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Digital touch experiences: Educating the designers

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Digital Touch Experiences: Educating the Designers

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ABSTRACT

This paper provides the emerging EDUCHI community with a case study example of innovation within HCI education, in the context of Industrial Design, at a moment in time where both disciplines are experiencing radical transformation in terms of their identity and scope. Here, we present a novel pedagogy for designing digital touch communications, developed by an interdisciplinary collaboration of HCI, design, and social science academics, and advanced through a coursework assignment for around eighty undergraduate design students undertaking a User Experience Design module. We discuss the role of low-fidelity experience prototyping of interactions beyond screens, and the need for new educational ‘tools’ to support the design of digital touch experiences. We conclude the paper with reflections on the collaboration so far and ongoing work.

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KEYWORDS

Digital touch; HCI; experience prototype; design pedagogy; user experience

INTRODUCTION

This paper presents an ongoing collaboration between an interdisciplinary team of academics in HCI, design, and the social sciences, that explores what happens pedagogically when we move ‘digital touch communication’ to the centre of a Human Centred Design (HCD) design process. The collaboration brings together researchers from the IN-TOUCH project at the UCL Knowledge Lab, University College London [1], and design educators from Loughborough Design School (LDS), Loughborough University, UK [2]. Advances in haptics, virtual reality and bio-sensor applications are re-shaping what can be touched as well as how it can be touched, shifting digital communication from ‘ways of seeing’ to ‘ways of feeling’ [3]. While technological frontiers continue to be pushed, there is scope for innovation regarding the kinds of meaningful communication experiences and activities that these technologies might enable or support. In this paper, we present the joint development of a digital touch design brief and experience prototyping workshops, which sought to open up this design space for Industrial Design (ID) students on an optional User-Experience Design module at LDS. We reflect on the ways in which the students’ existing pedagogical experience with design ‘materials’ at times led them to resist a more speculative and sensory emphasis on touch experience prototyping. We first contextualise the students’ wider learning experience in relation to recent changes in HCI, ID and HCD education, with a subsequent focus on experience prototyping as core to the LDS design pedagogy. We then outline the nature of our collaboration around digital touch and how the students’ processes and outcomes have led us to develop a toolkit that seeks to enable ID UXD students to bring more social and sensory-experiential sensitivities to their design process.

THE SHIFTING BACKDROP TO HCI EDUCATION

The boundaries of the disciplines of HCI and ID are undergoing rapid change. We have seen the expansion of HCI beyond its roots within human factors and cognitive psychology where efficiency and usability were paramount, through a time where the hedonic aspects of interaction were acknowledged but still bolted on [4], to today where design of experiences is now the ‘central and explicit’ object of design [5, 6]. This has coincided with similarly seismic shifts within ID practice from form making to consideration of form and function, through Interaction Design [7], User Experience Design (UXD) [8], and now Experience Design. Today’s Experience Designers draw on both disciplines to not only deliver products that are useful, usable, and satisfying to use [9], to operate within contexts where the boundaries between business and design are increasingly blurred [10], and to design systemically across multiple physical and digital touchpoints, taking the needs of diverse stakeholders into account. The materials available to designers from which to craft experiences have never been so diverse, particularly at the intersection between physical and digital materiality [11] where digital touch communications reside.

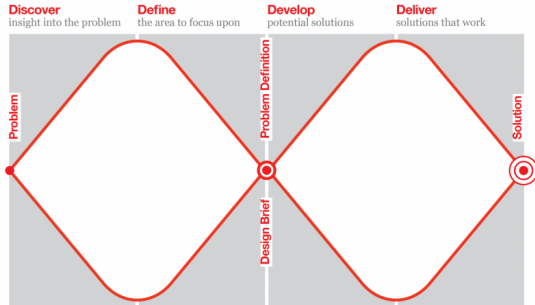


Figure 1. The Design Council ‘Double Diamond’ design process model [14].

A NOVEL PEDAGOGY FOR DESIGNING DIGITAL TOUCH COMMUNICATIONS

Background to UX Design Teaching at Loughborough Design School

LDS has a reputation for creating highly employable design graduates. ID education in the context of LDS has therefore a signature pedagogy as students are predominately motivated to learn for a particular profession, rather than to acquire domain knowledge [12]. Teaching of UXD to ID undergraduates began at LDS in 2007 with a similar emphasis on developing professional practice alongside the qualities needed for critical enquiry and independent learning. In the UK, HCI teaching at this time resided predominately within computer science or psychology departments. However, the paradigm shift of HCI towards experience [6] within industry and academia required a holistic, visual, problem-based way of thinking [13] that has much in common with ID practice. The new module therefore fitted well into the existing undergraduate curriculum, with many students going on to careers within the fast growing UXD industry.

UXD teaching at LDS from the outset used the UK Design Council ‘Double Diamond’ [14] as a framework to structure student design practice. The Double Diamond describes four key stages of design common to any design practice focused on innovation: Discover, Define, Develop, Deliver (see Fig. 1). This framework communicates the need for both divergent and convergent thinking within an HCD process. Equal emphasis is given to strategically identifying the ‘right thing’ to design and then, once a vision for the future product has been established, designing ‘the thing right’ [15] through iteration of product concepts in collaboration with representative users. This is consistent with the representation of design as overlapping processes of elaboration (divergent opportunity seeking) and reduction (convergent decision making).

The pedagogic approach to UXD teaching at LDS is broadly project based learning [16] where students address over extended periods of time complex tasks based on challenging questions or problems, culminating in iterated and refined design outcomes [17, 18]. Studio-based workshop activities are used at key stages of the project to enable ‘learning by doing’ and support cycles of experimentation and reflection [19, 20]. Throughout the project, the student designer is on a learning pathway towards the reconciliation of two states – from the problem towards the solution [21, 22]. By reflecting upon phenomena and their own understanding, reconciliations (concepts) are made and further reflected and iterated upon.

The Role of Experience Prototyping

A core development of the LDS pedagogy for UXD is the extensive use of low-fidelity experience prototyping [23] as the means to help student designers understand that user experiences are situated and constructed by the context of use [24] and that their design and meaning should be negotiated collaboratively by designers and users [25]. Theoretically, this approach is underpinned by the notion of embodied interaction [26] at the heart of 3rd paradigm HCI [6], particularly that the meaning and nature of interaction is grounded in the context within which the interaction takes place and that the embodied meaning of interactions unfold over time through use.

Pragmatically, if we accept this premise, then user experiences should be designed and evaluated within the context within which they will be used [27]. This requires the student designer to locate their generative and evaluative design activities out of the safety of the studio and collaborate with their target users 'in the wild'.

Storytelling is core to our pedagogy as the natural medium for constructing and conveying meaning in relation to the context of use [28]. Students use narrative form to make sense of the problem space with users; to create temporal based abstractions of reality, such as experience maps, to then generatively explore future experiences, using contextual scenarios. In doing so, they move from understanding 'the world as it is now' to exploring the 'world as it might become' [29]. These scenarios then form the basis for experience prototyping [23] with target users, using constructed props and prototypes to act out choreographed scenarios within a realistic context of use. Finally, students create video-based prototypes [30] of their final concepts to convey their visions for future experiences, with storytelling used explicitly to convey the 'hero's journey' and to manifest how their future product enhances the experience of their target user.

At the core of the LDS pedagogy, experience prototyping has evolved over the last 8 years to become a scaffolded learning process structured around 4 prompts: Question, Plan, Test, and Reflect (QPTR). At the start, students decide the question(s) that the experience prototype will be used to explore and resolve, prompted with a simple but specific targeting structure of trying to understand the 'user', the 'task', and the 'environment' (as simplified proxies for the 'motivation', 'action', and 'context' elements of an experience [24]). Acknowledging that a single prototype alone will not address all possible questions students are encouraged to create multiple 'low-fidelity experiments' to resolve a wide range of issues.

Students then create a plan to strategically decide how to address their question(s). A narrative structure guides the plan, with the students creating a compelling scenario that explains how a user will interact with the concept towards achieving a goal. Emotive sketched storyboards represent a context scenario [28] from the point of view of the target user and introduce a compelling 'call to action' (a narrative device here used to introduce the problem) before presenting the enhanced user experience. Pragmatically, roles and scenes are then discussed; types of data are considered; protocols established; ethical clearance obtained (if necessary); tools, props, and actors found; and a low fidelity prototype designed and produced.

In the Test phase, working in small groups and building on the theatrical method of investigative rehearsal [31], a more staged variation on the bodystorming [31] format is introduced, following a watch (act out the scene without interruption), understand (act out the scene again but call 'stop' to question aspects of the experience), and change and iterate structure (act out the scene again, but this time make changes to enhance aspects of the experience). The iterated version of the scenario is captured as rough video using the students' smartphones for future development and reflection.

The final stage is Reflect. Here students are engaging, and making explicit in their working, the concept of reflection-in-action [21] through cycles of experimentation and reflection [19, 20]. Students through this QPTR process are not only 'doing' but also making criteria-based

judgements towards the generation of insight and original knowledge [32]. The students are scaffolded through this process with a few simple prompts; ‘What did you learn about the user experience?’, ‘What did you learn about your process?’, ‘What will you do next?’.

This entire QPTR process is rehearsed through three three-hour studio-based workshops designed to guide the students through the experience prototyping process including: the construction of a meaningful narrative to convey their emerging experience design; encouragement towards experimentation to develop empathy with the user and their desired experience; and to provide a supportive resource for transition to independent learning and practice when they take their prototypes ‘out into the wild’ to evaluate with users in context.

Collaborating with the IN-TOUCH Project

Collaborating with the IN-TOUCH project at the boundaries of touch communication was of particular relevance to our ID students because of the emerging intersections of physical and digital materiality; the landscape in which their future professional careers are likely to be situated.

A project brief was devised collaboratively between LDS and the IN-TOUCH team and set as an assignment for around eighty second-year design students taking an optional module in UXD. Students were introduced to the notion of ‘digital touch’ through an introductory lecture by one of the IN-TOUCH academics. Digital touch was broadly defined as touch that is ‘digitally mediated’, and could involve a range of technological domains, including haptic devices, virtual touch applications, wearables and bio-sensing, within co-located and remote communication contexts. Through the lecture, students were encouraged to consider how its digital mediation and manifestations had the potential to change who, what, and how people (and machines) were going to be able to touch, how they might relate to each other, and how they may come to know and experience the world differently through touch. The students’ assignment brief was:

‘to develop an innovative, future-facing digital product or service that enhances communication through touch in one of three sectors: personal relationships, leisure, or health and wellbeing. To do this, [students] need to first research a specific communication context that would benefit from the introduction of touch technology, for face-to-face or remote interaction. [Students] then need to identify specific user needs and, in collaboration with target users, develop and refine a product or service that will respond to those needs that includes an element of digital touch.’

The students’ concept development and experience prototyping workshops were led by the LDS academics and supported, observed and recorded by the IN-TOUCH team. Loosely based on the design of previous IN-TOUCH rapid prototyping workshops [33], students were provided with a range of sensory materials and touch words to consider the sensoriality of the experiences they



Figure 2. Sensory materials used within the workshop.

were going to design. These included foam/polystyrene shapes, fabrics (fun fur, felt, silk, leather), rubber and silicone, pipe cleaners, feathers, plasticine, play-dough and air clay. ‘Body scaffolding’ materials, such as plain white socks, hats and face masks (developed as part of LDS’s experience prototyping process) were also provided to encourage experimentation of touch interfaces that go beyond the hand.

Towards a UXD Pedagogy for Designing with Digital Touch

In reflecting on the students’ workshop activities and subsequent concept development and storyboarding, our interdisciplinary team was struck by the relative conservatism with which the design students approached the brief. There was also a sense that the quest for technological solutions overrode considerations of the sensory-experiential and social aspects of the products and services they designed for. In the following, we focus in on one example of this, the students’ relationship with prototyping materials, before turning to pedagogical implications.

The range of sensory materials curated by the IN-TOUCH team had previously been used by the researchers as part of rapid prototyping workshops with interdisciplinary groups of postgraduate students in media and communications, HCI, sociology and linguistics [33]. In this context, rapid prototyping was more aligned with arts-based approaches and ‘speculative design’; sensory materials served as creative prompts to support the process of ideation around remote personal touch communication, rather than represent or test it. In the case of the LDS collaboration, the materials were thus introduced to the UXD students in the first of three workshops (see Fig. 2.), designed to support ideation of initial ‘sketchy’ concepts, before experience prototyping one or more of these concepts using the QPTR process. The premise was that at this divergent and highly creative stage of the UXD process (the ‘Develop’ stage of the Double Diamond) exposure to a wide variety of sensory materials would provoke the students to consider a broad range of touch-mediated communication experiences.

Whereas the materials had been embraced by participants in the previous, more speculative IN-TOUCH rapid prototyping workshops, the LDS UXD designers were unexpectedly ‘hands off’ and uninquisitive about the sensorial qualities of the materials. This was despite being encouraged to explore and play with them and consider their affordances as they collaboratively progressed their early concept ideas. Whilst they enthusiastically engaged in the experience design process, scaffolded with the QPTR framework and storytelling activities, their engagement with the sensory materials was predominately in the context of seeking out and constructing props to support acting out and exploration of concept ideas through storytelling. Their final concepts created in response to the brief similarly foregrounded application of digital touch technologies to deliver novel product features, with less reflection on the meaning and role of touch interactions within their imagined future experiences.

Despite the obvious and fundamental differences in design pedagogy across the two student cohorts, the markedly different levels of engagement with the sensory workshop materials was still surprising. This has led us to reflect more broadly on the role of prototyping materials within UXD and the implications for HCI teaching. This issue is particularly relevant at this moment in time



Figure 3. LDS students experience prototyping.

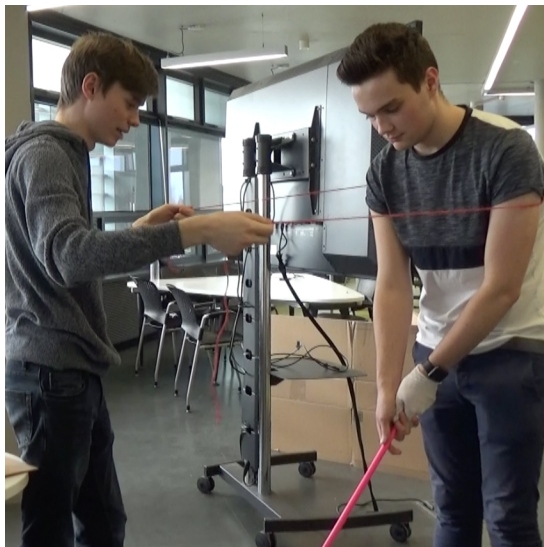


Figure 4. Exploring the role of digital touch within a golfing context.

where the signature pedagogy of Experience Design is evolving to meet market demands for graduates equipped to think systemically whilst designing at the intersection of digital and physical product design.

The ID students undertaking the optional UXD module had developed a relationship to physical materials (wood, metals, plastics etc.) in line with the traditional teaching of their discipline, where knowledge about material properties is developed somewhat separately from their application. In response to exploration of the problem space and generation of key insights and opportunities, concepts are typically sketched on paper, with rapid ideation encouraged to explore a variety of forms and functions before moving to low fidelity prototyping using blue foam or card, and then switching to CAD and increasingly 3D prototyping to further refine the design. Whereas consideration of the feel and properties of materials is encouraged, it is subservient to considerations of form and function within this iterative but ultimately reductionist process of moving from problem to solution. The LDS UXD pedagogy, although prioritizing design of experiences over products and more divergent exploration of problem and solution spaces, still leads to a similar relationship with materials and technologies, even though both are now predominately digital. Similar to the refinement of sketches and prototypes from low to high fidelity, within UXD, scenarios are used to mediate between problem and solution with increasingly detailed narratives and visualizations used to advance the fidelity of ideas towards the final solution. Students are initially encouraged to ideate concepts using sketchy contextual scenarios to narrate experiences at a behavioural level, deliberately omitting the details of user interfaces to keep the story focused on conveying the desired experience, undistracted or constrained by the detail of specific interactions.

At the concept ideation stage where we introduced the sensory materials, the students' pedagogic training therefore led them to prioritize rapid and divergent ideation of solutions as they acted out different contextual scenarios and questioned aspects of the experience through bodystorming with quickly constructed experience prototypes. Although the role of mediated touch communications was often central to these bodystorming experiments, the sensory nature of these interactions was downplayed as students focused on crafting the narrative of their proposed future experience. For example, Fig. 2. And Fig. 3. show students exploring the role of digital touch communications within an experience designed to help amateur golfers adopt the correct posture when practicing their swing.

Experiments with different forms of digital touch are apparent (a surgical glove is being used as a prop to signify a smart glove that senses the golfer's grip on the club; string and a balloon are being experimented with to explore how pressure on the back and/or shoulders could be used to direct the golfer into the correct posture as part of a shirt-based wearable). Although the nature of the sensations conveyed was discussed and negotiated amongst the student designers, this was 'broad brushed' typically at the level of 'inputs' and 'outputs' (e.g. the thumb of the glove could vibrate to alert you [the golfer] that the grip is correct and you can begin to swing). The sensation of touch or situated meaning of touch in this context was not articulated (e.g. a 'sharp touch' or 'angry touch'), which was contrary to that seen in the more speculative rapid

prototyping workshops where the nature of touch was foregrounded as its meaning was critically explored. This emergent UXD practice for designing with touch is in line with established UX pedagogy, particularly how contextual scenarios are used to explore behaviour and the narrative of experiences before the details of user interfaces and (typically screen based) interactions are resolved. How students go on to articulate the sensory interactions once the overall narrative of the experience has emerged has yet to be resolved, requiring further iteration and expansion of our methodology.

FINAL REFLECTIONS AND ONGOING WORK

So where has our collaboration so far left us? While we were disappointed that UXD students did not more fully embrace the opportunity to explore different sensory experiences and consider their meaning within future digital touch communications, fuller consideration of their current relationship to materials confirms that their engagement in the workshops reflects their knowledge of ID and UXD practice and is worthy of further development within these signature pedagogies. Experience prototyping in the studio supported by staff gave them the knowledge and confidence to take these prototyping techniques out into the wild to further resolve their designs with target users. Our student designers had little or no knowledge of technology prototyping tools, such as Arduino, which are often used to explore emergent touch technologies. However, the workshops confirmed the potential of using low fidelity prototyping to rapidly explore and prioritize considerations of experience, rather than the capabilities of technologies as part of an UXD process unfettered by the time taken to construct technology prototypes or knowledge of how to do so. Further collaboration will return to how to consider the sensory meaning of interactions (comparable to transiting from contextual scenarios to wireframing of screen-based user interfaces and semantic consideration of graphical design and branding).

Current student design practice within ID and UXD presents itself as rather linear, despite encouragements to iterate and reflect. We are currently developing an educational toolkit to enhance construction of meaning at all stages of Experience Design (broadly framed by the Double Diamond) and to encourage further situated reflection. Our premise is that seeding understanding of the nature and meaning of touch in an accessible and relevant form from the beginning of the HCD process will encourage students to more fully explore opportunities to design new ways of seeing and feeling rather than 'bolting on' considerations of touch once the problems to be solved have been defined. To this end, one of the elements of the toolkit is a 'Pre-Discover' phase which solely focuses on explorations of and sensitisations towards 'touch' as it manifests itself in a range of social and embodied contexts. The toolkit then reframes each DD design phase through an emphasis on touch, inviting students to explore different FILTERS (contextual questions), ACTIVITIES (structured explorations), and WILD CARDS (abstract provocations) that put touch and its possible mediation at the forefront of their thinking and making. Examples include such questions and suggestions as: 'when does it matter who touches?'; 'how do you touch to communicate?'; 'touch meaningfully'; 'touch out of context'; and, at the Develop stage, 'how visible is your touch? - hide it'; 'got a button? - take it away'; 'amplify the touch'; 'make it

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soft'. We are about to test the toolkit with a cohort of MA UXD students, in order to explore its use, refine it, and make it available for the wider design education community.

REFERENCES

- [1] IN-TOUCH. Digital Touch Communication. Retrieved February 19, 2019 from in-touch-digital.com.
- [2] Loughborough University. Design School. Retrieved February 19, 2019 from lboro.ac.uk/departments/design-school.
- [3] Sara Price, Kerstin Leder Mackley, Carey Jewitt, et al. 2018. Reshaping Touch Communication: An Interdisciplinary Research Agenda. Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems (CHI EA '18).
- [4] Mark Blythe and Andrew Monk. 2018. Funology 2: Critique, Ideation and Directions. In *Funology 2*. Springer, 3–13.
- [5] Marc Hassenzahl. 2018. A Personal Journey Through User Experience. *Journal of Usability Studies* 13, 4: 168–176.
- [6] Steve Harrison, Phoebe Sengers, and Deborah Tatar. 2011. Making epistemological trouble: Third-paradigm HCI as successor science. *Interacting with Computers*.
- [7] Bill Moggridge. 2007. *Designing Interactions*. The MIT Press.
- [8] Marc Hassenzahl. 2005. User Experience and Experience Design. *Encyclopaedia of Human-Computer Interaction*.
- [9] Nigel Bevan, Jim Carter, Jonathan Earchy, Thomas Geis, and Susan Harker. 2016. New ISO standards for usability, usability reports and usability measures. *Lecture Notes in Computer Science*.
- [10] Aleks Melinkova and Val Mitchell. 2018. Service design and experience design: what unites us is greater than what divides us. *Experience Design Meets Service Design – Method Clash or Marriage? CHI' 18*.
- [11] Sarah Pink, Ardevol Elisenda, and Debora Lanzani. 2016. Digital Materiality. In *Digital Materialities: Design and Anthropology*. 1.
- [12] Alison Shreeve. 2015. Signature Pedagogies in Design. In M. Tovey, ed., *Design Pedagogy*. Gower, 83–94.
- [13] Bill Buxton. 2007. *Sketching User Experiences: Getting the Design Right and the Right Design*. Morgan Kaufmann.
- [14] Design Council. 2005. Eleven lessons: managing design in eleven global brands. A Study of The Design Process. Retrieved February 14, 2019 from <https://www.designcouncil.org.uk/resources/report/11-lessons-managing-designglobal-%0Dbrands>.
- [15] Garrath T. Wilson and Val Mitchell. 2018. Crafting a Sustainable UX Vision Toolkit. Retrieved February 14, 2019 from DOI: 10.17028/rd.lboro.6188699.v1.
- [16] Robert M. Capraro, Mary Margaret Capraro, and James R. Morgan. 2013. *STEM project-based learning an integrated science, technology, engineering, and mathematics (STEM) approach*. The Netherlands: Sense Publishers.
- [17] John W Thomas. 2000. *A Review of Research on Project-Based Learning*. Learning.

- [18] Panayiotis Koutsabasis and Spyros Vosinakis. 2012. Rethinking HCI Education for Design: Problem-Based Learning and Virtual Worlds at an HCI Design Studio. *International Journal of Human-Computer Interaction* 28, 8: 485–499.
- [19] David A Kolb. 1984. *Experiential learning: experience as the source of learning and development*. Prentice Hall, New Jersey, USA.
- [20] Sven Nilson and John Dewey. 2006. How We Think. *The Philosophical Review* 44, 1: 75.
- [21] Barry Checkoway and Donald A. Schon. 2006. The Reflective Practitioner: How Professionals Think in Action. *Journal of Policy Analysis and Management* 4, 3: 476.
- [22] M Tovey. 2015. Designerly Thinking and Creativity. In M. Tovey, ed., *Design Pedagogy. Developments in Art and Design Education*. Gower, Farnham, England, 51–66.
- [23] Marion Buchenau and Jane Fulton Suri. 2000. Experience Prototyping. *Proceedings of the conference on Designing interactive systems processes practices methods and techniques DIS 00*, 424–433.
- [24] Anu Kankainen. 2003. UCPCD: User-Centered Product Concept Design. *Proceedings of the 2003 conference on Designing for user experiences (DUX'03)*.
- [25] Michael J Muller. 2003. Participatory design: the third space in HCI. In *Human-computer interaction: Development process*. 165–185.
- [26] Paul Dourish. 2004. *Where the action is: Foundations of embodied interaction*. MIT Press.
- [27] Phoebe Sengers, Kirsten Boehner, and Nicholas Knouf. 2009. Sustainable HCI meets third wave HCI: 4 themes. *CHI 2009 workshop*.
- [28] Jon Kolko. 2011. *Exposing the Magic of Design: A Practitioner's Guide to the Methods and Theory of Synthesis*. Oxford University Press.
- [29] Hugh Dubberly, Shelley Evenson, and Rick Robinson. 2008. The Analysis-Synthesis Bridge Model. *Interactions* 15, 2: 57.
- [30] Salu Yliris and Jacob Buur. 2007. *Designing with video: Focusing the user-centred design process*. Springer Science & Business Media.
- [31] Marc Stickdorn, Adam Lawrence, Markus Hormess, and Jakob Schneider. 2018. *This is Service Design Doing*. O'Reilly Media Inc.
- [32] David R Krathwohl. 2002. A Revision of Bloom's Taxonomy: An Overview. *Theory into Practice* 41, 4.
- [33] Carey Jewitt, Kerstin Leder Mackley, Douglas Atkinson, and Sara Price. 2019. Rapid Prototyping for Social Science Research. In L. Pauwels and D. Mannay, eds., *SAGE Handbook of Visual Research Methods*. Forthcoming.