of accessible information for visually impaired people. Design researchers and software developers at Sheffield Hallam University have worked in collaboration with the Sheffield Royal Society for the Blind to optimize the software and its interface and subsequently the design and production of the tactile maps (Fig 1). The maps are created on screen, with the support of a simple set of instructions, and then printed on a standard printer using "ink swell paper". The printed maps are then passed through a special heater and the black ink swells to provide a raised tactile surface; the users can then 'read' and translate the information through touch.

Figure 1. TacMap screen based interface

Towards an international language Context

Although we found little that would inform our enquiry related to an iconography for the blind we must recognise the contribution work of Otto Neurath and others in our research. The Austrian philosopher of science, sociology, and political economist, Otto Neurath.conceived and developed an international picture language that became known as ISOTYPES (International System Of TYpographic Picture Education), using self explanatory symbols based on scientific and psychological experiments. Neurath is widely acknowledged to have evolved the first theoretical framework for modern visual education and the effects of his pioneering work can be found in most of today's visual culture (Fig 2).

Figure 2. Current road sign

Figure 3. Isotype pictographs

Just before his death in 1945 he completed his 'visual autobiography' (Neurath 2010) in which he describes how the growing emancipated proletariat could be educated not through opaque scientific languages but directly illustrated straightforward images. Another proposed outcome of this work was that language and cultural barriers could also be overcome as isotypes would be universally understood. The idea was that images can bridge the differences between languages because it is easier to remember simplified images than exact figures.

Political artist, Gert Arntz, was commissioned with the design of the Isotype's pictograms and visual signs. Published in Leipsig in 1930, his work 'Bildstatistisches Elementarwerk' contains 100 visual charts, providing an overview of the essential empirical data of the world at the time. This publication is an example of the 'Vienna method' to present generally accessible information regardless of language barriers with the aid of images (Fig 3).

Key features of the isotypes were the use of colour combined with silhouetted forms which compels us to look at essential details and sharp lines where there is no defined backgrounds. Symbols are often combined: a symbol for a worker and a symbol for agriculture could be combined to make one symbol for an agricultural worker.

Coincidentally from the perspective of our research and development of the TacMap Nuerath's second wife Olga Hahn was blind but there is no evidence to suggest he explored or developed his work in a tactile language[1].

Iconic language

Neurath admired Egyptian hieroglyphs and while he did not suggest there was any continuous development from Egyptian wall painting, he did describe his work as a 'renaissance of hieroglyphics'. Hieroglyphics should not be assumed to stand as direct representatives of things or simply depict things, they were often phonetic characters and also highly symbolic.

Contemporary interface culture uses iconic signs in abundance. Hartmann (2008) suggests these signs represent not objects, but often, algorithmic processes. As for pictograms used in public communication, semiotics allows us to distinguish between pictographic and ideographic signs. He warns while pictographs are figurative signs that may be interpreted for their literal meanings, reading them as a picture language may lead to confusion. In other words, it is misleading to think of pictographic writing as existing outside a certain culture and context. This potential dichotomy-misunderstanding was fully understood in the development of the symbols for the TacMap.

Although there are some signs that relate to certain objects (like 'car' or 'key'), as illustrated by Lupton and Miller's table (Fig 4), the implications for meaning become extremely complex when they are combined. Hartmann suggests 'a car dreams of a key' might be called poetic, but it is hard to imagine a sign being interpreted like this in everyday communications. At the airport, we are more likely to interpret this sign as 'car rental', thus treating it as an ideograph, and not as a pictograph.

[1] Hahn died before Otto fled to the UK where he married Marie Reidemeister and where he developed the Isotype Institute in Oxford. After his death, Marie continued the work of the Isotype Institute. The Otto and Marie Neurath collection is now part of the research archive in the department of Typography & Graphic Communication at the University of Reading, UK.

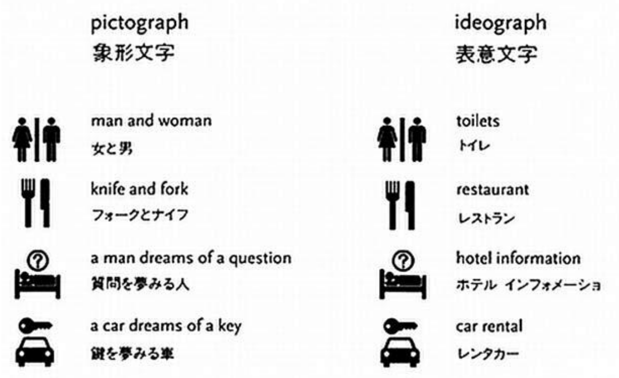

Figure 4. Lupton & Miller 1996

Communication systems for blind people

The blind and partially sighted population is approximately 2 million in the UK and over 160 million over 177 countries (WBU). This number will increase in the near future due to the increasing proportion of older people who will be encouraged to be independent. It is predicted that by 2050, the numbers of people with sight loss in the UK will double to nearly 4 million (RNIB). The Braille system was based on a method of communication called night writing originally developed by Charles Barbier in response to Napoleon's demand for a code that soldiers could use to communicate silently and without light at night. Barbier's system was too complex for soldiers to learn and was rejected by the military, but in 1821 he visited the National Institute for the Blind in Paris, where he met Louis Braille. Braille identified the major failing of the code, which was that the human finger could not encompass the whole symbol without moving, and so could not move rapidly from one symbol to another. His modification was to use a 6 dot cell, the Braille system, which revolutionised written communication for the blind.

Though Braille is thought to be the main way blind people read and write, in Britain (for example) out of the reported 2 million visually impaired population, it is estimated that only around 15-20,000 people use Braille and its use has decreased with the emergence of non-specialist school teaching (NFB). With the emergence of mobile technology and GPS, there are audio systems to help blind people navigate and be guided without the need for Braille. Audible GPS is a suitable tool to instruct direct routes to the user to get from A to B. However, they are relatively expensive and once inside buildings, are limited and cannot provide a detailed level of spatial information.

Blind people are routinely provided with text material in Braille, audio or large print but pictures, diagrams and maps (tactile graphics) are often only briefly described (RNIB). Tactile graphics is a specialist field with many methods and processes including embossing, etching and thermoforming, for educational and recreational use.

Challis and Edwards (2000) are critical of much that exists and in ‘Good Tactile Diagrams can look bad’, state ‘It might seem trite to state that the sense of touch is vastly different from that of sight. Nevertheless, it seems that the designers of some tactile diagrams do not bear this in mind. Thus, the diagrams they produce may look good - but are most impractical to explore manually’. They support the development of guidelines for tactile design, ‘to ensure that the right amount of information is available to the user through the fingertips,’ that should lead to tactile diagrams which are, ‘much easier to use - though they may be harder to interpret visually’.

Our investigation aims to inform the development of navigation aids (tactile maps) for blind people that will help support independence and could enhance their quality of life.

However our objective is to challenge whether tactile diagrams should and can be both clearly interpreted through vision and through touch.

Method

Key to this research was the utilisation of tangible artefacts as a methodology for eliciting knowledge This approach has been significant in the Art and Design Research Centre, informing the design of patented solutions and award winning commercial outputs of research programmes (e.g. Roddis' 'TTurra' and Rust's 'Prosthetic Arm' both funded by AHRC). Chamberlain (2010) has discussed the limitation of traditional user-centred research methods that focus on verbal and visual protocols. The use of 'design' and 'artefacts' as research tools to help us engage with and better understand people rather than just to provide solutions and responses to problems has been extensively explored within the Art & Design Research Centre at Sheffield Hallam University [2]. The user group in this context (blind people) challenges again those traditional protocols. In his research we exploit the design and creation of physical artefacts early in the investigation to help us understand the complex needs of the user who may or may not be blind. Following a search on current work in this field and existing communication and navigation systems for the blind we embarked on recruiting a lead user group through the Sheffield Royal Society for the Blind (SRSB).

The research team, in collaboration with blind people, has developed a tactile language (tactile symbols and textures) to represent for example entrances, exits, fire exits, direction of doors openings, reception/ information points, disabled, male and female toilets, stairs, lifts, access ramps, canteens, classrooms etc: information they usually seek by asking the help of sighted people.

User engagement

The research team, working closely with a software programmer at the University, developed a prototype screen interface that was able to take architectural plans and other appropriate information and translate them into simplified maps suitable for printing on ink swell paper to create a tactile map, 'TacMap'. Potential TacMap producers, e.g. administrative staff, or receptionists with limited or no CAD expertise were recruited (ten participants) and allocated the task of creating a map in controlled conditions following only the prompts embedded in the software and presented on screen in the form of video clips. Each of the producers engaged in the test were successful in completing the challenge of creating a map.

The research team presented the project to SRSB in 2008, gaining a positive response from their members to support and engage in the research and development of a tactile language for the creation of a tactile map system. Two lead users were recruited to work closely with the research team to evaluate current systems, develop a suitable series of icons and identify appropriate information that might be required as content for the tactile maps. The findings were then presented to and debated in a wider forum with other blind members from SRSB through a series of user workshops (Fig 5). Following a six month collaboration, the design team collated standard architectural symbols generally grouped into 'Building parts', 'Rooms' and 'Facilities'. Each of these are generally represented on traditional plans and maps as pictographs, ideographs, symbols or text. For blind users we could add Braille. Utilising the ink swell process,

---

[2] Research by Chamberlain et al that investigates the role of haptics (touch) in enhancing communication in the design of products for profoundly sensory impaired people (Chamberlain, Roddis 2003) and a non-interchangeable medical connection system (Chamberlain, Gardner, Lawton, 2007).These investigations highlighted the value of optimum combinations of sensory prompts in the design of products to maximise usability.

tactile versions of these were created for evaluation in the workshops. Feedback from a series of tests suggested many pictographs and ideographs used to visually communicate information on maps/plans became difficult to recognize and understand when a tactile ‘copy’ was created. This was largely due to the small scale the icon would need to be to be included on a map/plan, as Barbier had discovered with his code language in the early nineteenth century. The research team in close collaboration with the blind users then modified the visual symbols so they became easier to understand through touch. In many instances, the visual symbols evolved from pictographs and ideographs into abstract symbols. (Fig 6).

Figure 5. user workshops

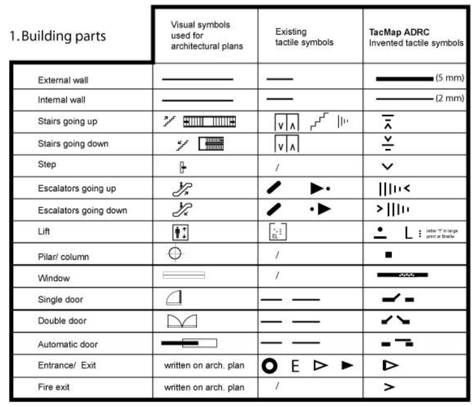

Figure 6. example icons

Field trial 1

Sheffield Hallam University’s Furnival Building was selected for an initial field trial and tactile maps specially created for the space utilizing the software were developed. The Furnival Building is modern, has four levels and includes stairs, lifts, a reception area, gallery, atrium, restaurant, classrooms, meeting rooms, offices, toilets and laboratories. Two booklets composed of information about the location of the building, the key to icons and the plans were posted to two volunteers two days before the trials. On average the volunteers took about 45 minutes to ‘*read’* the booklets prior to the visit to the building. Each volunteer was then scheduled separately to visit the building and prompted to undertake a series of tasks (Fig 7) e.g. go to reception, find a specific room, find the toilet . Each volunteer was observed during the trial but offered no help. At the end of the task each volunteer was interviewed to reflect on their experience. Each volunteer completed the tasks successfully without the need for any additional supporting intervention. Each volunteer undertook the task with only brief checks with the map/plan and key during the trials.

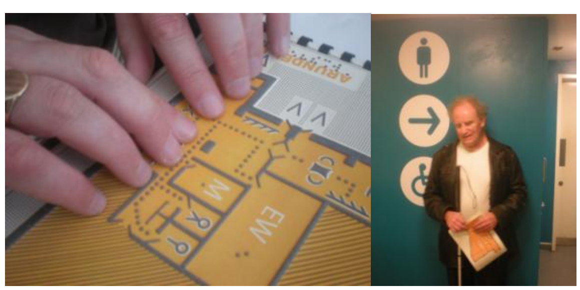

Figure 7. Field trials

The 2 volunteers stated that:
-the tactile symbols were **easy to recognize and remember**.
-they had for the first time an idea of the **composition of the space before visiting** a building.
-they appreciated the fact of being **more independent** finding their way without being guided by someone sighted.

There were recommendations for the inclusion of a scale and minor adjustments to some of the icons. Following these modifications a second trial was undertaken with a larger group of volunteers and with the support of Sheffield City Council in the Award winning city centre Winter Gardens and Millennium Gallery. Sheffield City Council were interested in supporting the development and potentially adopting the TacMap system to support the city’s accessibility agenda. Engagement with the accessibility advisory team led to the adoption of an auditory guide to support the tactile map aimed specifically to users who were not familiar with Braille.

Field trial 2

Winter garden/Millennium Galleries - This enclosed public space has six entrances and a maze of walkways through plants and artworks. There are shops, exhibition galleries, seating and cafés. Sixteen volunteers with no prior knowledge of the TacMap were recruited through SRSB and comprised of;

Completely blind: 11/ 16
Partially sighted: 5/16
White cane user: 11/ 16
Guide dog user: 5/16
Familiar with tactile images: 5/ 16
Could read Braille: 11/16

Volunteers were allocated two booklets, two days before they undertook the trial, which comprised of plans of the space and a key to icons created with the software. Volunteers were asked to meet our research team at the reception of the Millennium galleries at a prescribed time. Each volunteer was then asked to undertake a series of navigation tasks (Fig 8). At the end of the tasks each volunteer was asked a series of questions and given the opportunity to reflect on their experience.

Figure 8. Field trial

A brief summary of findings include;

15 / 16 had no problem understanding the maps/plans
6 / 16 found the audio description useful
15/ 16 found tactile maps useful in navigating their way around building
15/ 16 would use it if available
14/ 16 suggested changes

With a mixed group of volunteers in terms of familiarity with Braille, the feedback and suggested changes focused mainly around the use of text, Braille and audio prompts. Braille users did not use the audio prompts, non Braille users found the Braille a distraction. Each participant was interviewed at the end of the trial and feedback was generally extremely positive.

> *"This is wonderful, this illustrates so many things; plans are really useful, and it is great to be able to go in a room like for example here the toilets and to know where the basins, the WC and the hand dryers are".*

> *"We were talking about the difference using a tactile map and not using one, the thing is that without a tactile map I wouldn't have thought to come in here, but the difference is that I have actually attempted to do this".*

> *"I have spent a few months at a College for the Blind and it would have been handy to have something to show the layout of that building…"*

> "*I'm familiar with the Sheffield train station but things change, and there are certainly a lot of things at the train station which I don't know is there, I have walked passed it hundred of time and I'll never know it's there, like the main reception and the lift here at the Millennium Galleries. To have something like this would be very good"*

Findings

42 icons were identified for potential use with the TacMap. Of these many had equivalent symbols commonly used on architectural plans and maps intended to be interpreted visually. These icons could be represented as follows.

pictographs	ideographs	abstract symbols
55%	15%	30%

Our investigation identified existing tactile icons but did not find an existing cohesive tactile cartographic language with evidence to support it. However those existing tactile icons sourced as suitable for our application were tested along with our modified architectural icons. There were some applications for which no icon existed, often represented by text on plans/maps. While Braille could be used in place its limitations have been discussed and in response new icons were developed and tested. However the software does allow the easy inclusion of Braille prompts if needed, so utilising Braille to present information to those who may benefit was considered and tested in our study.

Working together with the volunteer blind community new tactile icons emerged through a further series of workshops and field trials. The 42 tactile icons developed and used in the TacMap can be categorised as follows;

pictographs	ideographs	abstract symbols
7%	15%	78%

Notably, from the study, pictographs utilised for visual communication in maps/plans for sighted people do not easily translate into tactile versions, or convey appropriate information through touch. Our findings propose a significant increase in the use of abstract symbols in place of pictographs in the design of tactile maps. The proportion of ideographs which are themselves abstractions did not change. While Braille is a valid alternative to the use of icons its use as highlighted is limited, however alphabetical notation has been included and tested as an optional solution (Fig 9).

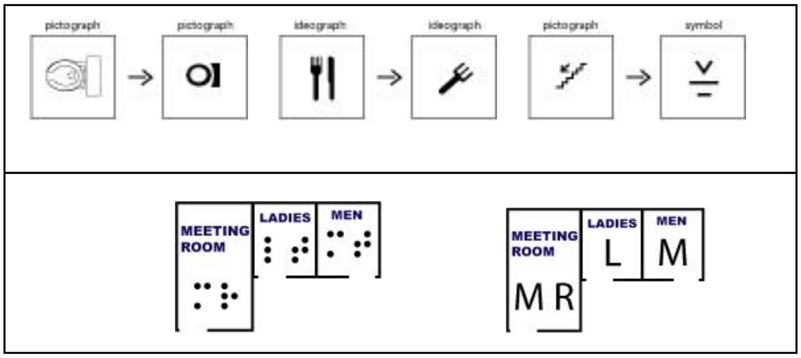

Figure 9: examples of modified symbols and use of Braille/text

Conclusion

The product

Our versatile, low cost, low-tech, tactile solution has a number of benefits over audible high-tech solutions, including the fact that it does not impede environmental sounds that enhance our multi-sensory understanding of our landscape. Our solution provides a more holistic picture and understanding of the environment than GPS can provide.
The research to date has informed the development of a unique software programme to create tactile maps from complex architectural plans. Our research has determined that there is no international standard for tactile symbols and in response we have developed the TacMap software to be customisable. Users are able to download the most suitable or preferred symbols or textures and adopt national protocols accordingly. The software has been designed to be easily operated by a sighted non-CAD expert.
The research has in addition focused on the development of an icon-based tactile language informed and developed with blind users.

Beneficiaries

According to the Disability Discrimination Act (DDA), which promotes civil rights for disabled people and protects disabled people from discrimination, service providers have an obligation to make reasonable adjustments to premises or to the way they provide a service. Access to services is not just about physical access, it is about making services easier to use for everybody. This system could easily change and improve the way organisations and business welcome and facilitate their visually impaired guests, visitors, and clients with a low cost system. The evacuation of buildings is as equally as important as access and working closely with Health & Safety officers within the Estates Department at the University, we have identified the potential benefit of integrating our system as part of the PEEPs (Personal Escape and Evacuation Programme).

Research outcomes

Previous work by Chamberlain highlights the limitations of some user-centred research methods in challenging contexts. Interpreting and understanding complex environmental and spatial arrangements without vision is yet another example where there is value in design interventions as research tools to establish knowledge. Significant in this study has been the engagement of end users from the outset. The research team has importantly been researching and developing 'with' and not just 'for' the end users and the insights might contribute to the growing interest in co-design and cooperative research methodologies.

The system to create the TacMaps has been purposely developed to be accessible to encourage uptake from a broad community. The research has attracted the interest of the Estates department of the University and the local council who, as stakeholders, could make a significant contribution to support its development and potential implementation. As early adopters, they might influence policy and standards to enhance accessibility and inclusivity.

The study highlights the need for further work exploring and evaluating TacMap as an aid to navigation for blind people, as well as the development of a flexible tactile language that does not replicate our visual world, yet does not discount it so that we may achieve an outcome that might both 'look' and 'feel' good.

References

Chamberlain, P, Roddis, J. (2003) - 'Making sense'. The Design Journal, Volume 6, issue 1, Ashgate Publications Ltd. England. ISBN 0-7546-0910

Chamberlain, P, Gardner, P, Lawton, R (2007) 'Shape of things to come'. 'Design Research Now', Essays and selected projects. p. 99-119. Board of International Research in Design. Edited by Ralf Michel. Birkhauser ISBN 978-3-7643-8471-5

Chamberlain, P (2010) 'Horses, Elephants and Camels….barriers to user-centred design research'. (Design Society) Conference proceedings 11th International Design Conference– DESIGN 2010, Dubrovnik, Croatia.

Challis, B, P, Edwards, A, D, N (2000) 'Good tactile diagrams can look bad'. International Conference on Tactile Diagrams, University of Hertfordshire, http://www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm.

Hartman, F (2008) 'Visualising Social Facts'. Otto Neurath's ISOTYPE Project. In European Modernism and the Information Society, Informing the present Understanding the Past. Chapter 15, edited by Boyd Rayward Published by Ashgate, ISBN 978-0-7546-4928-1

Neurath, O. (2010) 'From hieroglyphics to Isotype': a visual autobiography. London, Hyphen Press, edited by M. Eve & C. Burke 2010 ISBN 978-0-907259-44-2978.

WBU - World Blind Union (http://www.worldblindunion.org/en/)

NFB – National Federation for the Blind (http://www.NFB.org.)

RNIB – Royal National Institute for the Blind. (http:www.nctd.org.uk)

BANA - Braille Authority of North America (http://www.brailleauthority.org)

CNIB - Canadian National Institute for the Blind (http://www.cnib.ca/)