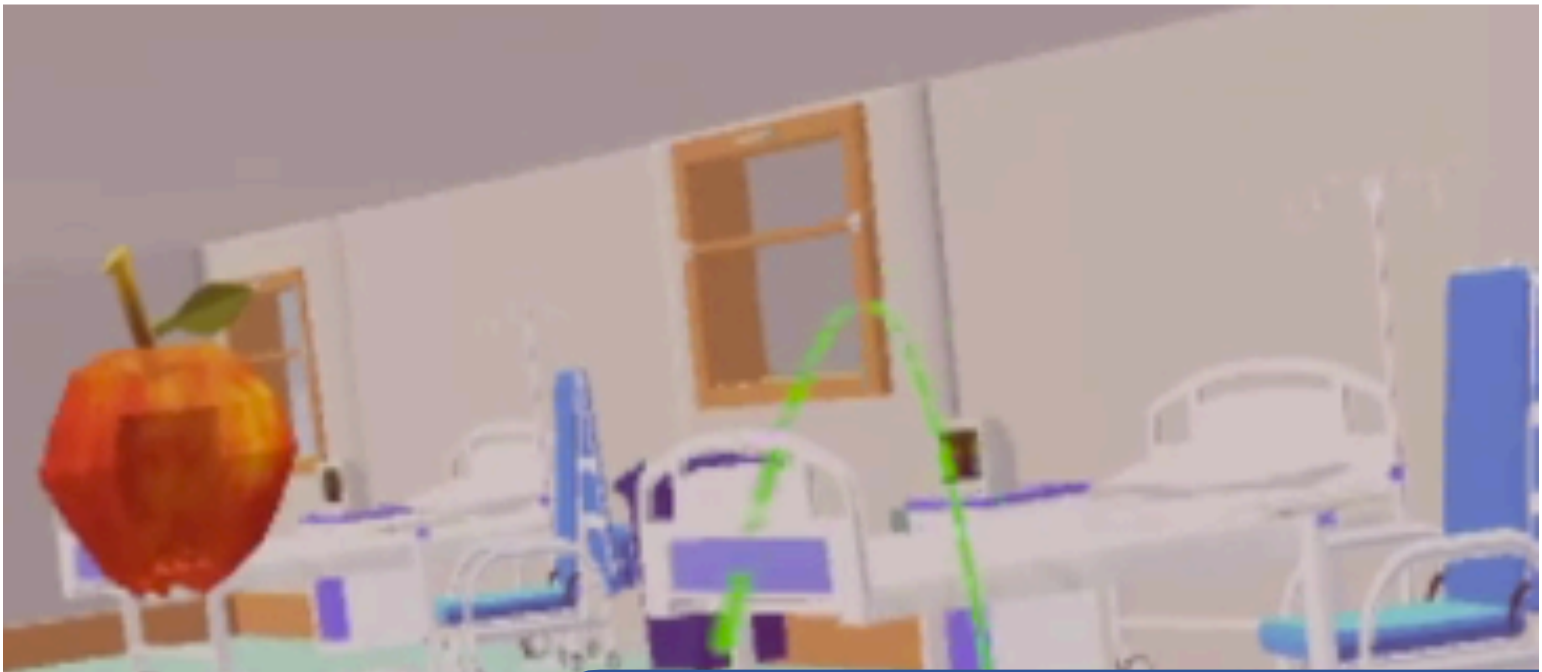

VR Nursing

Group Report | CI7810

Baizhu Zhang| K1730894

Duygu Olmez | K1651384

Gordon Johnson | K1451760

Jessica Martin | K1649325

Jiexiang Shen | K1725602

Michaela Lewin | K1107764

Thomas Parker | K1320666

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Introduction

This collaborative project, utilising expertise from the varying fields of UX, game design, development, animation and simulated learning, aims to explore the potential for a nursing-focussed, Virtual Reality (VR) educational game.

VR was identified as an appropriate training medium due to its immersive and simulative nature (Richardson, 2017). The project is timely, with advances in training and technology being a focus for the NHS as they seek to both grow and retain their nursing workforce (Darzi, 2008). The NHS have identified nursing as a priority area for 2020, with a required increase of 6,000 nurses (England.nhs.uk, 2018). A client meeting with the brief owner was conducted, to allow the group to fully understand and interpret the brief requirements outlined below.

Aims

The project aims to create an environment which can be used to improve nursing students' situational awareness, as this a vital skill for their profession (Davis, 2016). This aim has multiple dimensions, or criteria.

- Firstly, the game should increase the players' stress levels, mimicking how nurses would feel whilst working.
- Secondly, the game should provide scenarios where the player needs to balance their awareness of, and attention to multiple, overlapping situations (Survival, 2016).
- Thirdly, the game play needs to be immersive. The students should be able to get swept up in the game play, which if the first criteria has been achieved, will result in emotional responses similar to those experienced in practical exams and role plays within the nursing school.
- Fourthly, the game should be appealing. Whilst it is intended to increase stress levels, players should not view this as a means of punishment. They should want to engage with the game whilst at university.
- Lastly, game play should be seen as beneficial to the students' education; they should be able to see that the skills learnt in the game are transferable to the real-world environments that they will be working in.

Team and Project Management

Our Team

Jessica Martin *Research Lead*

Gordon Johnson *Game Developer*

Thomas Parker *Animator*

Baizhu Zhang *Animator*

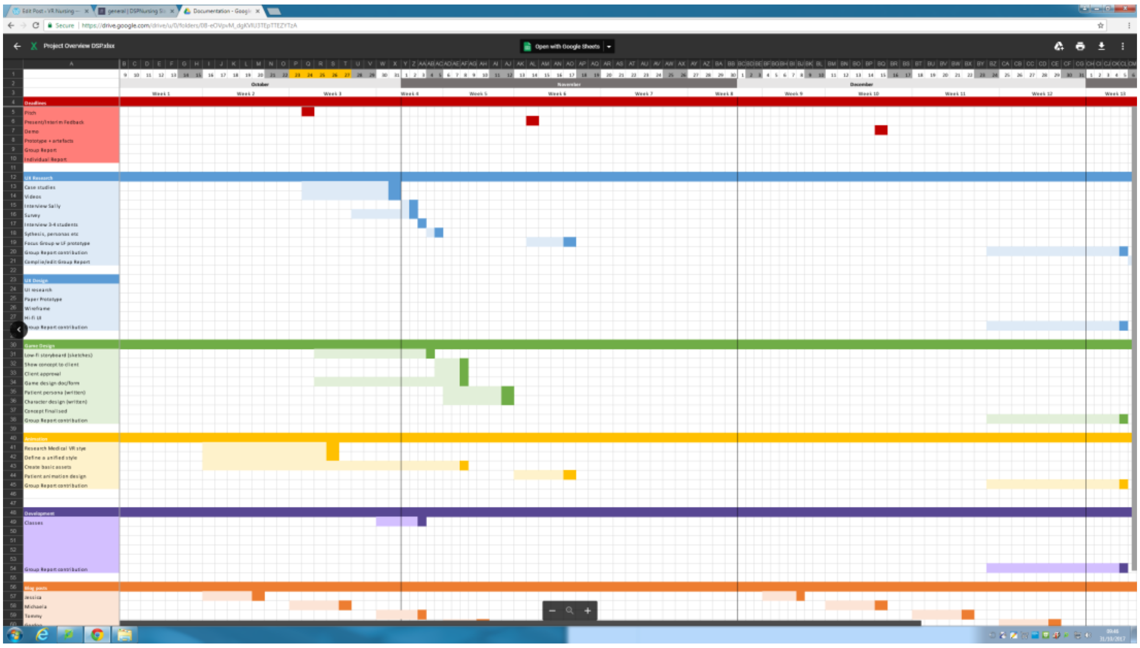
Michaela Lewin *UX Designer*

Jiexiang Shen *Game Designer*

Duygu Olmez *Animator*

The team consisted of a researcher, UX designer, game designer, programmer and three animators. Weekly team meetings were held allowing the team to assess the project development and progress. Various channels were utilised for work collaboration. These included: excel (Figure 1), slack, email and whatsapp.

Figure 1: Gantt chart produced for project management



Sprints

The design of the game was divided into two distinct sprints. In sprint 1, there was a noticeable demand on the nurse's memory and medical knowledge, which strongly mirrored the practical exams held within the nursing school. Although the game aims to support students' performance in practical exams, and real life settings, it was decided that the game should complement as opposed to duplicate the practical exams within a VR setting. The game direction was therefore adjusted and sprint 2 resulted. Sprint 2 had a greater focus on gamification, team work and time pressure.

Research

State of the Art Research

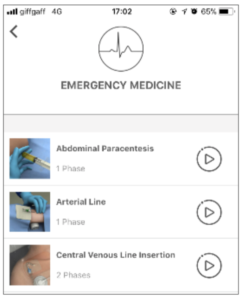
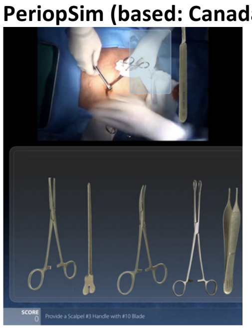
Medical Education is a new and rapidly evolving field of innovation and research. A new "Virtual Residency Program" was launched by launched by Ethicon, in conjunction with Touch Surgery, in early 2017. The program is the first of its kind and has 75 participating institutions. While not VR, this is the first time 3-D simulation will be fully integrated into training curriculum for residents (markets.businessinsider.com, 2017). Further innovative learning platforms are outlined in the competitor analysis.

Competitor Analysis

Advances in technology and medical training are receiving investment. London start-up, Touch Surgery, received a £15 million increase in funding (Field, 2017). Another MedTech company, VirtaMed, combines anatomical models, haptics and tools with simulation and has been utilised as a test requirement for Orthopaedics in Switzerland (Virtamed.com, 2018).

Notable companies modernising training methods are outlined in the Competitor Analysis Table (Table 1). Many of these systems could be of benefit for nurses as they simulate clinical procedures.

Table 1: Competitor Analysis

	Specialism/Market	Unique selling point	Feedback
Touch Surgery (based: UK, US) 	• Nurses • Medical staff • Surgeons • Clinicians	Easily accessible and free to use. Allows user to test and familiarise themselves with procedural steps. The user can't make decisions, the system takes them through the procedure steps.	No feedback. Non-VR simulation only.
VirtaMed (based: Switzerland) 	• Surgeons • Specialists • Training institutions • Potential for nurses Currently used as a test requirement in Switzerland for Orthopaedics.	Combines physical models with tools to simulate surgery. This type of simulation could be adapted/developed for nurses wanting to practice invasive procedures such as catheterisation, which are usually unpleasant for patients.	The physical models are lifelike so realistic feedback is achieved.
PeriopSim (based: Canada) 	• Perioperative nurses	Nurses learn about instruments and procedures through repetitive practice, preparing them for real-life scenarios. They are verbally asked for an object and must identify it and select it for the surgeon.	Scores and 'time saved' information are provided at the end of the simulation.
Practigame (based: Finland) 	• Nurses • Educators	Uses training scenarios for a nurse to practice decision making and knowledge of clinical procedures. Can be used as a teaching medium.	Story and patient outcome adapts to the decisions made by the player.

Sources: touchsurgery.com, virtamed.com, periopsim.com, practigame.com

Informative Research

Nursing and Environmental Factors

Required Attributes for Nursing

Nursing has a strong focus on six key values, the '6Cs', which comprises of; care, compassion, competence, communication, courage and commitment. These values form part of the 'Compassion in Practice' strategy, utilised in the NHS (Health Careers, n.d.).

Factors that Impact on Performance

A literature review found that nurses are likely to experience 0.4-13.9 interruptions per hour depending on the environment and specialism (Monteiro, Avelar and Pedreira, 2015). Additionally, the review showed that nurses were often unable to complete activities without being interrupted at some stage.

Aspects that impact patient care are conveyed on the Human Factors Model (Figure 2) (The Royal College of Nursing, 2018). Awareness can be seen in red, marked as an action or omission that can impact a nurse's performance, and subsequently, patient care.

Figure 2: The Human Factors Model

Environments

A stakeholder interview allowed the Hospital Ward environment for the game to be set. The majority of student nurses will at some point work in a hospital ward. Simulations are also conducted in a ward-style environment (Richardson et al., 2017).

Nursing as a Market for VR Educational Gaming

Nurses are the most prolific presence in the NHS, with 2017 figures stating that there are 285,893 nurses and health visitors, compared to 106,430 doctors (Nhsconfed.org, 2017). Given these numbers, using a VR game to improve situational awareness could have a large effect.

A BBC investigation found that 33,000 nurses left work in 2016, "meaning that there are now more leavers than joiners" (Figure 3) (BBC News, 2018). 51% of the "leavers" were under 40 (Figure 4), with over 6,000 leavers aged between 25 and 29 (Kendall-Raynor, 2018). This could correlate with the NHS' aim of getting more nurses to return to work (England.nhs.uk, 2018). While the VR game could help prepare new graduates for the pressures of the job, VR training could also be of benefit in the return to practice curriculum. Currently costs for training a new nurse is between 50- £70k versus £2k to return a nurse to practice (England.nhs.uk, 2018).

Figure 3: More Nurses are Leaving than Joining the NHS in England

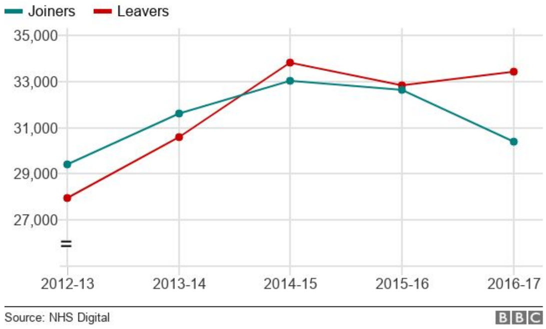
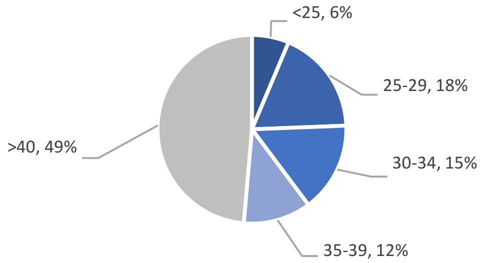


Figure 4: Age breakdown (years) of nurses who left the NHS 30/09/2016 and 30/09/2017



Source: NHS Digital (Digital.nhs.uk, 2018)

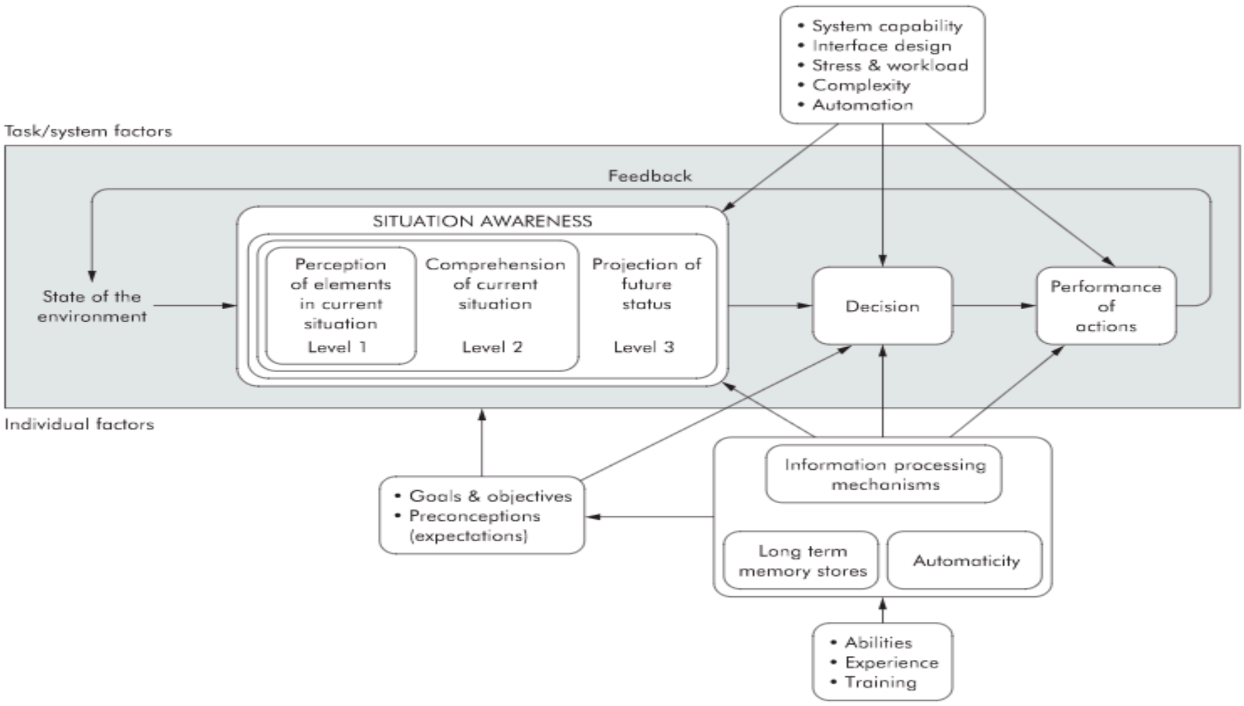
Non-Technical Skills

Non-technical skills – that is cogitative or social skills – are required for nursing students to provide good quality care to patients (Figure 2). This is in addition to clinical skills such as taking observations or administering medication. Situational awareness (Figure 5) is considered a non-technical skill alongside decision making, teamwork, communication, stress management and recognition of fatigue (Flin and O'Connor, 2017). Situational awareness has an influence on the clinical outcome (Stubbings, Chaboyer and McMurray, 2012).

The attributes of situational awareness are: *Perception* being aware of your surroundings, *Comprehension* of the situation and *Projection* i.e. forecasting future outcomes (Williams, Cooper and Quested, 2013).

While these attributes are hard to measure, Wright outlines potential measures for observing situational improvement scores as: *direct performance measures*: time on task, error rate, degree of error (such as deviation from planned path); *indirect performance measures*: self-ratings and observer ratings; *Mental workload measures*: subjective ratings of workload, secondary task measures and physiological measures (Wright, 2004).

Figure 5: Model of Situation Awareness in Dynamic Decision Making



Source: researchgate.net (from Endsley, 1995)

A review of situational awareness through simulation found that nursing students had low levels overall (41%). The review acknowledged Situational Awareness as being paramount for clinical decision making and patient care outcomes (McKenna et al., 2014).

Cues that can inform situational awareness include things people can see, hear, touch, smell and taste. Cues can be bold or subtle such as a loud noise or a quiet hum which may or may not be registered consciously (Endsley, 2000).

Virtual Reality

Virtual Reality is becoming more mainstream with market-value predictions varying widely. Intelligence firm, SuperData, estimates the VR market to be worth $28.3B market by 2026 (Superdataresearch.com, 2017).

VR can be described as a virtual setting, that contains visual and aural cues, settings and items that can be touched and interacted with (Bates-Brkljac, 2012). With headsets now costing in the region of £350-600 (Painter, 2018), VR is a readily accessible medium for both individuals and institutions. Ruthenbeck states the benefits of VR learning as facilitating “self-directed learning” along with allowing “trainees to develop skills at their own pace and allow unlimited repetition of specific scenarios that enable them to remedy skills deficiencies in a safe environment” (Ruthenbeck and Reynolds, 2015, p16). In summary, the format of passive learning changes to participatory learning (Futuresource-consulting.com, 2017).

How can VR apply to the nursing industry? In 2015, In response to recent NHS leavers’ data (Figure 3) (Digital.nhs.uk, 2018), RCN general secretary Janet Davies stated that “Patients get the best care when the most experienced nurses work alongside the newly trained – this practice is now at risk” (Kendall-Raynor, 2018). A recent press release from trade union UNISON notes that “New recruits are quickly realising that the demands placed on them are unrealistic and overwhelming.” (UNISON, 2018). With VR’s immersive qualities, combining virtual mentorship with fun games with narratives, problems and distractions could increase confidence and situational awareness, thereby giving nursing students training tools specific to stressful environment preparation.

Potential drawbacks of VR include the slow uptake from the public due to hardware and headset investment along with the need for improved content (Terdiman, 2017). As VR uptake is not likely to be ubiquitous for some time, training and familiarisation with VR would need further consideration as part of the learning curriculum.

Gamification for Learning

Gamification for educational purposes should aim to make learning engaging and fun, providing both motivation and reward systems. Having a goal, obtaining feedback, motivators (including points), progression and pacing (level design) and learning metrics are all required to create an engaging learning game (Saunderson, 2011).

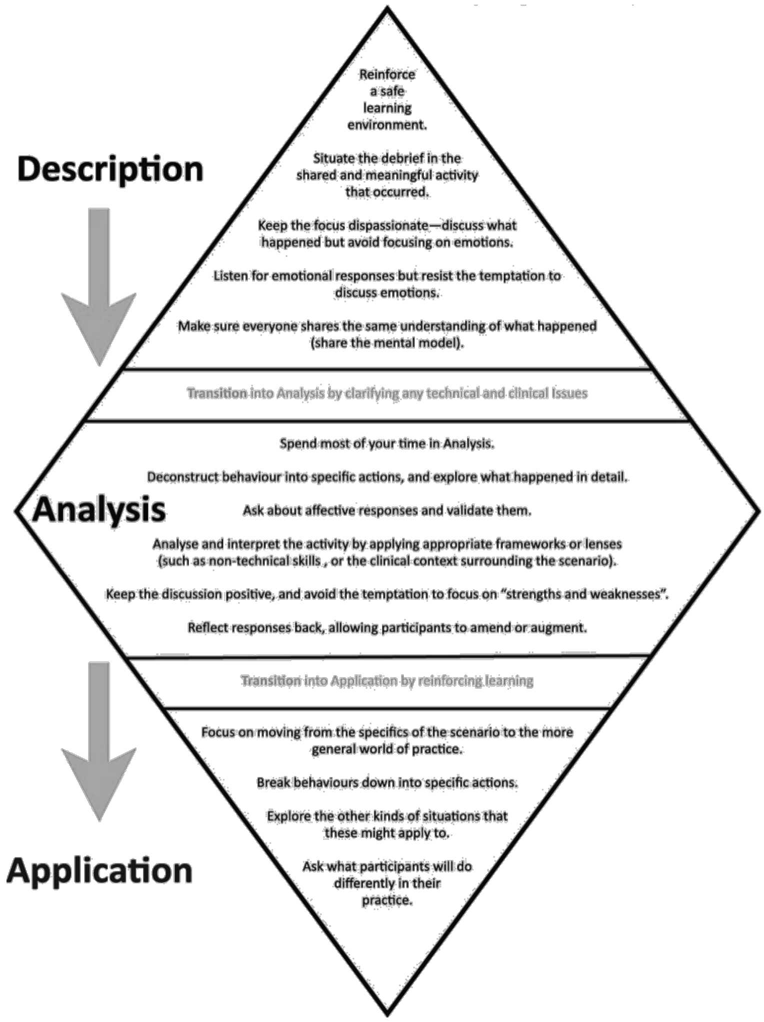
Mini games are typically short, 2D games that provide an alternative gameplay and can be used as a break activity (Hauge et al., 2017). Mini games should be used strategically as part of the experience design of the game. Communicating the mini game to the player can be achieved through ‘trigger components’ and the design of a distinguishable user interface (Hauge et al., 2017).

In a 2012 focus group, staff’s perception of gaming for nursing education was positive. The opinion being that increased motivation or could engage students would be beneficial (Johnston et al., 2013). A VR game aiming to allow the study of the human skeleton provided increased interactivity among students (Nicola, Virag and Stoicu-Tivadar, 2017).

Feedback

Feedback at Kingston is in the form of the 'Diamond Debrief' (Jaye, Thomas and Reedy, 2015). This feedback comprises of three phases: objective (description of the event), analysis (deconstruction of the event) and application (to general future events) phases. Most time is spent on analysis of the event, hence the Diamond aspect of the model.

Figure 6: Underlying principles of the Diamond Debrief



Source: (Jaye, Thomas and Reedy, 2015)

An experiment of an educational game found that feedback in the form of guidance and reflection obtained different results. Asking participants to reflect of their answers had no effect while "exploratory feedback produced higher transfer scores, fewer incorrect explanations and greater reduction of misconceptions during problem solving" (Vandercruysse, Vandewaetere and Clarebout, 2012, p8).

UX Design

Qualities of User Experience Sought

Engagement
An engaging user experience has been described by Benyon (2005) as a successful narrative and an immersive environment which allows for a seamless flow between states.

Learnability
The game will be played infrequently by nursing students. Tutorials and an intuitive user interface (UI) will support players in their understanding of how to play the game (Preece, Sharp & Rogers, 2015).

Affordance
The affordance of objects, such as levers and buttons, will be utilised to take advantage of the benefits of VR (Norman, 1988). The use of common real life affordances should support casual users to engage with the game.

Design Overview

The design of the game was divided into two distinct sprints. In sprint 1, there was a noticeable demand on the nurse's memory and medical knowledge, which strongly mirrored the practical exams held within the nursing school. Although the game aims to support students' performance in practical exams, and real life settings, it was decided that the game should complement as opposed to duplicate the practical exams within a VR setting. The game direction was therefore adjusted and sprint 2 resulted. Sprint 2 had a greater focus on gamification, team work and time pressure.

Due to the nature of VR, the presentation of user interfaces (UI) presented unique challenges, which will be discussed in the following section (rationale).

Wireframes and clickable prototypes for UI were created to make decisions concerning how the user would interact with the menus in the game, and how key information should be represented (Preece, Sharp & Rogers, 2015).

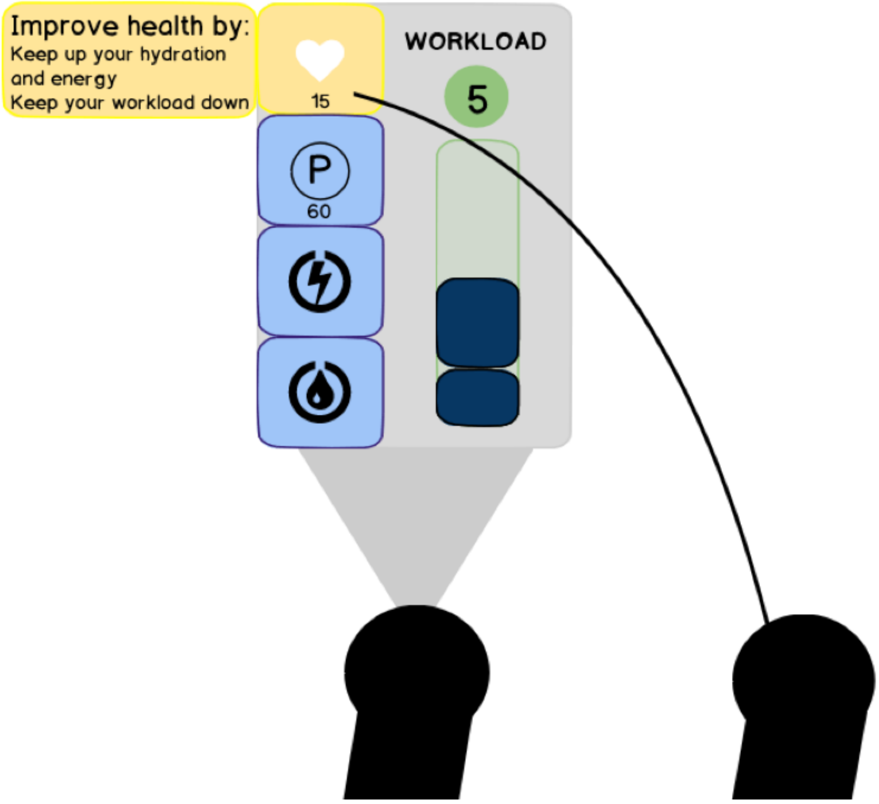
Rationale

UI Location

When deciding how the player will bring up the menus, several design options were considered. In sprint 1, information was split between two UIs: one diegetic UI displayed on a smart watch, and the second a heads up display (HUD) which would be triggered by selecting objects in the environment.

In sprint 2, all UIs have been created as HUDs. The personal statistics UI is projected from the controller, allowing it to be moved by the user. This was chosen to minimise the obstructiveness of the menu, and allow players to remain immersed in game play (Oluto, 2016; Stonehouse, 2014). The task UI and other characters' statistics UI are projected from a stationary machine when activated by the player.

Figure 7: Interacting with the player's UI



Activation of HUD

In sprint 2, the capabilities and limitations of VR were further considered. Due to the relative size of a smart watch, small icons or text would be illegible. Initially, having a simplified UI on the watch, which when selected triggers a projected HUD with more detailed information was considered. However, in the final design the personal statistics UI has been simplified to one HUD, which is activated by the menu button. To fully utilise the physical aspect of VR, the task UI is interacted with through pushing buttons and pulling levers. These techniques have been successful within games such as Job Simulator (Clark, 2016).

Transparency

The UIs are displayed on an 80% opaque background. This will allow the information to be legible (Olutu, 2016) within the busy hospital environment, whilst still allowing the player to partially see what is happening behind the menus.

Figure 8: Final designs for UIs. Left: the task machine displaying another character's information when 'delegate' has been pushed. Right: the player's personal UI, activated by pressing the menu button on the controller

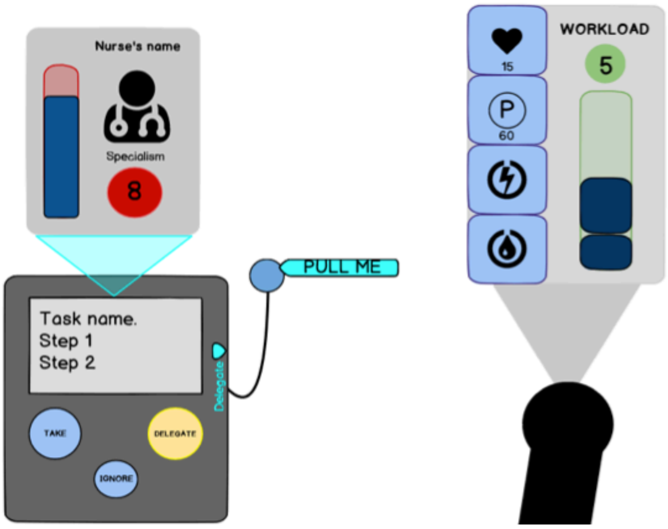
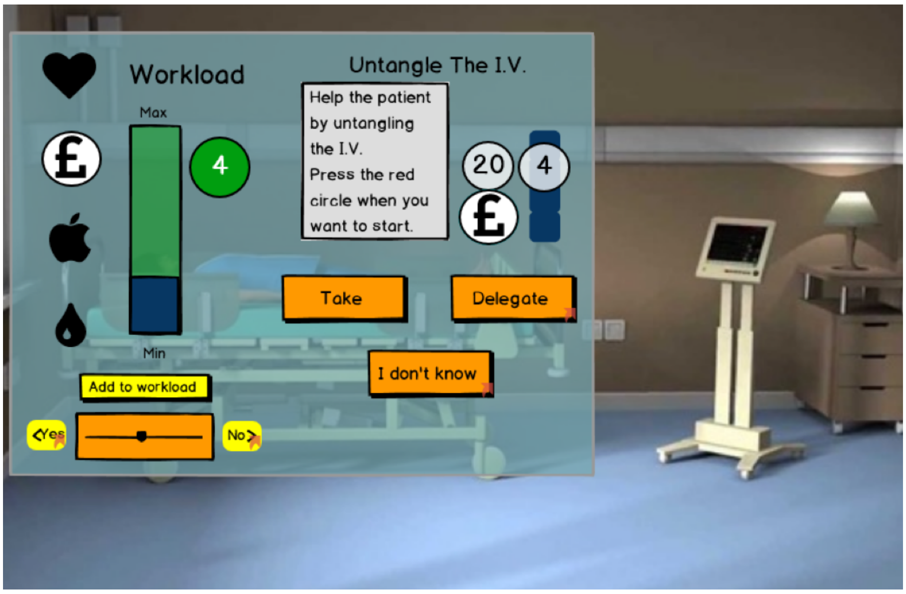


Figure 9: Example of a partially transparent display from early prototyping



Content

How the concepts to be communicated through the UI were to be displayed was decided through collaborative design with users (Preece, Sharp and Rogers, 2015). A questionnaire was used to establish users' perception of icons, and paper prototype testing was used to establish how information should be organised.

Figure 10: energy icons showing a decrease in the player's energy level (right to left)

Usability Investigation Results

Questionnaire

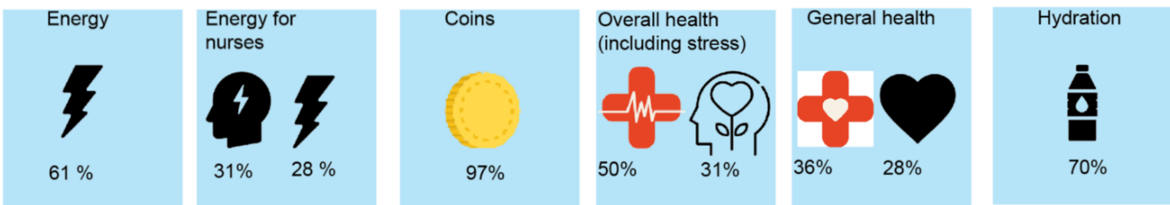
Whilst game-play is intended to induce stress within the player, an intuitive UI was desired in order to increase the learnability of the game. A digital questionnaire was used to obtain feedback on the UI, and ensure that users will understand the abstract concepts that it represents. An explanation of the game was provided, then participants provided feedback on their perception of what each icon could mean, which icon they preferred to represent a concept, and which style of design they preferred for energy and hydration levels.

Icon Meaning:

The concept of 'energy' appeared to be abstract and multifaceted. Participants were divided in their choice of representation, the two categories of representation were split between food and electrical energy sources such as batteries and lightning bolts.

Preferred Icons

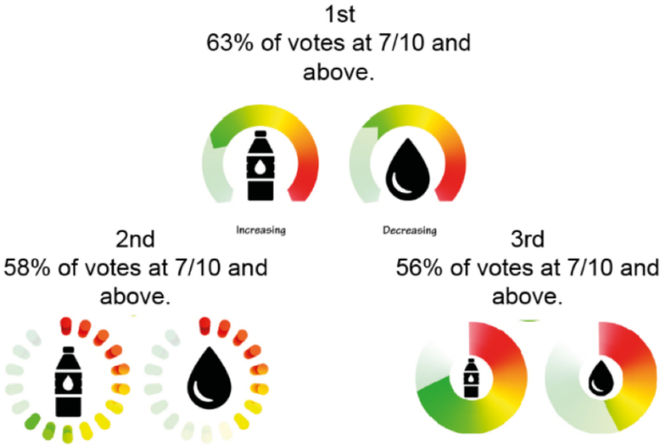
Figure 11: the preferred icons for each concept, and the percentage of participants who chose them



Representation of Energy and Hydration Levels

Participants preferred a design which used common western colour conventions (Chapman, 2010) of green for full and red for empty.

Figure 12: the three most popular representations for hydration levels



Paper Prototype Testing

A collaborative design technique was used to develop the structure of the UI (Preece, Sharp and Rogers, 2015). Participants provided insight into what they would expect to be able to do when presented with the UI, and expressed their perception of the game's mechanics as a consequence of the UI.

Feedback from these sessions fed into the redesign of the UI, and impacted the game mechanics. For example, initially coins were to be allocated for completing tasks and spotting hazards, this was changed to points, as participants thought that coins were too relatable to the nurses' income.

Figure 13: A participant expressing a preference for the representation of a countdown timer

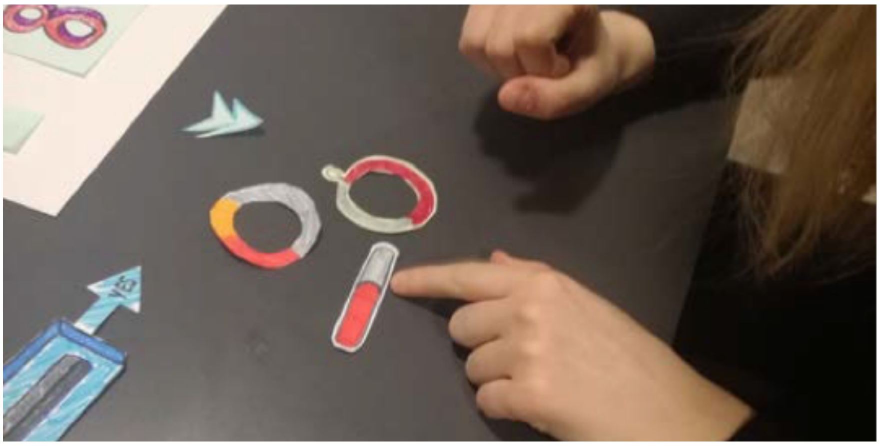
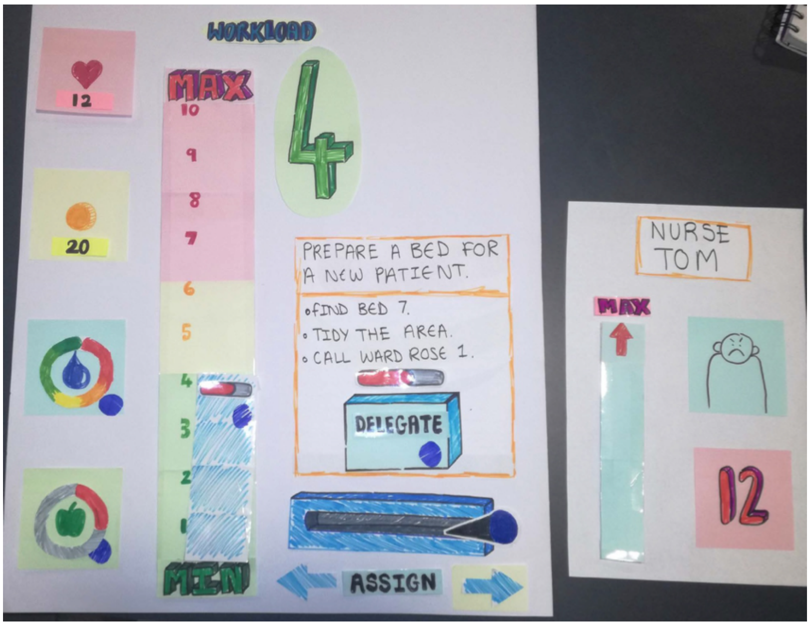


Figure 14: an example UI layout during paper prototype session



Audio

Auditory stimulation can be effectively used to induce stress (Anderson, 2016). Toprac and Abdel-Meguid (2010) highlight the impact of changing the volume of audio within a game. Situational observations of a busy ward in St. Mary's hospital provided realistic audio for the game. (Audio can also be heard in the game story video.) It would be beneficial to gain insight into the impact of audio on players' choices.

Summary and Feedback

Due to the timeframe of the project, testing was done on early iterations of the product's UI. A full usability report on the completed game would provide insight into whether the game's aims were achieved. When the project prototype had been completed, the game was shared with a participant. Due to the scope and time restraints of the current project, all of the project aims were not fully addressed within the final prototype. As a result of this, conducting a full usability test was not deemed necessary. Appeal testing was used to gain insight into the successful aspects of the game's aesthetics.

Feedback was obtained on the following aspects of the game:

Colour

- The participant liked the bright, airy choice of colour.
- The texture of the floor was confusing, and reminded the participant of the sea.

Audio

- The background audio seemed realistic for a hospital setting.
- The patient who talks to the player during the pipe task was frustrating (the desired response).
- A countdown timer sound would create a sense of urgency when completing mini-tasks.

Task tutorials

- The participant felt the tutorial was clear, and they understood the tasks that they needed to complete.

Next steps

- Consider using tiles for the floor, or a less textured carpet.
- Incorporate a countdown timer sound to mini tasks.
- Including the designs for the UI into the game, so that icon and number meaning are clearer.

Game Design

Sprint One

Outline

Level One
The nurse has two patients to look after. One patient is severe, the other is a distraction. Mentor. Main aim is training player decision making.

Level Two
Two patients, severe cases, they need a lot of medication/ interactions. Mentor. This level will join one more player or AI cooperation with player. Main aim is training communication and teamwork.

Level Three
Four patients to look after. More distractions. Main aim is training leadership, decision making, managing stress, and coping with fatigue.

Level Four
Four patients to look after. Delegation from a doctor whilst helping your patients. More distractions. No mentor. Level 4 will include situation awareness (seeing the bigger picture, predicting future events), decision making, communication, teamwork, leadership, managing stress and coping with fatigue.

As in sprint 1, the levels will get progressively harder. The objective of each level is to complete the main task that has been set. The difficulty of each level is determined by the number and frequency of distractions presented to the player, the amount of 'sub-tasks' that they can complete, and the amount of staff and patients that the player needs to interact with.

Gameplay

Beginning
The player is a new nurse in a hospital, she has a mentor who gives her two patients to look after on her shift. The patients, Harold and Nancy, have different needs which vary in urgency.

The nurse must choose which patient to help first. While the player is helping a patient there are distractions designed to test for situational awareness.

Middle
Distractions occur as the player navigates their way through the game. These distractions include: family member interactions, noises in the hospital, other patients talking loudly, colour and sound changes. In harder levels, the player has more interactions, including interactions with staff members and delegation.

End
When the time has lapsed, the player is given feedback on their performance. Their times and decisions are compared to how an expert nurse performed, based on the number of patients helped. The mentor gives words of encouragement at the end of game play debrief.

World

The world consists of four main areas:

The hospital ward: where the player takes care of their patients, envisaged as (Figure 15)

The repose zone: where the nurse can find water and food to maintain their energy levels.

An office: where the player can get instructions from another character.

Downstage: where the player can interact with the patient's family.

Figure 15: Example of a 3d hospital ward

Sources: wales.nhs.uk

Experience and Mechanics

The game needs to be enjoyable to play but at the same time it needs to be challenging with an increasing sense of difficulty as the level progresses. Initial impressions for the player should be of a peaceful environment as they are introduced to playing in a VR setting and becoming familiar with the premise of the game. As the game continues, the pressure will increase as the player tries to complete more tasks and make decisions.

Interactive elements will have a glow feature. This will increase when the controller is pointing at it with the trigger down indicating that the item can be interacted with. Elements within the game include:

Hospital equipment: this can be interacted with and picked up, moved around.

UI and menus: these have been outlined in the UX section of the report. They can be activated and navigated through with the handset.

Power-ups: Food and drink power-ups allow the player to keep their hydration and energy levels maintained. Situational awareness involves being aware of fatigue symptoms.

Distractions: Players can choose to interact or ignore distractions – sometimes with negative consequences.

Mini games: These mini games can be interacted with and need to be completed within a set time.

Sprint Two

Gameplay level 1

Beginning

When the player starts the level, they are given a task to complete by a senior member of staff. In level 1, this is to collect medicine from the medicine cabinet. The nurse is also offered a tutorial on how to carry out basic actions within the game, such as removing hazards.

Middle

On the path to complete the main task, there are two sub-tasks that the player could complete. The player needs to monitor their own and other nurses' current workloads, and decide whether to take or delegate each sub-task. If the tasks are taken, and completed, the player will gain points. Whilst balancing their workload, and interacting with inquisitive patients and relatives, the player should be observant of their surroundings, and spot and react to any hazards, such as scissors on the floor.

End

When the player completes the main task, the senior member of staff thanks the player for their help. The player is then shown a breakdown of their game play statistics.

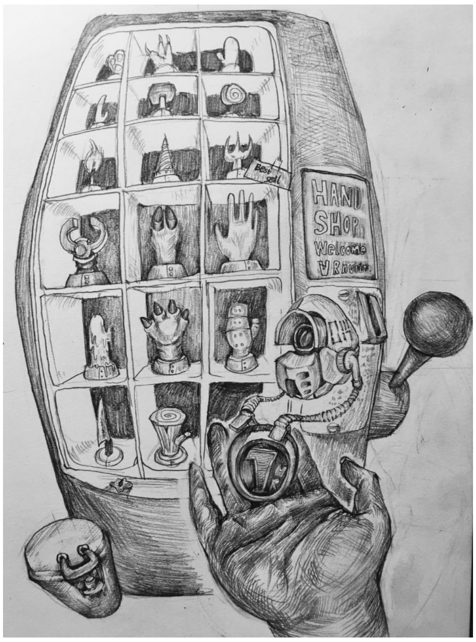
World

The sections of the world described in sprint 1 have been consolidated into one hospital ward: the player can find food and water scattered within the ward; the machines which will provide task instructions will be located at the site of the tasks; and in harder levels relatives will interact with the nurse on the ward.

Experience and mechanics

The overall experience and mechanics of the level which were designed for sprint 1 have been carried through to sprint 2, with the addition of one important gamification element in sprint 2. Through prototype testing, and interviews with participants it was identified that the use of 'coins' as a reward for completing tasks held too much of a connection to the concept of a salary. To address this issue, points replaced the reward of coins. These points can be used by the player to buy special hands to play with within the game (Figure 16). This feature draws inspiration from popular games which allow players to personalise their playing experience, and encourages continuous play, to gain enough points to purchase the desired skin (Noordzij, 2015).

Figure 16: Illustration of hand selection



Game Development

Tools and Technologies

Unity 3D

After analysing the brief and discussing various options with the rest of the DSP Team, it was decided that the Unity 3D Game Engine (Unity, 2018), would be the main development tool we would use. This is the engine that most members with development experience, are familiar with. As the coding language for this engine is primarily C#, with minor patching it supports Microsoft Mixed Reality (Microsoft, 2017). The version of Unity 3D used, was originally 2017.2.0p2. In December, the project was updated to version 2017.3.0f3.

Steam VR

Switching to the Steam VR SDK was important, as it provided multi hardware compatibility, primarily including the HTC Vive, Open VR and now Microsoft Mixed Reality. This SDK provides access to many of the primitive VR functionalities, such as access to camera rigs, tracked controller, model renderers and interactions.

VRTK

The VRTK plugin was chosen for some of its compatibility features, such as the ability to implement multiple SDK's for various devices, such as the Oculus Rift. Once setup, VRTK will operate using the correct Vendor SDK, for the headset in use. VRTK also includes a simulator, this allows members of the group without a VR headset, to test the development of the project.

GitHub

The repository for this project, including a complete history of the development process (also found in Appendix One), can be found on GitHub. Git, is an invaluable development tool, showing each iteration of the project, with the ability to revert to a previous commit if required. It also ensures, that every device / user involved in the development, can always be working on the latest version of the project.

Implementation

Prior to starting the implementation of the project, the various UX and Game Design documentation, produced during these phases was analysed. The most valuable document, was the game flow diagram which provided a summary of events across a timeline, this ensured that events were implemented in the order and structure of the design.

The code structure is organised into three types of scripts, the manager, objects and task scripts. Some of the manager scripts, implement and handle key aspects of the running game, while a subset of others, handle key information that is not always active.

Major Manager Scripts

Script Name	Purpose / Operation
Event Controller	The Event Controller, is a variation of the Unity messaging system (Unity, 2017). Functions are overloaded to allow for two types of events, one that can accept a float value to be passed through and one that doesn't. This allows functions anywhere within the code, to be listened for and triggered, without the need for finding components. This reduces overheads and improves performance.
Game Controller	The Game Controller, is the starting and end for the entire game. It controls the main game states, as well as variables such as scores, levels and timers. Where possible, all attributes that require an 'Update' function are managed within this class. The three main game states, are 'Brief', 'Playing' and 'Game Over' These are checked every frame, with the relevant functions being executed. This controller, also manages the players statistics, such as the Hydration, Energy and Fade levels, throughout gameplay. The main components of this controller, can be seen in Appendix Two.
Spawn Controller	The Spawn Controller, handles all objects spawn within the game, such as water, food, hazards and task objects. A set of spawn locations have been placed around the scene, this controller takes the locations as a potential position for the next object to be spawned, it also checks whether an object already occupies this location, ensuring that two objects do not randomly spawn on top of one another. Once a suitable, empty location has been found, this controller spawns a relevant object. When an object has been collected, the controller removes it from the scene and frees up the spawn location.
Task Controller	The Task Controller, operates alongside the game controller. It instantiates new tasks into the scene, as and when required and removes the appropriate task once completed.

Game Task One Implementation

This task involves colleting three bottle of pills, once all three bottles are collected, the game ends. The Task 1 script, remains active throughout the entire game, spawning a new object at certain points during the game, depending on the player progress within other tasks. The task object, needed to be inter-actable, so when the grip button is pressed it collects the object. Once the first object is collected, the next task is instantiated.

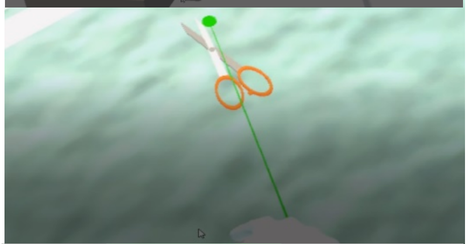
Game Task Two Implementation

Task two, requires a bed to be instantiated that does not conform to the presentation of the other beds in the scene. In this instance, three objects are placed around the bed. One is in the wrong place and should be placed in the correct position, the other two are rubbish that should be placed in the bin. Feedback is presented to the player, using 3D Text just above the bed, indicating how much time is left and how many completed objects have been dealt with.

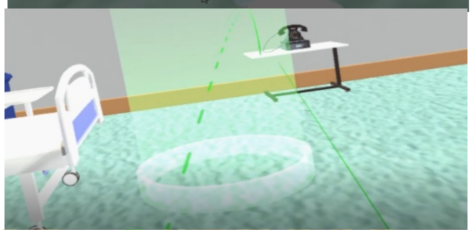
Game Task Three Implementation

Unlike the other two tasks, task three (Pipe Mini Game) has many more moving parts to its operation and is spread across four classes.

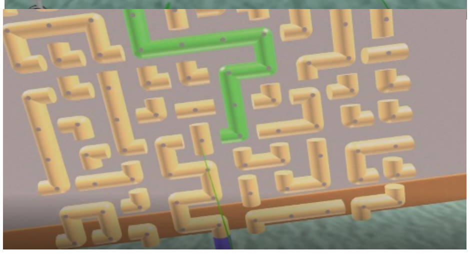
The major class here, is the Pipe Manager Class. Which once created, will generate a grid and populate each space within it, with a random pipe piece, until the grid has been completed.



Each piece of pipe has two classes attached. The first, is the Pipe class, this defines what type of pipe piece it is, its position within the grid, colour state and whether it is connected to a positive piece. This class, also handles the rotation of the pipe pieces. Using a coroutine, it adds a slight delay to prevent the objects rotating too quickly, this also makes the mini game more challenging.



The second class, is the Connector class. This handles the collision detection with other pipe pieces and checks the colliding objects connectivity states, reporting back to the Pipe class if successfully connected.



Animation Design

The animation team comprised of a lead animator, 3d artist and visual artist, creating the environment, props and characters in the game. Workflow was managed by the Lead Animator who delegated based on the individual skillsets of the animators. This set a standard for deliverables to the game designer such as: FBX, UV mapped, embedded media, scale in meters, freeze transformations and centred pivot point.

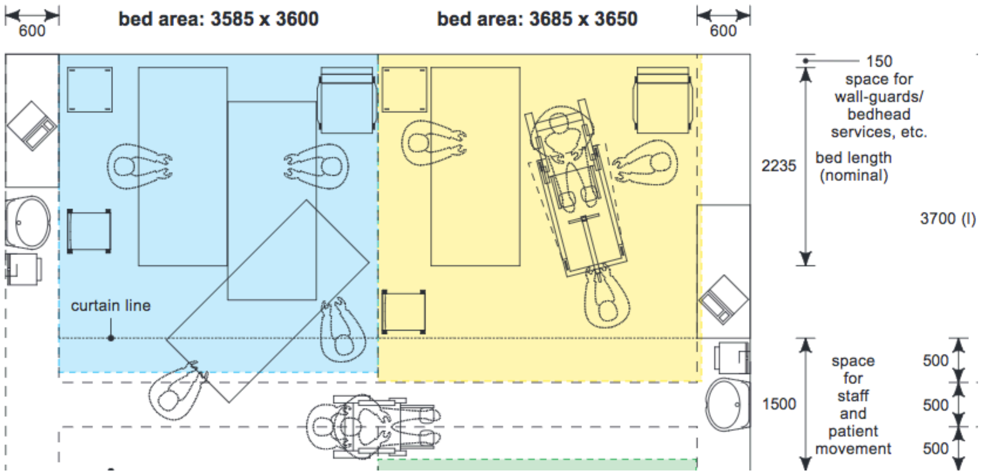
Aim

The requirement was to create realistic hospital environments and characters (nurses, doctors and patients) with animations. Assets created also needed to be prepared for the game environment.

Research

Research comprised of desk research, image research, architectural research and measurement benchmarking. Hospital wards are constructed to certain measurements, to accommodate the movement of patients, beds, machinery and staff (Wales.nhs.uk, 2008).

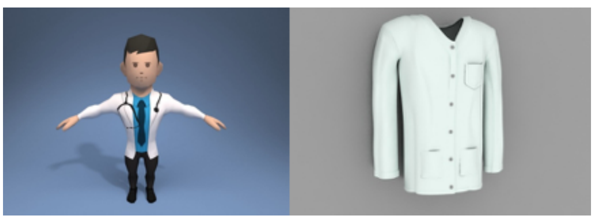
Figure 17: Space to manoeuvre a bed and transfer a patient to and from a second bed



Source: wales.nhs.uk

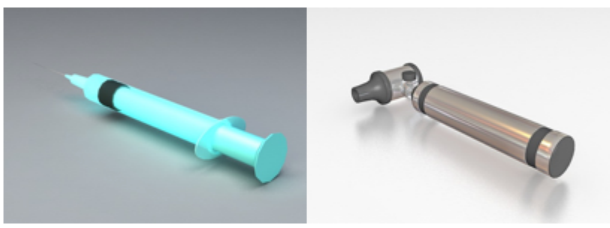
Research into character design informed the specification for a low poly aesthetic, as demonstrated in Figure 18. Hospital tools (Figure 19) were designed to look realistic to contribute to a better hospital environment. Research of animal movements were also beneficial in creating organic models.

Figure 18: Research into animation style



Source: cgtrader.com, cadnav.com

Figure 19: Research into hospital tools



Source: cadnav.com, cadnav.com

Design

Following group meetings, storyboard sketches were drawn to aid in the game design process. This helped define the environment and other deliverables required from the animation team for the initial sprint. An asset list for organisation was also created.

Prior to creating the objects, a colour guide scheme was created for the team. The colour guide maintained the integrity of final animations and provided a cohesive look and feel.

Figure 20: Storyboard of Game Design, Sprint 1

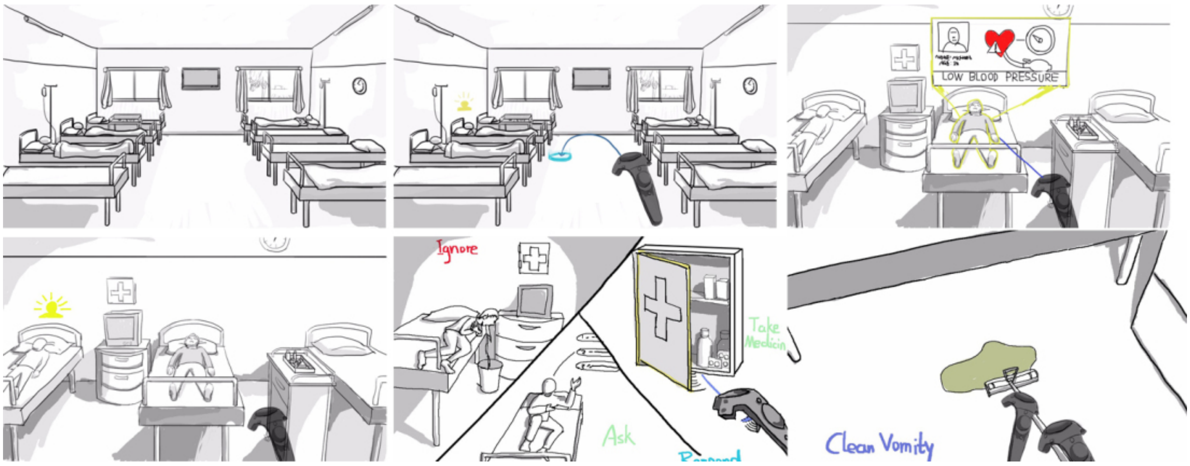


Figure 21: Animation Colour Scheme

Implementation

Modelling

Hospital items

The aim was to complete this project to a high quality and improve skills in different areas. This Included visual design and modelling.

In this project, various models for hospitals scene were made. Progress was made by following the animators' asset list. Pictures of hospital facilities on google were gathered, which is necessarily as reference for modelling. The process began with low poly models like a bed and table. Use extrudes cube then refining it the desired shape was achieved in Maya.

Some of the items were made by curve modelling, such as the IV stand. Next, UV mapping was done for all the objects. Then export the UV map to Photoshop to texturing it which is a very typical modelling workflow.

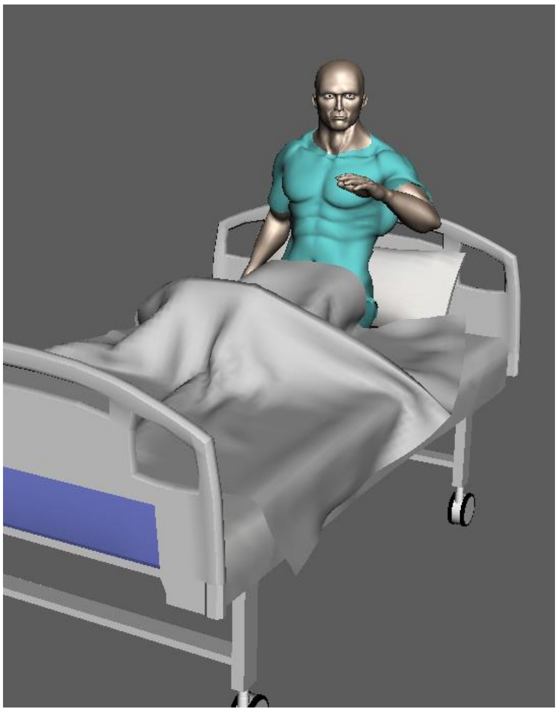
Textures

Some of the objects such as this cabinet were textured by using Substance Painter. This was because it can make a better metal effect.

But I got into trouble in transfers textures map in term, Unity can be able to display what is object showing in Maya, it takes me lot of time on this. A solution was found by straight export the map to unity then adjust it immediately in unity. This required learning new software. It was a new challenge for me but as a result I gained experience. It was a good way to work closer with programmer.

Organic Model and Animation

Patient and bed linen



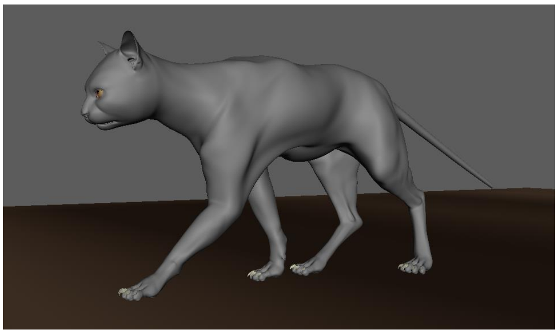
The character created is a patient with an uncomfortable expression, dressed in a green suit.

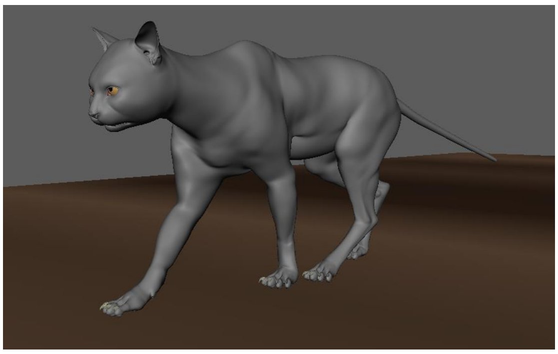
The body was extruded as bigger, then applied green material on the body, to make the patient uniform. Next, making him lay on the bed, have hand gestures (while explaining task) was achieved.

The sheet required research. Finally, a solution was found to make it look good. It was also the method used to make the pillow and bed sheet. This is a built-in function called "ncloth". This can help achieve a solid foundation for easily creating realistic clothing simulations in Maya.

Firstly, make a plane with 60x60 polygons, drag it to upside of the character, select the character and bed, then click create passive collider for them. Make sure you have enough frames at least 1000 showing on time slider, then click playback, you can see the plane slowly falling on the body, just need to stop at the right time that the sheet shape you want it to be, then just clean the history.

Cat walking





The game story includes a cat walking in the ward as a distraction the player should ignore. This was quite a complicated process as it involves a lot of animation principles.

It was important to find lots of realistic cat walking video clips. Then, writing down the characteristic of a cat's walk, and recording what each body part is doing at one second, 20 frames for one step.

This is the principle I made for the cat, its neck and shoulder moving at the same time, after long-time adjust I made the cat moving looks more realistic.

Unfortunately it was not possible to export the cat into unity. This is a problem to be solved after further investigation with the animation team and research.

This was an interesting animation function and area previously unexplored. It improved animation skills in animal animation.

People and items

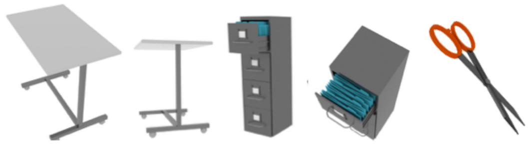
In this circumstance, Maya and Photoshop were useful to create reasonable scenes. Moreover, UV mapping was convenient to give models texture.

Water bottle and Bucket

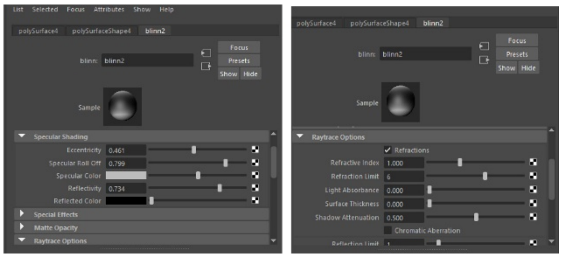
The bottle and bucket design process started out as low poly. Then the objects were textured in a simple way. For the water effect, polygons were textured with low-opacity and rendered using Arnold in Maya. The sky-dome light in Arnold made them realistic.

Drawer, Scissors, Patient Table

The creation process was the same as for the above items, however these items needed a metallic effect applied.



After the objects were created with low-poly, they were textured with a special effect and added reflective shadows. Making this arrangement provided a metallic effect. Lastly, the sky-dome light was applied.



Food Power-up

The process of creating an apple started with polygons. After creating the apple with low-poly, the object was textured with UV-map in Maya. The sample was textured in Photoshop. Lastly, the sky-dome light was applied.

Cat Character

The design of cat character was created from low-poly and simple texture applied on it. UV mapping was applied just for eyes.

Doctor Character

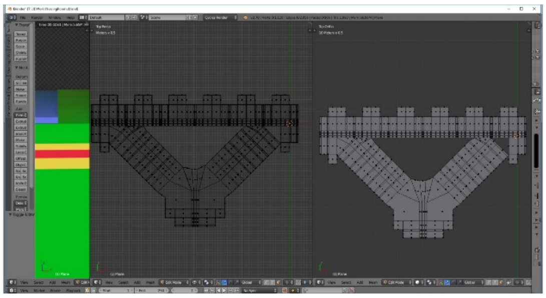
A doctor character was utilised from Turbosquid.com as a modelled basic human character with rigging system. The human character was redesigned from vertexes and a doctor uniform was created.

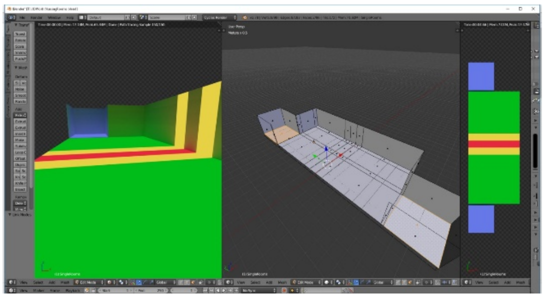
Source: turbosquid.com

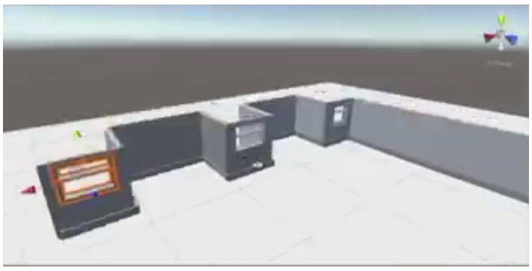
Environments

Wards https://youtu.be/iyrEShZZUbA

Unity prefabs https://youtu.be/8KBnPbyz0js







The first concept creation was from the main ward layout featured in the Ward excerpt from the NHS PDF document above.

As this was such a large layout it was decided it could simply be made in sections (corners, ends, straights etc) that could then be imported to layout any size ward fit for purpose.

Maya was used to create the 3D assets. Blender was used at first, however other 3D modules required the use of Maya so a switch was made early on. The rooms were kept very low poly and some procedural textures were created within Unity as well as image based textures as these are for hard surfaces so they could mostly be generated within the game engine.

Mission Select https://youtu.be/rRNc3EVOydY

The mission select room was more of a challenge as it was created purely from imagination and a very rough sketch.

A sphere was used for the room itself and inverted normals so that the player can be inside this giant sphere as a room within the game. A platform with bridge access was created in the middle of the sphere with the intention that the player would spawn on the platform when launching the game.

Lighting and prefabs of the room where set up in Unity by the lead animator to save the game designer time and effort while ensuring quality of lighting remained constant from Maya to Unity.

Summary

During the project, the group had team meetings and assigned deliverables to the animators. A collaborative effort was made from the animation team, with help provided to fill knowledge gaps. Future work would include rigging of the character animation.

Project Conclusion:

At the end of this project, the group's objective of achieving a VR demo game was achieved. The demo realised by the programmer incorporated the various aspects of the team make up; research, UX, game design and animation.

VR is an evolving technology and will require more time and development to become a ubiquitous feature of future educational curriculum. It was exciting to research developing industry trends and, as a group, design a unique learning tool for nursing students. The future of healthcare is also evolving, rapidly adopting new technologies to streamline services and improve training.

Future work on this project would prove rewarding. Refining the timing and scope of interruptions and distractions would prove useful along with further animation work and rigging. Formative usability testing with students would also be of benefit to the project to assess the effectiveness of VR as a medium for addressing situational awareness.

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