<CAVE WORLD OF NOTTINGHAM>

REPORT FOR MIXED REALITY COURSEWORK 1

RESEARCH

Nottingham is a vast and ancient labyrinthine underground world. There are more than 800 caves, tunnels and passages cut into the sandstone that lurk beneath the city, and more are discovered every year. Actually, the oldest recorded name for Nottingham is “Tigguo Cobauc” which means ‘land of caves. Because Nottingham is set on a soft sandstone ridge, which has been cut into low cliff faces in places by the action of the rivers Lyne and Trent. The exposed soft, brittle rock is very easy to cut and dig. These caves were used for a variety of different purposes, such as wells, dung pits, storage rooms for grain, wine, fish and meat, malt, breweries and tanneries, dwellings and hideouts, communication routes, small decorative houses, shelters in times of war and as a source of sand for construction (Walsby,1989). The English city of Nottingham is widely known for its rich history and fascinating folklore, so it is necessary to explore and research the history of the “City of Caves”. In addition, the National Justice Museum took over the management of the site.

I visited the city of caves in March and followed the audio guide to learn more about its history. I bought a Guidebook from the souvenir shop which clearly explains the use of the caves and why, and a copy of Tony Waltham's book Sandstone Caves of Nottingham which clearly shows the location of the caves throughout Nottingham. After the tour, I asked the staff for more historical details and did a Google search on the subject. Here are some details about the visit and research：

Figure 1. Entry

Figure 2. Ticket

Figure 3. Cave

Unlike other sandstone caves, Nottingham's network of caves was not formed by running water. These caves are entirely man-made. In the 'City of Caves' these sandstone caves were used for a variety of different purposes, such as some being used as filters to create cold, clear water, malt kilns for pottery making, raising animals, and tanning leather, and being rented by poor families to live in. The caves date from 868 AD when Nottingham was known as “Tigguo Cobauc” to 1994 when they were used as a tourist attraction. In the late 13th and early 14th centuries, these caves were used as homes for the inhabitants of Nottingham. In 1330 Edward III led an army through Mortimer's Hole (below Nottingham Castle) to raid Mortimer, the man who had killed his father and taken power over the country. In the sixteenth and seventeenth centuries, these caves were used for tanning leather. The Pillar Cave Tannery is an example of a medieval cave tannery. The sandstone caves are also often used as bar cellars because of their coolness and constant temperature of 14 degrees Celsius. During the Industrial Revolution, the poor rented these caves to live in. Then, these caves were converted into air-raid shelters with staircases to protect them from air raids during World War II. In 1975, the shopping center Broad Marsh was opened. City of Caves” has been managed by the National Justice Museum since 2004.

As well as the “city of caves”, there are also caves hidden beneath a large number of ordinary modern buildings. "If you run a pub in this city, nine times out of ten you're going to come across caves. Because

there are caves everywhere," says Tom Flynn, manager of the Bell Inn, one of Nottingham's earliest historic pubs. The Nottingham Cave Survey is a project by researchers at the University of Nottingham to digitally map caves. It maps the shape and details of the caves, and the entire cave is visualized in 3D using mixed reality technology.

This project is intended to be completed using AR technology.AR has a wide range of uses, as it can clearly demonstrate the concept of space, time, and contextual relationships between real and virtual objects (Woods et al. 2004). Information will pass “naturally” from one interacting object to another, while the digital world will coexist with and augment physical reality, resulting in a hybrid world (Stephanidis et al.2019) The foundation of AR technology lies in the support of human technology. For example, when humans have mastered the ability to use mobile phones and take pictures, AR products based on the camera function of mobile phones can be used.

The use of AR technology in this design allows virtual objects to be animated and to respond to the user's actions, giving the user a more vivid presentation of the historical story through animation, thus increasing the fun and educational aspect of the whole activity. As the design is based on the theme of historical sites, the historical story associated with the ‘City of Caves’ is very important in the design. In addition, the caves are very narrow and inaccessible to disabled people, which significantly reduces the visitor's experience, so it is important to be able to understand the interior and the relevant background story without having to enter the cave, which is the focus of this design. Besides, network connectivity is very important in AR design. There is no need to worry about the internet in the caves, the attraction provides a stable wireless network for the underground areas.

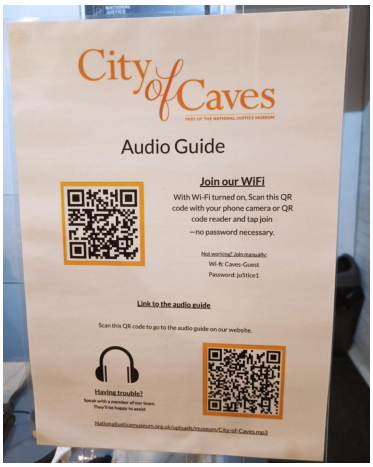

Figure 4. Network in the cave

IDEATION

The name of the game is Cave World because the city of Nottingham has over 800 sandstone caves and the history of these caves is over 1000 years. The goal of people visiting the cave city is to learn about the history of the place. There will be certain questions about the cave city and even Nottingham in general. Why are there so many caves in Nottingham? What happened in the 1,000 years of the City of Caves? The theme of this game is that help visitors find out what stories and characters are triggered by the different attractions.

At first, the format of the game was very vague, so I used idea cards to flesh out the whole game. There are 3 parts of ideation cards: Questions, Opportunities, and Challenges. Firstly, I hope that the game is interesting enough and engaging enough to be actively played. The game is linked to the cave tour and it adds to the fun of the game by interacting with the visitors and providing a more vivid explanation of the history. Also, due to the special position of the caves, disabled visitors and those who are not physically able to enter the caves can get some historical explanations through this game. Secondly, due to the planned use of AR technology and the geographic location of the caves, it is sufficient that the game is set indoors to avoid the effects of weather and light on the game. Third, the device required for this game is a

personal mobile phone. Since the access itself is mainly a personal activity, one player is allowed to play the game without interfering with each other, which enhances the player's gaming experience. Fourthly, this game does not require a large area, just a place where players can use their mobile phone camera.

As for Opportunities, the game is mainly presented using AR technology and illustrates historical stories with 3D content attached to real objects. Besides, as AR technology is affected by the angle of the shot, AR markers are set to avoid triggering a photo where the AR experience will not work due to the viewing angle. Finally, the inclusion of appropriate audio helps to improve the player's user experience and makes the whole game more interesting.

There are still some challenges for this game: the unstable internet in the caves, the need for some explanation of the game, the appeal of the AR game, and for the testing of the game.

Firstly, loading some simple 3D images offline can alleviate the problem of unstable internet connections. It is guaranteed to trigger some interaction even when there is no internet. Secondly, a simple tutorial needs to be set up to give players an example. Also.

Some interactive features such as clickable buttons need to be added to the game to add interest. Finally, photo and real-world AR recognition tests are needed during the testing phase, as well as unknown effects of different lighting on recognition in caves and normal rooms.

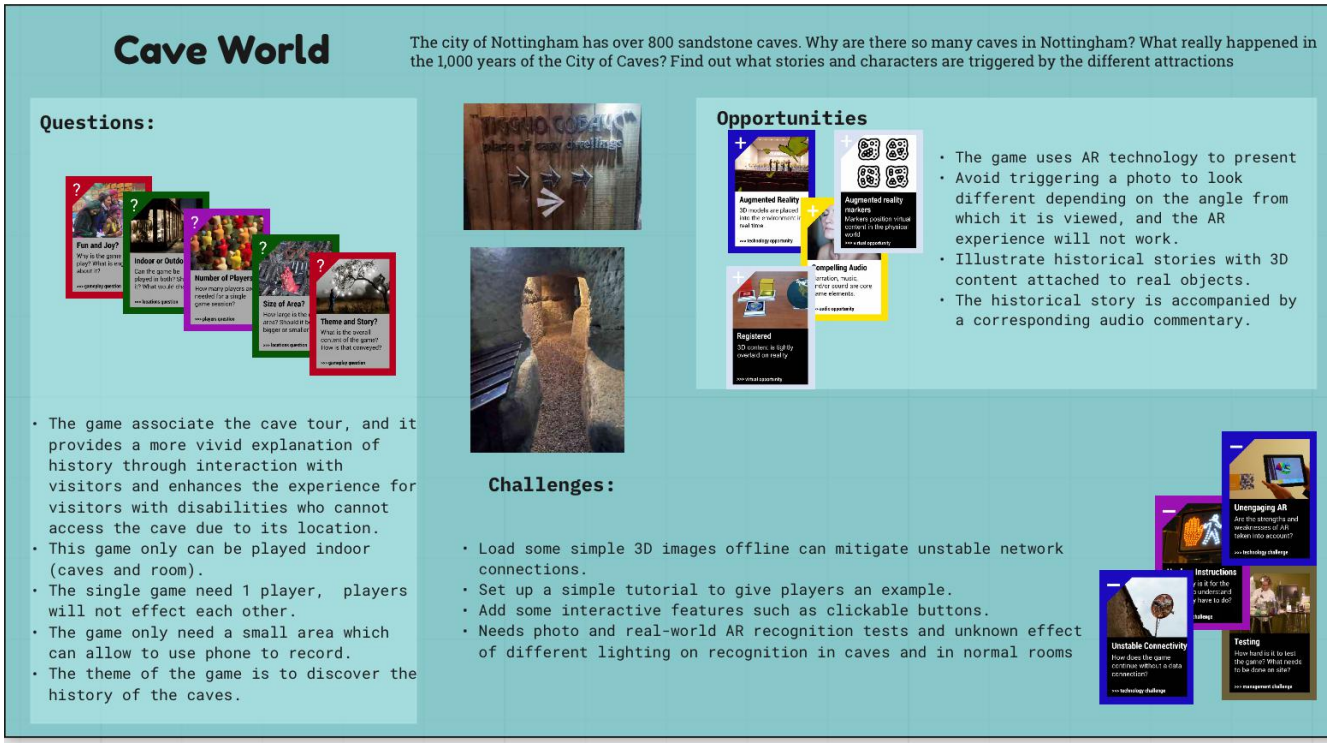

Figure 5. Concept sketch

STORYBOARD

For the game Cave World, there are two ways to play it: one is to use your phone to scan the actual scene in the cave, and the other is to scan the pictures indoors (visitor center). Scanning the scenes in the cave enhances the game as well as gives the user a more visual insight into the history. The indoor scanning of the images takes into account the unique location of the cave city, which is not accessible to disabled visitors and has insufficient air circulation, unlike a normal museum. There are also two ways for players to play the game after entering the cave: scan the real scene or scan the photos hanging on the wall.

No matter which way the player chooses, the player is required to download the 'Cave World' APP on the phone to play the game. Different animations are generated when the phone recognizes the corresponding scene or picture, such as a girl carrying wine in a cave or a worker making leather in a cave. While the animation plays, the user can tap on the on-screen buttons to learn more about the

history. Finally, the animation will end with an interaction with the player (movement or audio). The player will once again see the scene or the cave itself as it is.

There are 2 versions of storyboards: Cave World I illustrates the game progress in the cave, and Cave World II illustrates the game progress in the visitor center.

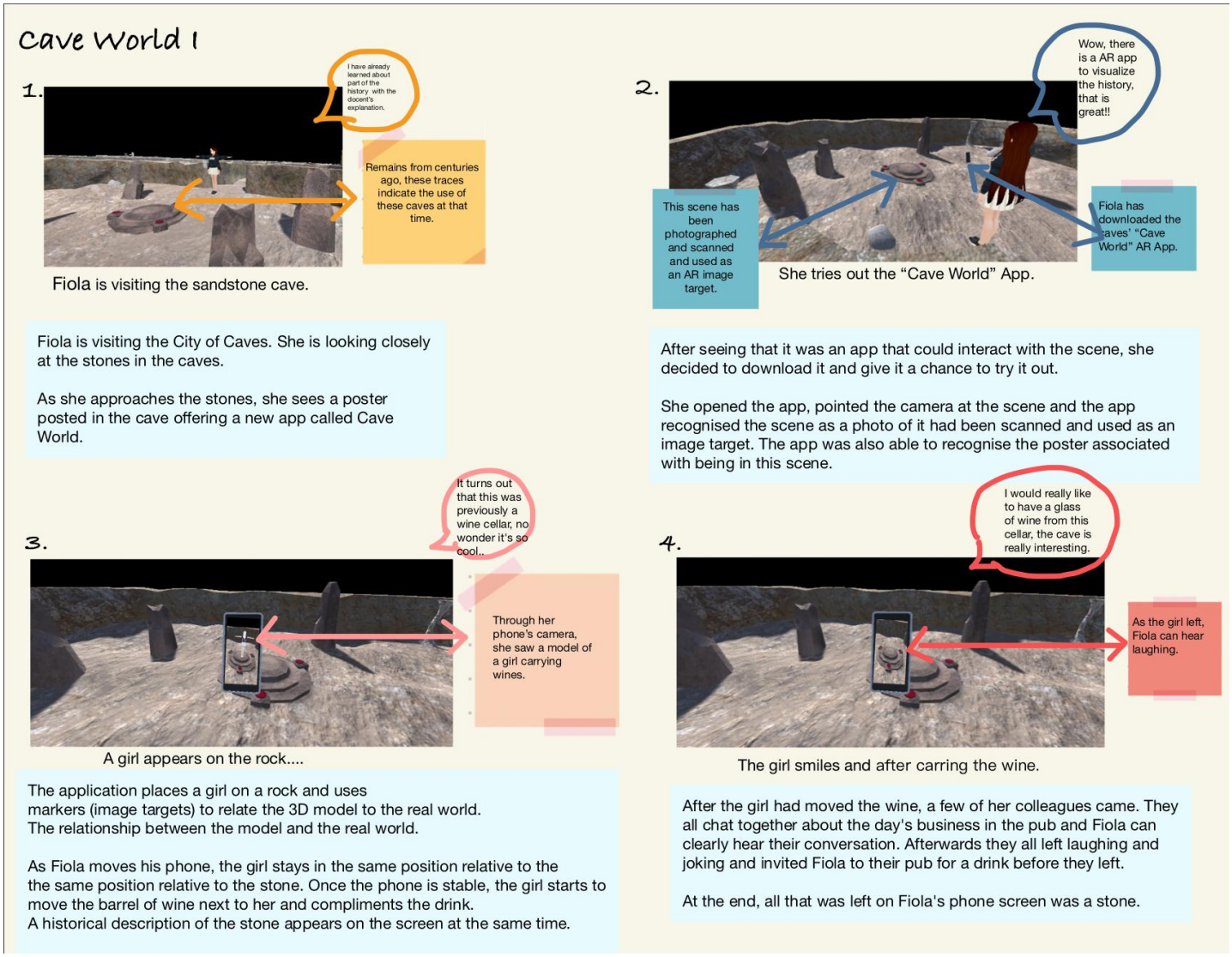

Figure 6. Storyboard 1

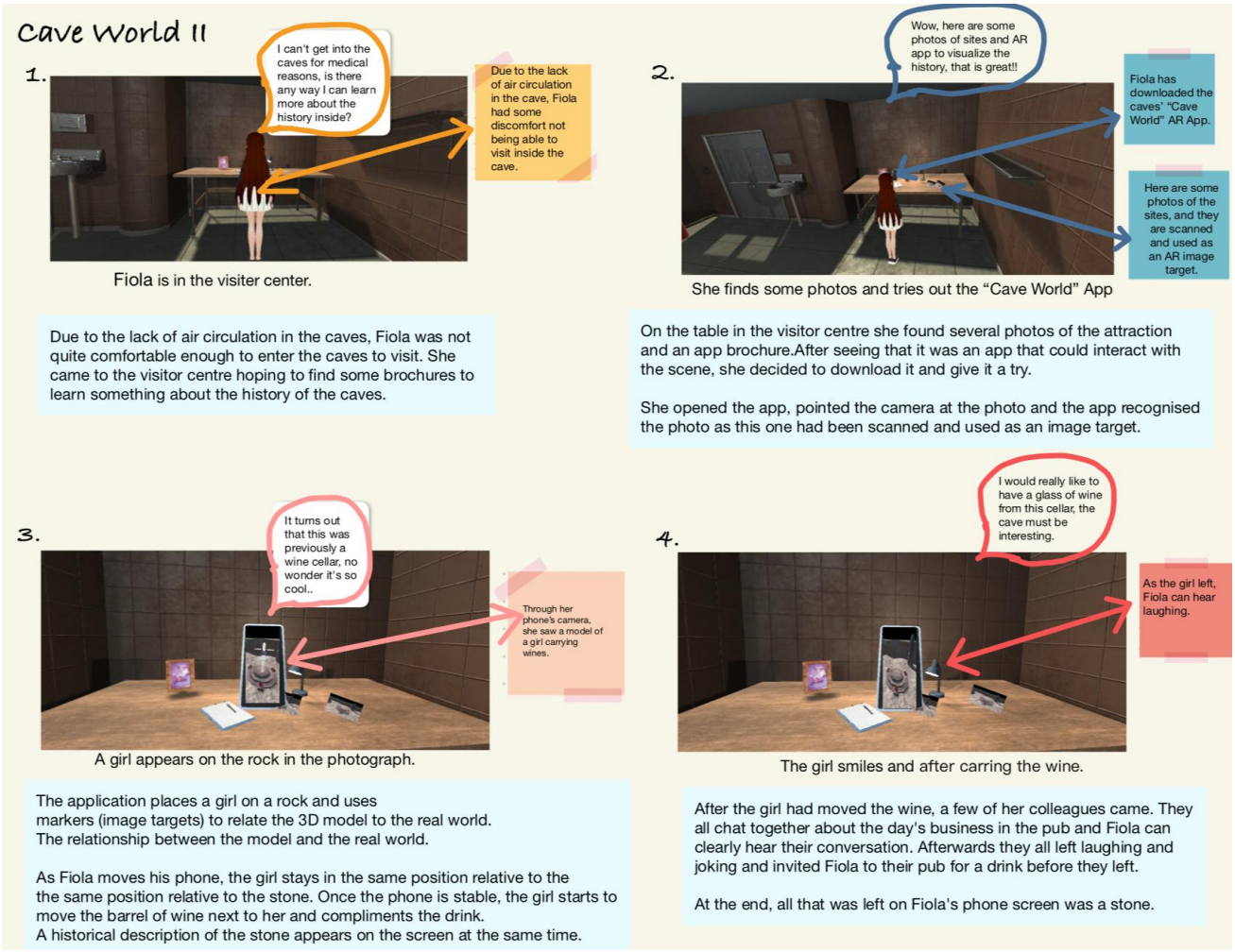

Figure 7. Storyboard 2

Words Count:1645

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