Creative Technologies Project: Reflective Report

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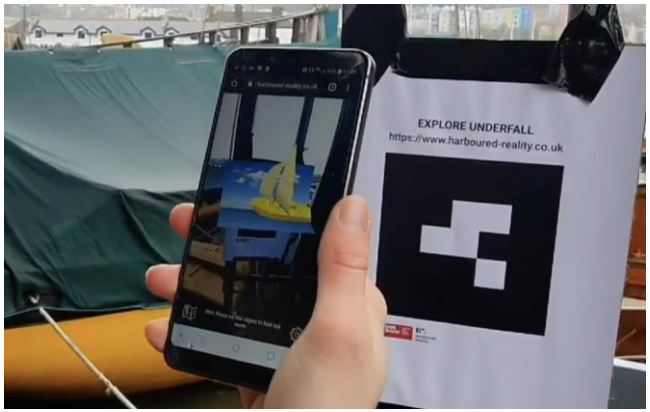

Abstract
This project uses Web Augmented Reality (WebAR) as a means to explore space in an interesting way, without the need to download a native-app. The aim is to reveal something new to the user through a specifically designed website that augments 3D objects, curated content and mixed media. AR.js and A-frame have been used and combined with digital media practices to deliver the experience.

Biography
Arron has a keen intrest in exploring creative and innovative areas of the digital world, merging skills such as creative coding, communication design, user centred research and rich-media production. This project provided an opportunity to delve into these interests and discover the emerging world of Augmented Reality and WebAR. Through this endeavor, Arron has not only learnt new skills, but also learnt about Bristol's maritime heritage which he hopes will encourage others to actively engage with their local places and communities.

1. Introduction

Harboured Reality is a WebAR experience that allows users to explore a stretch of Bristol's Floating Harbour with the intention to heighten the experience of the space and reveal it in a different light. A new layer of understanding of the space is dealt to the user that informs and contextualises artefacts that may often be overlooked. The environment of focus for this experience is The Underfall Boatyard, a key location of local maritime heritage significance along the Harbour Trail (Bristol Floating Harbour, 2009). Findings from early research interviews and observations of the space showed that Underfall is a multi-faceted place that prompts mystery by many who pass through the yard. People takeaway different elements and there is a lack of understanding of the space itself.

Historically, stories that have been told about a space have been revealed through plaques or monuments (Farman, 2012). But with the prominence of mobile devices, the ability to access information about almost any topic within these spaces has increased. Which instigates questions explored during this project. How can media elements affect our perception of these spaces? And how may we compete with and engage information in new interesting ways?

Augmented Reality (AR) is one such technology that can blur the boundaries between the physical and virtual environment (Rhodes, 2014). AR has many conceivable applications in various fields including culture or education, where AR can enhance learning further than the traditional approach (Pan et al., 2006). Both Civilisations (BBC, 2018) and Streetmuseum: Londinium (Thumbspark, 2018) allow users to uncover augmented artifacts to provide context and induce users to reflect in special terms. Mobile AR has increasingly become more of an availability to the masses through applications downloaded to their devices. However, Harboured Reality shifts the focus of AR away from native-apps and thus relinquishing users of hassles discovered during research that regard, space, size, time browsing or downloading from 'app-stores'. In this case, WebAR provides a useful alternative. The ability to access WebAR in any browser that supports webgl and webrtc means access is also cross-device (Etienne, 2017).

This project's deliverable is a hi-fidelity website for mobile devices; users can access their built-in camera to capture the physical environment, once this camera is directed at one of the markers in the space, 3D objects are superimposed on to the live footage in real-time, in the browser. Then by pressing on the augmented object users are presented with a series of screens in which they can navigate through to discover the historical surface of the space and stories, factual or otherwise, within the space, combined as a connected experience across locations. Each piece of information presented builds upon each other like a journey - to form a new understanding of the physical space.

Fig.1 Accumulator and model version.

2. Practice

Harboured Reality is ambitious in scope and the combinations of technologies being used provided fresh challenges. Having not used some of these languages and libraries before (SASS (2006), Node.js (2009), AR.js (Etienne, 2017), the learning curve required was broad as was the number of areas of digital media that needed to be explored.

There were also several frustrations at the beginning with setting up an appropriate development environment. Camera access requires a server with an SSL security certificate and personal hardware limitations meant that progress began slow. After some research, Node.js (2009), an open source server environment was implemented to provide a client.

2.1 Models and markers

AR.js is an open source JavaScript library based on THREE.js (2010) and JSARToolKit (2019) which allows for the development of html Web pages to include AR content. By combining this library with A-frame (2015) framework, augmenting models on markers can be achieved. Barcode markers are used in this project and they represent a number as a symbol, created with calculus on a matrix (Medium, 2018).

Throughout this project contextual interviews were conducted at multiple points with staff at Underfall Boatyard (referred to as the 'expert user') to gain insights about the space so that the content can be considered and be correct. This project will compete with existing media in the space [Appendix.C], therefore it became apparent that the platform should convey information that wasn't already available or obvious to people visiting. Also noted in research was that due to Underfall being a working place, they limit themselves to the amount of physical signs they affix. Points of interest were chosen that 'don't speak for themselves' which the expert continued to note were a constant struggle; 'we want to explain the slipway, but we don't want to have to cement signs in'. These markers would therefore provide an unobtrusive solution and discussions helped assemble content, elements such as the accumulator and the slipway which were chosen as people find them 'mysterious'.

3D Modelling was a new skill and building the accumulator frame took the most time. Videos on Lynda.com (2019) outlined processes in Maya (1998) of combining and mirroring which helped create the desired structure. Materials were applied to match the real artefact (Fig.1) but in reflection, custom texture UV-mapping (Autodesk, 2018) would have been ideal on the drum for more detail. However, asset loading became an issue, which is covered in project outcomes. All models were imported as object files with A-frame extras (Github, 2019) and then positioned and animated in the browser.

2.2 A-frame audio and video

Mobile browsers don't allow applications to play HTML audio and videos automatically without an explicit action (A-frame, 2019). In A-frame, this needs to be a

user interaction, such as a click. However, since audio wasn't seen as a leading element in research due to the nature of needing headphones in a public space, the audio is off by default. This is highlighted by an icon in the camera UI overlay. By pressing this icon, audio will play, by clicking it again audio will pause. Audio is also paused when the marker is lost so that it doesn't loop forever. This feature was only applied to one marker as a proof of concept that could be used across multiple markers. In reflection, you could argue that the sound is overkill as there are sounds in the environment around you, but this extra layer along with animated content provides a higher degree of emersion and yields connection to the objects themselves.

2.3 Click Interaction

Users of Harboured Reality can press on the augmented object on their screen to unlock information about it and the space they are in. To produce this, two questions needed to be answered. First, how to detect a user's tap, and second, how to determine what marker and which object was tapped to serve-up the correct information from the database.

A brief search on Github revealed many event-related issues, this is because AR.js is built at the top of A-frame and it's not clear how simple events on 3D objects can be handled. A-frame is an Entity Component System (ECS) which allows for the registration of your own components (A-frame, 2019). In our case, a custom component was created named 'click-interaction' and then attached to the '<a-marker>' entities to provide custom functionality. The option made most sense as it's not yet possible to add a tap handler directly on to a 3D entity.

The click event needed to be dynamic and scalable to allow for the possibility of new markers added around the harbourside. To combat this, instead of accessing the HTML entity 'object.visible' when the 3D object and marker was captured by the camera, a stricter conditional statement needed to be applied. The result is a comparison of five values to see if the event, intersected object of the event, object interested ID, a custom attribute 'dataset' and the marker are the same. Once satisfied, the modal of information appears with CSS animation and overlays the camera feed.

2.4 Information screens

Brought to attention in the research phase by interview participants was the desire to not include 'lots of text' as this can appear boring, with the expert participant recommending that 'visual was better'. Therefore, simply displaying content on a scrollable modal appears dull for user engagement and could be quite lengthy. By considering the recommended changes by the project supervisor, users are instead presented with a series of screens containing information data that supplement each other.

There were a number of hurdles to produce this content across different screens and for it to be dynamic from a mySQL database. For instance, each screen of

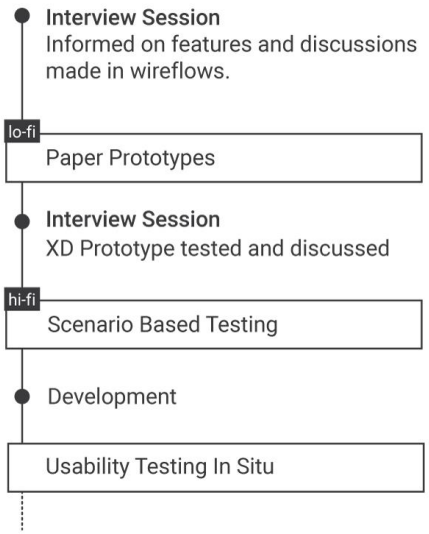

Fig.3 Prototyping workflow

information which we'll name parts, could have different types of media on it, either text, image, video etc. These media could be arranged in any order too. As a result, each row of the database is a HTML element that's later injected into the modal. AJAX (Asynchronous JavaScript and XML) was the obvious method of choice as it means that data is sent and received asynchronously. The heavy lifting is made by PHP (Hypertext Preprocessor) which receives a GET request once the user taps on an AR object. All rows that match the Marker ID field are queried, ordered and then sorted into a parts array

The most challenging aspect of this implementation was to update the modal with new data when the 'next' button is pressed loading the preceding part. An index of part was created to count an iteration every time the next button is clicked indicating a new part. The process of updating is split into two functions so that the data can be rendered into the correct media format using a switch statement and then output into the inner HTML of the modal body.

In a professional context, for this scale, a locally stored data JSON file would have reduced development overheads. But mySQL was chosen for a more scalable approach, if the decision was made to add more markers.

2.5 Prototyping

Low-fidelity

AR by its nature is user-centric (Rhodes and Papagiannis, 2014) and throughout this project users have been consulted at various stages to inform on design decisions. Semi-structured interviews took place in with expert users to consider possible features and navigation structures [Appendix.D and F]. From these discussions wireflows were developed [Appendix.E] and tested through paper prototyping to identify any issues in the flow and design (Usability.gov, 2019). However, the participants had no preference over either linear or global navigation proposals. Although one participant stated that they preferred the global navigation as it's what 'you're given to expect' in native-apps. This design draws from concepts people already know (Nielson Norman Group, 2017) but aren't geared towards website design. The linear navigation was chosen due to its simplicity with the camera screen acting as a home page.

Other features raised were instructions and a map feature to 'help keep track of where the markers are' to benefit users without prior knowledge of the project. Onboarding was introduced, a process of familiarising users with a new application (Material Design, 2019). Therefore, addressing concerns of the expert to 'not overwhelm people' by providing too much information. The instructions are kept short and a progress bar indicates where the user is in the system (Nielsen and Mack, 1994). It's a way to indicate that the task is incomplete and thus increase the likelihood it will be completed by the user (Medium, 2017). To avoid users forgetting instructions, not only are they forced through this process but also a hint section is added on the

camera screen to direct users to press the 3D object.

High-fidelity
During the second session there were further discussions and users (peers and expert users) were given a high-fidelity prototype [Appendix.G] made in Adobe XD (2019) that helped to determine the look and feel of the website but also provide realistic visual interaction. The method of task-based user scenarios (Usibility.gov, 2019) were used to evaluate the content and the linking structure [Appendix.H].

All participants found most scenarios straight forward although issues arose when trying to navigate from the camera to the about icon on the welcome screen at scenario 5. Each scenario lead to the next so they had to navigate accordingly. As a result, this scenario created some hesitation as users had to navigate back through onboarding to the camera and to the settings to return to the welcome screen. This felt like a long process, ideally this data would be presented in modals on the settings page, but due to time constraints and wanting to focus on the main features, settings isn't interactive.

3. Discussion of outcomes

3.1 Optimisation

Harboured Reality is an unconventional website. To provide unique experiences on the web for new and emerging technologies like WebAR, perhaps these sites need to be built with a different approach by thinking about optimisation first. Towards the end of development, it showed that this may have been an oversight to not consider asset and state management at the beginning of the project. By adding additional features that weren't planned at this point meant that loading time became more noticeable on some devices, depending on connection speed.

As a contingency, a loading message has been implemented on the camera screen, that uses a pre-defined duration set before it disappears. Ideally as an improvement, this needs to be dynamic disappearing and launching the camera once the assets have been loaded locally. Due to time constraints this was not achieved, but the pre-defined duration was set for some user feedback (nngroup.com, 2019) to reassure users that the website was preparing the experience. Require.js (2010) and the Lazy Loading (Fowler, 2003) method could be beneficial to include in a future context. This would improve reliability across devices, browsers and connections.

3.2 Usability Testing

Following the Deming Cycle (Deming, 1950), a final iteration of user feedback was conducted [Appendix.I]. Markers were set up in location and potential users were asked to explore the site, find each marker and use the website in a casual way within the environment. Using the phenomenological approach (Dennett, 1991), users expressed their thoughts and experiences that appear in consciousness through the method of concurrent think aloud (Giles, 2002). The

process went well, considering there was a concern that the think aloud method would distract users. Instead of probing the users as they conducted tasks, further questions were reserved to the end to provide a deeper summary of their thoughts. Usability testing provided insights into both strengths and weaknesses of the concept.

Asset loading was an issue for some on poor internet connection, but once loaded, participants all stated how simple they felt the process was. The strength seemed to be the UI design [Appendix.J] and the clarity of navigation, content and instructions. Participant C and D stated that perhaps the hint dialogue on the camera screen could have been bigger, but both seemed to know what they were doing. Participants were often surprised when they first saw augmentation of objects around them and able to link it to the space with participant C saying, 'I didn't really know that much about this place, so I've learnt something.' You could argue that the 3D models presented are simplistic in style, this is in part due to load-time limitations. But research has indicated that the general public don't want realism but entertaining immersion. It's suggested that it's not a lack of realism but a lack of meaningful content which impedes the enjoyment of mobile heritage (Champion, 2006).

The expert user was also consulted to see if the final deliverable met the original goals set out for this project. He stated that it complemented the interpretation (other medias) of the site and that the information provided was 'short enough that it wasn't annoying'. Other participants also shared this view by liking content to 'bitesize chunks'. This met the point raised during research and development interviews to not 'overwhelm users' with content. But perhaps considering options to learn more at other external web sources was suggested.

Overall feedback was generally positive. There was one confusion that cropped up from several participants, which could be a future improvement for better user experience. On the last information screens users found it unclear how to exit or if it had ended. The 'x' icon may be ambiguous in its design, the expert user suggested to make this more explicit.

3.3 WebAR

The immediacy of accessing the platform resonated well with participants too. Whereas other projects in the field of AR expect users to download applications (BBC Civilisations), Streetmuseum) by first navigating then searching application stores, which is timely and requires phone space. Here the entry point is much simpler. By accessing the browser and typing the URL, a user is instantly presented with the site and is able to interact with it forthwith. By knowing it's easy to access could promote it to be used over different days when people find themselves at different points of the harbour. Using AR.js has shown, it's not necessary to download a third-party app that could deter users. Delivering augmented reality on the web and making it suitable for a range of users and abilities is the key to

Fig.4 Qr-Code Marker

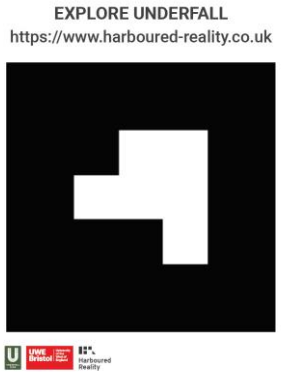

Fig.5 Final Marker

making this technology pervasive.

3.4 Markers

Marker design is crucial as an entry point for users. A combination of QR-Code and barcode marker was initially tested in development (Fig.4) but due to the scale of the marker in this example, the augmentation becomes jittery and unstable. For this reason, the final printed markers are large with a URL provided [Appendix.K] (Fig.5). Feedback from testing suggested that the markers should be more explicit, prompting users to 'visit this website to explore the space'. Of course, marker-less augmentation, without the need of markers could be used with geolocation in a professional context. But markers are just as valid for this type of special work. By removing that initial interaction of 'scanning' a marker also removes the level of engagement, which is shared by other special AR applications such as Spacial Heritage (2018).

3.5 Learning Outcomes

The project timeline [Appendix.B] was followed but by attempting to add futher features shifted plan, resulting in some tasks to be concurrently completed in the last four weeks [Appendix.A]. But it's believed that Harboured Reality has been successfully completed and the goals of the project met.

4. Conclusion and recommendations

that allowed me to delve into multimodal design practices (3D, interaction, user experience, interface design, multimedia, data and spatial). By exploring and discovering these disciplines has allowed for a varied showcase of skills and understanding grounded in digital media. The relatively new area of WebAR has been exciting and the potential of libraries such as AR.js are only emerging. The most rewarding outcome has been learning and improving confidence in programming, especially JavaScript.

With the focus at Underfall Boatyard, Harboured Reality provides value to their space by supplying quick access to engaging with content that benefits both users and the organisation. The platform outlines the groundwork for a potential expansion along the harbour trail that could be installed especially for maritime events such as Bristol Harbour Festival or for casual permanent use. By bridging the public and personal space, users can access the project with their own devices, without needing a native-app.

In addition, further developments are needed to iron out issues outlined within this report such as asset-loading and run-time. But also, a higher degree of detail on the models with added gestured interactions to rotate, scale or launch events would take the experience to new heights of engagement.

Finally, leaning about Bristol's maritime history has been interesting and investigating the local area has been insightful. The input from participants and Underfall Yard Trust has been greatly appreciated and it's hoped that Harboured Reality will encourage others to engage with their local places and communities.

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Appendices

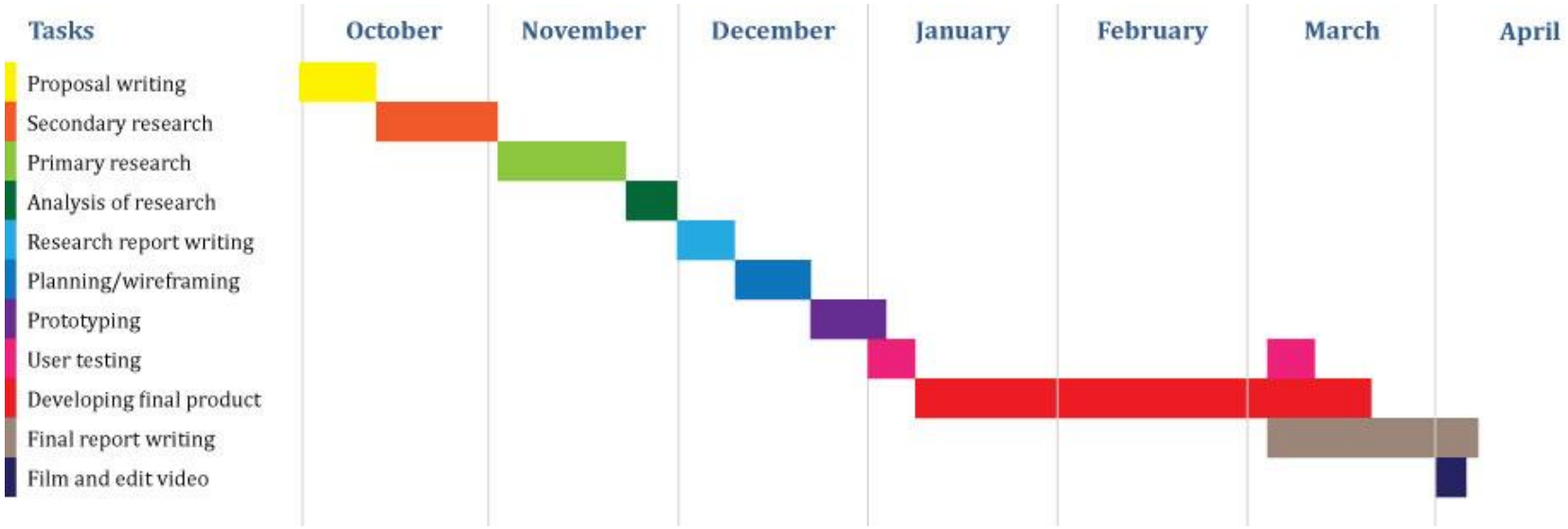
Appendix A -Project Log

Name: Arron Taylor-Peter **Student Number:** 14041505	**Project Title:** Harboured Reality

Week	Task	Outcomes	Takeaways
JAN 14-20	Present Demo. Colston Hall Showcase. Learning SASS, Grid and Flex to use later in development.	Demo feedback: could consider map to help users navigate or introduce gamification elements. SASS needs ton be compiled so need to look into this, but research shows that you can nest styles and use variables which will make work efficient.	Need to discuss feedback with supervisor, don't feel gamification suits the project. CSS Grid and flexbox seem to be the most obvious option to style and position elements consistently.
JAN 21-27	Meet with supervisor. Reading.	Discussed demo. Continue Reading into areas of AR, especially Virtual Heritage Project.	Need to fix loop problem on click interaction. Sometimes it firers repeatedly by it's self
JAN 28 – FEB 3	Contextual Interviews, Fixing Demo OnClick Issue. Design wireflows, testing.	Semi-structured interviews with Underfall. Discussed possible content, features and navigation. Issue fixed, had to really delve into the marker entity and compare intersected element with the marker id. Two wireflows have been designed, one for linear navigation. The second for global, like an app.	Discussions were difficult as they were more interested with what content could be displayed rather than answering some of my questions. But instructions and a map feature seem like a must to help users. Could do different interactions on this click event now. Need to test these wireframes with others.
FEB 4-10	Start designing hi-fi prototype.	Using a mix of Adobe Illustrator and XD.	Realised that 'Investigate' button may be too big.
FEB 11-17	Finish Design Icons – asking peers. Scenario Testing.	Map Icon appeared like user icon to some people. Positive feedback, like the illustrations.	Could animate the illustrations.
FEB 18-24	Decide on 3rd location	Want to keep it people based. Been provided audio clips and transcripts.	Cut down appropriate clips for consideration.
FEB 25 – MAR 3	Building UI Onboarding Camera screen	Building the first main screens using SASS and HTML.	CSS partials have been used to nicely split up style sheets.
MAR 4-10	Thinking about content, need to make improvements so that it's not dull.	Reading back proposal and research report to remind myself of goals.	

MAR 11-17	Meet with supervisor. 3D modelling. Contextual Interview	Present work in progress and discuss improving engagement with the information presented from interacting with the marker. Watched Lynda tutorial.	It would be better perhaps to be presented with information that leads on to another piece and so on.
MAR 18-24	Meet with supervisor. Database/ajax/php	Discusssed improving the information screen engagement, where one piece of info leads to another.	Will need to investigate how to update the modal on each information screen.
MAR 25-31	Ajax looping through parts. Begin writing report. Built map and settings.	Managed to loop data array correctly.	Need to test this further.
APR 1-7	Meet with supervisor. Continue writing. Begin Filming. Refactor code.	Adding animations and audio was suggested to bring it to life. Animating in a-frame is mostly trial and error, trying to work out scene positioning.	Audio assets have slowed the site load time so a loading screen has been implemented as time constraints mean I don't want to be adding additional features in the final week.
APR 8-14	Usability Testing Finish Writing. Edit video, Submit everything.	Usability testing showed that stronger internet connections are best, but once loaded people seemed to enjoy the site. They particularly liked the UI and navigation flow.	

Appendix B – Project Timeline



Appendix C – Existing Media

Observations made in the yard.

There are two A-boards introducing The Winch Shed and the Pump House. In the pump house are very limited amount of information. A chalk board displays times of public displays.

Fig.1 The Pump House

The accumulator and the entrance to the Yard are the only to significant medias in the space. They are signboard with custom design in the Underfall branding.

1. Entrance Sign – This is a map showing the different buildings, exits and a little history.
2. The accumulator sign shows a diagram of how it works but requires effort on the reader's part to imagine the process.

Fig.2 The accumulator sign board.

Also, lo-fi paper media are available around the harbour side that partially inform on Underfall. SS Great Britain have their own trail and so does http://www.bristolfloatingharbour.org.uk/harbour-trails/.

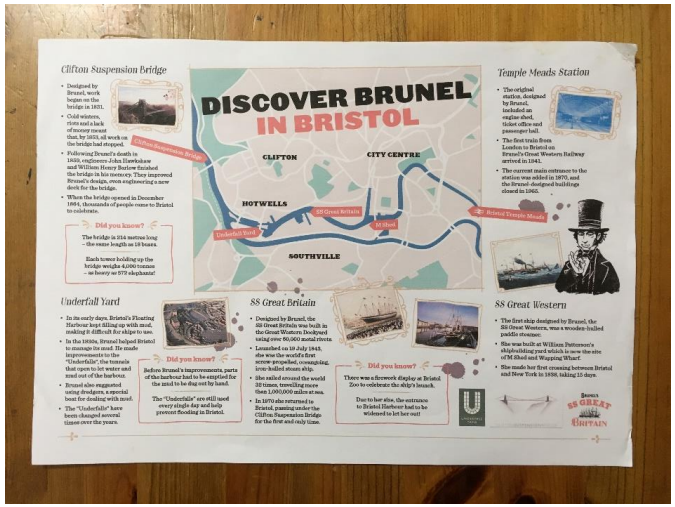


Fig.3 Paper based harbour map from SS Great Britain.

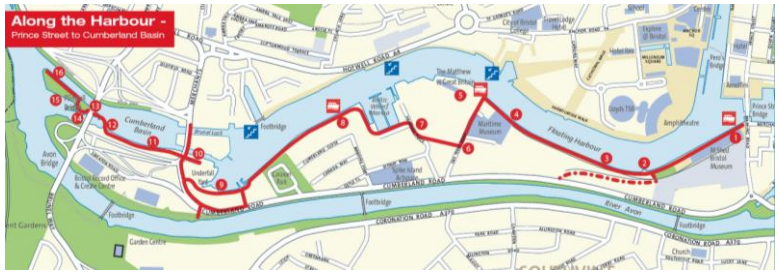


Fig.4 Image of Harbour Trail from www.bristolfloatingharbour.org.uk (available online).

Appendix D – Transcript of discussions.

Transcript: Underfall Prototype Feedback Discussion 31/01/19

BOLD – Arron
Regular – Andrew (expert)
Italic – Mark (expert)

So this is available if I get my phone out. How will you tell them that? Will there be a sign? To get their phone out and do it? You know once you do it would you then need an introduction screen?
I'm probably a good person to ask about this because I'm not someone who is computery. So I think about it from the point of view of someone who doesn't tend to go in for apps and things, you know I'm just not really

that person – maybe a lot of people are like that. So I'm just trying to think what would want me to engage with it. I think maybe the one thing it has got going for it is that you don't have to download an app.

That's the big usp.

Yeah because that's frankly very off-putting, I find when you go to a museum and they say you have to download an app. Really? Come on! I can't be bothered.

In my research I found people said that.

Frankly you will need a sign or a poster to instruct you of what to do? I suppose you could put it next to the marker would you not?

What do you think would be best as a user?

Often audio tours do the same thing..

Audio is another option.

Yes you could do, but you have got to have something to start off with. You imagine there will be signs, one or two signs around which has got weird symbols on it which could draw peoples attention.

Could you just not have the web address? Go to the web address and point your camera at this. Let people work it out.

Could you use a QR code?

But again that would need an app to scan QR codes whereas at the moment you type in the url which is much easier.

Right

Do you like the mystery of just having a website?

I think people will work it out.

Should there be a welcome screen?

If you for example had a marker there and one at the far entrance and one in the middle at the slip way. You don't know what direction people are coming from. There are technically three entrances around here. Someone could stumble across your marker in the wrong order.

So logistically I'd have to work that out. What if there was a map or a menu that listed all the different markers do you think that would be something that would be useful?

Maybe so. I mean I think people are also a little suspicious of random websites on random bits of paper. I'm not sure if that was part of your research, how do people feel about that image and what is it going to do

to my phone. Obviously even I know this project is not a problem, but maybe there are people that would think is that somehow putting a virus on my phone.

Often websites have security certificates.

Yes this has got a certificate, I wouldn't be able to access the user's phone camera without it.

It has? Great.

I was just think, if it looks like an official information thing than people are more likely to trust it. So I would sort of imagine if the joining instructions were on something that looked official then people would probably do it then.

That's an interesting point because that's the first time that's been raised actually. The credibility of it.

I could just be our mad paranoia.

Haha It's always good to be sceptical of new technologies.

I mentioned the map idea just now and you weren't that interested in that concept?

Would it be three you're thinking of?

For this project yes.

But there could be more.

If it was to go further, then it would be along the harbourside yes.

It will help keep track of where you are I guess. Just a quick thought. What would the difference fundamentally be between putting a number up, lets say by the accumulator and you give someone a guidebook. What's the edge if you like that this brings?

The point is that you don't have to print books of course, but it's interactive, you can read more and it will take you to more information.

It would be lovely as well to have a picture of The Matthew on there.

I saw it when I was filming.

I would take your chance to get more photos because the slipway is usually empty. Well 35% of the time there is probably something on it. That's the secret they get if they bother with this. It's interesting because they will see the size of the thing. And the accumulator they will see it go up. Obviously a guidebook could show you a picture of The Matthew but it's nice to discover that for yourself.

Back to the instructions. Aren't they incredibly simple though?

I'm more interested in how you access and use the instructions rather than what they are. So for example if there was a map available how would you imagine you'd find that and how would you interact with it? I want to make it as straight-forward as possible.

Is it better to have a menu or an icon? Those are the sort of thing I'm interested at looking at at the moment.

Unless you plan to be ground-breaking or whatever then you should lever on what people already know. If there navigation features you need you should try and take it from them. I mean here, our tour has 11 stops to it. That's the number of interest points we have. It doesn't sound like a huge number to navigate around.

For your three locations, what are they?

I haven't decided on them yet.

There is another one that I didn't remember about when we first met. You know the accumulator is raised by electric pumps and those pumps are the great engine type things that you may have seen, that's actually be a seriously good use for us because we have to decide to put up many signs in there to explain them. It's quite a hard concept for people walking past to get. It's not like a steam train, where you get what it does. They are kind of abstract, they make that go up and make things in the past happen. So, we don't like to clutter that with too much interpretation, too many sign-boards because we don't want to turn it into a museum. And the volunteer that's on duty in that area may explain it. There's not always a volunteer in that room and so a lot of people walk past and not really know what they do probably. So that would be good location from our point of view actually, if you're searching for another one. That would be a good thing for us. To have something as discreet as that in the space to say that will do it.

At the moment when I press on the augmented object it takes you straight out of the scene and presents you with the information. How do you feel about that?

Would it be easy to come back from where you've gone too?

Yeah. Back button?

Something like that yeah. Otherwise it becomes more complicated. I don't think most people will want to randomly jump around.

Could you have it so, I have my phone, I scan it, it's great. I don't have to do anything, I then just walk around see another one and even with the accumulator still on my screen, I can scan a new one.

You would have to be on a camera screen.

If the back button was shaped as the camera I think that would make it clear I suppose.

Can these markers look different? Like a camera? Can they be any size?

I suppose it's how far you stand from it?

You could print it on a massive billboard and stand really far away.

Or the opposite where you have to go all the way up to it to see it?

Yes I could play around with that.Do you think being able to interact with the elements augmenting in the scene is important?

3D models of like the accumulator?

You could with the accumulator, pan around to the top, press the little access hatch and then you would zoom in and see the scrap metal inside.

Is that's what's inside?

Yeah it's supposedly a scrapped dredger or bits of. So you see all sorts of gears and wheels inside.

The accumulator you definitely need to know what it is. When I've got school groups and things, of all the things we have it's relatively the hardest thing to actually explain.

You could have an Easter egg inside that if you get it you could make it pop up through the roof! This happened in 1965. Yes Mr. Homer was in the sluice room, I was told, when there was an electrical fault and it kept on going through the roof. I don't know how dramatic it was. I've not been up to see what the evidence is, to see if it was real.

This is great content. These are little stories I like.

In terms of the user, I have relatively very little experience of self-guided apps and things. What I mean is I don't have much draw having not used them that much in museums and things.

It would be important not to overwhelm people. SO they scan it and get 12 options and it feels like a lot of work. You know I just want a couple of things, maybe a video.

Do you think descriptions should be short, maybe with a photo or video and then an option to read something a bit longer?

Yeah and an option to spin the 3D thing and look around it and inside it. That really appeals to me.

How much time do you expect people to realistically stay within your site looking at stuff? Maybe think

about the target time too. I can't imagine anyone, will you know, see a lot of options and not think it's a bit much.

Defining that content is important.

Content that goes beyond what's already on the boards. It will need to add something else. Whatever's on those it needs to be a bit more you know. If you look at those boards and still don't get it, maybe that's something that should be look at.

The process of clicking through seems quite simple. The user interactions that are laid out here?

I think so, the most obvious easy – you could see this as a reference that could go into great detail., But I don't think that's for the casual visitor. I would have thought the things to focus on are the things that you don't see on the day-to-day.

So looking at these wireframes, what do you think? The welcome screen has 2 buttons, info and the camera. The camera takes you through to the screen where you augment and by clicking on this object it then brings up the information.

How do you know you can click on the 3D object or a thing? Also, wouldn't you need to know what you're looking for or what you're scanning? Even if it said 'find these'.

These are good points, I would put them in the instructions at the start.

But I may not always read the instructions. I might just launch into it?

Oh I didn't think of that. Perhaps it should be forced on the first visit?

You could take away that option. But you don't want to see the instructions every time.

If it's very simple I think that would be a good thing to do. It depends how wide you open up to the audience I suppose. Because would it be inclusive for children that's something to think about content-wise.

One more thing in terms of content. One of the things people seem to be interested in when I'm doing tours and I see it on there faces is the world war II damage. Whenever I point that out to people..

Was it hit directly?

Well there's shrapnel and some people say machine gun marks or cannon marks. But there are marks on the walls of the accumulator tour and the visitors center as it now is and at other points around the place. People go 'oh really' you know they always react like that.

Appendix E – Wireflows

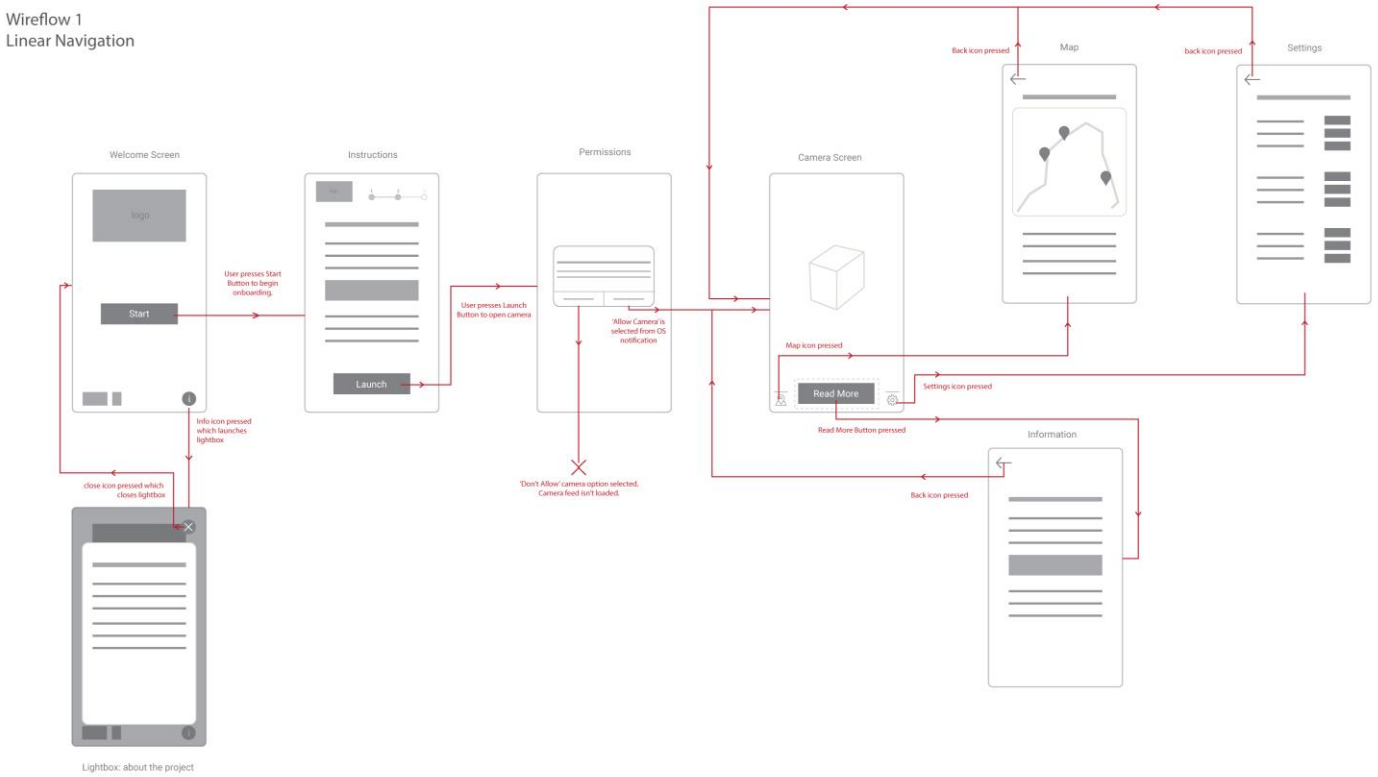


Fig.1 Wireflow 1 – Linear navigation

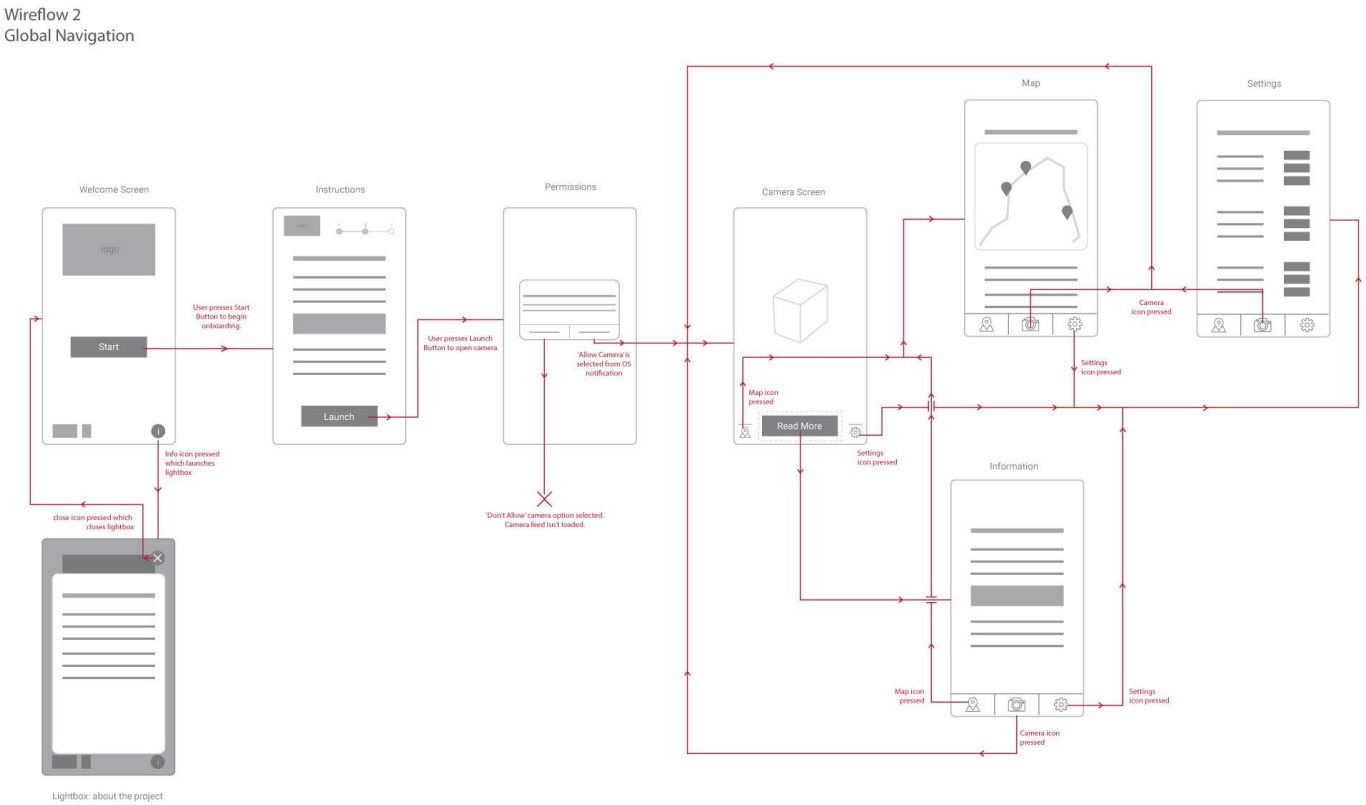


Fig.2 Wireflow 2 – Global Navigation

Appendix F – Transcript of Discussion 2.

Underfall Catchup (March 2019)

Comparing navigation of Wireframe 2 and Wireframe 3 – Linear Navigation vs Global

What would you prefer?
Perhaps W3 could be considered a little confusing? So, let's just imagine I stand at the accumulator and this is on a little plaque [gesturing to marker], I do the process and I press something, click?

Yes

And then this comes up on my phone, information an image a little bit of audio or whatever it is that you've got and I can bounce between these map and back?

No, you wouldn't be able to get back to the information screen, but back to the camera.

I see. My disadvantage I have is that I personally I'm not a big user of maps and don't tend to use apps that often. This is not an app, I know, I tend to check my emails in my browser, and I get a little message from Yahoo saying I should use the app you know. But anyway, flexibility is what most people go for. This [W2] might feel a bit amateurish, back, back, I don't know? Whereas this [w3] is what you're given to expect with BBC News app which is a high-quality thing. You can jump from that to, that to, that and not think about process or directions.

Some things start with a map thing of course which tell you where you are and then burrows down you know so you don't get lost. But this is you know, relatively simple. If the back button takes you back to a relative place then yeah, the camera screen acts as like a home page.

Exactly, everything is navigated to from there.

<u>Looking at icons.</u>

As you can tell I want to use icons to represent those pages, map and settings. I want to find out what you think of that and what you think of the ones chosen.

Yeah, that's great, everyone does that now, it's simpler. What is that there a little face?

That's the map icon. A couple of people have said it looks like a user icon shrunk down. I have some other options here if you could take a look?

Yes, I would say to rule those out (indicating to first two) they look like leaflets. The pin has sort of become as the icon of choice you know. They aren't too bad but are a bit busy for a small icon (3, 4). The pin on it's own is getting towards the point now that that's universally recognised as the location.

<u>Content and Information Screens.</u>

If you remember back to a previous discussion you suggested that people don't want loads of text and information thrown at them. People are going to get bored. I've worked to improve the information screen so that it's little chunks of information and you click next and get another piece up to a maximum of four.

And then they can go straight from the fourth one and back to the camera?

Yes exactly.

Perfect.

I have put some content together that you've provided and I wondered whether you could review it to see if it's factually correct?

Slipway [Part 1, Part 2, Part 3, Part 4].

Yeah, I really like this and it's really simple. Another evolution you could have of this is have it that the fifth-slide so to speak could be the more graphic detail. Getting into the nitty-gritty about the whole thing. But 90% of people don't want that, they just want to look at it and they want to see the thing working and then they'll move on. The video is probably the thing they like the most.

Having the timeline first on the slip, is having text too boring?

Yeah that's so light touch it's fine, it's video that people will want. You definitely need to add the context at the start.

[Accumulator part 1]

And the next one is the accumulator, do you do those drawings?

Yes

They're really nice, how did you do that?

I use a programme which allows me to draw them.

They're great, I might be cheeky and ask if I could use that! You could make a little fridge magnet out of that.

If I have time, I'll animate them.

That's cool I could put that at the bottom of my email signature! That would be sweet. Anyway so, let me see, can I write on this?

Sure

Okay I would rephrase this. The system is the whole harbour and that system doesn't work anymore. But what does work is the pumps plus the accumulator. It is still technically a system, the water goes in through the pumps and raises that and then goes back in. It is by definition a system, but it's not actually working.

There's a risk there that the public could actually think that if that goes up and then comes down that a gates working. It's not true. But you could probably get away with that. I would maybe change this paragraph to the hydraulic system use pressurised water to move bridges, sluice gates, lock gates. That's all I would say.

Next one, [part 2] will this be animated too?

Yes, I would show the water moving.

Yeah, you know what I would think about is if the little pipe came off like this instead [outflow pipe] and somehow, I don't know, you could animate a little swing bridge moving. Or maybe the sluice paddle, although they might not know what that is. Or a crane, let me just try and remember what type of crane it is. Because that would be easier to animate. That would really help matters because all our diagrams they don't show the bridge, the things, it just says 'to the network'. What I'm going to do before I forget is get you an image of the right crane. Because there are so many different types of crane that I wouldn't want to mislead you.

What's that called?

It's a hydraulic crane and you could probably re-create that.

Thank you, that looks good.

And so, this one then. [part 3]. Did you read about that one then in the transcripts?

No, Mark told me the story.

Well, be careful, because it is said.

I know, but do you think people like little local stories or myths like that?

Yes definitely, in essence, that's about the original accumulator is in the tower of course. In WWII they were worried it would be bombed and out of action. So, they made a kit. A kit accumulator so they could install it very quickly, knowing it was ready to go you know.

That would have been very heavy wouldn't it?

Well, yeah the whole thing itself would weigh 100 tonnes.

So that one you see outside the building is the kit one?

Yeah, so they didn't need it in WWII, but in early 50's they needed it because it's said that the original wouldn't stop going up. That's what is said. The thing with this is you're absolutely right, there's so much you can say, as I'm talking, I'm thinking this and that.

Yeah, I'm trying not to bog down

-exactly right. There's also war damage.

Yeah bullet holes and shrapnel? Or they think that?

Yeah, yeah, bullet and shrapnel.

Where are they?

They're sort of all over the side of the building. Particularly on the tower. But yeah that's the story about that. I don't know if you're going to get audio to tell about that accumulator story. The risk is sort of with text, you don't want more text necessarily.

So, is the accumulator story not true?

Well, the fact that it's said is true.

Do you think people like little stories like that?

Well we tell, well, some of our guys who do the talking they tell people that. Then, on to this one, [part 4] I would change that slightly. The Underfall Trust cares for and regularly operates the pumps. The other thing you could do, this story is great [accumulator through the roof], and you're going to animate this diagram. You could get a video of it going up. Is there any way you could tell the story and give the details, either audio and text, or whatever and the they vote. Would that relate to others? Or could you tell them the story and ask them true or false?

You could do that, that will be nice to add I think.

Did Underfall play a role in WWII then?

Not massively no, but a building was destroyed where the car park is now. You could do a spot the war damage.

That leads us on nicely to marker 3. There are a couple of options here, the war damage you mentioned. Or the winch shed and operating the slip, but it's similar. The other would be the cranes up at Mshed.

-that's a bit of a well-trodden path.

Or something about Docks life, I'm trying to get something a bit more people based.

Yeah, I know. The audio files are the closet things we have to that. It would be nice to keep it all in one location because the cranes down in Mshed are a bit of a pain, especially for your testing session. What about the boat builders and the boats they build like the Bristol Pilot Cutter? That's people based, I mean you might not have time to get too many anecdotes. But you know, it's still craftsman based, it's what they do they work with wood. The pilot cutter is really interesting. Have you seen it? Well if you step outside, I'll show it to you...

This is called the big shed, in there we have boatbuilders. This boat was made in there and is owned by the guy who owns the company. They used those to race out as fast as they could to the incoming boats to

meet them. The first pilot who got there was able to use his pilot skills to bring the boat in. So, it's like an early form of a fast yacht. We have some brilliant photographs of it in action that we can share with you. That's one option. The boatbuilders are in here.. this door is often shut.

[walk towards pump house]

Wow, I can see the bullet holes now. I never really noticed them before.

Yeah, a lot of people probably don't.

[entering the pump house]

If you remember that you said, that your work is designed to bring people to engage in things yeah. One thing that we've deliberately done in here is not to put up too much interpretation. There's actually a couple of posters, but that's it, there's not really any explanation. That would be genuine use to The Underfall Trust because someone could come in here and scan a marker and be told about these. We have footage of these things working. It's up to you, I know you have a little concern because you've done the accumulator. But we do draw the distinction between the accumulator and the whole system and the pumps. To be honest it would be boring for most people, but not for me I like it, but it's not everyone's cup of tea.

<u>On the topic of testing</u>

Where would you position them?

In heritage sites you obviously have to be mindful of the protected nature, so you couldn't just come along and drill it into this. So, you need to think about that. Even in some sites, you can't even put in a sign in, because you have to dig the ground in. Sticker. That's what I would do. As long as people can see what the hell it is. Did you say you were going to label the markers?

Yeah that's the plan.

Appendix G – XD Prototype.

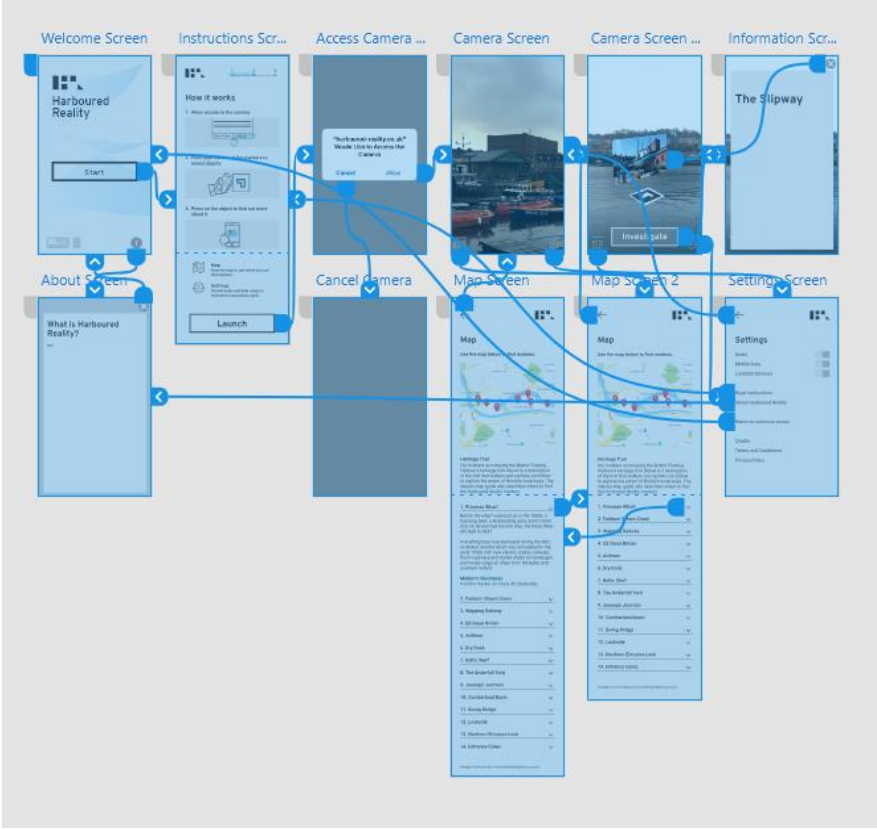


Fig 1. Screenshot of prototyping in Adobe XD.

Appendix H – Task Based Scenario Prototyping

The aim was to identify how the participant accomplished a task and to show whether the interface facilitates provided any problems or fall-offs. Information regarding how to complete a task was not provided.

The Scenarios

1. You are standing near the harbour and come across this marker. What do you do?

2. Follow the steps and augment an object, then tell me information about it.

3. Now find where another marker is.

4. You've forgotten the instructions, how will you read them again?

5. You want to know who is behind this project and why it was made.

The testing was conducted with three different users, these users have been catogrised in the table below by asking the following questions before-hand to determine ability and experience. For scenario one the XD Prototype was not given, they only had their phones. An image with a marker and url above it was also provided. From Scenario 2 onwards the High-fi prototype was provided on an iPhone 5s.

These different users were chosen to represent the potential audience that may casually come across the markers.

User Type	Name	Age	Education	Occupation
Novice	Participant 1	30+	Masters degree	Community Engagement Officer
Intermediate	Participant 2	20	Student	Events
Expert	Participant 3	16	A-levels	Retail

Table.1 User Classification.

Question	Novice	Intermediate	Expert
Before Testing			
What would you consider yourself as; expert, an intermediate or a novice.	Urm.. As you know I don't have many apps and things and it took a bity of head scratching to work our what it is. AR. So novice.	Well I know what it is, but I've only had limited contact with actually having a go. Obviously everyone had *Pokemon Go!*	I have *Snapchat* and *Pokemon Go*. Does that count?
What would you expect to find in AR application that informs on the space around you?	To tell me about the history, have some information or 3D thing pop up that tells me about it.	Maybe make you think about the history more, something you wouldn't already know.	Some cool 3D stuff that move around.
Are you interested in your local places?	Very much so! There is always new stuff to learn.	Sometimes, depends if I have time.	I guess. But I don't explore that much, it's something I need to do.
Testing			
Scenario 1: You are standing near the harbour and come across this marker. What do you do?	The user opened their camera first and realised that that didn't work, then navigated to the web browser and entered the website address.	Opened the camera and hovered over the image.	Opened the camera.

Scenario 2: Follow the steps and augment an object, then tell me information about it.	Proceeded well through the onboarding, taking time to read instructions. Got to camera screen (slightly confused by the prototype as nothing was augmenting) then clicked screen again to reveal it. Then clicked on the investigate button not the object.	Proceeded through on boarding quickly not appearing to take much time to read. Clicked Investigate.	Proceeded through onboarding at a usual pace, reading and then clicking Investigate button.
Scenario 3: Now find where another marker is.	Closed modal, after some hesitation clicked the map. (Hesitated between map and settings).	Closed modal and pressed map icon.	Closed modal and pressed map icon.
Scenario 4: You've forgotten the instructions how will you read them again?	Pressed back and remembered reading that they were in settings. Navigated to settings and clicked appropriate link.	Pressed back and after some thought clicked settings and found the link.	Thought and then navigated back to the camera screen and clicked settings and then the correct link.
Scenario 5: You want to know who is behind this project and why it was made. (from instructions)	Correctly clicked launch again after noting that there was no back button. Allowed camera and navigated to settings to click about.	Clicked launch and proceeded to settings, first clicked credits then failing that clicked about.	After asking how to go back (no response provided) Clicked launch and proceeded to settings to click about.

Analysis

Most scenarios were straight forward for the users but scenario 1 and 5 have some concerns. Scenario 1 has shown that the markers themselves need to be more explicit with perhaps a label saying 'navigate to URL then scan the marker'. People seem to be drawn towards the image more than the text. But this could be because they know it's testing for AR. A QR code could be provide as users seemed to know how to use them but this could confuse and clutter the marker.

Scenario 5 shows bad UX in my opinion, need to rectify this. The links on the settings page take you back to the beginning meaning you have to return through the process of launching the experience to get back to the camera.

Appendix I – Usability Testing

09/04/2019

Participants included the expert, one peer and two members of the public.

Throughout, audio recordings were made and transcribed into notes below along with observations.

User Classification

Name	Age	Device	Browser
Participant A (Expert User)	30+	Apple Iphone 8	Safari
Participant B	60+	Samsung S9	Google Chrome
Participant C	22	LG G6	Google Chrome
Participant E	40+	Apple Iphone 10	Safari

Table.1 User Classification

Participant A – Expert User

Device was slow on camera load.

THE SLIPWAY

- Could have the marker on the other side of the slip so that it matches the AR photo and the video.
- Noticed that I hold the camera in front of the marker although I don't need to stay in that position once the information has popped up.
- How do you know the information has ended. The 'x' icon isn't really clear. It should say end or close.

THE ACCUMULATOR

- Really impressed with the re-creation, impressed how you can move around the sides of it as it's 3D.
- Like the gif animations, adds another visual element to the information.
- Really likes the illustrations.

USING THE MAP TO FIND THE NEXT MARKER

- 'The design has a really lovely feel to it, you know a professional feel is what I mean. That little map is very clear too'.

PILOT CUTTER

- Had to position phone so the light was right for augmentation.
- Wasn't sure what to click on it didn't work on first attempt. This is because the user didn't click on the boat object.
- Signal connection was lower so video buffered.

<u>Questions</u>

Overall what do you think of the experience?

I think it adds to our interpretation of this site, the most important thing about is that we don't have to

have loads of sign board, it's a working site so this is really useful for that. I think there a couple of niggles where you have to wait for things to load and I have to re-press things, but these could be ironed out I'm sure.

What would you improve?

In terms of content it's brilliant, it's the right amount for someone who is doing a huge trail of the harbour. The last thig you'd want is loads. I might have a find out more option so that it can cater to everyone. Some may look at one in every three, others might want to spend the day really getting into it. Apart from that I really like it.

How did you feel about the navigation?

I think it made sense, because the information was short enough that it wasn't annoying, if it had all been in one place it would have felt like a leaflet and less engaging.

Of course, you didn't need to download an app.

That's the best part because who really wants to do that. It's a bit of a pain in the 'ass' isn't it?

Final question, in terms of the markers themselves, how would you improve how they would look?

In the event of this being done properly, I think, you know, it's very standard issue. It should say go to this website now or visit this website to explore the space'. Or even simply a bubble saying no app needed.

Participant B

Device was fast, with slight lag on parts.

ONBOARDING

- Skipped over instructions, didn't really read it.

SLIPWAY

- Reads hint to know what to do
- Commented it's like 'magic'.
- 'Commercially why stop doing this at the underfall yard, you could do this everywhere!'
- The user stands too close to the marker and had to stand back.
- 'Video really good, for younger people, but as an older person I don't mind text too'.
- Seems simple, you press one thing and then stuff happens.
- Listens to audio but pauses it half way because he found it boring.

ACCUMULATOR

- Thinks it would be better to make the close button clearer.
- Could click on each number of the diagram to read about it.
- Avoids playing the audio.

PILOT CUTTER

- Timeline feature is useful as it covers a lot of history in a small chunk.

USING MAP

- Useful feature 'I think it would add to coming here, you can check the map and then see it'

Questions

What do you like the most about this experience?

Everything about it, apart from the close button, the videos are great. It's funny because over there looks like a pile of wood doesn't it? But no, it's not with this. I use to go to school in St.Mary Redcliffe and I used to walk home through here, in those days it was a working docks. But until I came down here with my son, I didn't even know what this was. I lived in Bristol all my life. My father worked for the docks company, I had no idea.

How was it to navigate was it easy to understand?

I do, being able to do that walking around the docks. You could make a fortune!

Was the content good enough?

I think yes.

How would you improve the markers?

I think you'd have to have something that explains what it was, even say how to use it. Once I did one, I would recognise all of them and maybe do them on different days.

Participant C

Device was fast, with slight lag on parts.

ONBOARDING

- 'JavaScript is that dangerous as it use to be?'
- It's like a QR reader, instructions seem pretty intuitive.

SLIPWAY

- Reads the hint and stood back.
- The time-lapse is brilliant, not seen a boat on it before.
- Listened to audio.

USING THE MAP

- Found the 'x' faddily to close on the map info box.
- Thinks it was clear.

ACCUMULATOR

- 'Wow, it's an exact replica'
- 'Could have audio here to explain the diagram.'
- Listened to audio.

PILOT CUTTER

- Like the 3D, 'it draws the attention'.
- Struggled to press, couple of attempts then pressed the boat correctly.
- Not too much information which is good, bitesize chunks, not overwhelmed.
- Time-lapse is impressive.

Questions

What did you think?

It's a good way of getting information across, there's a lot of good in that.

What would you improve?

You could add more and more content couldn't you?

What do you think of the design and navigation?

It's pretty good, once it gets going it's fine. Although I would like to see the icons and the text at the bottom slightly bigger.

Did this effect how you experienced the space?

I didn't really know that much about this place, so I've learnt something.

And of course, this isn't an app. What do you think about that?

Yeah that's great. People would need an internet connection wouldn't they, that's the only disadvantage, I'm a tight-wod. But I like it, yeah it's tremendous.

How would you improve the markers themselves?

Well anyone knows what a QR code is so I think it's fairly straight forward to pick up.

Participant D

Device speed was moderate.

ONBOARDING

- That's clear, smooth.

SLIPWAY

- Surprised there was multiple info screens.
- Good variation of media.

ACCUMULATOR

- Good that you can look around it.
- Hint box could be bigger, feels a bit small
-

Questions

What did you think?

It's a curated thing, I can access the info if I wanted it, I mean, I wouldn't probably engage with it unless I wanted too.

What did you think of the content?

The different media was good, especially the videos. I personally learn by watching, others like to read you know.

And of course, it's not an app.

Yeah, don't get me wrong, it's amazing you can do this now. I'

I'm not one for downloading apps.

Appendix J – UI Design

The design is subtle to not overwhelm the user and to not draw attention away from the camera feed and therefore the 3D objects. The colour scheme is subdued and drawn from the location itself. Often grey skies with the addition of blue which reflects the waterside element.

The design style was constructed to ensure consistency throughout the site.

Also, illustrations were designed and animated personally using Adobe Illustrator and Adobe After Effects. Unless stated in the guide, Icons were also my own.

Design Guide:

Fig.1 Cover

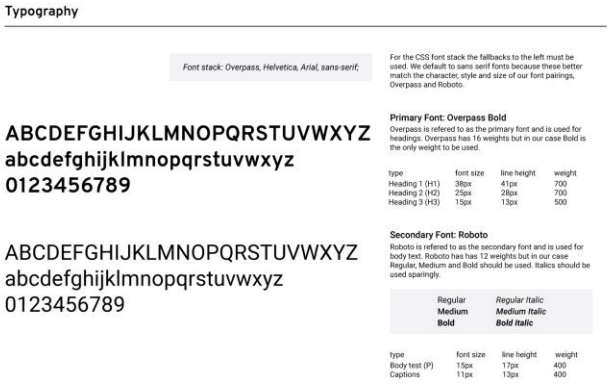


Fig.2 Typography

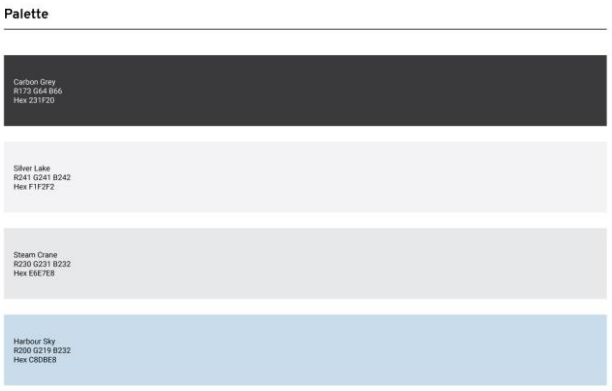


Fig.3 Colour

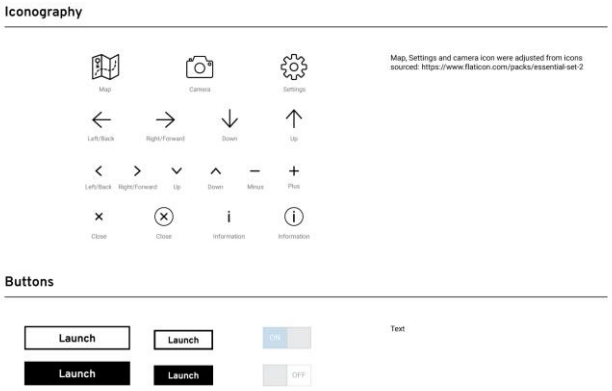
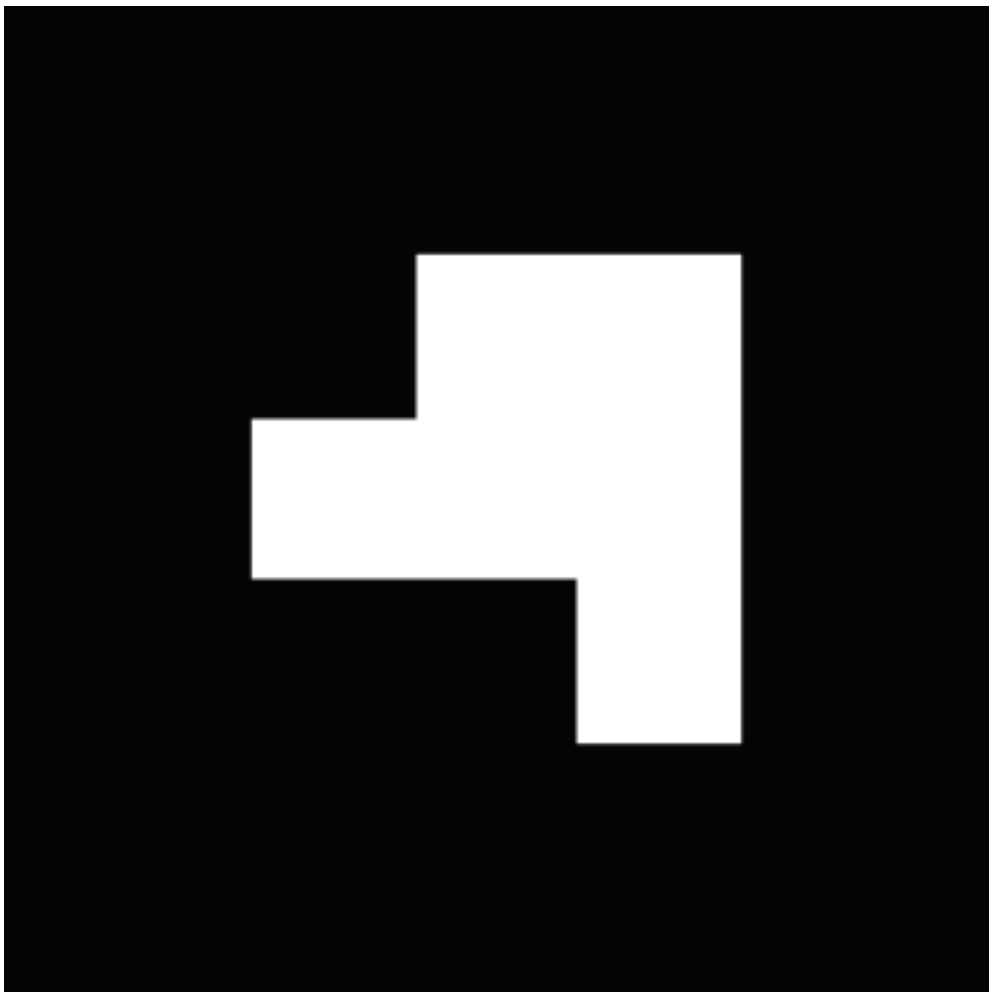


Fig.4 Icons and buttons

Appendix K – Final Markrer (Used in Usability Testing)

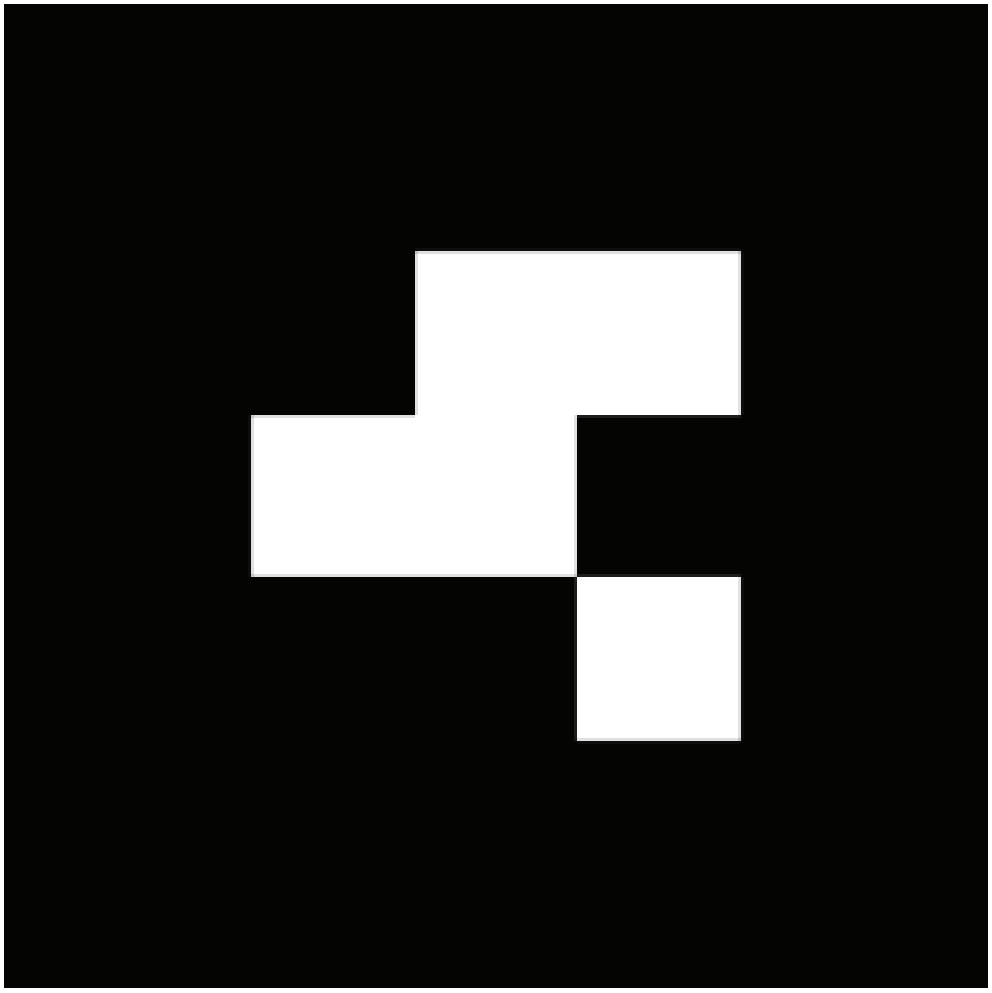
EXPLORE UNDERFALL

https://www.harboured-reality.co.uk



EXPLORE UNDERFALL

https://www.harboured-reality.co.uk



EXPLORE UNDERFALL

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