Insights Into Legacy: Issues of Handover from a Partner-Initiated Project

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Emily Thorn
Mixed Reality Lab, University of Nottingham, United Kingdom
emily.thorn@nottingham.ac.uk

Jocelyn Spence
Mixed Reality Lab, University of Nottingham, United Kingdom
jocelyn.spence@nottingham.ac.uk

Boriana Koleva
Mixed Reality Lab, University of Nottingham, United Kingdom
boriana.koleva@nottingham.ac.uk

Steven D. Benford
Mixed Reality Lab, University of Nottingham, United Kingdom
steve.benford@nottingham.ac.uk

ABSTRACT

We report on a six-year collaboration with a small community organisation to develop and deploy a permanent physical / digital locative media experience as part on an ongoing community regeneration project. We describe how this unfolded over four phases: approach and pilot; public deployment; supporting subsequent community-led spin-off experiences; and planning legacy and technology handovers. The project was distinctive for being a Knowledge Exchange project in which we were approached and formally contracted by the community to deliver the digital technology, rather than instigating and leading a research project. We identify seven considerations for handing over technologies that combine both digital and physical elements to communities of stakeholders that encompass businesses, councils, and volunteers, and how this illuminates the unique strengths and weaknesses of Knowledge Exchange projects within the wider design research landscape.

CCS CONCEPTS

• **Human-centered computing** → Interaction design; Interaction design theory, concepts and paradigms; Human computer interaction (HCI); HCI theory, concepts and models.

KEYWORDS

Knowledge Exchange, Handover, Legacy, Community, Stakeholders, Locative Media, In-The-Wild, Installation, Digital, Physical

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1 INTRODUCTION

Researchers rarely learn what happens to their projects after they are handed over to partners. We have the pleasure of building on the findings of previous studies by discussing a long-term design engagement that neither started nor ended as a research project. Instead, it is an ideal opportunity to engage in truly community-led research – more than six years at the time of writing – that we did not seek out, steer, or even 'need' to write about. The unusual nature of this situation provided us with fascinating insights that support and extend existing HCI literature around legacy, community handovers, and Knowledge Exchange (KE) projects through design interventions. The unusual part was that the project grew, and responsibility was shared, in a non-linear, stakeholder-led way that we have not seen explicitly described in the literature. Our analysis of the long-term growth and attrition of this project fills in some important gaps in the literature around the underlying assumptions that researchers may bring to their projects regarding legacy and handover. It also calls for researchers to seriously consider how different types of funding can have ripple effects throughout and beyond the project lifecycle.

To provide a brief overview of our multi-phase project: in 2016, we were approached by the Interpretation and Community Engagement Officer (ICEO) of Nenescape, a temporary UK Landscape Partnership Scheme (LPS) with the mandate to increase community engagement with the local area and its history. The area, once the thriving centre of shoe manufacture in the nation and therefore boasting the associated businesses and infrastructure to support it, has been in relative decline over the past few decades. The disused railway along the river has recently been converted to a public pedestrian path, but it had not yet become embedded in the daily lives of the people in the area. Nenescape aimed to improve access to the water, restore wetland and wildlife habitats, uncover and celebrate the area's history, develop tourism, and develop skill in local communities (at time of writing, https://nenescape.org).

The ICEO had previously attended a workshop organised by us that promoted aesthetic visual markers, called Artcodes [26], as an enabling technology for heritage experiences. Artcodes builds on

the d-touch approach proposed by [8] that recognises topological structures in images. People can draw aesthetic and meaningful codes by following a simple set of rules, which previous research has shown are easy to understand, with a variety of interesting designs created [3] and an Artcodes app can recognise these as though they were QR codes. The ICEO wanted us to provide technology-based KE activities that would support their bid for funding from the UK's Heritage Lottery Fund (HLF), which was formed to distribute a share of the proceeds of its National Lottery, primarily to legacy-building heritage projects for local communities[1]. The ICEO's pre-existing familiarity with Artcodes and friendly relationship with the lead author went a long way towards relieving any potential tensions around experimental technology [32]. During this phase, running over 2016-2017 and which turned out to be the first of four, we led workshops to generate and refine ideas for how the Artcode technology could form an initial proposal for a project that would benefit local communities by celebrating history, developing tourism, and supporting community skills.

Phase 2 began later in 2017 when Nenescape's bid was successful and they were awarded £2.6M to fund a network of 11 partners to deliver 16 projects that collectively celebrate, protect, and conserve the natural and built heritage of the river River (name changed for anonymisation). This included a two-year research collaboration with us to create an app-based locative experience based on smart devices recognising Artcode visual markers and to develop a content editor. Phase 3 began in 2019 and spanned the time between the end of our official participation in the project and the (planned and intentional) end of the Nenescape project, as different organisations joined in and appropriated the technology for themselves to extend our initial experience and to develop new ones. Phase 4 ran from the end of Nenescape's HLF funding in 2022 until the time of writing and beyond. It covers Nenescape planning its legacy while the community continues to develop further experiences in the context of our university being unable to commit either the financial or the human resources to long-term maintenance, and cash-starved local organisations struggling to justify any non-essential outgoings.

In this paper, we first provide a review of previous work reflecting on legacy and handover, and on Knowledge Exchange practices, showing that these require more unpacking, especially within HCI and design research. We then outline our methodology as a KE project and a constructivist investigation of Nenescape as a case study for understanding the longitudinal shifts in stakeholder relationships, skills, responsibilities, and engagement in a community-driven, location-based design installation, with the main body of our paper examining the 4 phases of the project through this lens. We found every one of the themes proposed by Taylor et al [32] in our own data – 'expectation management', 'tensions around experimental technology', 'iterative development', 'creating skills', 'reaching a mutual agreement', 'planning for handovers', 'evaluating success', and 'ongoing relationships'. However, we also note significant differences underlying the premises of the terms 'legacy' and 'handover', and the consequences of working through a Knowledge Exchange partnership rather than a research-led partnership. We consequently contribute six further considerations for successful handovers: engage a diverse network of stakeholders through a core community partner; individual relationships are key to successful handovers; address the sustainability challenges of physical handovers; draw up formal legacy plans; communities managing their own funding rebalances power and responsibility; and recognise knowledge exchange as agile iteration rather than a linear pipeline.

[1]In the 12 years since its launch, the fund has awarded over £200M to 125 projects, a significant investment in a sector that often finds itself starved of funds

2 RELATED WORK

2.1 Legacy and handovers in community-based research

Research with external partners, particularly research with a public face, often needs to contend with how the legacy of the work will be handled once the funded research project comes to a close. This may also include the handover of digital and/or physical elements of the project and the skills to maintain them when the researchers are no longer able to provide support. Traditional thinking in computer science and related fields has often been rigid, from international standards on asset life cycle management plans (ISO 55000, https://www.iso.org/standard/55088.html) to organisational mishaps in digital and physical handovers of International Space Station assets [33] to dissatisfaction of government officials with the transition of their new software from production to operations and finally to their ability to use it – or not [25]. Rigidity is not necessarily a bad thing: as John C. Mankins has demonstrated over the course of many years, carefully defined Technology Readiness Levels and assessments of those technologies have played a large though not always reliable role in successful communications and handovers among organisations [22, 23]. However, the relative flexibility of design research methods is no guarantee of successful legacy or handover, either. As Mankins points out, 'There is a real need for practices and metrics that allow assessment of anticipated research and development uncertainty' [23, p. 1223] – and design research is nothing if not an exploration of uncertainty.

The authors of [2] pithily identify key problems in HCI's attempts to engage productively with the public once an intervention comes to a close, which come down to paying insufficient attention: first to the sustainability of public deployments after the researchers have withdrawn, then to handover and appropriation processes, and finally to methods for assessing impact. They also provide an overview of the work at that time addressing these issues in their field of HCI for Development.

Success in terms of the first two of Balestrini et al's criteria [2] begins, according to our reading of Johnson et al [17], with the development of a positive working relationship where stakeholders and researchers remain committed to the project. Johnson et al [17] focus on the relationship between the researcher and their end users, who signed up in advance of any interaction and came to know the researcher. We see this as an approximate framing of researcher interactions with stakeholders working on behalf of end users who are members of the public and will encounter the technology with no direct human intervention at all. Johnson et al [17] distinguish between a researcher's roles as facilitating, encouraging, and/or explaining. They also note the importance of striking a balance in the level of authority the researcher is perceived as having: not

dominating, but not letting their contributions be undervalued. They see familiarity with participants as important to improved communication and a deeper understanding of the context behind that communication.

Another such reflexive account focusing on community-based design research was the extremely turbulent process of gaining stakeholder trust described by LeDantec and Fox [21]. They undertook what might be seen as a fairly innocuous project to identify interested stakeholders in a nearby underprivileged neighbourhood and co-design interventions guided by stakeholder needs and preferences. However, the researchers were initially refused access to the neighbourhood's planning committee – in public and in strong terms [21]. It was only through the personal interest they piqued in a person at that meeting who ran a community arts organisation, extending to two months of secretive, personal meetings to avoid condemnation by her neighbours that she, on behalf of the researchers, was able to re-present their proposal as a partnership with her organisation and the neighbourhood association. Interestingly, the highly specific Memorandum of Understanding (MoU) drawn up among these partners, in which the researchers committed to providing the necessary technology and training for anything that community participants would be involved in, proved critical throughout a year and a half of working together as suspicions waxed and waned. From the initial intervention of the arts organisation leader through the researchers' willingness to reject 'etiquette' and share the same details of their lives as they were asking of their participants, LeDantec and Fox concluded that 'Ultimately, the personal connections we formed were the most important part of the work' [21, p. 1355].

Rogers and Marsden [30] present a model for making HCI research available, though theirs is more reflective of [21] and more radical in its insistence that researchers provide technological opportunities via toolkits that participants can configure and appropriate for their own desires. The 'hand-over approach' involves three main proposals: technology that facilitates users' creative and cognitive processes, opening up the design space through toolkits and workshops from which users do the creating, and striving to make technologies ever more accessible [30]. These proposals echo the emphasis of [19] in the 'materials' to be handed over becoming more skills-based and ephemeral: LeDantec and Fox's project caused them to change their traditional, research-driven view of design workshops resulting in artefacts that formed the main output for both researchers and community to the view that those workshops, consisting as they did of design-driven interactions between researchers and community members, were 'an end, rather than a means' [21, p. 1356].

A later project very much in the spirit of [30] demonstrates the successes of an action research digital storytelling project in rural Argentina [1]. There, the researchers worked with local stakeholder groups, primarily a local school and a photography collective, in initial phases that gathered momentum through local media coverage and other recognition to create this user-generated, living memorial to their own town. The authors note: 'It is important to emphasise the very active role that the stake- holder groups took in the project. Not only did they initiate the project, but representatives from the local school and the photography collective raised the funds. . .' [1]. The criteria for success that they note from this project are, in short: ensuring value for all stakeholders, use off-the-shelf technologies, facilitate as many face-to-face encounters as possible, design for stakeholder appropriation, and 'aim for broad media coverage' [1].

The projects and resulting advice described here demonstrate a fair range of work that deals specifically with legacy and handover in HCI and design. However, we find the most direct guidance for the work we report here to be the work of Taylor and colleagues [32]. They analysed two in-the-wild, long-term deployments of design research projects in and with local communities. Notably, as we will point out later in our own findings, one relied heavily on a 'champion' participant who facilitated access to the wider community [32]. Unlike many other papers, though, this one explicitly examines the handover processes and legacies of the two case studies. The community for the second case study felt a similar negativity from their partner community to that felt by [21], also because they had been studied by researchers time and time again with little, they felt, to show for it [32]. Taylor and colleagues analyse the problems faced during and after handover, coming up with the following recurring issues and possible remediations: 'expectation management', 'tensions around experimental technology', 'iterative development', 'creating skills', 'reaching a mutual agreement', 'planning for handovers', 'evaluating success', and 'ongoing relationships' [32].

3 KNOWLEDGE EXCHANGE

We can begin by pointing out that in the UK, university research is supported by our government through the UKRI (United Kingdom Research and Innovation) and includes in its remit projects such as business support and an Industrial Strategy Challenge Fund. Not only is bringing innovation to market a UKRI priority that it seeks to develop much further, but many non-university public sector research establishments such as the Environment Agency or Space Agency may find themselves unable to apply for UKRI funding because of the way in which funds are allocated to different types of organisations [13]. We do not write this in the spirit of complaint, but rather to indicate that the definition of 'research' is not always as straightforward as it may seem.

A CHI Special Interest Group over a decade ago noted the increased demand for researchers to demonstrate impact among a call for fairer and more ethical funding on a global scale [11], including the balance between research-oriented and KE-oriented funding. Seven years later, a short paper examining one 'data-driven innovation' project in the creative industries raises specific and truly challenging questions about how it is ethically or epistemologically feasible to combine both research and innovation in a single project [20]. However, even they speak from the position of researchers in a research-led project: we share their concerns but wish to reveal a little more about KE in particular.

A detailed review of KE practices among UK universities (the authors specify that KE and their term, Knowledge Transfer, are equivalent) written in 2018 points out as its first key issue that not only is KE generally – and incorrectly – thought of as a one-way handout of information from universities to industry, but that the knowledge that is exchanged often takes the form of 'activities' as well as 'informal contacts', with knowledge artefacts such as patents playing relatively small role [34]. Moreover, they point

to the need for ongoing relationships and for both universities and their partners to find value in the process in terms of each one's institutional cultures and requirements [34]. This document provides a wealth of interesting facts regarding KE activities in relation to different types of research that are sadly outside the scope of this paper: suffice to say that a close study of the KE literature indicates that it seems to be broadly in line with work regarding legacy and handover to stakeholders.

KE is an example of the impact that a research project has upon the wider world. Impacts are notable and financially valuable when the work leads to successful commercialisation and/or a spin-off company [4, 24]. Outside of obvious successes such as commercial spin-offs, the UKRI feels that its own impact is muted due to difficulties in communication, and its latest report does not applaud the university research sector for successes in this area, either [13]. Researchers at Edinburgh Napier University also highlight the process of HCI knowledge transfer, or more accurately expertise, to industrial partners as a desirable outcome, where the focus shifts to the individual rather than the organisation as the recipient. They describe the 'associates' that they send to industry partners for knowledge transfer as having 'added value' that translates to 'successful careers' [25]. In all, Knowledge Exchange requires a good deal of unpacking, especially within HCI and design research, before best practices can be productively uncovered and tested.

4 METHODOLOGY

The question of methodology is an interesting one in this case as it began as a KE project, with our university providing the 'knowledge exchange' rather than conducting research. Phase 2 was an in-the-wild [31], in-situ design installation not based on user needs or ethnographies but rather leaning heavily on aesthetic elements to augment public places and improve people's experiences there [9]. Because the novelty and value of this work for the HCI community comes from the fact that our research involvement was so heavily contextualised by our KE role, though, we are not analysing the design per se using Research through Design methods (e.g., [12]), its public deployment 'in the wild' (e.g. [9, 17]), or its adoption by the members of the public (e.g. [5]).

Had we planned a long-term, multi-faceted research engagement from the start, we might have followed the lead of [28], 'left the wild', and adopted an Action Research methodology (e.g. [15]). This might have focused our attention to the potential problems of insufficiently robust technology, lack of use, and lack of resources that [32] identifies. However, we cannot claim to have conducted Action Research throughout the Nenescape project when we had no research responsibility in Phases 1, 3, or 4 and did not anticipate that there would be any opportunity for research at all.

Instead, we consider the underlying stakeholder relationships that evolved over time and therefore changed what was created. In the following we focus on stakeholders who became directly involved in the project, either through formal contracts or by being officially recognised and credited for their contributions. These took part in project meetings and workshops, contributed content or materials, or hosted installations and events. In many cases they represented other 'stakeholders' within the community who were affected by the project, even if not directly involved. We also consider ourselves as researchers to be stakeholders in the locative experience developed in phase 2 and some of the new experiences that emerged in phase 3 (but not all of them as in some cases the technology was adopted by other orgnisations for a project without any involvement from us). We describe this paper as a constructivist investigation of Nenescape as a case study for understanding the longitudinal shifts in skills, responsibilities, and engagement in a community-driven, location-based design installation. This description aligns with the stated aims of the small portion of this long-term project that did have an explicit research orientation, which were to identify the key feature(s) of having semi-permanent aesthetic visual markers – built to last in situ for at least several years with no fixed date of removal – and to assess their longevity and any correlated community benefits. As our goals and those of our partners developed over time, the related skills, responsibilities, and engagements shifted with them.

We draw our data from years of 'active' and 'embedded' participant observation [18], as the lead author has been personally involved with the project from the very beginning and has personally led or participated in most of the key stakeholder meetings, skill-building workshops, and the research elements of Phase 2. Following Johnson and colleagues' descriptions of the various roles a researcher might take with their participants, we describe our role as 'facilitator' [17], first when the lead author explained the mechanism of the technology to be used. As the participants decided what they wanted to do with it, we also offered 'technical support' [17]. Overall, we were 'friendly outsiders' [17, p. 1137] whose friendliness grew and outsider role receded over the years. (The ICEO has asserted this to be the case and now considers the lead author to be a 'friend', and vice versa.) This allowed us to grow into and then step back from our more research-intensive collaboration. Our data collection took place with the full knowledge and consent of our project partners, and it received a favourable opinion from the School's ethics committee.

The documentation available to us for analysis includes: draft and final pilot project applications; plans and risk assessments for role in the pilot project; amended agreements covering extensions to our involvement; the grant approval for the development, creation, and rollout of the full digital/physical creation and installation; text and images from the three ideation workshops in summer 2018 during phase 2; transcripts of 9 stakeholder interviews conducted during the project's soft launch in September 2018; transcript of the handover discussion in June 2019 (end of phase 2 and beginning of phase 3); transcript of a project close interview in March 2022 (end of phase 3); the written Nenescape legacy plan from June 2022 (beginning of phase 4); and logs of numbers of devices that have used the app in the past 30 days (from less than 20 at soft launch to a maximum of 95, rarely dipping below 25 even in winter).

Our primarily deductive analysis is based on the work of [32], using their themes to make sense of our data, while we also looked out for any additional or contradictory themes emerging from our own experiences. Their underlying themes are issues that can be attributed to technology, usage, and/or resources, while their specific themes are expectation management, tensions around experimental technology, iterative development, creating skills, reaching a mutual agreement, planning for handovers, evaluating success, and ongoing relationships [32, pp. 1555-57]. We will

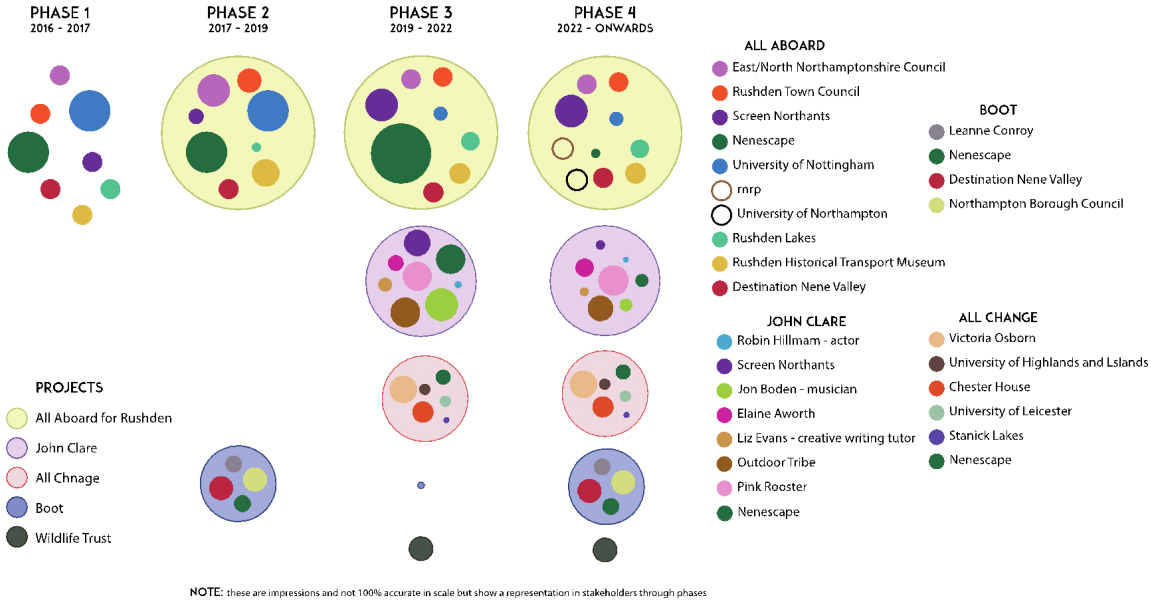

Figure 1: Stakeholders and projects across the four project phases

point these out when they are prominent in the findings, and will elaborate on our own adaptations and additions to [32]'s list in our discussion.

5 PROCESS

The project was complex: unfolding over six years, growing to involve many stakeholders, evolving in response to their various interests, ultimately creating five public experiences using the Artcodes-based technology platform we built, all while accommodating the impact of the Covid-19 pandemic. In the interests of clarity, we present it below in the form of four phases:

- Phase 1: the project proposal and an initial pilot activity (2016-2017)
- Phase 2: our team being commissioned to deliver a public installation and building a content editor for the community to contribute their own experiences (2017-2019)
- Phase 3: different stakeholders extending our initial experience and developing new ones (2019-2022)
- Phase 4: the funded Nenescape project drawing to a close and planning its legacy while the community continues to develop further experiences (2022 onwards)

To convey the richness and complexity of community engagement, Figure 1 depicts how the project grew over the 4 phases to encompass 23 stakeholders who were directly involved in delivering 5 projects using our technology platform. The outer circles represent the projects that we discuss later. The smaller solid circles inside these represent the stakeholders, growing or shrinking based on their level of engagement in the project at each phase, according to discussions with the coordinating partner, Nenescape. A notable feature of this image is the core presence of Nenescape in the first three phases, which greatly shrinks in the final phase as their funding winds up. The stakeholder community is notable for the breadth of its membership, including two town councils, local business groups, museums, a media company, individual artists and musicians, and four universities. Note that the Frederick Smythe and Boot projects ran independently without our direct involvement and that the Boot project was inactive in Phase 3.

5.1 Phase 1 – Proposal and Pilot

Our involvement was initiated by the coordinating partner Nenescape whose ICEO initially approached us with the idea. The collaboration began with a nine-month long pilot project from January to September 2017 in which we led workshops to form an initial project idea. This involved local council members, historical society volunteers, museum volunteers, a Northamptonshire history professor, local artisans and of course the Nenescape organising team. Our role was to introduce the technology, point out where opportunities might lie, and help keep ideas grounded and realistic. The ICEO played a vital role in championing the technology, recruiting participants for the hands-on workshops, and presenting technologies to them in a positive light. The workshops introduced the Artcodes technology and showcased what had previously been done on other projects. We ran workshops with a local leather artisan exploring material use and developing our own Artcodes. All participants took part in the iterative development process [32] to generate and refine ideas for how the technology could benefit local communities. The outcome of the pilot project was to identify an initial project to deploy Artcodes along the public footpath that followed the route of a disused railway, running between the town of Rushden and the new development of Rushden Lakes, with the aim of engaging the public with the heritage of the area.

Nenescape's goals for the project were to: 'bring hidden heritage alive', 'attract more visitors', create a novel 'educational resource' that would attract 'a broad audience', deliver an easily maintained and updated 'decorative experience', 'pass on the knowledge' of the Artcodes technologies, and to improve visitor tracking and 'marketing capabilities' of local heritage organisations (Project Plan, 2016). The legacy that the project aimed for was primarily the sharing of technology and transfer of skills to partner institutions so that the public experience can 'evolve and grow after the project has ended'. This aim was only one of several instances of creating skills [32] in this project.

Our research team's primary objective was to deliver impact from our work and to gather evidence that we might report to various funding bodies as part of their growing interest in documenting impact. The opportunity to conduct research by studying how the project unfolded was also seen as valuable, but secondary. In short, the collaboration was community led and funded, and driven on our part by the desire to deliver impact rather than explore specific research questions.

While it is not customary to discuss the details of research funding in papers, it is important in this case in order to properly contextualise our involvement. We did not initiate or even join these project partners in applying for research funding. Instead, Nenescape supported our engagement through a series of grants to our team: the initial pilot study (£3,000) in Phase 1; the major project development in Phase 2 (£25,000); and a subsequent follow-on award to help deliver the subsequent Wildlife Trust project (£3,000). In turn, we provided £14,000 of our own funding, drawing on our University's Impact Acceleration Account (a block grant from our national science funder to help promote research impact) alongside £6,000 of in-kind match funding in terms of staff time. This balance of Nenescape and University funding had two important implications. First, the formal aspects of our engagement with the community were encapsulated in a legal contract. A key stipulation of this was that we committed to provide software support for five years after the project ended. Second, our engagement was framed from the outset as being a combination of 'consultancy' and 'impact acceleration'.

5.2 Phase 2 – Delivering a First Public Experience and Content Editor

The KE process of engaging stakeholders to ideate a feasible public experience began with a series of three further workshops over a period of three months to develop a detailed project idea. The first involved walking Nenescape's public path, identifying key local stakeholders, reviewing local histories, and anticipating key challenges including building community interest, training people in the technology, and designing Artcodes to work reliably outdoors. The second explored various histories that might be drawn on including those of the prominent local shoe industry, the World Wars, the local high street, and that of the railway itself. We also considered the physical forms to which Artcodes might be applied including sculptures, information panels, carvings and being embedded in pavements. The third workshop addressed the challenge of engaging younger audiences and families, considered physical installations for the Artcodes, and ended on the history of the disused railway as the chosen narrative for the project.

5.2.1 All Aboard for Rushden. For the historical narrative, the stakeholders decided to focus on an event that happened on a nearby stretch of that railway in September, 1911. A porter was carrying a handcart full of luggage, including a bag of mail, and did not see an approaching train until the last moment. He escaped, but the train ran over the mailbag, and private messages were inadvertently made public in a sensational way. The public experience, delivered as a mobile app, involved people walking Nenescape's public path and scanning specially commissioned Artcodes signs with their phones in order to open a series of letters whose content derived from local history and events. The local history society and our local history professor played a key role in this. It was hoped that this combination of location, art, and personal historical content would enlighten visitors, increase their interest in that part of their local area, and encourage pedestrian access to the town centre. The app was titled 'All Aboard for Rushden'.

5.2.2 Physical Signposts. The project's interest in community engagement continued when looking for an artist to create the Artcodes signs that would be placed along Nenescape's public path. The project group issued a public call for local artists to design these signs. Four responded to the initial workshop where we introduced the project to those interested and explained the Artcodes technology, showcasing how to draw an Artcodes so that they felt confident enough to create an initial design idea. Anyone that then wanted to submit a design was given a design brief: 'Based on our Mail-Bag accident reported in 1911 we would you to produce a single Artcode. This needs to have a broad overall gesture towards the story, the surrounds as well as the transport history in and around Rushden. You can use the transport museum as further inspiration'. Three artists responded and we selected and commissioned one of them (see Figure 2) based on the criteria of clearly reflecting the railway theme and local landscape, viability as an Artcode, having an attractive and distinct aesthetic that would stand when deployed on public signage; and yet also being sensitive to the wider landscape within which it would be deployed.

We also noted that, as the project was intended to expand in the future, we wanted to create an aesthetic that became recognisable in the local area as an Artcode. This was done by using the same image as the basis for multiple signs with slight tweaks to make each distinctly scannable. (A key feature of the Artcodes technology is being able to create images that look the same to the human eye but that are then recognised as different from each other by the app.) The final selection was up to the stakeholders, who preferred the aesthetic of their chosen design; that choice was also very robust and easily expandible in terms of the Artcodes technology.

Designs are nothing without a medium to display them, though, and again stakeholders were key to deciding what the signs should be manufactured from and the physical form they should take. We provided insights we had gleaned from previous arts-based projects but did not take any final decisions. The group felt it was important that their signs should be: recognisably railway-themed, recognisably 'branded' as part of a unified project along the river; recognisable as an image to be scanned using the Artcodes app;

Figure 2: The Artcode public signposts: the original design submitted by the winning artist (left), a subsequent design printed onto metal (middle), and mounted onto a post (right).

overtly aesthetic in their own right; and striking a balance between capturing interest and fitting in with the natural environment. Their choice to meet all of these needs, once the image style had been selected, was enamel-plated metal signs. However, the local council voiced concerns about the cost of upkeep, so the signs were digitally printed onto metal, mounted onto stands, and set into the ground with concrete (see Figure 2). As a further anti-theft mechanism, the metal signs were encased in an overlapping metal frame. Each pole had printed instructions to download the app. This proved to be a wise choice, as one sign was stolen and had to be replaced while 2 others were quickly vandalised (in what looked like attempts to steal them) and so had to be repaired shortly after being installed, through since then problems have been minimal. Five signs were created and installed at key locations along Nenescape's public path. Locations were chosen on the principle of evenly spacing the Artcodes along the targeted stretch of the walkway.

5.2.3 App. There was already a generic Artcodes app freely available in the Apple App Store and Google Play that could be used to access a variety of Artcodes experiences. However, this would require the public searching out the experience from among the many various possibilities offered by the generic app, which was felt to be an unnecessary and complicated additional step in the user journey. We therefore created and released a separate bespoke Artcodes app just for this experience that offered a more streamlined user experience.

The design aesthetic and railway theme also needed to be considered through the app's user interface. The premise was that participants were physically walking along an unused railway line where each Artcode was a railway stop that showcased a letter based on the narrative. Figure 3 shows a selection of screenshots of the user interface. To start their journey in the app, a user needed to collect a digital ticket and enter in their start destination (shown in the far left image of Figure 3). Once an Artcode was scanned, the ticket was 'punched' much as a conductor would have done while passing through the carriage to check tickets (second image from left, Figure 3) and one of the letters lost from the railway incident would be opened (middle image, Figure 3). This triggered historical content and video (examples shown in the two images on the right of Figure 3) to appeal to younger and older audiences.

5.2.4 Content Editor. Although our contracted involvement was near its end, the stakeholders needed a far easier way of updating the app and creating new experiences than what we had become accustomed to. We therefore developed an online editing tool and trained key stakeholders to use this. Figure 4 presents a series of screenshots from this tool covering setting up a new experience, configuring what happens when specific Artcodes are scanned, and editing text for reward screens. It was important to include visual cues to enable those editing to understand exactly what section of the app they were editing. We tried to break down the editing tool in the same way the app is broken down so that they were comparable. The top image shows the sections they can click into in order to edit a ticket. The second image down shows the editing section of the branch line and each stop along with the finished screen once all the Artcodes were scanned.

5.3 Phase 3 – The Community Develops Their Own Experiences

In the third phase, some new community stakeholders used this editor tool to extend our initial public experience and create new ones called the Frederick Smythe Contemplative Trail, The Giant Dr. Martens Boot, All Change and the Wetlands / Wildlife Trust.

5.3.1 All Aboard for Rushden, extended. We supported the community to create a further 6 Artcodes signs and to use the editor to create further content to extend All Aboard for Rushden further along the Nenescape path from the Transport Museum in Rushden town all the way to the new retail development of Rushden Lakes. Figure 5 shows the final locations of the 5 initial 'stops' that we

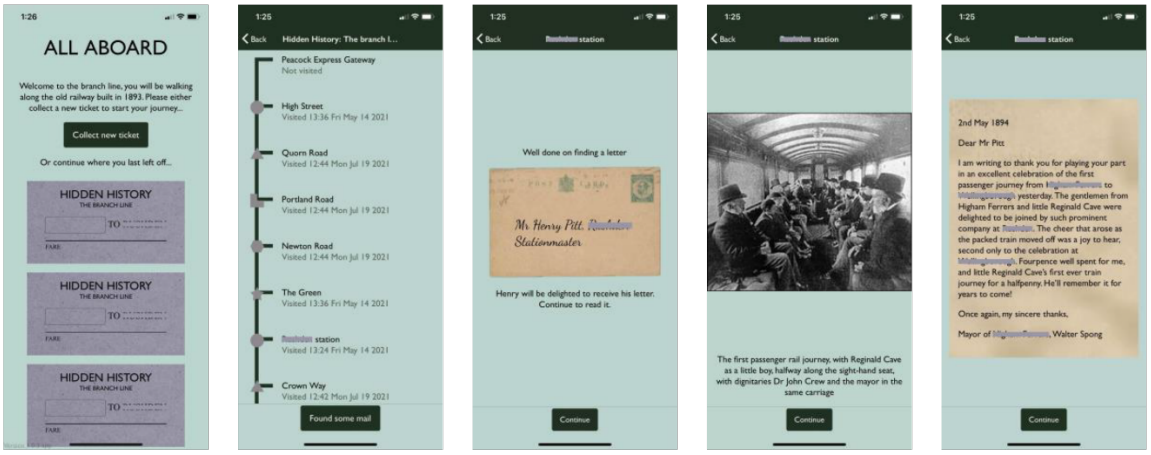

Figure 3: Screenshots of the 'All Aboard for Rushden' user interface

delivered (pale pins) and the six further ones that the community created (dark pins). Due to Covid-19 restrictions, the stakeholder Screen Northants invited local filmmakers to produce their content at home.

5.3.2 The Frederick Smythe Contemplative Trail. Nenescape was already supporting an ongoing project to address the heritage of the local 19th century poet Frederick Smythe (name changed for paper anonymity) and introduced our Artcodes technology to its stakeholders, leading to the idea of establishing a separate Frederick Smythe trail. The subsequent development brought together community members who combined their own original music, choral song, poetry, creative writing, and acting in an experience to encourage visitors to contemplate Frederick Smythe's local landscape by interacting with new Artcodes signs. To save on both time and money, the project elected to reuse the Artcode designs from All Aboard for Rushden (the technology allows the same Artcodes to be mapped to different content layers or experiences), though the Frederick Smythe signs were coloured green to give them a somewhat distinct identity from the now recognisable Nenescape brand (see Figure 6). The Frederick Smythe Contemplative Trail was intended to be launched as part of the River Valley Festival 2021. However, when the festival was cancelled due to Covid-19 restrictions, the society quickly created a mobile trail at nearby Stanwick Lakes (name changed for anonymisation) for one week in September. This inspired the idea of delivering a portable experience that could be moved to different locations along the course of the river River. To date, it has been deployed at four locations spanning a 40 km stretch of the river and continues to be a live project.

5.3.3 The Giant Dr. Martensä Boot. Nenescape was also working with the tourism agency Destination River Valley to promote the heritage of the local shoe industry, especially that of the Dr Martensä company, famous for their boots. In response, local artist (name removed for anonymity) created a giant boot sculpture for Northampton Borough Council (see Figure 7). Her Dr. Martensä boot depicts some of the River Valley's most-loved creatures, including kingfishers, otters, and dragonflies. Six of these images are Artcodes which when scanned deliver information about things to do and see in the local area. Following various temporary exhibitions, the Boot is currently housed at the Rushden Historical Transport Society.

5.3.4 All Change. Together with the charitable arm of a local stately home and an MA student in Contemporary Art and Archaeology from another university, Nenescape is working to develop a new approach to the interpretation of archaeology, moving away from traditional research papers towards more interactive, digital methods of exhibiting findings to the public. At the time of writing, the details of this project are still developing. Stakeholders plan to take a similar approach to the Frederick Smythe project by reusing existing Artcodes from All Aboard for Rushden to display new content for the public to scan.

5.3.5 The Wetlands. Members of the River Wetlands Nature Reserve, part of the Wildlife Trust, saw the Artcode signs deployed in the area and approached Nenescape about the idea of developing an app to enable visitors to document wildlife that they spotted. (Note that the discussions and implementation of this project made it difficult to align neatly with the phases shown in Figure 1; this is our best representation of the bulk of the work.) We entered into a separate contract to support the Wildlife Trust in developing this bespoke web app.

Using this web app, visitors and volunteers could scan an Artcode that would record where in the reserve they were and invite them to log the animals they had seen. Trust volunteers were given the ability to include further details such as specific species and gender. To maintain cohesion across the emerging Nenescape brand, the project adopted a very similar graphic style as All Aboard for Rushden – without the railway references – and 5 new designs were created for it (see Figure 8). The project was delayed due to Covid-19 and at the time of writing has yet to go live.

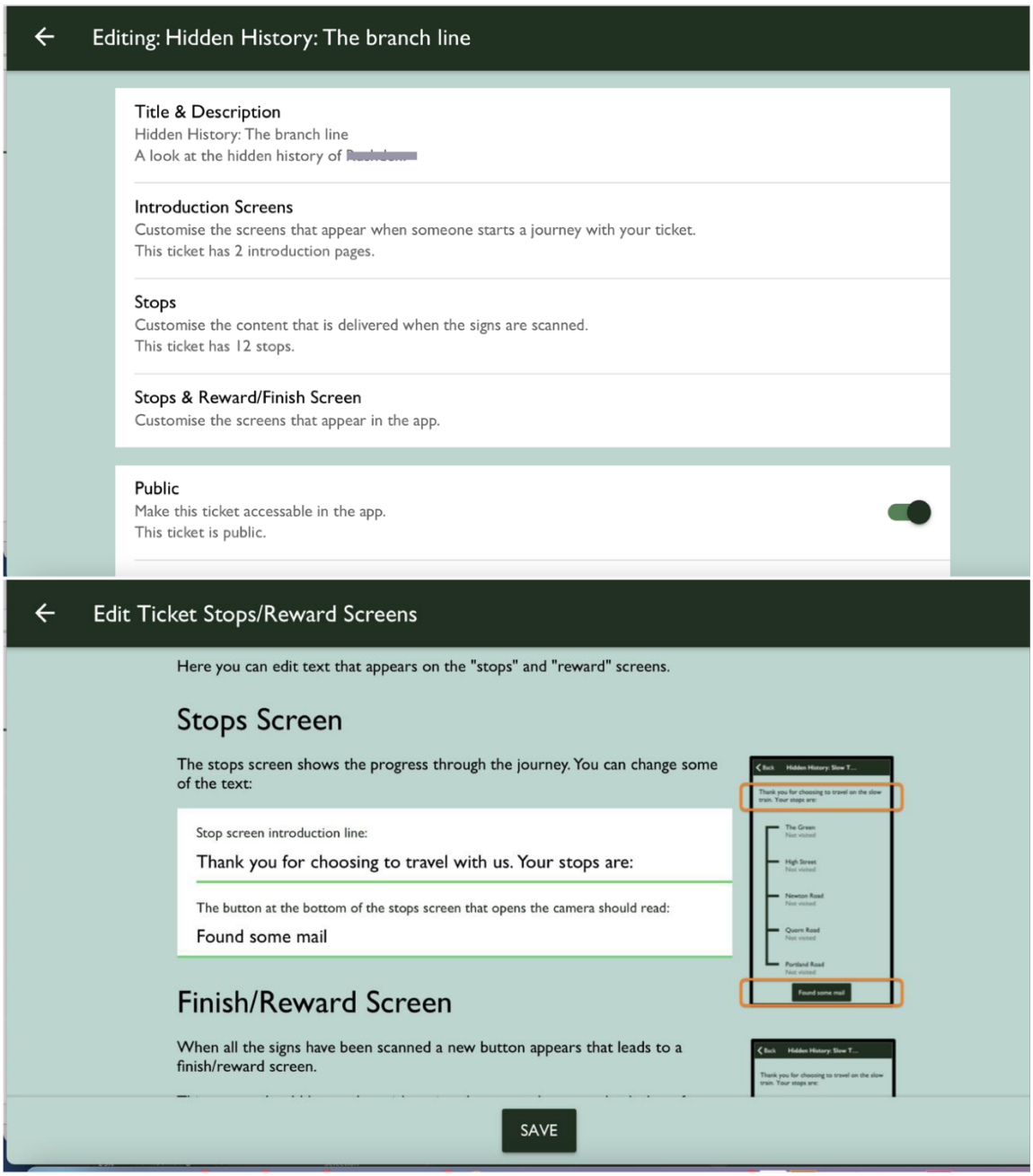

Figure 4: Screenshots of the content editor

5.4 Phase 4 – Planning the Legacy of Nenescape

2022 saw the Heritage Lottery Fund support for Nenescape come to its end, raising questions about the legacy of the project and whether and how the community and stakeholders might continue to work with our technology in the future. This poses a major challenge as several projects are either still in development or in the early stages of deployment (in part due to delays imposed by the Covid-19 pandemic). Are the Artcodes platforms we created sufficiently handed over to stakeholders? Can we continue to deliver to the contracted level of technical maintenance, or do we need to maintain a deeper engagement? If so, how can we do this without funding? Who among the stakeholders is in a position to take on responsibility for physical and digital aspects of the projects? Even if no further projects emerge, how will existing deployments be maintained? Ultimately, who is responsible for 'cleaning up' after

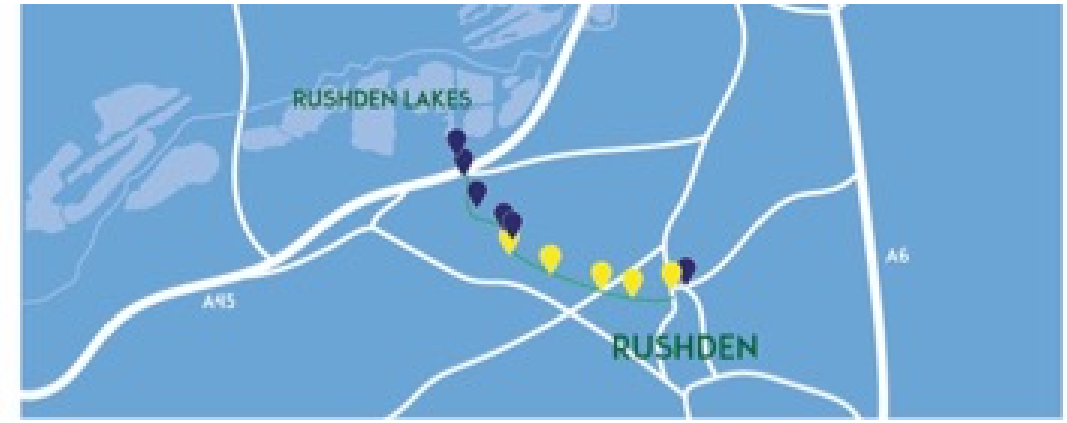

Figure 5: The locations of the final 11 signs along the Nenescape public path

Figure 6: The Artcode displayed at Stanwick Lakes

Figure 7: The giant Dr. Martens™ boot sculpture decorated with Artcodes

their useful lifetime has ended? As just one example of the challenges, we received reports in September 2022, as we completed the first draft of this paper, of a new incidence of vandalism to one of the signs along the Nenescape public path (see Figure 9).

With such questions in mind, the Nenescape management team drew up a formal legacy plan for the project covering physical legacy, digital legacy and knowledge and skills. The plan identifies the physical legacy of the project as comprising 16 Artcode signs, 11 of which are already permanently installed (10 on signposts and 1 on a wall), while the remaining 5 are currently tourable but ultimately intended to be permanently installed. These require regular cleaning and possible repair or even removal should they become worn or damaged. A particular challenge here is the distributed nature of responsibility which spanned both public authorities (Rushden Town Council) and private landowners (Rushden Lakes, River River Regional Park and the Rushden Historical Transport Museum). Should the signs be further vandalized, or staff turnover cause institutions to lose the skills for creating or linking Artcodes content, the software alone would become useless. The project agreed to supply the Council with a spare di-bond set of all signs to allow for replacement when needed. Digital versions of the Artcode designs also need to be handed over in case any further signs needed to be fabricated in the future.

The digital legacy of the project included the Artcodes app, which needs to be updated and maintained on both the Apple App Store and Google Play, as well as the bespoke editor tool, CMS, and existing content that needs to be hosted and maintained. Aligning with [32]'s toolkit approach to community projects, we emphasise that the toolkit nature of Artcodes facilitated technology handover. Artcodes sits somewhere between being a bespoke one-off technology and an off-the-shelf product. The app is stable and freely available for many phones, while being open source allows the development of bespoke software such as our Nenescape app and content editor. It is stable enough to persist across multiple projects while being open to extensive tailoring in response to the community's needs. However, there is also risk to the digital legacy, particularly with respect to hosting and maintain the existing content. While this was initially the responsibility of the researchers, this should be handed over to the Council's IT support for the long term. It would

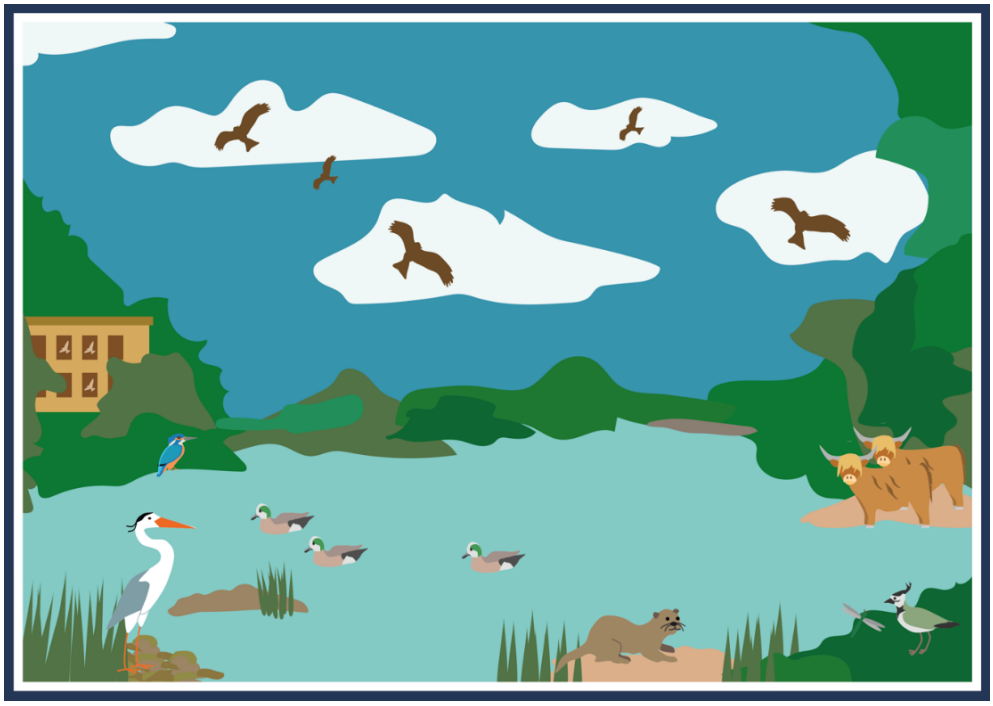

Figure 8: Wetlands Artcode design

Figure 9: A vandalised sign

be easy for project partners to assume that having introduced them to the Artcodes technology and having adopted new projects and changes of direction through the years, we might be equally flexible after the project comes to a close. However, we have limited scope to extend this small project beyond the six years we have already enjoyed.

Beyond the actual physical and digital assets, the handover of the knowledge and skills required to make them is essential. In Phase 2 the artists who participated in the Artcodes creation workshop gained skills in creating these codes and in thinking in terms of embedding technology in their designs (although creating an Artcode is arguably not a critical transferrable skill). On the other hand, Screen Northants grasped the opportunity to develop their students' broader media production skills by helping make video content for the project, so that the introduction of even our relatively niche and experimental technology had the knock-on effect of fostering wider digital skills development. Through Phase 3, 'creating skills' was so enthusiastically requested that it not only avoided significant 'tensions around experimental technology' but even served as a means of 'evaluating success' and creating 'ongoing relationships' [32]. At the project endpoint, though, only members of the core Nenescape team had learned 'content editor' roles, making the upskilling of other stakeholders in the wider network a key priority. In response, the Nenescape team created a 'how to' guide and provided training to the working group of partners. However, at the time of writing none has yet come forward to take on responsibility for editing new content. The plan also noted the importance of regular promotional activities to refresh content, ideally from the user community. When the Nenescape LPS ends, its employees disband, and its champion ICEO leaves, there will be no institutionally mandated ongoing relationships [32] with these organisations. At least one individual will need to champion the role of content editor, or else the content will be

impossible to refresh, and the project overall will most likely lose the interest of its local community.

6 DISCUSSION

Examining the development of the Nenescape project over six years and more reveals a complex story of researchers helping embed an emerging technology into a community regeneration project. On the one hand, the project has enjoyed successes, engaging a network of stakeholders with the technology who have created a series of projects inspired by our initial public experience of All Aboard for Rushden. On the other, these projects face an uncertain future as the period of public funding draws to a close and it is currently unclear who can continue to develop them, or has the responsibility and capacity to maintain what has already been achieved.

Considering the successes, looking at our findings through the lens used by [32], we noted every one of their themes in our own data, so that our project could be seen an example of the principles they propose in action:

- 'Expectation management' and 'reaching a mutual agreement' were formally built into our contract and solidified by positive relationships between key individuals;
- 'Tensions around experimental technology' were mitigated by the fact that the Nenescape ICEO made the initial request for the Artcodes technology, which we then explained and supported over a long period of time;
- 'Iterative development' took place in first undertaking the pilot, before then delivering a first public experience, that subsequently led various community groups to create their own;
- 'Creating skills' applied to both the digital skills we presented (Artcodes) and the supporting skills our partners developed in relation to it (digital media creation);
- 'Evaluating success' could be measured against the impact metrics in our contract but are more gracefully described by the eagerness of local organisations to join in;
- 'planning for handovers' and 'ongoing relationships' were addressed through drawing up a formal legacy plan, even if the legacy of the project remains uncertain.

However, turning to the challenges, reading between the lines of their work in contrast to our own, we note significant differences underlying the premises of the terms 'legacy' and 'handover', and the consequences of working through a Knowledge Exchange partnership rather than a research-led partnership. This has caused us to go back to first principles to question the nature of the handover process, which in turn has raised six key considerations for future projects: engage a diverse network of stakeholders through a core community partner; individual relationships are key to successful handovers; address the sustainability challenges of physical handovers; draw up formal legacy plans; communities managing their own funding rebalances power and responsibility; and recognise knowledge exchange as agile iteration rather than a linear pipeline.

6.1 Engage a diverse network of stakeholders through a core community partner

When discussing such projects, it is tempting to talk about handing over technology to 'the community', as if the community were some clearly identifiable and coherent entity to whom things can directly be handed over. Our experience reveals that this is far from the case. Figure 1 reveals how our community comprised a network of entities of different types including: cultural institutions such as museums and libraries; commercial enterprises such as shops and retail parks; creative professionals such as musicians and artists; local authorities, in this case spanning multiple councils; educational institutions such as schools, colleges and universities (including ourselves); and individual community volunteers.

These stakeholders bring different motivations to the table with regards to handovers and legacy. Legacy goals from our project included maintaining the various public experiences that had been created, enabling further use of the Artcodes technology, and the broader aims of promoting Rushden town centre as a destination and the Nenescape public path as a health-boosting natural resource. They also engage through varied contractual relationships. Commercial enterprises and creative professional may work through formal contracts; authorities through statutory process; and volunteers in less formal ways that reflect their personal motivations and circumstances.

That the community is so evidently such a heterogeneous mix makes the challenge of handing over technology especially complex. Vitally important in our case was that we were not responsible for directly dealing with this complex network ourselves, but rather, there was one community-facing organisation – the Nenescape project – that was dedicated to engaging the wider community and driving the handover of the technology. As HCI researchers we were fortunate to be able to rely on Nenescape to drive the engagement and handover process.

6.2 Individual relationships are key to successful handovers

While at first sight, the answer to the question of who is doing the handover may appear to be institutions (for example, handing over from us to Nenescape, and then from them to others), in practice, though, it must be individuals – likely the ones with the most personal or professional investment in the legacy – that they are handing over and/or receiving. As funding has drawn to a close, the loss of the lead individual at Nenescape ICEO has proved to be a critical point of weakness in the handover even though organisationally, 'on paper', there is no problem at all. Considering individual relationships is also important for volunteers who may be driven by diverse personal motivations such as sense of belonging, desire to learn new skills and wish to give their time and skills to others [6] and whose 'continuance commitment' may be non-contractual, fragile and in need of ongoing nurturing [7]. We highlight the importance of personal trust, in this case the key bond of trust that formed between the lead at Nenescape and the lead researcher on our team. This was crucial to sustaining the relationship and commitment over time, especially when navigating through challenges such as COVID, and working beyond the formal requirements of contractual relationships. We see no surprise or coincidence that the Nenescape ICEO's comfort level with both the technology and the individual researcher working on it with them [32] made commitment easier than it might for other stakeholders with less of a personal connection. This importance of building

and maintaining relationships with and among stakeholders has already been highlighted in participatory design [10]. In short, it is important to recognise and support key interpersonal relationships, especially between the research team and lead community organisations, when trying to handover technology to a complex network of community stakeholders.

6.3 Address the sustainability challenges of physical handovers

The digital legacy challenges that arise from handing over software are relatively well understood in HCI and the wider software literature (e.g. [1, 21, 23, 30, 32]) and were explicitly recognised in us being contractually obliged to provide technical support for five years after the end of funding. In contrast, the challenges of physical legacy arising from the upkeep of the Artcodes signs came as more of a surprise. We had no idea that by the end of the project, our 11 signs along the River would be split among multiple Local Authorities and landowners, which caused considerable difficulty in the handover process. Evidently, handing over physical technologies may become especially complex in projects that cover large geographic areas and span administrative boundaries and/or public and privately owned places.

It proved important to consider the value the signs would have should Artcodes not be maintained in the longer term. What would they mean to future visitors as standalone artefacts? At what point might they be seen as junk or litter? In the case of 'All Aboard for Rushden', the signs were intended to be in keeping with the Nenescape public path, but the motivation for their railway-based design is not necessarily apparent to the casual visitor, and it is not clear what else they contribute to the area. Moreover, our signs were designed for a cost/durability trade-off, without significant consideration for their potential for recycling or reclaiming. Of course, these long-term outdoor signs could not be made biodegradable, but this might be a viable and positive option for other projects. This echoes a recent call that ecological impact should be considered by community-based HCI [29]. The environmental impacts of digital infrastructure have been a key theme in sustainability research [14], but the physical legacy should also be not overlooked. In short, digital projects need to also consider their physical legacy, recognising key challenges of physical and well as digital future proofing, distributed authority, and the importance of environmental sustainability.

6.4 Draw up formal legacy plans

A notable facet of the project of particular interest here was an explicit consideration of project legacy, contributing to positive 'expectation management' [32] from all parties. Drawing up a formal legacy plan that explicitly articulated these goals was a positive development that helped make these goals clear to all stakeholders, including ourselves. It is perhaps no coincidence that a heritage project such as this recognized the importance of legacy and handovers; such projects are naturally aware of the importance and challenges of preservation, including of digital resources. Konstantelos and Hughes, for example, propose assessing the digital sustainability of Heritage Lottery funded projects using the criteria of content sustainability, technology, preservation, and promotion [19]. Indeed, the formal planning of project legacy is widely seen as best practice (if not a formal requirement) for humanities projects in general, something from which the HCI community could learn.

The project also provoked us to reconsider our own legacy goals as, much as [20] do. Our own motivation for engagement with this project was to deliver 'impact' in the sense of activity that makes a difference to the 'real world' beyond of academic research. In the UK research landscape in which we operate, delivering such impact has increased in importance over recent years; grant proposals now routinely set out formalised impact plans, while funders gather post-hoc evidence of impact to shape their policies. Our aim was to generate an impact story and supporting data that could be reported to research bodies such as UKRI (the UK umbrella research body, via its data platform Research Fish), the UK's 'Research Excellence Framework' (via its seven-yearly national data gathering exercise). It was important to explain our impact plans to the community from the outset and to secure their permission to capture and use supporting documentation.

6.5 Communities managing their own funding rebalances power and responsibility

Underpinning the project, and especially Nenescape's vital role in it, was the funding that they acquired and that they administered, which placed both the power and responsibility for delivering the community engagement firmly in their hands. The entire project was partner-led. Partners were responsible for establishing goals, achieving delivery, and determining success. They acquired the funding for themselves, including for our involvement, and they conducted all project management. Our engagement was outlined in a formal contract and technically, our remit ended there (though we felt a moral obligation to support the community beyond this basic level of support where possible given that they have chosen to invest in our technology).

Even in the most ideal participatory design or action research projects, research interests tend to drive the aims and general direction of the work, if not the specifics of the intervention, and this is strongly tied to the researchers holding the funding. Research agendas are explicitly written into research proposals, often before communities become deeply involved, and holding funding inevitably means holding a large degree of power to shape the direction of the engagement. Our project was different in that initial proposal writing and the management of funding lay with community partners rather than ourselves who became involved later once the agenda had been defined and the funding allocated. Our experience may offer a glimpse into what lies beyond even participatory design or action research: a project in which responsibility squarely lies with the 'users' and where there were no overt research aims to begin with at all. In particular, it may be that HCI participatory design and action research projects should hand over significant funding to the communities and participants they seek to engage, without many strings attached, as a way of rebalancing power relationships and enabling participants to take greater control of design.

6.6 Knowledge exchange as agile iteration rather than a linear pipeline

As a KE partner, we served as consultants, albeit not in a typical commercial environment. Ultimately, however, this led to research insights (that we report here), even though this was very much a secondary, even opportunistic, aspect of our engagement. More generally, research and knowledge exchange are not always well aligned in this domain. Lewis [18] reports significant tensions that arose in community heritage projects that were supported by both research (the UK's Arts and Humanities Research Council) and Knowledge Exchange (the Heritage Lottery Fund) funders including a lack of synergy between their aims and aspirations, as well as the more pragmatic issues of differing funding constraints and timetables. It has also been noted that university researchers could not see how being involved in knowledge exchange would enhance their research careers and that 'HLF showed little interest in the research outcomes of the community projects' [19].

Many disciplines with less of a user-centred and participatory focus than HCI explicitly adopt pipeline models of innovation in which research precedes impact, notably NASA's widely adopted framework of technology readiness levels (TRLs) [28]. In contrast, user-centred and participatory approaches typically involve more cyclic and iterative approaches in which research runs parallel to, or even follows, impact. Thus, Nenescape is hardly the only HCI project in which impact preceded research, and it will certainly not be the last. Indeed, a swath of practice-led approaches that falls under the broad umbrella of Research Through Design involves research emerging from practice to varying degrees. This is critical, but sometimes challenging, to communicate to funders and government. For example, the UK's REF has explicitly requires evidence of how you as a grant holder have generated impact that follows from previously published research. If a funder does not recognise the value of a backwards-looking approach, they may be less inclined to award funding. HCI can play a role in championing more agile relationships.

7 CONCLUSION

The Nenescape project provides a case study of handing over digital technologies to a local community that is distinctive in several respects. First, it has been a relatively long-lived project, six years to date, and so allows us to chart how a technology spread throughout a network of stakeholders over several phases. Second, it was very much driven by the community who secured considerable funding, approached us to use a specific technology, managed the project, and essentially engaged us as consultants.

Nenescape has yielded insights into the challenges of technology handovers and legacy in community projects. First, our mapping of stakeholders reveals how they spanned commercial, public and education organisations, as well as individual professional artists and local volunteers, each with their own motivations, practices, and constraints. It is important to understand such complexities rather than treating 'the community' as a monolithic or homogenous entity. Second, what is being handed over and left behind as a legacy does not only comprise digital technologies; there is also digital content, physical infrastructure (e.g. our signs), and skills. The challenges of maintaining the physical deployment in the face of wear and tear, vandalism and somewhat fractured local government boundaries, and the question of its long-term impact on the landscape, came as something of a surprise to us, and should be borne in mind by future projects that try to situate digital technologies within the community using signs, public displays, and similar physical infrastructure. Third, it was significant that Nenescape was framed for us as a knowledge exchange project, funded and led by a community partner, rather than ourselves. This directly placed power and responsibility in their hands while also delivering an impact story for us. It also separates the activity from familiar methodologies such as action research and participatory design as there was no upfront research agenda driving the work. Finally, the project explicitly addressed legacy through a formal legacy plan and contractual arrangements. While this is commonplace in humanities projects (including digital humanities) it is less so in HCI, and we therefore encourage our community to adopt such practices.

8 DATA ACCESS STATEMENT

In accordance with University ethics practices and relevant legal requirements, full transcripts cannot be made publicly available as they might compromise participant anonymity.

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