Design from the Everyday: Continuously evolving, embedded exploratory prototypes

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ABSTRACT
One of the major challenges in the design of social technologies is the evaluation of their qualities of use and how they are appropriated over time. While the field of HCI abounds in short-term exploratory design and studies of use, relatively little attention has focused on the continuous development of prototypes longitudinally and studies of their emergent use. We ground the exploration and analysis of use in the everyday world, embracing contingency and open-ended use, through the use of a continuously-available exploratory prototype. Through examining use longitudinally, clearer insight can be gained of realistic, non-novelty usage and appropriation into everyday use.

This paper sketches out a framework for design that puts a premium on immediate use and evolving the design in response to use and user feedback. While such design practices with continuously developing systems are common in the design of social technologies, they are little documented. We describe our approach and reflect upon its key characteristics, based on our experiences from two case studies. We also present five major patterns of long-term usage which we found useful for design.

Keywords
Social practices, appropriation, design, field study, iterative design, messaging, situated displays, text messaging, social systems.

ACM Classification Keywords
H5.2. Information interfaces and presentation: Prototyping

INTRODUCTION
Across contemporary computing disciplines there is an abundance of systems with a social dimension, either designed for the primary purpose of being used between people (such as Facebook), or those designed with respect to the wider social context, such as control room interfaces. In this paper we focus on the former: technologies whose usefulness is largely conditional on its use by multiple people in some kind of broadly cooperative fashion.

The trend of social technologies is enabled by the increasingly widespread availability of sophisticated, connected infrastructure and systems, for example smartphones, wired and wireless broadband internet, internet-enabled digital picture frames, streaming radio and various XML-based formats and protocols. Systems often have very little sophistication on the client side, with user experience and functionality determined server-side, or increasingly, 'in the cloud', and thus highly amenable to rapid change.

Moreover, these technologies have for many people become commonplace, mundane and thoroughly integrated into everyday life. Along with gains in technology, the HCI field's perspective on the largely inescapable social dimension of technology has gained in sophistication. It is now accepted that technology is not used in a vacuum and that to understand use and improve design, we must pay heed to the multifaceted environment in which it is used.

If we accept Lave's [23] and Suchman's [35] notion that action is intertwined and inseparable from the social environment then it follows that to understand action, we should favour genuine use in everyday settings rather than formal, contrived laboratory studies [5, 7]. Ethnographic fieldwork has been widely used for developing insights about people and cultures that can inform the design of technology. An ethnomethodological analytic stance that examines the ways in which people make sense of their world, display this understanding to others and produce the mutually shared social order in which they live could be particularly instructive for understanding the social use of new technologies. Repurposed as it is from social science, ethnography however sits awkwardly with the design of new technologies, as its primary remit is to investigate and describe a culture, rather than proffer suggestions of a possible future. Moreover, trends in technology such as ubiquitous and mobile computing hamper observational fieldwork's effectiveness as significant elements of interaction are outside of the purview of the ethnographer [11]. While useful, ethnography is not a complete approach to investigating use and needs to form part of a wider exploratory, iterative research programme.

Use is not an inherent property of a system or artefact, rather something that is developed and maintained over

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time by a number of actors, as the artefact is appropriated [13]. As such, time is an important and in some cases, critical, component of study. “Snapshots of use” [7] of how people use a system in its first week of introduction are illuminating however they are unlikely to be indicative of longer-term everyday use nor how it is appropriated into routine. Nor are short term studies likely to reveal how prototypes nestle into the assemblage of devices that people already use, the role that they might play as conscription devices to enlist others, the role they might play as boundary objects to communicate between parties [18] or how they might act as magnets for user-generated content, which requires commitment and interest from its potential providers. In summary, we need an approach to designing social technologies that can both support and evaluate emergent use over time.

The approach we describe in this paper is centred on the design and deployment of a continuously evolving exploratory prototype that is embedded within a social setting and evaluated longitudinally. Our approach leads with design by identifying a social need or opportunity and using design intervention and the ensuing community response over time to explore that opportunity. Design then is done as a fundamental research activity, rather than as a means to an end within a product development lifecycle.

The design is made concrete and functional, deployed in a real-world setting and continuously iterated while in use, in response to observations about use and non-use, contextual fit and community feedback. The role of ethnography is to explicate the accountable structures of action and to explore the topics identified through the design intervention, after Crabtree [10]. In this way concepts and visions of the future are taken seriously by exploring them concretely though design and ethnomethodology, helping to flesh out abstract design concepts.

The continuously evolving exploratory prototype is conceived within a design approach that we call reflective, agile, iterative design (RAID). We acknowledge there is nothing intrinsically novel in the framework we describe and approaches similar to ours are often glimpsed in HCI and CSCW-related work. Our contribution in this paper is to place the methodological discussion at the fore: to describe our continuously iterative approach and reflect on its application and key challenges with two case studies of social technologies.

CASE STUDIES: RHUB AND NNUB

The framework has been developed from our experiences of designing, deploying and studying the use of ‘Rhub’, a tool for mobile social communication [19], and later refined with a study of ‘Nnub’, a community digital noticeboard [32]. We conducted informal observational fieldwork, interviews, workshops and quantitative analysis of usage to monitor how the systems were being appropriated into their respective environments and to gain a sense of how the systems were perceived.

Rhub allows groups of friends to communicate, coordinate and share in a cohesive manner using simple technologies such as instant messaging, text messaging and the web. It was developed as a design response to the problems of mobile group communication observed in club that consisted of an evolving and changing membership and continued need to organise ad hoc socialising. Rhub was in use for over 1.5 years by over 170 participants who used the system on an everyday basis for everyday socialising needs. Mostly, this was to coordinate ad-hoc social events and activities by using Rhub to communicate within the group across text messaging, the web, email and instant messaging. This type of activity is difficult to accomplish with usual group text messages as messages must be manually relayed around the group as coordination evolves. We seeded the social network with our own friends and colleagues, who in turn invited further people to the network.

Figure 1. A Rhub workshop session.

Nnub is a suburban community digital noticeboard system that can be accessed through a touchscreen display installed in a local convenience store or via the web, email or Twitter. Nnub was conceived to support timely communication between residents in suburban communities, bridging between different types of topics such as garage sale announcements, community meeting announcements, opinions about community development, recycling clothes and sharing gardening tips. Nnub aimed to give residents a place to which anyone could post with search and archive capabilities and only light moderation. It was developed in response to the difficulty that community members articulated about reaching out to others in their local community. Traditional methods of leafleting and shop noticeboards were either time consuming or ad hoc in their ability to reach people. Nnub has been in use in one suburb for two years, a university community for six months, and is now being deployed at other trial sites.

In both case studies there was a clear imperative to attract and maintain participants in order to broaden representativeness. Both systems were bound by ‘network effects’, whereby the reasons for using the system were largely dependent on whether people in your social group

or community were already using it. Moreover, we hoped that higher-order uses would emerge once there was a critical mass of active participants. In emphasising exploration of everyday use by a community of people, we forsook – to a certain extent – pushing technological boundaries and instead leveraged commonplace technologies such as text messaging and the web.

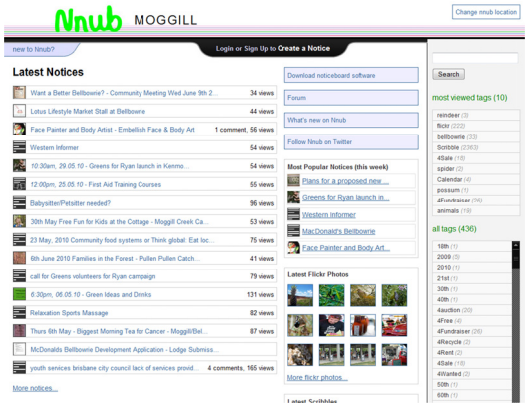

Figure 2. Nnub web interface.

REFLECTIVE AGILE ITERATIVE DESIGN

Our key goal in the Reflective Agile Iterative Design (RAID) framework is to support developing a rich, grounded understanding of a problem or opportunity in a particular use context in an open, exploratory manner. RAID consists of three stages: design, use and reflection, which revolve around a continuously usable exploratory prototype (Figures 4 and 4). The form and functionality of the prototype is shaped over time in response to how it is used and appropriated, as well as through the designer's own 'probing' activities, small changes which are deployed to see how participants react.

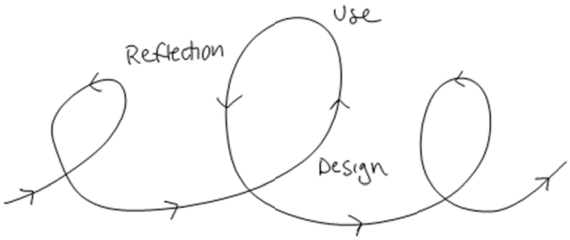

Figure 3. As in Action Research, each iteration takes us to a new site of further design and research.

After an initial deployment of the rough prototype, use is observed and actively probed. Analysis and reflection on data takes place, with the designer/researcher considering appropriate design and methodological responses which are then executed - usually by altering the prototype - and the process continues. During the RAID process, which can take place at multiple levels of granularity and localisation with a single system, a *change log* is used to monitor the evolving design and a *question log* to inform data analysis and exploration. A *reflective journal* is used to record reflections on observed use, the changing context in which it is used and results of data analysis. More remarks on these artefacts appear in the discussion section.

Throughout, the emphasis is to deploy a useful prototype as quickly as possible to enable immediate use and once deployed, to make it as available as possible to build trust with participants. People participate by using, mis-using or not using the prototype, and the use of the design is the metric by which it is judged. Iteration of features can and should be swift to speed exploration of the problem space.

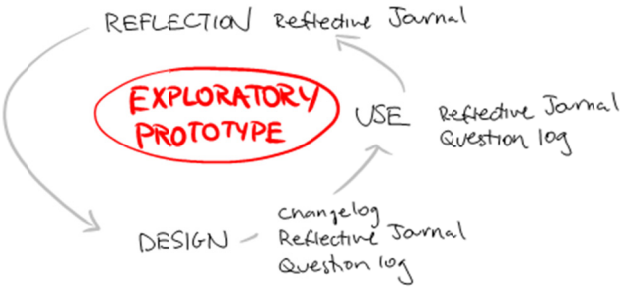

Figure 4. Design, use and reflection take place around a continuously usable exploratory prototype. This is facilitated by the reflective journal, change log and question log**.**

1. Design

To begin the RAID process an initial exploratory prototype is required. Functionality is loosely sketched and supports a high level of open-ended use, yet still offers utility. We established a motto, or one-line manifesto for the system in order to keep the evolving design true to a unified spirit. It can enforce design discipline, simplicity and focus over multitudinous features.

The initial design requirements might draw upon preliminary design workshops, field studies, interviews and so on. In cases that we have undertaken the core purpose arises from a perceived social need that can be investigated through design intervention. Once deployed, agile development methodologies are useful to enact change quickly and reliably [4]. Deciding which changes to make to the prototype involves a delicate balancing of available design and development resources, research goals and participants' requests.

Distributing the altered prototype depends on the underlying system architecture. For screen-oriented systems, it may be that the interface is rendered locally based on remotely-issued instructions, such as HTML. In this case, simply changing the server-side interface generation will in effect update all client endpoints. Where more sophistication on the client side is desired, the prototype might self-update by downloading new versions of its code from a remote source, as demonstrated by the Nabaztag robotic 'rabbit'[1].

During development, a *change log* is maintained in order to keep a record of when bugs were fixed or features added, removed or modified. In our case, we leveraged the in-built

[1] http://nabaztag.com

change log feature of the version control system to record changes, simplifying the process considerably.

2. Use

Once the initial prototype is deployed and participants begin using, misusing or under-using the system, there is opportunity to begin data collection and analysis. Quantitative data can come relatively 'free' by logging system usage, with qualitative methods useful for explaining or further exploring discovered phenomena. Largely, evaluation in RAID takes place through use and design. We draw from ethnomethodology in our emphasis on situated use and willingness to be led by discovery. Observational fieldwork, often employed in ethnomethodologically-oriented studies, was used in the investigation of the prototypes.

Prototypes can and should be instrumented to collect as much data as possible given privacy and ethical concerns. Rather than simply logging successful interaction transactions, it can be useful to also capture attempted, failed or aborted transactions. Distributed logging scenarios present some logistical difficulties with the storage and transport of data [9].

A *question log* is maintained for open questions regarding the use of the system. These arise throughout the RAID process, and the log helps the team to prioritise and focus data analysis efforts. The log can support a kind of unit testing or validation when designing alterations or new features. Questions are added at design time to be later resolved when the changes are in actual use.

3. Reflection

The reflection stage is concerned with digesting available information from the design and use stages to produce considered design and methodological responses. It is through this reflective design step whereby the researcher opens new areas of inquiry. Schön describes this as part of a "move-testing" experiment, in which theory, developed through reflection can be confirmed or negated in the course of action [33]. Understanding what to respond to and how is critical for the next iteration to progress instead of regress.

A continual *reflective journal* is kept to record observations, thoughts and ideas during the design process, as well as data extracts and notes on the prevailing social environment. The journal, together with its associated artefacts, permit a dialogue to take place between the design and the designer as well as the research programme itself. Ephemeral observations gained as a result of being an embedded researcher can be recorded, for example the 'back story' behind events, or ad-hoc remarks made by participants. Along with notes, we included screenshots, photographs, extracts of interviews and user-created artefacts, charts of usage data and so on into entries made on a weekly basis. The journal was a working document, rough and incomplete, yet served as a valuable aid not only for on-going reflection and design, but for when exhaustive data analysis was carried out much later.

In deploying changes, we change the world to some degree: we change the design, change ourselves and change others' behaviour. Unexpected events and phenomena abound. The reflection stage is where pause is taken to consider these outcomes with respect to the research and design goals and analysed usage, before devising responses. The design motto can be useful to guide and moderate response, as not all observations can be reasonably acted upon. Responses can also be a reflection on the research programme: perhaps new methods or tools need to be used or existing techniques refined.

The emergent experience of the system - for example how Rhub transcended being a discrete prototype with discrete technical features and became an everyday, natural tool for coordination – can easily escape analysis. The reflection stage is an excellent opportunity, with assembled observations of usage, analysis and notes to explore notions of higher-order experience.

RELATED WORK

Iterative design and development has long been accepted as an important means to mitigate some of the inherent risk of design: we never fully know what we are designing until we begin. Even under tight time constraints [14] or limited cycles [30], iterative design is considered beneficial. RAID has a similar workflow to various iterative development methodologies, such as Rapid Evolutionary Development [1] but differs in that RAID has a greater emphasis on the reflective process and is focused on exploring emerging use and appropriation rather than striving for software quality and correctness.

There are many cases in the literature where a 'real-world' prototype has been used. Motivations vary, but commonly include: testing and capturing usage in realistic scenarios; deploying in non-public contexts such as the home; probing to see how the prototype is appropriated; and how and what kinds of use develop [25, 34, 37]. Few, however, deploy prototypes for long continuous periods, thus restricting opportunity for appropriation or non-novelty usage. Moreover, there is little articulation of the methodology used or reflection of its implications. Some notable systems that were deployed for a long period and used by a number of people, such as the SPAM and Hermes systems [9] only had limited iterative development during the deployment.

Crabtree's treatment [10] of "technomethodology" [6] argues the case for real-world deployments and provides an outline for how it might proceed in practice. Technomethodology is positioned as an approach for bridging ethnomethodology and system design. Prototypes are deployed in the world as breaching experiments and use studied with an ethnomethodological perspective. New design solutions are devised based on findings and then redeployed, forming an iterative cycle. RAID however emphasises long-term use of a single prototype and far more intertwined relationship between design and analysis.

A commitment to in-situ, longitudinal design has been explored in the context of co-designing a museum guide

with curators for museum patrons [16]. A key difference is that our approach focuses on in-situ use by target users of a continuously usable prototype and emphasises exploring and fostering long-term usage. Issues relating to the wider use of a system are difficult to anticipate, due to their complexity, uncertainty and emergent nature [29]. Nathan et al. [29] present four criteria to help envision an understanding of these issues early in the design process, however we suggest that it is through design and use that questions which arise in this process can begin to be resolved.

The interpretivist perspective of RAID, to learn through use in an exploratory, iterative fashion is inspired by Action Research [24]. The four stages of Action Research - planning, action, observation and evaluation – are simplified in the RAID framework and tailored for technology-oriented design. Here, ethnomethodological studies take place around a deployed prototype, with observations and analysis informing the next prototype's design.

Appropriation has been described as the process through which artefacts are adopted for use in everyday practice [13]. Appropriation work takes place in a number of different dimensions, such as social, technical and organisational [2]. As in the RAID framework, Carroll [8] argues appropriation is a valuable resource for design, and should not be seen as something that takes place once the design process is complete.

EXPLORATORY PROTOTYPE

In its original formulation [21], technology probes were primarily designed for open-ended use with minimal functionality[2]. They were introduced early in the design process and not altered during deployment, actively logging user activity while subjects experimented with them. Probes were presented as being different from prototypes which are usually designed for a particular purpose, have rich functionality, evolved iteratively, introduced late in the design process and primarily utilised for gathering usability feedback. In our work, we weren't satisfied with dichotomy between probe and prototype, thus preferring the term 'exploratory prototype' as some form of middle way.

The exploratory prototype is a usable and useful system, deployed over a long-term basis in real, natural settings. Like probes, they seek to be the tools or toys which participants can pick up, use and integrate into their everyday life as they choose. It is the analysis of people's activity with these tools that informs design. Like prototypes however, exploratory prototypes are iteratively developed and have rich functionality.

By presenting a single evolving prototype rather than a series of different prototypes, we aim to smooth over logistical difficulties often encountered when deploying prototypes, such as delivery, configuration and training. Moreover, participants are able to build trust in the prototype over time, which might be manifested by using it for more personal activity, recommending it to others or even coming to depend on it. Difficulties in deployment can severely limit the number of participants researchers are able to recruit and maintain, which in turn hampers design feedback. Today's commonly available internet-connected devices mean it is simple to offer a technically sophisticated exploratory prototype which can be iteratively developed with zero or minimal impact on participants.

DISCUSSION

In this section we dissect elements of the RAID framework, relating them to the literature and our experiences with the two cases of Rhub and Nnub.

Feedback through use

The necessity to "reconcile the fragments" [11] of data from disparate sources was for us, largely mediated through the reflective journal. In the journal we brought together extracts from our other information sources and analysed them as a whole. With time stamping across data and artefacts such as the change log, we could consider usage with respect to the state of the design in time, or in relation to changes that occurred before or afterward. Logged usage data needs to be significantly pre-processed to be useful, such as through time-series trending and activity clustering.

In some cases, we created instrumentation to provide the design team with live usage metrics of a feature in parallel to creating the feature itself. For example, as Rhub grew, it became necessary to offer enhanced functionality to limit its push messaging. One design response was a text message command which would stop all Rhub messages from being forwarded to that person's phone for a specified time period, or by default, several hours. While designing and implementing this feature, we were curious as to whether it would be used, for what reasons, and if time periods would be specified. These questions were noted in the question log for follow-up in interviews with participants after the feature had been deployed for some time, as well as for the creation of simple data visualisations depicting live usage of the feature with regard to received message quantity and so forth.

Participants' interactions leave their mark in the data differently, perhaps only appearing as faint traces, necessitating follow-up interviews or workshops to form complete accounts. In Nnub, sometimes a particular posted notice would be accessed more than expected, leading us to examine the pattern and chronology of access to discern whether the pattern was attributable to the notice design, aspects of search or interaction, or other contextual factors. For example, while text posts were more frequently posted, it was picture posts that were viewed the most, so we looked for ways to simplify their creation, such as integration with Flickr and a drawing mode.

We observed five major patterns of participants' usage that were helpful in the design process: deluge, accretion,

[2] The term 'technology probe', like 'cultural probe', has since been applied to a wide variety of work, not necessarily in the same spirit of its original use.

drought, erosion and missteps. Designers can use these patterns for pre-emptive evaluation and consideration during design (for example, how will sudden surges of activity be handled?) and also for suggestions of analytical perspectives on usage.

Deluge

A rapid influx of usage can expose scalability issues with usability and technical architecture. For example, one group of Rhub users treated it like instant messaging, sending a rapid, large number of short messages, overloading the system and resulting in messages being delivered out of order or not at all. This incident occurred after many months of stable usage by a much larger group, the difference, however, was they used it akin to text messaging, sending longer, but less frequent messages. In Nnub the introduction of scribbles led to a large number of scribbles per day, displacing notices (which usually take more time and effort to construct) from view. This led us to redesign the interface to give appropriate visibility to both forms of content.

Accretion

In systems that allow people to create artefacts (such as photos, groups, annotations and so on) or have other by-products of use, gradual accumulation of these may reveal design deficiencies. As the number of artefacts rise, attention needs to be paid to their usability and management. It can also be useful to examine what kinds of artefacts are being created and for what purpose, perhaps with a view to better supporting this usage scenario. For example, we noticed people creating locations in Rhub for their home address, so they could set their location as 'home', and for this to be visible to friends. After observing the accretion of home locations, which aren't really useful for others, we decided to special-case this scenario and the creation of 'home bases' which are represented differently and do not appear in public location listings.

Drought

Under-use or absent use of features can hamper the viability of other dependant features or create a disinviting, barren user-experience. Use can be encouraged by improving usability and utility, while objective review of the feature might lead to its redesign or removal. In the case of Rhub, we were curious about the use of location-based services, however too few participants were setting their location for these higher order services to offer value. As a result, we made location-setting successively easier and more rewarding which in turn led to greater use of dependent features. Non-use of Nnub by some community group leaders was followed-up by ethnographic study, proving informative. Both systems had a majority of passive users who preferred to observe rather than participate. Although acknowledging the benefits of a digital noticeboard and the need for outreach beyond their group, some group leaders only used email for group announcements, due to lack of time. We explored this use context further, leading to design interventions aiming to better support or potentially transcend existing email practices, for example allowing people to post content with email.

Wearing in

Erosion or wear can reveal repeated use in physical artefacts. For example, patterns of worn paint on a mobile phone might reveal how it is usually held. Software-based systems do not physically wear, however user activity can be logged and then later analysed for trends and established usage patterns. Like the accretion pattern, it may reveal activity deserving of further analytical focus or design response. Basic usability can be improved for example by shortening navigation trails and surfacing information to more accessible locations. More substantial changes can also be made. Over time it became apparent that Rhub was used mostly for group communication, and in particular, for ad-hoc group coordination, such as planning a night out. Our users had a loose, dynamic perspective of groups. We thus successively altered the design to support a more fluid group structure and additional support for coordination, allowing people to 'tune in and out' of event organisation as interested dictated.

Missteps

Users' missteps - trying to do something the system doesn't support, or causing an error, for example - are valuable for design. Missteps can surface basic usability flaws as well as mismatches between the design and participant's expectations and intuitions of how it should work. Because deployment and use is outside the lab, missteps are not as easily captured as in traditional usability testing. Extensive logging and exception handling is critical to respond to missteps and judge their importance, and serves as a useful input to qualitative processes to understand the nature of the misstep. In the case of Rhub, we significantly improved its text messaging interface through observation of attempted commands sent by users. Similarly with Nnub, we provided support for creating notices based on content from other websites after we observed the practice being performed using crude copy and pasting. In this way, features are co-evolved with users' expectations of what they can be useful for and how to use them.

Feedback over time

Exposing the prototype to use over a long period better positions it to capture intermittent and periodic events which might otherwise fall outside of a short term study period. For example, consider how activity within a household changes throughout the day, week and year. During weekdays, there might be a regular pattern of early morning activity, a lull during the day and burst in afternoon which tails off into the night. When examined on a weekly basis, weekend patterns emerge. When examined on a yearly basis, events such as holidays and birthday celebrations become apparent. In our deployment of Nnub, clear usage patterns emerged that corresponded to community activity, such as surges of use when the nearby school was starting or finishing. Identifying and analysing such patterns can be informative: correlation of usage and important community events led us to explore

how events were publicised, discovered and communicated within the community.

Over time, the system is exposed to more varied use contexts, not only because people themselves vary their activity, but because new people begin using the system. Alternative perspectives on existing practices become evident, or in some cases entirely new use contexts emerge. For example support for PDF notices in Nnub was not implemented until a government agency began using the system and had exacting requirements on how notices were to be presented. This requirement did not emerge until Nnub was deployed for three months and now that it is implemented, sates one particular user group and opens the possibility for new and interesting practices by others.

Continuously available

The RAID framework suggests that the exploratory prototype be continuously available and usable, so that participants can build trust and come to rely on it. With the knowledge the prototype will not be taken away after a short period, participants are able to view their usage and conscious appropriation-work with a long term outlook [7] and invest in appropriation. Work such as tailoring and negotiation with others to establish mutually beneficial usage patterns can be amortised over a long period, rather than be neglected for short term gain.

Care can and should be taken when analysing the in situ use of short-deployment prototypes, where there is considerable novelty usage and minimal appropriation. Fundamental differences exist between novelty usage and longer-term 'sustainable' usage. In our experience, novelty usage is characterised by playful experimentation, which stabilises as users - with regard to others and the environment - establish how to use the system in a beneficial manner. Analysis of novelty usage is still useful for design, however any such analysis should be considered and presented in this frame and not necessarily representative of normal use. If a prototype is not able to sustain long-term use, more fundamental questions arise regarding its actual usefulness and desirability.

Keeping the prototype stable and working during iterative development with minimal resources is a core challenge. This can be partly mitigated by managing participants' expectations of the level of functionality and reliability of different parts of the system, for example clearly sign-posting areas which are new and not completely tested. In our experience, we found that participants had very high expectations of the prototype and did not fully appreciate the difficulty in delivery of desired functionality. However, this pressure is lessened by the privilege of having people use a system, and serves in a variety of ways to remind designers of priorities from a use perspective.

In any research project, participants are a valuable asset, and care must be taken that they are not lost due to frustration with system. In the case of Rhub, alarmingly soon after its introduction, people depended on it for communication and coordination. If a Rhub message did not reach the intended recipients due to a system fault, people would naturally be disappointed and reduce their usage, or use it only for inconsequential messages. In one case, a leader of a student group assignment established a Rhub group and invited the other members. A number of messages were successfully sent to the group via Rhub, however on the one occasion that he attempted to use Rhub to organise a group meeting, Rhub failed to deliver the message due to a fault. After this, the group effectively abandoned Rhub and thus we lost four participants and the exploration of a new usage scenario for the system.

Contingency and context

Use is contingent. How we use something and for what purpose cannot be dictated in advance by the designer: he or she can only make some ways easier than others. There is a place for formal laboratory-based studies of interaction; however, it is in the artefact's natural environment that it is exposed to realistic contingency. For new technologies, studying everyday in-situ use of prototypes can be necessary as people are poor at anticipating their need or potential use before they are actually using it and have integrated it into their normal routine [31].

Following on from Heidegger, it is by way of everyday use that a tool transcends being present-at-hand to become ready-to-hand at which stage activity can take place *through* the artefact rather than *with* the artefact. The appropriation process might realise the artefact's intended uses or perhaps, by using it in ways the designers never intended, transform the artefact entirely. Use does not take place in a vacuum: we observe others' use, others observe us and we operate within semi-rigid cultural and societal structures. Thus how someone uses an artefact and what that artefact means to them is contingent on properties far beyond the material and functional attributes of the artefact itself.

While we acknowledge that all action takes place with regard to context, some design problems involve action that is particularly sensitive to the context in which it is usually carried out. If a reasonable facsimile of the context with its salient features cannot be recreated, testing the action outside of the context can offer only limited insight. For example, exploring action in a waste water treatment plant - which provides a rich phenomenological experience - demands grounding to the actual plant [7]. Social, personal or intimate contexts like the home may also reveal their contingencies best through in-situ use without researchers present [34]. With social technologies the context of action is enormously variable and difficult to effectively recreate or represent in a laboratory environment.

Utility

Everyday use can be realistic use. Where the exploratory prototype offers enough value or utility, people will use it not because they are paid or asked to follow a synthetic scenario but because they have a genuine want or need. In addition, they can use it when the desire arises, rather than be limited by a short deployment period. Evaluation of contrived use can give a distorted impression of the system [3].

Artefacts offer utility or value in different ways. Some might enable an activity that was previously impossible or difficult to accomplish. Other artefacts might offer value because they are enjoyable to use, or support self-expression and creativity, such as a musical instrument. Where the utility of an artefact is compelling enough, people are willing to sacrifice a high level of usability [12]. For example, text messaging was not dismissed in its infancy due to limited text input capabilities or 160-character message limits.

Text messaging's utility - along with factors such as an affordable unit-based pricing model - led to its long-term regular use by millions of people. In turn, this has provided opportunity for researchers to explore the way it is used and the socio-cultural practices that have emerged around it (for example, [17, 22, 26]). Findings from this research has led to the development of a variety of technologies which aim to better support practices evident in text messaging usage, our prototype Rhub being but one example.

Although original text messaging implementations suffered from numerous shortcomings in their usability, widespread, rapid growth in usage demonstrated its utility and provided the means for improving design by studying actual usage. We have previously suggested [20], along with others [15], the importance of utility, and its relatively minor role in HCI discourse. Longitudinal design processes such as RAID help to ground design and hold its actual usefulness to account, as people will cease to use an artefact if it does not provide enduring value.

Rapid evolution: opportunity and risks

Traditionally, once a prototype is deployed and being used the designer is relatively powerless to influence how it is appropriated. Means external to the artefact are available, such as training or marketing, but little change can be made to the artefact itself to encourage or discourage particular ways of use. Prototypes need to be recalled or replaced with an updated version and there is accompanying difficulty and effort in this transition, inhibiting iterative design. Connected systems and devices, however, can be iteratively changed with minimal inconvenience to users. This new trend of continuous or online iterative design enables it to be an activity that takes place over the life of the artefact, rather than taking place once or at sparse intervals. By responding to contingency and emergent use more quickly, exploration of a design space can be more expansive and thorough.

Change, and the communication thereof, must be carefully managed so that in the pursuit of exploring unfolding use, participants are not alienated by a changing or unstable system. If the prototype is continually evolving, a clear concern is how to update participants with new, removed or changed functionality. During the early deployment of Rhub, bugs were fixed hours after they occurred and new functionality introduced on a daily basis. If new functionality is silently introduced, it may be some time before it is stumbled upon, and thus not serve its purpose for evaluation through use. Non-use through non-discovery of new functionality is quite different from non-use through disinterest or dislike. Too much change risks lessening the benefits of the long-term prototype, as participants will not be able to bond with a kaleidoscopic system.

To keep users informed, we sent periodic emails to users of the respective systems. The newsletters were a digest of entries from a frequently-updated development blog, which early adopter users monitored. Early adopter users are a useful resource for idea generation [38]. By making usage of features externally observable where possible, early adopter use could be noticed by others and was an effective way of spreading knowledge of new features.

The embedded researcher

For both systems, we were active participants in not only the use of the system, but the wider social context in which they were initially employed. As in Action Research [24], from which we draw inspiration, we were thoroughly embedded in the context, playing an active role in encouraging and facilitating use. Accordingly, we were in an excellent position to observe use of the systems in practice and how they changed the social context. Because of our existing personal ties to the user community - which we wished to maintain - we were easily sensitised to concerns such as privacy and spamming. Moreover, with both case studies, we hoped to *strengthen* ties between participants, including ourselves.

As with many highly-situated investigative approaches, questions can be raised regarding generalisability and validity, especially as we are actively shaping use through iterative design. We would suggest it is a necessity to maintain an open and honest stance, to be led by the unfolding use and understanding. Generalisability and validity can be improved through triangulation of data gathered with varied analytic perspectives as well as deployments in multiple contexts [28].

A native's knowledge and ease of access to the social context was highly beneficial for fieldwork and initial design and deployment, and eased some of the difficulties associated with the observational study of mobile and ubiquitous technologies [11]. However, as the user population grew and new sub-groups arose, our privileged position was diminished. How well the RAID framework adapts to deployments in alien or relatively inaccessible contexts is an open question.

Confined design and re-design

One of the concerns rightfully levelled at the use of functioning long-term prototypes is that once deployed, the potential for the design to evolve is limited: the premium placed on use and user feedback may come at the expense of design flexibility. There is a balance to be struck between providing utility in the prototype, yet for the design being sufficiently 'open', to be led by participants and the exploratory process. Too much "closure" [27] and users will either use it exactly as intended, or not at all. Too much openness and perhaps utility is diminished. In

functioning software prototypes, openness seems to equate with providing power and preventing excessive structure and detail. In contrast, non-functioning lo-fidelity prototypes don't provide functional power but can furnish an array of different designs with minimal effort particularly with respect to physical affordances and evoking imagination about use. However, these non-functioning prototypes do not yield the same form and depth of data in context and over time. Functional prototypes can be narrowly scoped at first to explore particular core aspects of functionality over time. The art of RAID is deciding how to develop the prototype and being judicious about when to discard the prototype and begin anew, paying particular attention to the relationship established with user communities and responsibilities in relation to user generated content. Clearly there is a place for both approaches, for example, conducting early workshops with numerous design alternatives, followed by a course of long-term use. With Rhub, we were able to completely redesign some aspects of functionality whilst still within the overarching design paradigm, and as far as the participants were concerned, same system. Data from long-term use can also feed into fresh, experimental designs which can be explored tangentially.

CONCLUSIONS

In this paper we have argued for a reflective, agile, iterative approach to socio-digital systems, emphasising longitudinal, everyday use of an evolving, continuously available exploratory prototype. This is particularly important for social technologies, which tend to be used in an ad-hoc manner highly contingent on context. In examining the use and appropriation of technology with this perspective, we are able to proactively explore a design space, evolving the prototype as participants' activities, needs and understanding evolve.

The RAID framework suggests iterative cycles of design, use and reflection around an exploratory prototype, assisted with the use of artefacts such as the change log, question log and reflective journal. These artefacts help to document ongoing change in relation to observations and questions regarding use.

Time is a good test of a design intervention's usefulness and relevance in any given context. Over time, we can observe use in time frames and contexts that suit peoples' lives rather than rapid research or product development cycles. We can see the ways in which people bridge existing practices with the new system, "making it at home" in their personal and social environments. Everyday use exposes the prototype to natural, everyday contingencies, providing reason and opportunity to use the system in new ways. New possibilities emerge from use in related or unexpected contexts. With a continuously available, long-term prototype, we aim to foster participants' investment in appropriation and use, potentially resulting in richer, more realistic observations and testing the enduring validity of research claims.

Analysis of how people use the exploratory prototype is core to the framework. We identified five usage patterns which are particularly informative for design: deluge, drought, accretion, wearing in and missteps. Aspects of appropriation and configuration activity are revealed through these patterns of use, non-use and difficulty of use.

Wider availability of online systems taking advantage of pervasive mobile devices and connectivity improves the feasibility of rapid development and continual data collection across a wide variety of technological artefacts. RAID exploits this trend in order to rapidly co-evolve design with use and understanding.

As the prospect of long-term use and real uptake are the major questions that surround many designed systems, the approach is particularly promising. However it requires an artful consideration of appropriate design response to both user and research needs. This paper serves as a reflection on our experience with long-term evolving prototypes but raises many further questions that are beyond the scope of this paper such as the role of the designer and how to disentangle emergent use from designer-directed use.

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