Figure 1 An individual using the Future Sea Walking device and observing that their garden will soon be submerged.

Figure 2 A cloud of 'Va au Vents' cast into the wind. The design form is based on sycamore seeds.

What Can We Expect from Navigating? Exploring Navigation, Wearables and Data Through Critical Design Concepts

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Abstract

What is it to navigate or to be navigated? How, and through what, is information communicated to us? Do our interactions with space need to be limited to when we are moving through it? This paper describes a collection of design concepts generated as part of the initial stages of a research project that combines a critical design mindset and research through design process to explore these types of questions. The project seeks to problematise and diversify the discussion and understanding around pedestrian navigation, wearable technology, crowdsourcing and human data interaction. The goal is to develop one of the concepts using research through design as part of PhD research studies, leading to possible future applications.

Author Keywords

Critical Design; Pedestrian Navigation; Wearable Technology; Human Data Interaction; Crowdsourcing

CSS Concepts

- Human-centered computing~Interaction devices

Introduction

Navigation, from the Latin *navigatio*, can be understood as meaning voyaging or journeying i.e. having elements of the experiential, not simply moving from

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Figure 3 A Plant Hostage Taker in various stages of opening.

one point to another. *Navigatio Sancti Brendani Abbatis* (The Voyage of Saint Brendan the Abbot), for example, is a collection of mediaeval stories and adventures of a travelling Irish monk [16]. However, as our knowledge of the world has become ever more detailed, the way we see navigation and how we navigate ourselves has become more rigid. Even 'getting lost' and experiencing 'serendipitous moments' are seen as formulaic, able to be created with data [12,18]. Technological elements such as wearables, crowdsourcing and geographic information systems (GIS) are predominantly used to confirm and reinforce this approach to navigation.

What if these technological elements could instead be used to challenge and explore these conventions? What if the resulting concepts could be used to study alternative experiences in navigation? To conduct this form of research, a design approach that is explorative, conceptual and that asks 'what if?' questions is required. Critical design, a facet of critical practice [24], is an area of the design discipline which aims to challenge a topic's orthodoxy (such as science, technology and society) and the designed objects within it by using design methods and artefacts. In this context, critical design has facilitated the creation of concepts that sit on the edge of what is accepted as a navigational tool and experience. This paper presents some of the results of this work-in-progress design stage in the form of three areas of interest, describing related concepts and detailing how one concept will be used in a research through design (RtD) PhD project. By describing these concepts, this paper seeks to disseminate the notions explored in this process in order to create debate around what experiences we expect from the artefacts that navigate us.

Pedestrian Navigation Research

Pedestrian navigation (much like vehicular, cyclist, etc.) is a rich and complex subject that spans many disciplines including psychology, design and anthropology. Many streams of research seek to expand upon what is possible from a technological and experiential basis. There is a predominant focus on the optimisation and refinement of systems that provide 'A to B' navigation through 'turn-by-turn' navigational instructions with screen-based mediums. Whilst the research is integral to the field, it is often critiqued by academics, proposing more explorative forms of navigation (e.g. [20,21,25,31]). However, their 'critical' work mainly remains within the confines of what is easily identifiable as navigation apps or wearables and does not use the mindsets and methods typically seen in critical design. This presents an opportunity for research to be conducted with these methods.

A Critical Design Exploration

Pedestrian navigation is a prime area for problematisation. To facilitate this, a design exploration [7] with a critical design mindset was conducted at the start of a PhD project and in parallel with the literature review. This design exploration sought to engage with navigation and its connected topics, including wearable technology, crowdsourcing, GIS/mapping, and data visualisation, to discover how these could be disrupted. A key consideration when creating the critical designs was the balance of provocative or unexpected uses of technology and defamiliarization. If the concepts were too unfamiliar it ran the risk of disengaging its intended audience, too familiar and they would accept it with little or no reflection [19]. Various designs were generated using methods such as ludic design [8] and post-optimal design and user-unfriendliness [6]. A

Figure 4 A Colour Collector in use. The environmental sensing wearable (seen here on the left wrist) will perpetually collect data whilst the engagement 'carriable' device (seen here in the right hand) can be used as desired. The combinations of sensor and other technologies are effectively limitless and could be configured to the data needed/required.

workbook [9] was used to store and communicate ideas through ambiguous and abstract images. These images were then interpreted into potential design concepts, some of which will be discussed below.

Three Areas of Interest

After reviewing and discussing the workbook and design work, several recurring 'themes' or 'areas' of interest were identified. For the purpose of this paper, only three areas, and promising related concepts, will be detailed below. These areas are 'Navigating and Experiencing the Intangible', 'Influencing Navigation' and 'A Data Hungry Home'.

Area 1 – Navigating and Experiencing the Intangible

We navigate through a multitude of phenomena daily (e.g. global warming, pollution, WIFI/mobile signals and litter) without being able to truly feel or quantify them. Projects have sought to engage and sense phenomena including radio waves [13] and Wi-Fi [4], permitting a new experience when moving through space. This has the potential to change traversal decisions based on the new information. Perhaps if we sense WiFi through vibration we might change where we choose to walk. The concepts in this area include 'Future Sea Walking' and 'Constricting Shirt'. Future Sea Walking (Figure 1) is a large wearable device that provides its wearer with the experience of walking in the sea of the future. It does so by using GPS, sea water (in a container), pipes, valves and computer models of future (raised) sea levels. Once the user steps into the future sea, the water will be released at the corresponding depth on the trousers. As the user walks further 'out to sea', so the higher valves release water. Constricting Shirt is designed to enhance the experience of moving through polluted space in a mildly

unpleasant way. This is done by slightly restraining its user's breathing in relation to the pollution in the vicinity. The wearable could use a particulate sensor and 'exaggerate' the impact of the pollutants on the respiratory system by tightening straps or inflating bands around the torso.

Area 2 – Influencing Navigation

Data, such as social media activity or location tagging, can be used to influence direction and path structure (e.g. [1,26,29,32]). However, approaches that engage with environmental or in-situ social phenomena are relatively lacking. In this vein, concepts such as 'Va au Vent' and 'Excuse me!' were created. Va au Vent (go with the wind), is a trackable object that can cover a large distance in the wind (Figure 2). The user would release (preferably on a windy day) and then locate it with a corresponding tracker and repeat as desired. Excuse me! plays on people's tendency to apologise for situations such as bumping into or being bumped into. This concept consists of a wearable that has some contextual understanding and alters an aspect of its user's navigational plan (path, destination, transport mode, etc.) when it picks up words such as 'excuse me', 'sorry' or 'pardon'. Both concepts put part of the navigational control in the hands of uncontrollable and unpredictable aspects of life.

Area 3 – A Data Hungry Home

In-home artefacts that collect and interact with data from indoors or outside and display it have been explored before. These devices [2,10,11,15] seek to contextualise the home in relation to its unique physical location in lieu of acquiring generic information that is widely available (such as national television) [11]. Taking inspiration from this interactive approach,

Figure 5 An example of a simple Periplus visualising collected data. The number of data 'dimensions' will depend on the design. This Periplus is capable of visualising four dimensions: colour (light colour), altitude (height), temperature (pulse speed) and humidity (luminosity).

concepts such as 'Plant Hostage Taker' and 'Colour Collector' were created. These concepts seek to explore novel ways of 'feeding' these 'hungry' devices by 'foraging' for data from the outside world. Plant Hostage Taker (Figure 3) presents a peculiar interaction where a house plant is taken hostage by a device that withholds sunlight. The user must 'navigate' themselves sufficiently for the device to open itself. Colour collector combines wearable technology with in-home data visualisation devices. The wearable (Figure 4) is composed of passive data collection (humidity, temperature, pressure, altitude, etc.) and an environment engagement device (in this case a colour sensor). It is designed to enhance its user's ability to interact with an environment, influencing how they choose to navigate through space [27]. The in-home device, called a Periplus (Figure 5) displays the data in an indirect manner that approaches data physicalisation, casual visualisation and ambient displays [14,30,33] in lieu of a screen. The Periplus was inspired by works that seek to visualise natural data through technological means (e.g. [5]). The user can navigate with the ability to engage with the outside in an alternate manner and is able to plan and execute their navigation with questions such as "what will my house look like when I get back?".

Catalysing Design Research Studies

The use of critical design has led to discursive and occasionally absurd concepts around the topic of pedestrian navigation. Developing an idea and generating models or prototypes for the purposes of demonstration and dissemination in a 'showroom' [22] would be a valid next step. However, the work is part of a RtD process that seeks to develop a selected concept. Of the concepts, Colour Collector represents a

navigational system that could benefit a user before, during and after navigation and posits a relationship between the house and the outside that is mediated by its occupants. It can also be used for opportunistic crowdsensing (a form of passive crowdsourcing) [23] and aligns well with gamification [17]. Gamified crowdsourcing incentives have yet to explore the use of physical outcomes, favouring instead virtual rewards [28]. As such the Colour Collector has been selected for use in a descriptive study [3]. The study will be conducted as a comparison of typical crowdsourcing systems with the Colour Collector in order to determine if it could be a valid incentive mechanism and/or attract individuals to crowdsourcing. It will also be interesting to consider how Colour Collector contributes to the spectrum of approaches in exploratory navigation and how users will build a relationship with the Periplus as it becomes "part of the furniture" [10:3456].

Conclusion

This paper has presented critical design concepts created from the generative stages of a work-in-progress design research project. None of the concepts propose a solution to a problem. They instead pose questions around assumptions of navigational experiences the artefacts we use to facilitate them. Can we navigate through future seas? Where will we end up if we let external phenomena guide us? How will people move through space if they are doing so to harvest data for an in-home product or to save a plant? Furthermore, a design has been selected to be part of a research study to potentially advance understanding around wearables, crowdsourcing and data interaction. This additionally demonstrates that critical practice is not only useful as a stand-alone process but as a generative tool in other design processes.

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References

- [1] Ricardo Andrade and Ava Fatah Gen. Schieck. 2015. Wayfinding to support urban exploration : Combining space syntax analysis with social media data for navigation system design. In *Proceedings of the 10th International Space Syntax Symposium, London*, 117:1-117:19.
- [2] Jacob Beaver, Andy Boucher, and Sarah Pennington. 2007. *The Curious Home*. Goldsmiths University of London. Retrieved from https://research.gold.ac.uk/4722/1/curioushome_spreads_3.pdf
- [3] Lucienne T.M. Blessing and Amaresh Chakrabarti. 2009. *DRM, a Design Research Methodology*. Springer London, London. DOI:<https://doi.org/10.1007/978-1-84882-587-1>
- [4] Bas van den Boogaard, Louise Ørsted Jensen, Stefan Engelbrecht Nielsen, Vibeke Thorhauge Stephensen, Karina Lindegaard Aae Jensen, and Markus Löchtefeld. 2018. SKIN - Embodied Navigation through WiFi Traffic using Vibro-Tactile Feedback. In *Proceedings of the Twelfth International Conference on Tangible, Embedded, and Embodied Interaction - TEI '18*, 598–604. DOI:<https://doi.org/10.1145/3173225.3173314>
- [5] David Bowen. 2011. tele-present wind. In *ACM SIGGRAPH 2011 Art Gallery on - SIGGRAPH '11*, 358–359. DOI:<https://doi.org/10.1145/2019342.2019354>
- [6] Anthony Dunne. 2006. *Hertzian Tales: Electronic Products, Aesthetic Experience, and Critical Design*. The MIT Press.
- [7] D Fallman. 2008. The Interaction Design Research Triangle of Design Practice, Design Studies, and Design Exploration. *Des. Issues* 24, 3 (2008), 4–18. DOI:<https://doi.org/10.1162/desi.2008.24.3.4>
- [8] B Gaver. 2002. Designing for Homo Ludens, Still. *I3 Mag.* 12 (2002), 2–6. Retrieved from <http://www.paulos.net/teaching/2011/AO/readings/homoludens.pdf>
- [9] William Gaver. 2011. Making Spaces: How Design Workbooks Work. In *Proceedings of the 2011 annual conference on Human factors in computing systems - CHI '11*, 1551–1560. DOI:<https://doi.org/10.1145/1978942.1979169>
- [10] William W. Gaver, John Bowers, Kirsten Boehner, Andy Boucher, David W.T. Cameron, Mark Hauenstein, Nadine Jarvis, and Sarah Pennington. 2013. Indoor Weather Stations: Investigating a Ludic Approach to Environmental HCI Through Batch Prototyping. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*, 3451–3460.

DOI:<https://doi.org/10.1145/2470654.2466474>

- [11] William Gaver, Alex Wilkie, Andy Boucher, Andy Law, Sarah Pennington, John Bowers, Jacob Beaver, Jan Humble, Tobie Kerridge, and Nicholas Villar. 2008. Threshold Devices: Looking Out From The Home. In *Proceeding of the twenty-sixth annual CHI conference on Human factors in computing systems - CHI '08*, 1429–1438. DOI:<https://doi.org/10.1145/1357054.1357278>
- [12] Xiaoyu Ge, Ameya Daphalapurkar, Manali Shimpi, Darpun Kohli, Konstantinos Pelechrinis, Panos K. Chrysanthis, and Demetrios Zeinalipour-Yazti. 2017. Data-Driven Serendipity Navigation in Urban Places. In *2017 IEEE 37th International Conference on Distributed Computing Systems (ICDCS)*, 2501–2504. DOI:<https://doi.org/10.1109/ICDCS.2017.286>
- [13] Erik Grönvall, Jonas Fritsch, and Anna Vallgård. 2016. FeltRadio: Sensing and Making Sense of Wireless Traffic. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems - DIS '16*, 829–840. DOI:<https://doi.org/10.1145/2901790.2901818>
- [14] Trevor Hogan, Eva Hornecker, Simon Stusak, Yvonne Jansen, Jason Alexander, Andrew Vande Moere, Uta Hinrichs, and Kieran Nolan. 2016. Tangible Data, explorations in data physicalization. In *Proceedings of the TEI '16: Tenth International Conference on Tangible, Embedded, and Embodied Interaction - TEI '16*, 753–756. DOI:<https://doi.org/10.1145/2839462.2854112>
- [15] Steven Houben, Connie Golsteijn, Sarah Gallacher, Rose Johnson, Saskia Bakker, Nicolai Marquardt, Licia Capra, and Yvonne Rogers. 2016. Physikit: Data Engagement Through Physical Ambient Visualizations in the Home. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems - CHI '16*, 1608–1619. DOI:<https://doi.org/10.1145/2858036.2858059>
- [16] Federico Italiano. 2012. Translating geographies: The Navigatio Sancti Brendani and its Venetian translation. *Transl. Stud.* 5, 1 (2012), 1–16. DOI:<https://doi.org/10.1080/14781700.2012.628809>
- [17] Aikaterini Katmada, Anna Satsiou, and Ioannis Kompatsiaris. 2016. Incentive Mechanisms for Crowdsourcing Platforms. In *Science*. 3–18. DOI:https://doi.org/10.1007/978-3-319-45982-0_1
- [18] Ben Kirman, Conor Linehan, and Shaun Lawson. 2012. Get Lost: Facilitating Serendipitous Exploration in Location-Sharing Services. In *Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts - CHI EA '12*, 2303–2308. DOI:<https://doi.org/10.1145/2212776.2223793>
- [19] Mette Gislev Kjærsgaard and Laurens Boer. 2014. The speculative and the mundane in practices of future-making—Exploring relations between design anthropology and critical design. "*Collaborative Form. Issues*", *Res. Netw. Des. Anthropol. Semin.* (2014).

- [20] A. Komninos, M. Astrantzi, A. Plessas, V. Stefanis, and J. Garofalakis. 2014. Non-verbal Audio and Tactile Mobile Navigation. In *2014 IEEE 10th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob)*, 314–321. DOI:<https://doi.org/10.1109/WiMOB.2014.6962188>
- [21] Andreas Komninos, Peter Barrie, Vassilios Stefanis, and Athanasios Plessas. 2012. Urban exploration using audio scents. In *Proceedings of the 14th international conference on Human-computer interaction with mobile devices and services - MobileHCI '12*, 349–358. DOI:<https://doi.org/10.1145/2371574.2371629>
- [22] Ilpo Koskinen, John Zimmerman, Thomas Binder, Johan Redstrom, and Stephan Wensveen. 2012. *Design Research Through Practice: From the Lab, Field, and Showroom* (1st ed.). Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.
- [23] Huadong Ma, Dong Zhao, and Peiyan Yuan. 2014. Opportunities in Mobile Crowd Sensing. *IEEE Commun. Mag.* 52, 8 (August 2014), 29–35. DOI:<https://doi.org/10.1109/MCOM.2014.6871666>
- [24] Matt Malpass. 2017. *Critical Design in Context: History, Theory, and Practices*. Bloomsbury Publishing.
- [25] David McGookin, Dimitra Gkatzia, and Helen Hastie. 2015. Exploratory Navigation for Runners Through Geographic Area Classification with Crowd-Sourced Data. In *Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services - MobileHCI '15*, 357–361. DOI:<https://doi.org/10.1145/2785830.2785879>
- [26] Silvia Mirri, Catia Prandi, Marco Roccetti, and Paola Salomoni. 2017. Walking under a Different Sky: Urban Colored Routes for Creative Engagement and Pleasure. *Int. J. Human-Computer Interact.* 33, 12 (December 2017), 1010–1021. DOI:<https://doi.org/10.1080/10447318.2017.1321218>
- [27] Beatrice Monastero, David McGookin, and Giuseppe Torre. 2016. Wandertroper: Supporting Aesthetic Engagement with Everyday Surroundings through Soundscape Augmentation. In *Proceedings of the 15th International Conference on Mobile and Ubiquitous Multimedia - MUM '16*, 129–140. DOI:<https://doi.org/10.1145/3012709.3012725>
- [28] Benedikt Morschheuser, Juho Hamari, Jonna Koivisto, and Alexander Maedche. 2017. Gamified crowdsourcing: Conceptualization, literature review, and future agenda. *Int. J. Hum. Comput. Stud.* 106, March 2016 (October 2017), 26–43. DOI:<https://doi.org/10.1016/j.ijhcs.2017.04.005>
- [29] Daniele Quercia, Rossano Schifanella, and Luca Maria Aiello. 2014. The Shortest Path to Happiness: Recommending Beautiful, Quiet, and Happy Routes in the City. In *Proceedings of the 25th ACM conference on Hypertext and social media - HT '14*, 116–125. DOI:<https://doi.org/10.1145/2631775.2631799>

- [30] Jonathan C. Roberts, Panagiotis D. Ritsos, Sriram Karthik Badam, Dominique Brodbeck, Jessie Kennedy, and Niklas Elmqvist. 2014. Visualization beyond the Desktop--the Next Big Thing. *IEEE Comput. Graph. Appl.* 34, 6 (November 2014), 26–34. DOI:<https://doi.org/10.1109/MCG.2014.82>
- [31] Simon Robinson, Matt Jones, Parisa Eslambolchilar, Roderick Murray-Smith, and Mads Lindborg. 2010. "I Did It My Way": Moving Away from the Tyranny of Turn-by-Turn Pedestrian Navigation. In *Proceedings of the 12th international conference on Human computer interaction with mobile devices and services - MobileHCI '10*, 341–344. DOI:<https://doi.org/10.1145/1851600.1851660>
- [32] Martin Traunmueller and Ava Fatah gen. Schieck. 2013. Introducing the Space Recommender System: How crowd-sourced voting data can enrich Urban Exploration in the digital Era. In *Proceedings of the 6th International Conference on Communities and Technologies - C&T '13*, 149–156. DOI:<https://doi.org/10.1145/2482991.2482995>
- [33] Craig Wisneski, Hiroshi Ishii, Andrew Dahley, Matt Gorbet, Scott Brave, Brygg Ullmer, and Paul Yarin. 1998. Cooperative Buildings: Integrating Information, Organization, and Architecture. *Coop. Build. Integr. Information, Organ. Archit.* 1370, (1998), pp 22–32. DOI:<https://doi.org/10.1007/3-540-69706-3>