Prototyping InContext: Exploring New Paradigms in User Experience Tools

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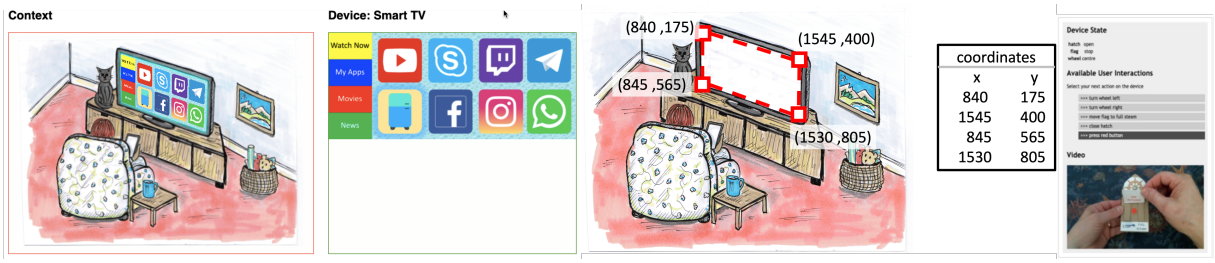

Figure 1: Tools that enable sketching (Scenario Viewer) and physical (PhysProto) prototypes with context.

ABSTRACT

The technologies we use in everyday contexts are designed and tested, using existing standards of usability. As technology advances standards are still based on planar displays and simple screen-based interactions. End-user digital devices need to consider *context* and physicality as additional influences on design. Additionally, accessibility and multi-modal interaction must be considered as we build technologies with interactions such as soundscapes to support user experience. When considering the tools we use to design existing interactions, we can evaluate new ways of working with software to support the development of the changing face of interactive devices. This paper presents two prototypes which explore the space of user experience design tools, first in the space of *contextual* cues when looking at multi device interaction, and second, in the space of physical prototyping. These prototypes are starting points for a wider discussion around the changing face of usability. We also discuss extending the scope of existing user experience design tools and rethinking what "user experience" means when the devices we own are becoming 'aware' of their surroundings, context, and have increasing agency.

CCS CONCEPTS

• **Human-centered computing → HCI design and evaluation methods**.

KEYWORDS

UX Design, UI Design, Prototyping, Design Tools, Storyboards, Wireframe, HCI Education

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1 INTRODUCTION

"Today we don't just use technology, we live with it." [21] – but how can we integrate the contextual cues of our lives with the tools that are used to design our digital interactions? Current user experience (UX) design tools *do* focus on the user, their journey, their story, but do not always enable designers to explore the context and real-world links that are so important to *living* with technology.

Since Campos and Nunes [6] 2007 UI survey, UX and interaction designers have evolved to using several desktop and cloud tools, demonstrated in the annual Taylor Palmer *Design Tools Survey* [24]. This lists the most common tools, from early sketching e.g. *Balsamiq* to high-fidelity screen-design tools e.g. *Figma*. However, these focus on wireframe and screen design, or early stage analysis and diagramming. By comparison professional tools for story-boarding and developing user-stories, do not figure highly on the lists, with most designers using free-hand techniques. Whilst the ubiquitous 'sticky' note offers a tactile, fast and cheap way to explore ideas.

Where tools do address aspects of the UX design process (e.g. Figma), they still have gaps, or do not integrate into a larger UX landscape, forcing designers to create work-arounds or use multiple tools. With the development of novel interfaces, there are also gaps in using tools to explore properties that go beyond 2D, planar environments – e.g. for tangible [13, 28] or shape-changing

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interfaces [2, 32], and for new technology encompasses entire surfaces or spaces – which is of growing interest in Human Computer Interaction [3, 16, 36].

Whilst there is no single solution in this fast-moving interface and software design landscape, we can explore new tools, by employing the processes we propose to augment. By identifying functionalities that are missing from current UX design tools, we can then provide insights using prototypical explorations which address what is missing.

Here, we explore two functional aspects that are not currently employed in design tools, using proof-of-concept prototypes aimed at integrating multiple usability concepts into novel design tools. One integrates scenarios and storyboards whilst the other integrates prototyping of physical devices. Additionally, we offer a preliminary analysis by people who use existing design tools in their everyday practice, research and education.

2 RELATED WORK

Whilst the term 'user experience' is often attributed to Don Norman in the 1990s [22], UX started before it was given a moniker. Usability processes up to and at the turn of the millennium, in line with changes in hardware capabilities during 'the pervasive computing age' [31]. Since 2000, the volume of research on UX is such that it is impossible to document its history here. However, as an example, Hassenzahl and Tractinsky's research agenda for UX [12] in 2006 hosted papers which looked at then-current technology and possibles experience, e.g. telepresence [33], location sensitive devices [5], emotions [4], and evaluations [25], but had not yet made the leap into multi-modal, intelligent, or tangible processes. We are now on the cusp of another leap in technological capabilities, which will in turn create renewed interest in the development and adoption of new guidelines, tools and ongoing research.

For the purposes of this study, we define novel interfaces based upon dominant paradigms in HCI research, namely, shape-changing and tangible interfaces, multi-modal interfaces (employing relatively unexplored senses such as smell and taste [17, 20, 23, 35], and/or existing modal interactions in combination), devices at scale (such as tabletop, wall, room and even entire environments), devices that are ephemeral, e.g. bubble or mist-based [34], biological [37], VR and AR, and those employing novel methods of interaction such as peripheral gaze, voice and gestural activation, and so forth. This paper's aim is not to build a tool that will support these advancements, but to take the first step towards developing the importance of *context* and *physicality*, both of which are relatable to the design space of novel interfaces.

Digital usability tools are big business, with designers free to adapt and change according to their processes. The *Design Tools Survey* [24] is the most comprehensive review of the existing UX tools, and provides a helpful resource for designers looking for new software and to identify gaps in the provision of digital UX support.

Of the 3359 respondents to the 2021 survey, 278 stated that they design *physical* experiences, despite the lack of current tools to support for this kind of interface. The remainder stated that they designed applications, digital, or printed media: all 2*D*, and largely screen based. No explicit mention is made of sound design, or other multi-modal interactions, but it is possible that the survey did not include those working with non-visual media, or that those individuals make use of visual tools at some stages of the design process. For example, *Adobe XD* is adding sound functionality to its application prototyping, although it is not currently a focus.

The nature of usability and User Experience design is fluid, although standards exist [1]. Practitioners work in ways which best support their project and work environment, Agile and incremental design, across many different offerings, and areas, means current digital tools and their use-cases are 'mix-and-match' as an approach. Many designers still use paper-prototyping, eschewing digital tools for some aspects of the design process altogether, this is reflected by the survey respondents who state that they do not use software for certain tasks. This could be a preference for tangible, hands-on work, but it is possible that there are gaps in the market for tools to support these processes. Several popular tools have been based directly on physical processes, such as *Mural* and *Miro*, which emulate whiteboard writing and drawing, and using sticky notes. These digital experiences benefit from a range of additional interactive media (icon libraries, video, digital content) but they lack the tactile response of their inspiration.

McCarthy and Wright's framework [21], states 'experience' is of utmost importance for the user, with the four threads outlining the *Compositional*, the *Sensual*, the *Emotional*, and the *Spatio-Temporal*. Whereas most of the threads are accounted for in current practices, we believe that the compositional aspect, of the 'coherent whole', is unaccounted for by current software. There is no 'one' software which can support a full and rich composition. Bringing together both the context and form could be an important step in developing new usability tools.

Underpinning commercial UX design software, researchers are working on new processes and tools, aimed at both current and future iterations of technology. However, the most of these tools are published in academic literature before disappearing into the black hole of UX possibilities. E.g. Jhala et al. [15] create an intelligent storyboarding tool that enables users to create 3*D* graphical environments. The tool was adapted but remains accessible only as a part of the work.

A tool that enables prototyping of all modalities within their individual context is required. However, there is a lack of multimodal prototyping work, and research that claims to be multi-modal often adds singular modalities onto the edge of screen based tools [7, 29, 30]. There are projects such as *SUEDE* [18] and *TalkOver*[8] that use Wizard of Oz to capture test data which participants can then analyse, however these tools are unavailable to everyday designers.

The necessity for physicality within prototyping tools was already prevalent and increased over the COVID pandemic [11]. Prototyping tools such as the *Telling Board* enable interaction with a physical prototype to drive creative thinking and in this case encourage children to practice verbal communication [27]. The most effective prototypes take into consideration the active and passive physicality in equal proportions [11], but within existing prototyping tools we are unable to consider both of these aspects. It is imperative for a designer to think of both the visual and functional needs as well as the contextual needs of the prototype, for example, prototyping flexible electrochromic displays on cups [19] requires the user consider the changes in visual design, and the effect of the casing and environment on the electrochromic ink functionality.

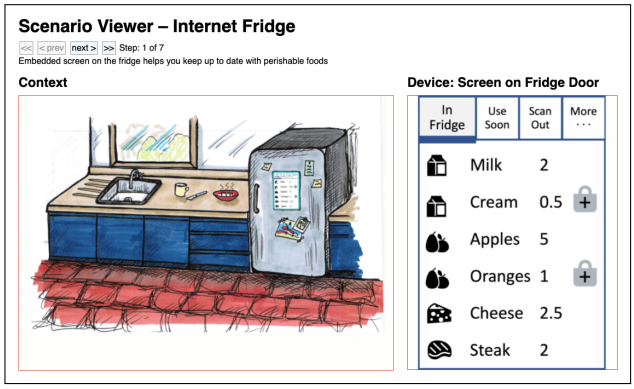

Figure 2: Scenario Viewer showing the use of a smart screen fridge door within the context of the user's kitchen.

3 INCONTEXTUAL PROTOTYPES

When UK students are given a design brief, they quickly produce sketches/digital views of screens and talk through the way clicking a button or selecting an option moves between the screens. If given a design brief for a physical device, they might sketch the device in different states. However, it is usually harder to get them to think about the wider context: who is using the device, where are they, what are they doing? This is a common issue for computing students and those on design courses. It is easier to look at the thing being designed than outwards to its context of use. As educators, we can encourage students to draw sketches of where the device is to be used, or even act out the use of physical devices. Ideally we might hope to point students at professional design tools, which include aspects of context as well as screen design. However, while there are some tools supporting storyboards and user journeys, the majority of tools are screen-focused [24]. This leads to our new designers not having the scaffolding to guide them towards best-practice design and experienced designers not receiving the required support, therefore resorting to generic tools such as Miro or paper sketches.

In the workshops we demonstrated two prototypes that enabled users to design whilst considering context for two different design styles: sketching and physical prototypes.

3.1 Scenario Viewer

The *Scenario Viewer* is an early version of a tool for designing prototypes. We hoped that it can act as a technology probe [14], and was used for this in our design futures workshops. This envisionment demonstrates how early device mock-ups and wireframes should be viewed in the context of physical environments and human activities. It allows a series of context and screen sketches to be played side-by-side following a scenario. The scenario may include several devices (fridge door display, fridge app on a smartphone, smart TV fridge app) and several physical contexts. A single context could also have more than one device within a contextual frame. These frames can be sketching, wireframes or other medium to high fidelity screen prototypes. To further bind screens to context, the area of the screen that corresponds to the device is defined so the prototyping tool can embed a scaled and transformed view of the screen within the context sketch. For example, Fig 2 shows the smart screen of a fridge with a display of the items within that it. It also shows the context of the fridge screen. In this scenario, a kitchen. Work on the Scenario Viewer is continuing as part of the overall InContext project looking at next-generation UX design tools.

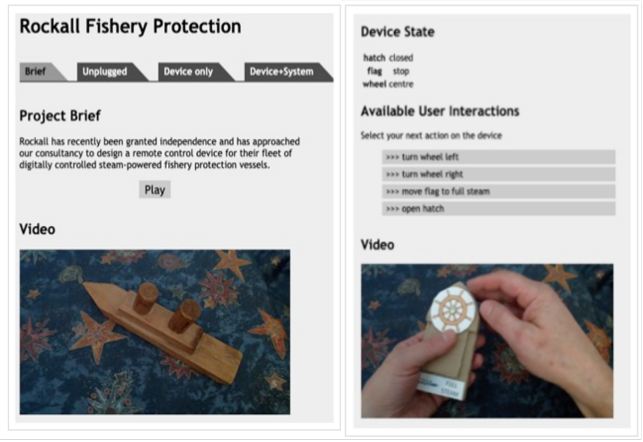

Figure 3: Overview page for *PhysProto*. A model boat represents the remote-controlled fishery protection ship. The user is shown a physical boat-shaped prototype of a control device with a closed hatch. The user selects to open the hatch.

3.2 Physical Design Prototype (PhysProto)

PhysProto is an early design software for enabling users to interact with physical prototypes virtually. This shows how early physical prototypes can be demonstrated to participants within context. *PhysProto* was created in response to the lack of online physical prototyping tools which incorporate videos in context [26]. *PhysProto* takes small video snippets of individual actions on a physical device, and allows others to interact with the device virtually. The system combines short video clips of the physical prototype being manipulated with a state machine representing the various settings of the device, a *physigram* [9]. The viewer can select actions, such as turning the small wheel on the device, or opening the flap and the relevant video sequence is played. The actions of the device can also be linked to videos showing the effect of the device on the environment. The example is based on a fictitious brief where the newly independent state of Rockall wants to deploy remote-controlled fishery-protection ships. PhysProto shows a prototype controller for the remote-controlled ship (represented in the videos by toy ship).

The first two tabs in the prototype, 'Brief' and 'Unplugged', provide videos of the project brief and a demonstration of the control device capabilities, respectively. The 'Device only' tab is where users can trial controlling the device themselves, (Fig 3). The tool can also enforce the prototypes physical constraints, relating to individual controls or physical elements of the device and the prototypes current state (e.g. if you have turned the wheel fully

to the right, you can only move it back to the centre). PhysProto includes state variables (rudder direction, engine state) and has a model of how actions and changes on the device translate into effects on the controlled system. When the user performs an action, the device action video is played again, but a new short video of the effect on the ship's state is also shown.

4 WORKSHOPS & PROTOTYPE FEEDBACK

UX design tools are used extensively across industry and in research and higher education. To scope the design tool preferences of these groups, we held a series of four interactive workshops with industry, academic experts and students within university education with familiarity with UX design tools (N=24). These workshops prioritised the analysis of existing UX design tools, the identification of pain points and their possible solutions. Prior to workshops participants completed a short version of the UX Tools survey.

Each workshop was hosted via Zoom, recorded, and consisted of two stages over a two hour period – this paper concerns itself with part two of the workshops, but for clarity we will describe the full session protocol. For each incidence of the workshop, a dedicated Miro board was set up to enable participants to make notes, sketch and interact with each other. In stage 1, participants began by listing their preferred UX design tools for each stage of their design process, before moving on to listing 'pain points' and issues they experienced with their preferred tools and methods. These pain points were presented to the group, before each participant was then tasked with ideating possible solutions or adaptations to either their own pain points, or those of another participant. The ideation session was then presented and discussed. Part one was primarily about expanding requirements for UX design tools, and establishing a wider view of the state-of-the-art and any issues from expert users.

At the beginning of the second part of each workshop, participants were presented with a demonstration of the two prototype design tools. After demonstration, feedback was gathered as to the efficacy and use of these tools in context of existing software and the first stage investigation. Participants were then asked to complete a second ideation and feedback session based upon potential innovations driven by the opportunities presented by the tools. The two-stage approach allowed participants to present unbiased opinions of current tools, then explore and identify potential solutions or amendments presented by the novel tool prototypes in relation to their initial ideas. The prototype presentation within the workshop structure served as an evaluation tool – helping to draw out details from earlier ideas and give them a platform.

Our tools tapped into several of the major themes discussed in the first stage, and a preliminary analysis of the data highlights several points indicating the potential of the tools prior to their presentation. For example, many participants said the lack of compatibility between existing tools meant that they had to keep switching between techniques and software to achieve what *Scenario Viewer* was able to achieve – namely integrating the storyboard and user journey with the wireframe or more detailed prototype. A recurring point suggested that we are moving beyond 2D planar screen-based devices, and that design tools should support multi-modal and multi-scale interactions – such as the ideas presented in the *PhysProto*, which enables sound, physicality, and video together, and can be linked up to tangible devices for testing. A major finding from the workshops suggests there is a gap in the market for an integrated, seamless tool suite that support these links.

With *PhysProto* more direct feedback focused on the need for 'physical twins' to complement the concept of digital twins [10], and that this prototype offered a route into achieving this. Tangible prototyping and testing has been held up due to the ongoing pandemic, and participants feedback that this kind of approach could circumvent such hold-ups and also maintain the 'playful' nature of tangible prototypes.

The major takeaways from the workshops with regards to the presented prototypes can be summarised as follows: 1) Integration of multiple UX designs and stages within a single tool or modular suite would enable seamless transitions, editing and support cross-disciplinary and stakeholder communication; and, 2) UX design tools of the future should consider multi-modal, physical interactions as standard, either as a bespoke tool, or as a functionality within a tool suite. Further analysis and investigation of the initial workshop stages (part 1) are planned, with the intention to create a series of guidelines for the future development of UX tools, and also develop new example prototypes to elucidate and inspire this area of research. Both the prototypes presented here have enabled the first steps in developing new experiences, by offering an opportunity for exploration, interrogation and needs-finding.

5 DISCUSSION

We have outlined the need to adapt our tools to the design trajectories we are experiencing. In essence, the design tools we need to bridge the gap between industry and academic research design need to address a variety of modal interactions that go beyond the screen to ensure our design education is fit for purpose. PhysProto is an example of a tool concept to address an aspect of this. However, there are opportunities for extending this and creating alternative tools to address issues such as audio-rich interfaces.

Finally, there is no road-map for companies to follow to enable them to integrate different stages of the design process, nor is there a tool that enables cross-functional working of these stages in a collaborative way. UX professionals and UI development teams use a wide variety of tools, often from different vendors, especially when interacting with stakeholders who may not have as detailed technical knowledge. While some vendors create easy workflows between their applications, cross-vendor integration is usually limited to import/export. There is an urgent need for methods and cross-vendor standards to allow more fluid integration and management.

The two prototype tools presented here have so far been predominantly used as technology probes to inspire practitioners and researchers to consider next generation tools for UX design. As a team we are planning to continue this engagement through workshops and one-to-one interviews. In addition, the prototypes are first steps towards usable applications for HCI education or UX practice. We wish to develop these further, to bring them to a stage where they can be released as experimental tools for others to use so that their utility can be tested in practice. Having such a suite of experimental tools will in addition create a platform for research on cross-tool integration.

For more about InContext see: https://hcibook.net/incontext/

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