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ShopLand

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Abstract

Contained in this document is a description of a software development project that attempts to demonstrate an enhancement of the user's experience of

shopping online. An attempt has been made to "gamify" shopping, opening it up to the capabilities of 2D graphics in a prototype that makes the experience more efficient, effective and memorable to help encourage the return of customers. This has been developed with the help of online tutorials and creative exploration to produce a world in which the user can explore products physically and purchase them in a way that more accurately simulates real shopping.

The report starts with an exploration of online shopping to find the justifications for such a project, it then goes into the high-level discussion of the project as details are slowly unrolled to plan-for and produce the final deliverable.

Aspects of PRINCE2 were used to manage the project, it was planned to be an Agile development but it took more of the form of Waterfall. The development process involved creation of a MySQL database, Node.js middleware and HTML/CSS/JavaScript frontends to provide both a customer-view and a manager-view. Reasons are also given for the selection of these technologies.

Finally, the project is evaluated and a post-mortem done to consider whether the objectives have been missed, reached or surpassed, and any deviations from the objectives are discussed considering their appropriateness.

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https://github.com/Plymouth-University/prco304-final-year-project-tb991

1. Introduction

Online shopping is a multi-trillion-dollar industry in which consistent financial growth is predicted, which reached around $23 trillion in 2017[1]. It allows the user to avoid travel (and all associated risks) and the inconveniences of physical shopping while making the physical transportation of goods more efficient, thus burning less fossil fuel.

The video games industry is worth billions of dollars and involves the creation of 3D worlds through which players can navigate, acquire virtual items, socialize and accomplish tasks.

One of the problems that online shopping faces is that users often abandon their carts, for example at a recorded average rate of about 70%[2]. I believe that by

making a more exciting and interactive environment, the user will be more inclined to start and finish their order, which could greatly increase the revenue acquired through online shopping. Furthermore, by using an environment like a game, with a world, a character and products, the user is in an environment more suited to shopping than current methods, and thus more inclined to return to the environment to complete their shopping because it is more efficient given their knowledge of how to interact with a game environment.

Ultimately what is proposed is an extension to an existing game, or the development of a new game, where the user can choose the products they wish to have delivered to their real address and transmit the necessary funds, having full confidence that the items will be delivered promptly and accurately.

Studies show that the richness of an online environment is an important factor in customer satisfaction, with web designers encouraged to include “rich media attributes”[3]. A 3D environment in virtual reality would be the ultimate form of richness and would be ideal, and I believe is the inevitable future of this industry, however, in this project a very simple 2D prototype will be developed instead due to time constraints.

On the frontend the areas that will be explored are: world-creation, player-navigation, the existence of virtual products and environmental collision. The middleware will involve identity-tracking, authentication/security, SQL queries and serving the relevant webpages. The backend will involve a database normalised to 3NF that enables placed-orders to be seen by the manager, historic orders seen by each customer, monetary balances seen and modified appropriately, authentication, registration and the loading of products.

Due to many younger and emerging generations being exposed to and enjoying digital environments through console, PC and mobile-based gaming – it may be the right time to introduce these virtual worlds as an option for online shoppers. Virtual shopping could implement existing game features or develop its own, it could combine the purchase of digital and real assets in a way that completely revolutionises the way business is being done.

The aim of this project is to give an example of the combination of gaming and shopping but ultimately to get some experience in the creation of virtual worlds and to incorporate this into a shopping system to demonstrate its viability to three main beneficiaries: customers, retailers and game developers. Customers will benefit from less physical risk (and wasted time) from travel, retailers will benefit from increased revenue and game developers will benefit from having a new market in which to apply their skills and earn an income.

The proposition that guides this project is that the gaming and online shopping industries will soon merge and that autonomous delivery and a demand for virtual labour will come afterwards.

2. Background

2.1 Previous ventures into gamified shopping

The idea of "gamified" online shopping is not completely original, retailers such as Amazon have invested into developing a Virtual Reality marketplace[4]. Other companies (MasterCard and Swarovski, Tommy Hilfiger, Samsung and Carnival Cruises) have also researched this subject area tentatively[5].

The exploration of this area by leaders in industry suggests that it is a pathway that is known and possibly welcome, but that there is some risk or limitation associated with it since it hasn’t yet been implemented.

The evidence that purchases of real products has not been taken up by gaming companies may suggest that they are reluctant to develop in this area due to uncertainty. Their focus is on producing games, so it is left to retailers to explore this area, as some have done. However, retailers' technical skills do not seem to be enough to produce something that would pass as a modern game, so arguably the retail companies lack skilled manpower, time and resources. For example here is a 3D environment produced for the purposes of virtual-retail by Amazon in 2018:

https://venturebeat.com/wp-content/uploads/2018/07/Screen-Shot-2018-07-12-at-8.27.28-AM.jpg [Amazon's VR shopping screenshot]

Although the interactivity maybe superior due to VR inputs, graphically the above seems of less quality than games released around 2002 for typical consoles, for example:

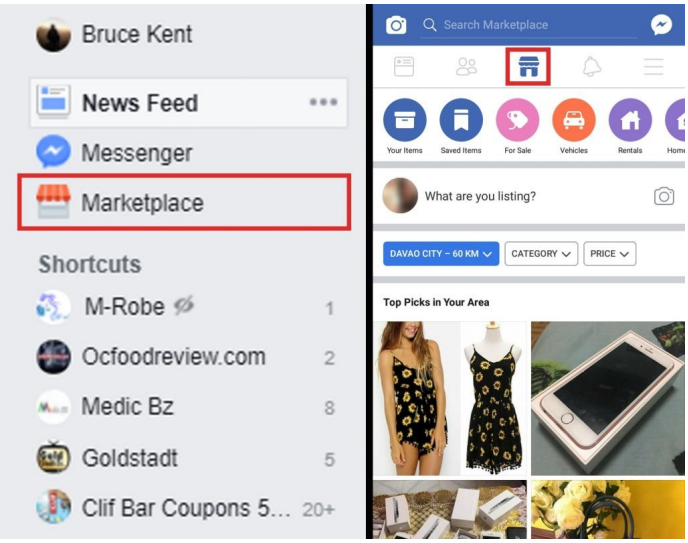
https://www.gtainside.com/downloads/picr/2017-11/1510093431_1510090517_Screenshot02.jpg [GTA Vice City screenshot]

If top companies cannot produce what gaming companies could 16 years ago then the customer is left confused as to why their software is lacking, which is an avenue to more doubts about the company which could arguably manifest as fear or apprehension. Conversely if a retailer acquires the skilled developers and artists that can create modern virtual worlds then the customer is likely to have trust in the software of the company.

By exploring the potential of this area in some depth and implementing a system permanently for a modern retailer, huge improvements will be made to customer satisfaction and some of the "fear" of online shopping[6] can be removed by the pleasant interactive environment. These fears are known to stunt business and tactics have been suggested for dealing with them. Ultimately though the goal should be to create a social marketplace where the customer can even sell their own products, and where the exchange of goods, services and money comes secondary, or in equal-footing to the environment being an enjoyable and safe place to socialise online.

The reason socialisation is mentioned is that it is a consequence of brick-and-mortar shopping and the suggested goal of development in this area is to emulate the real-world experience as much as possible. By removing the possibility of socialisation (as many online markets currently do) there is an unwelcome illusion in online shopping that human beings are not part of the system of trade except as customers, when in reality they are every part of the process.

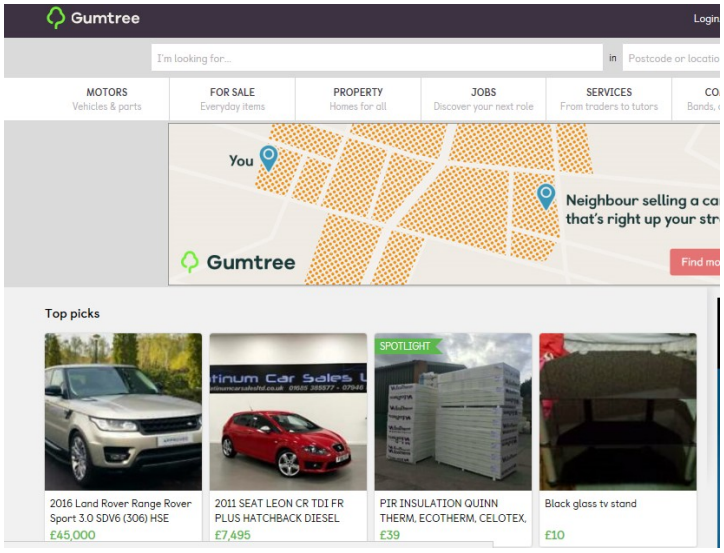
It should also be mentioned that competition is arising in this area from social media websites such as Facebook, where customers are creating their own "virtual markets" in order to buy and sell products. Below is an image of Facebook advertising its own marketplace:



https://caffeinerobot.com/facebook-marketplace-the-good-and-the-bad/

[image of Facebook marketplace]

Furthermore websites like GumTree are showing a demand for cyber trade:

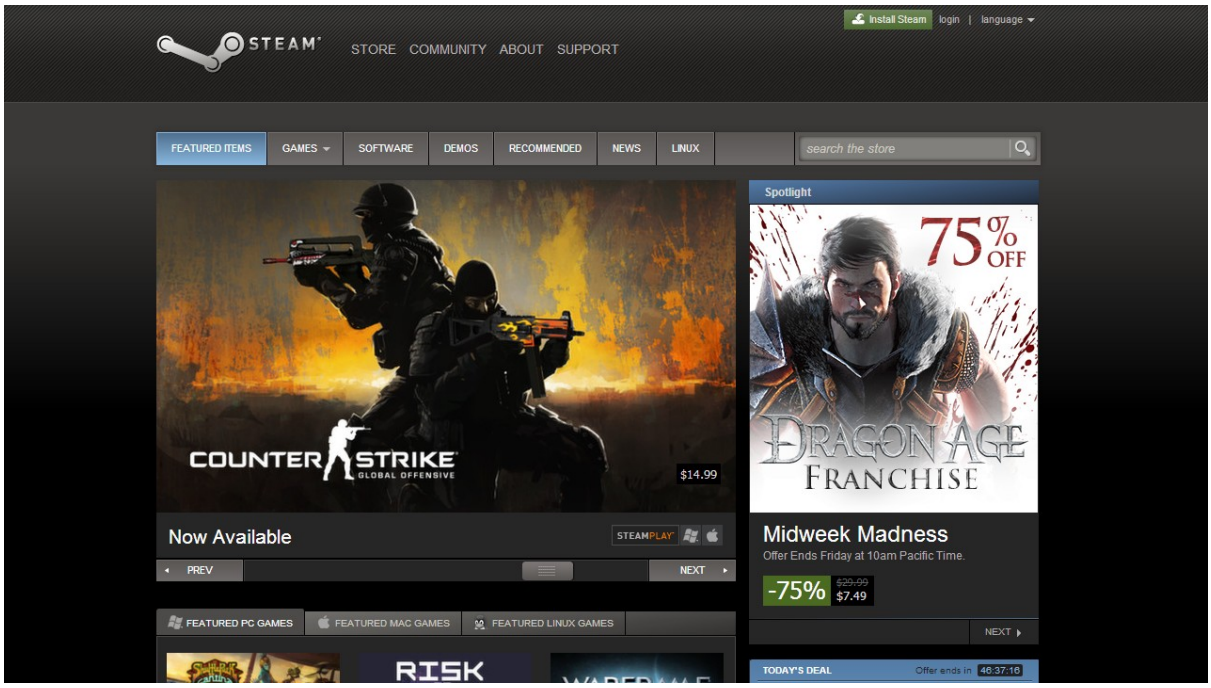


[screenshot of the gumtree marketplace]

If retailers do not advance in this area, then they may find their customers slowly trickling away to companies that are satisfying this demand for cyber-trade.

It should also be noted that this area could be open to all areas of trade, including services. People should be able to negotiate, advertise and buy/sell online. Since the UK is a service-based economy[7] (services account for almost 80% of the total UK economy) this area should be fully incorporated into the future software product. Other mechanisms that would be useful are feedback systems such as seen on eBay, so that buyers and sellers can have confidence in each other. Also product reviews such as with Amazon may be another suggested feature.

Another thing that should be mentioned is that games companies are somewhat experienced in this area due to virtual purchases of (and within) some games, however the games companies avoid the issues of logistics and delivery and all associated legal barriers to online commerce because the products they sell are purely virtual (for example “gun skins” in Counter-Strike: Global Offensive or the actual game data). An example of Steam’s marketplace is shown below.



http://www.seethru.co.uk/wp-content/uploads/2017/09/SteamStore.png

The above images demonstrate that games companies are becoming pioneers in e-commerce and arguably have the potential to overtake traditional online marketplaces such as Amazon and eBay if they were willing to advance in this risky area (and if customers were willing to give-up their delivery address to a games company to enable this feature).

This shows that games companies are potential competitors to retailers, if they can make the leap towards the acquiring and delivery of physical goods and services. And likewise retailers could become competitors to gaming companies. A mutual transfer of intellectual property seems necessary before these industries can merge.

2.2 Problem identification

Simply put, this project is about presenting a way in which the problem of boredom in online shopping can be solved. Currently products are advertised to users in such a way that bulk purchases are very inefficient. In current internet shopping, users are given a search bar and various images in the vain hope that algorithms will work to show relatable products, or that the customer knows exactly what they are looking for. This model is very weak and takes away the essential element that has been a part of caloric acquisition in humans for millennia; random exploration. By providing a means by which the customer can explore randomly, the acts of caloric acquisition more accurately simulates the prehistoric experience of hunting/gathering which (when implemented) will drastically improve customer satisfaction in a way by which humans will not actually need (or more importantly 'want') to physically travel in order to acquire their nutrients.

In order that the fear of online shopping is overcome the customers must have confidence in the software of the market that they use, and this can be provided by developing virtual worlds of transactions, exploration and business.

3. Objectives

3.1 Business Objectives

The main business objective is to provide an environment in which shopping can be done more quickly and efficiently than in current online environments. This will be done to show the potential of gamified/virtual online shopping, and hopefully encourage retailers to develop more advanced versions, to begin to fund serious research into this area or to start headhunting game developers to develop their own virtual worlds.

3.2 Project Objectives

The project was initially divided into two main sections (the customer's app and the manager's app). It still is divided into these categories; however, it was decided to put the majority of the effort into the customer's app since it is the most significant, and also due to time constraints. Therefore, there will be a client app where the user can browse a 2D world of shops, finding various products and adding/removing them to/from their basket and finally checking out. There will also be a very primitive manager's system which can see the orders which are up for delivery, which is merely a fulfilment of the proof of concept. The customer will be able to see their monetary balance, pictures of the

products and their recent history of purchases. The 2D world must integrate with a secure login-system and accurate checkout-page. This project will involve full-stack development of a backend (database), middleware (server) and frontend (manager and customer programs).

4. Legal and ethical considerations

4.1 Legal issues

Since customer information will be held on a database, the Data Protection Act 1998 and 2018 must be adhered to if this project were to be implemented as a non-prototype. Furthermore, the law "Distance Selling Regulations 2000" must be adhered to also, which provides protection for people buying goods and services in a non-face-to-face manner[8]. It covers the returns policy and information that the user must be provided with before a purchase, as well as exceptions to the rules such as with perishable goods like food.

There are also other relevant laws such as: Sale of Goods Act 1979 (updated in the Consumer Rights Act 2015) which provides protection to the customer with rights regarding the quality of the goods.

The three prior mentioned laws translate as responsibilities on the behalf of the business providing this virtual marketplace and things which they may be accountable for. They should be fully adhered to such that things are done properly; protecting the business implementing this idea from legal troubles.

Another point is that this project has been partially influenced by code developed by the owner of http://technologies4.me/. This means that this work may be subject to copyright restrictions as the 2D world created constitutes an “adaptation” of the original[9] and copyright is typically applied automatically without requiring an application. Since this is just a prototype and for academic purposes it would seem permission is not necessary under fair use[10], it is however recommended that appropriate permissions are acquired and acknowledgements-given from anything else that does help the development of the implemented world. The initial tutorials for the 2D world were watched and influenced the development of my own simpler version, however concepts were borrowed and adapted rather than code being directly copied.

Finally, although it has not been implemented in this project, a way to block minors from using the app (perhaps by using ID verification) would also be appropriate. This would avoid legal troubles related to laws that forbid data being held on minors.

4.2 Ethical and social issues

Customers may wish their data to be deleted or corrected, there may also be situations where orders are not received correctly, refunds are demanded, or products are not adequate. All of these areas are opportunities to further develop the software product to accommodate these needs.

If the environment that is developed has a social aspect to it then care must be taken to warn customers against sharing identifying or locating information with strangers. This problem is an interesting one because it begs the question of whether real identities will be used, as in with websites such as Facebook and Twitter, or whether constructed identities will be an aspect of the system such as with Internet Forums, Games and IRC. In any case, the problem of internet-based predation will be something that requires addressing and cooperation with law enforcement may become necessary if the app is ever used for illegal activities.

For the usability testing, peers on the course were approached for feedback and informed consent was acquired in each case, therefore conforming to the University's Ethics Policy. Furthermore this product is designed for adults (rather than minors) and so there are no ethical or legal problems there with regard to storing data about minors.

5. Project Management

PRINCE2 was used as well as Waterfall in managing the project. Agile was tried for a brief period but abandoned due to lack of inexperience and confidence. The main development stages of the project were as follows:

A. 2D World with walls, products and avatar.

B. Authentication system for customer and manager.

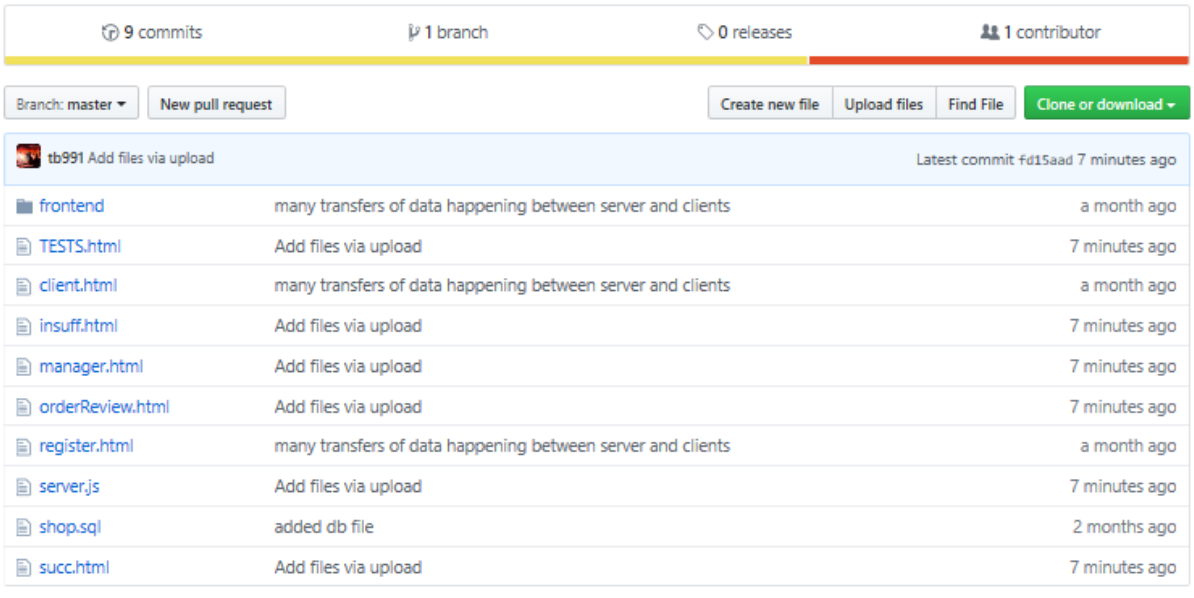
C. Basket to allow the accumulation and removal of products.

D. Checkout page.

E. Testing.

These stages were completed with minimal overlap between them in the order that they are presented, transitioning from one to the other through trial and error approaches and adopting a programming-style whereby problems are solved by iterating solutions of even-simpler analogues.

Git was used for version control, however there was some failure here as it was not maintained on a single repository, this is due to being somewhat unacquainted with version control and using it for practise rather than fully for its proper usage. The project was maintained over two repositories and there is a gap between them where commits are unknown/absent, unfortunately only the final set of commits are visible as the prior data has been lost. Git was used to revert to earlier commits on several occasions and therefore proved very valuable to the project.



6. Requirements

Non-functional requirements are known as traits/aspects/qualities of the system (things the system is) whereas functional requirements are behaviours of it (things the system does).

6.1 Non-functional requirements

- Customer interface must be easy to use.
- Shopping must be able to be done quickly.
- Adding/removing a product must be as simple as possible for the manager.
- The user accounts must be secure.

6.2 Functional requirements

- Customers must be able to explore the world.
- Customers must be able to add/remove to/from basket.
- Previous orders must be visible.
- Purchases must update the stock of the shop.
- Customer/manager must be able to log in.
- User must be able to register.
- Orders must be confirmed in a way that the user is fully aware of the purchase.

7. Initial Research

It was decided that many NodeJS modules would be used in developing this project, particularly the websockets module which was known from a previous project. Websockets will allow easy client-server communication. For the 2D world a set of tutorials was found[11] and early versions of this code was loosely emulated (though significantly modified). Since NodeJS is a very extensive library, the majority of the project's server-side requirements are contained in it. A list of the modules that were used is provided below.

websocket - heavily used module for client/server communication

http - allows a http server to be used

js-sha256 - password hashing

mysql - enables access of a mysql database

fs - filesystem access

path - utilities for file/directory paths

url - lets URLs be used effectively

sync-mysql - synchronous mysql access, needed for consecutive/dependant database queries

Game Engines such as Love2D (using Lua) and Unity (using C#) had been briefly explored prior to this project (mostly Love2D) and a simple prototype was made in Love2D (an implementation of Newtonian Physics) to explore the possibilities.

However, with regard to the front-end, everything that is needed can be done through plain Javascript/HTML/CSS and therefore no extra research was required. It was known that highly complex games involving virtual worlds could be made in pure Javascript[12] and therefore no further technologies were assumed to be needed to make a simple one.

If this project were to be implemented with a retailer, it would be recommended to use a 3D game engine such as Unity to develop the product, unless a 2D version is desired. This would also be done on another iteration of this project in greater depth to explore more relevant technologies. However simpler graphical designs have shown a recent resurgence in the gaming world and therefore impressive graphics can always be compensated for by enhanced game mechanics and control (such as with Minecraft).

It is also important to note that a requirement of advanced graphics hardware to complete weekly shopping would be quite an unreasonable demand on the customer, therefore there is a good reason to use simple graphics but appealing or advanced game mechanics.

7.1 Assessment of online shopping

Post-purchase regret is common in online shopping and can have lingering effects on decision-makers. There has been some success in re-establishing the role of cognitive effort (of the customer) in reducing this experience of regret. One suggestion has been to encourage the use of cognitive effort by allowing the customer to “compare products freely without pressure”. It has also been shown that the customer’s feelings of justification (or knowledge of an “acceptable reason”) play an important role in reducing the experience of regret. [13] As much should be done to reduce the possibility of post-purchase regret in the final product.

Clearly trust plays an important role in e-commerce. It has been shown that three website-based determinants of trust are “Website quality”, “Perceived usefulness” and “Perceived ease of use”. [14] Therefore, these attributes should play a role in the product.

There is some agreement that online shopping in its current form is “frustrating or mundane”[15]. Some effort has been made to encourage the merging of social media and online shopping to deal with this, and this does seem like a possible direction of the market.

It has been suggested that the ultimate role of online shopping environments is to bring the experience closer to real-life experiences[16]. It seems reasonable to assert that the creation of a physical world is a good first step in delivering this.

There has been some suggestion that hedonism and emotions play a vital role in shopping, particularly the happiness of the customer seems to play an important role[16]. This may be the driver behind the growth of social-media marketplaces, where there is a social aspect that is integral to it. Perception of the environment also plays an integral role of the customer’s experience of online shopping. The emotions and experience of the online shopper are seen as fluid rather than fixed, this is in conflict with the state of current online environments which are not providing adequately for the emotional and experiential aspects of shopping.

The problems of current online shopping seem to be that the method by which humans naturally discover is completely absent (random exploration) and also bulk-purchases are extremely tedious because they require long streams of clicking through alphanumeric categories (browsing) or coming up with appropriate search-terms to locate the product. If a user is able to *walk* to their product then the act of navigation is introduced, which is a core part of the functioning of every animal’s biology and therefore is arguably linked to pathways in the brain that will better enable memorisation as well as the expression of other emotions.

There has also been the suggestion that “helpful staff” are not viable in online shopping environments[16]. However this is only because the actual notion of an

environment is not fully established yet in online shopping and therefore there is no space in which the shopper or staff can tangibly exist and interact (the pathway of the customer is hidden from staff). This project will not produce a system to enable helpful staff to be present, however it does create a foundation from which that can be built. It is not hard to imagine a simple chat-message facility and the ability to perceive other users being present, which would provide the means by which staff could be present.

There has also been acknowledgement that information overload is a problem in current online shopping systems and has negative consequences, and likewise that scarcity of information fails to stimulate or challenge the user[17]. By creating a physical environment in which movement is possible, particularly from a bird's-eye view, information overload becomes impossible and scarcity of information becomes a choice based on the navigation decisions of the user.

It has also been suggested that retailers need to "implement mechanisms that will study their customers' attitude and behaviour"[18], this is another justification for the development of a physical environment (world) in which to shop, because the navigational path would then be new information that retailers would be able to study which would elicit information which is currently unavailable due to the primitive way in which current online shopping systems are built.

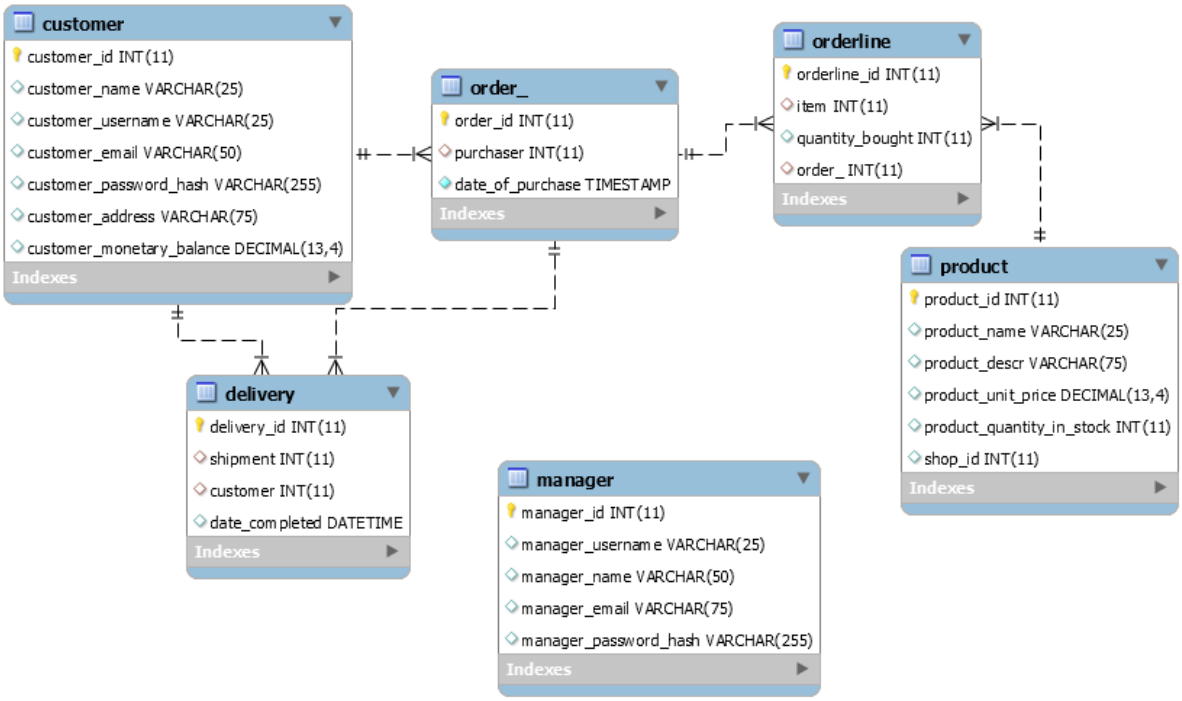
In the prior-mentioned study it was found that cognitive perceptions played a more important role than affective perceptions in personalized online shopping. This might encourage other avenues of development in online shopping environments, such as the use of problem-solving to unlock features or abilities. However, this finding is probably based on the current features of online shopping environments, in that they are product-focussed rather than environmental and customer-focussed. As a consequence of being product-focussed a user only finds utility in the system by knowing exactly what they want and so most of the emotional/affective experiences have taken place before accessing the online shopping system. A more physical environment in which to shop online may help to cultivate affective emotions that lead to or occur prior-to purchases.

The two states of online shoppers (having a task vs not having a task) have also been explored and it has been suggested that two different kinds of environments are required to tailor for these different kinds of shoppers, one shopping environment formal (for those with a task) and the other shopping environment aesthetic (for those without a task)[19]. This is clearly based on the desires of the customer, the one with a task will find that the seductive aesthetics of the environment are superfluous and will distract him/her from their task whereas the customer without a task is actively looking to be seduced into purchases and therefore welcomes the aesthetics. This may encourage the development of two systems; one pragmatic/formal and the other seductive and exploratory. This project offers a compromise between the two, it provides a foundation from which both formal and aesthetic environments can be developed. Although the arrangement of products can be formal; being located in shops that can be entered, there is room for the possibility of aesthetic appeal or seduction into purchasing. The introduction of new unexplored territory is an example of invoking curiosity in a user and the possible aesthetics of that environment are limitless.

8. Design

8.1 Database

A list of appropriate attributes was created that the system depends on. These attributes were then fully normalised to from UNF through to 3NF and the following Entity Relationship Diagram was produced.



Below is a view of the test-data that was used as seen from the MySQL command-line that enabled the main features of the products to be operational.

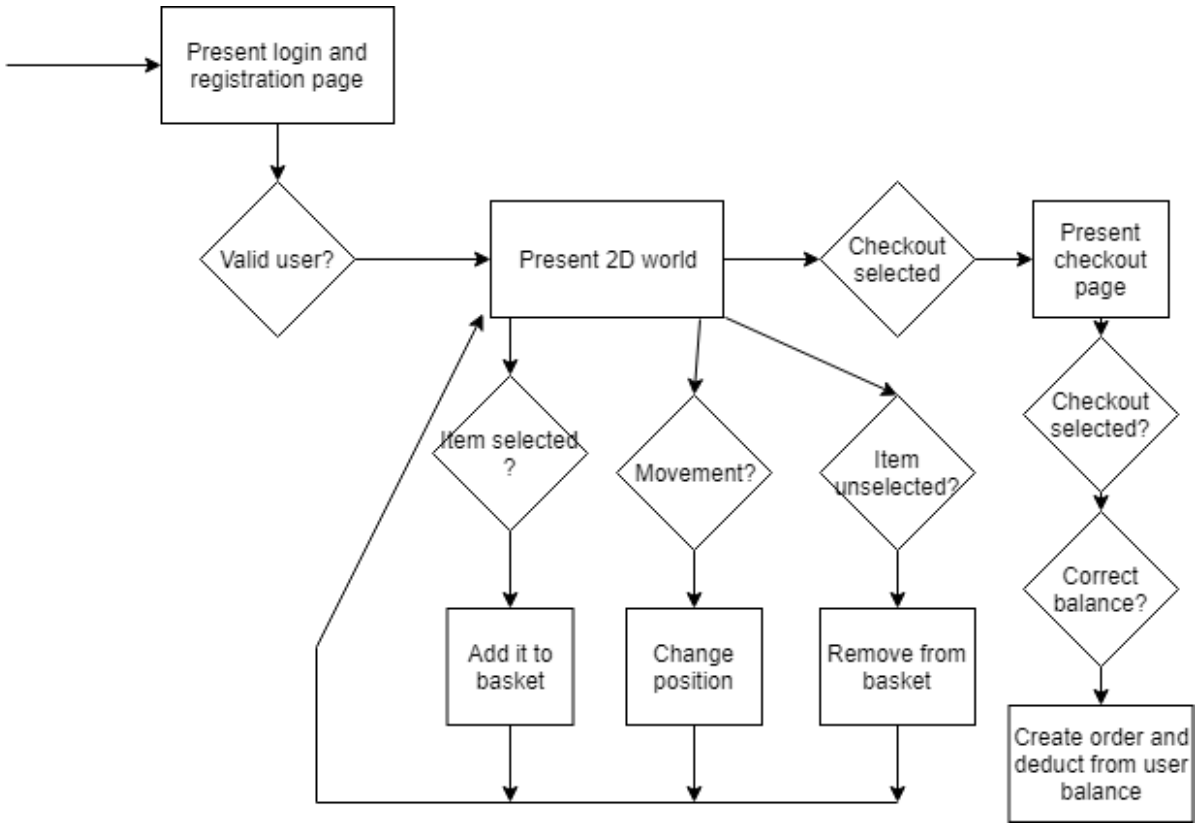
```
6 rows in set (0.00 sec)

mysql> select * from customer;
+-------------+-------------+-------------------+-------------------------+-------------------------------------------------------------------+-------------------------+-------------------------+
| customer_id | customer_name | customer_username | customer_email          | customer_password_hash                                            | customer_address        | customer_monetary_balance |
+-------------+-------------+-------------------+-------------------------+-------------------------------------------------------------------+-------------------------+-------------------------+
|           1 | NULL          | tom922            | tomburgess24@gmail.com  | 962E189E91D632CAA23F1BC14EF833AA74330D99BB6E7CF47731D3D85874A594 | NULL                    |                    NULL |
|           3 | NULL          | tom21             | example2@googlemail.com | EEC5650A944DA04BA6EFAE5EBC44B8AE26440237C98C072A0027CD015C51CFC9 | 1 Person Lane, TR12 8PO |                 64.0000 |
|           4 | NULL          | bob92             | hello@world.com         | 936A185CAAA266BB9CBE981E9E05CB78CD732B0B3280EB944412BB6F8F8F07AF | NULL                    |                    NULL |
|           5 | NULL          | tester            | test@tester.test        | B6A404C199E0F614CA0620F790650DDF2E50B09DB62EF73348BDAAABC4F49D8F | NULL                    |                    NULL |
+-------------+-------------+-------------------+-------------------------+-------------------------------------------------------------------+-------------------------+-------------------------+
4 rows in set (0.00 sec)

mysql> select* from manager;
+-------------+-------------------+-------------+-------------+-------------------------------------------------------------------+
| manager_id | manager_username | manager_name | manager_email | manager_password_hash                                             |
+-------------+-------------------+-------------+-------------+-------------------------------------------------------------------+
|          1 | tom               | NULL        | NULL        | 2CF24DBA5FB0A30E26E83B2AC5B9E29E1B161E5C1FA7425E73043362938B9824 |
+-------------+-------------------+-------------+-------------+-------------------------------------------------------------------+
1 row in set (0.00 sec)

mysql> select * from order_;
+----------+----------+---------------------+
| order_id | purchaser | date_of_purchase    |
+----------+----------+---------------------+
|       17 |         3 | 2019-03-19 05:12:59 |
|       18 |         3 | 2019-04-17 18:22:22 |
+----------+----------+---------------------+
2 rows in set (0.00 sec)

mysql> select * from orderline;
+-------------+------+-----------------+--------+
| orderline_id | item | quantity_bought | order_ |
+-------------+------+-----------------+--------+
|           24 |    4 |               3 |     17 |
|           25 |    3 |               3 |     17 |
|           26 |    2 |               2 |     17 |
|           27 |    5 |               3 |     17 |
|           28 |    5 |               2 |     18 |
|           29 |    4 |               2 |     18 |
|           30 |    3 |               3 |     18 |
+-------------+------+-----------------+--------+
7 rows in set (0.00 sec)

mysql> select * from product;
+-------------+-------------+-------------------------------+-------------------+-------------------------+---------+
| product_id | product_name | product_descr                 | product_unit_price | product_quantity_in_stock | shop_id |
+-------------+-------------+-------------------------------+-------------------+-------------------------+---------+
|          1 | brocolli     | 500g of brocolli              |            1.5000 |                        50 |       1 |
|          2 | carrot       | 500g of carrots               |            1.5000 |                        50 |       1 |
|          3 | mushroom     | 250g of mushrooms             |            1.0000 |                        30 |       1 |
|          4 | onion        | 500g of onion                 |            1.5000 |                        50 |       1 |
|          5 | potato       | 1kg of potato                 |            1.5000 |                        50 |       1 |
|          6 | tshirt       | a cotton plain green t-shirt |            9.9900 |                        50 |       2 |
|          7 | trousers     | denim plain blue trousers     |           14.9900 |                        50 |       2 |
+-------------+-------------+-------------------------------+-------------------+-------------------------+---------+
7 rows in set (0.00 sec)
```

The database is simplistic and contains the minimum data necessary to demonstrate the core features of the app. Each table is used by the middleware and transmitted to the client for specific purposes.

8.2 Middleware

An activity diagram was drawn to conceptualise the main behaviours of the application, it gives a basic description of the behaviour of the system when a

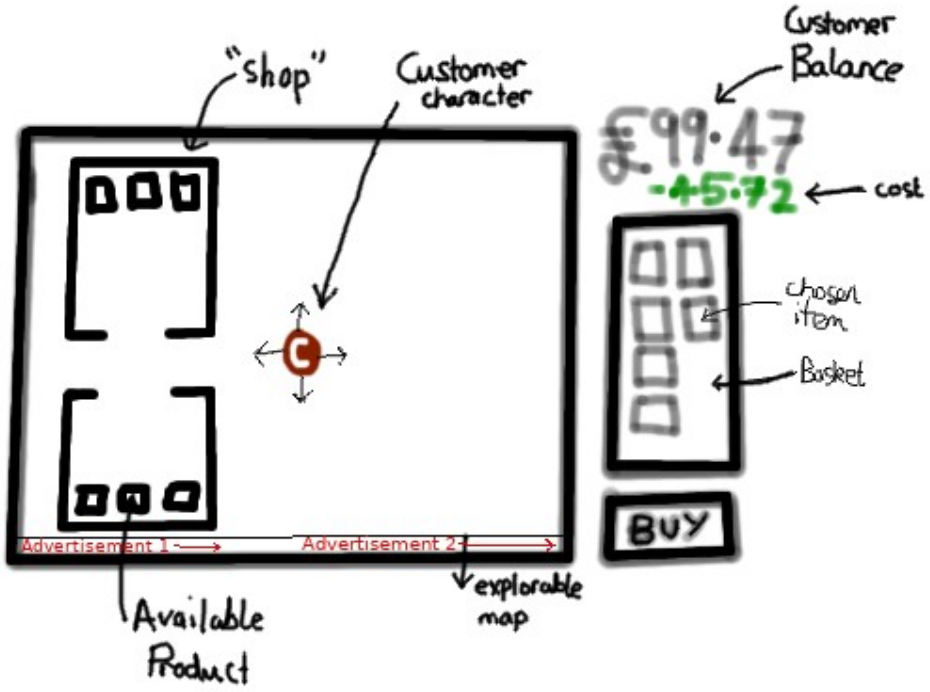
user accesses the webpage, it also continues to function like this for multiple users performing simultaneous events.



Sequence diagrams were also drawn to further conceptualise important processes and they helped inform the programming of the server.

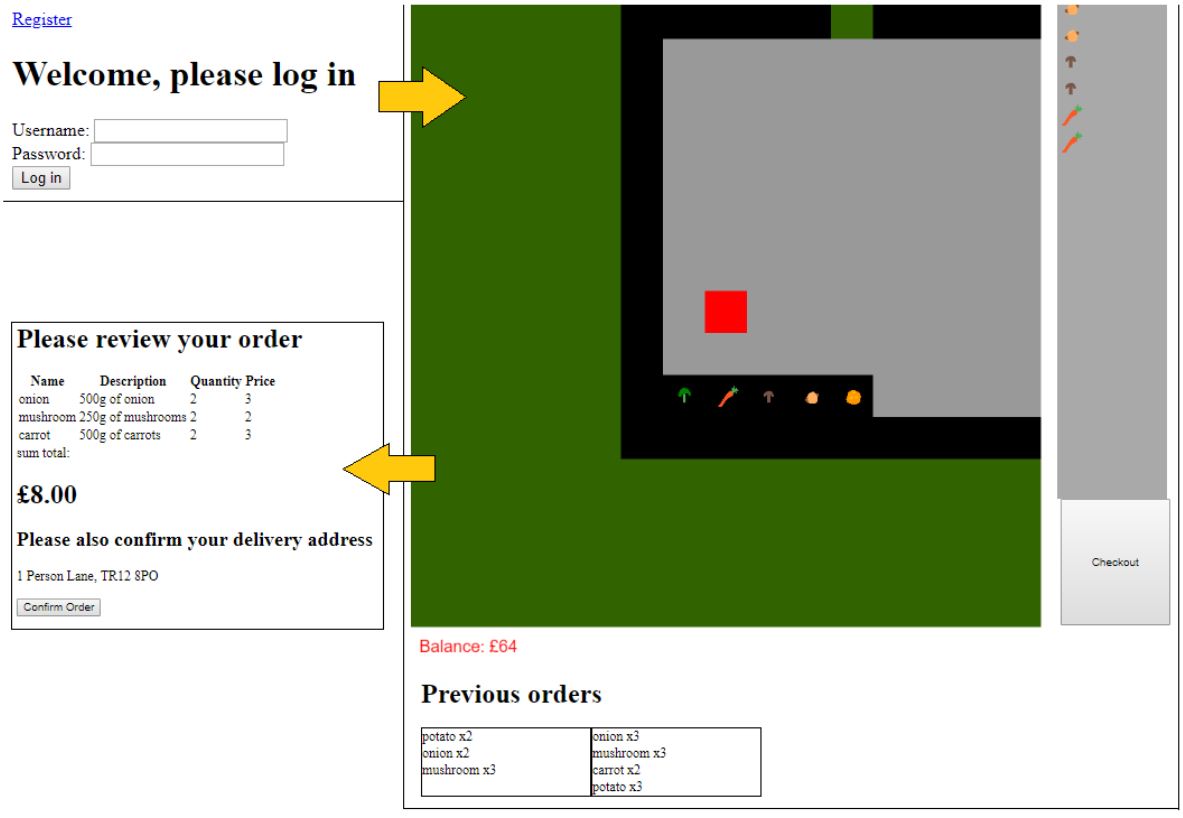
8.3 Frontend

A sketch was made for the client, shown below, demonstrating the desirable features of the most significant page for the customer.



9. Testing and Development

The three main interactive screens that were developed for the customer's app are shown below.



The green image shows the basic 2D world (from a bird's-eye view) where the user can move the red block around and beyond the screen and see the products below him. When he steps on the product some of its details are shown, and there is a door in the shop so that he can exit and explore more of the map, from

which he will find a clothes shop and finally a boundary from which no more exploration is possible.

9.1 2D world

After a few viewings of various tutorials (mentioned previously) enough information had been absorbed to begin to design and create a simple tile-based 2D world. The main design decision was to have an array of floating-point values in the 'World' class's data variable which would symbolise physical constructs within the 2d world.

0 - traversable (grass) block

0.5 - interior of a shop, traversable

100+ - images of products, traversable

otherwise - black, non-traversable (wall)

As shown above a design decision was made mid-coding that products would be traversable, this is because it was seen that standing over a product and pressing <enter> was a more efficient way of selecting a product than standing next to it and clicking it, it was also more easy technically.

Thus a 2D world of width/height 100 blocks was created (50 pixels per block). Making it explorable was a matter of containing the position of the screen inside the World class and having a Screen object which would contain the relevant subset of values of the World object's data; refreshing every time a button is pressed. A red block was used in the centre of the Screen object to represent the player.

Also relevant to the 2D world is the Shop class. This was initially made as a set of functions that simply drew a rectangle of non-traversable blocks on the World but was converted into a class as soon as major changes needed to be made (arrangement of products) and so that it could be modified as a global variable. This class would form two objects in the prototype which would represent a vegetable and clothes shop in the physical world, from which the player could enter and place products into his/her basket.

Initially all the code was placed into one file, but it was then split into Model, View and Controller files for pragmatic reasons.

To represent the product images, simple drawings were made using pixel art on the website *https://www.pixilart.com*, producing images of width and height 32 pixels in PNG format. This is something that would need to be done repeatedly for all products.

9.2 Authentication system

In order that the users could register and log in, and that managers could be distinguished from customers and vice versa, it was decided that an authentication system would be made. This involved transmission of the username and password via websockets, which for this project was (wrongly) sent over plain HTTP (it should be HTTPS, but I did not have a certificate) to the server, which hashed the password and compared it with the stored (hashed) password in the database for the appropriate user. Once a valid login is detected the relevant information is acquired for this user and the appropriate page (the 2D world or the Manager's Portal) transmitted to the client.

It would have been more secure to use a salt with the hashed password, which would have taken up another place in the database for each user. The weakness of the security currently implemented is that if the database is accessed then

identical passwords between users can be identified, however, this was not seen as a major concern and so salting was not implemented. In a proper implementation of a shopping environment a salt must be used inside (and beside) every stored hash.

9.3 Basket

The basket was a second canvas (other than the 2D world) that appears alongside the 2D world and represents the intended purchases of the user. It displays an image of each product that is selected by the user, and allows removal with the mouse-click of the appropriate product. It was decided somewhat arbitrarily that a total of 37 products would be the maximum per shop, this can be adjusted by changing the appropriate values and the dimensions of the canvas. The basket operates in two ways, first pictures of products are inserted into it when the user selects a product, secondly, items are removed by clicking them by removing the item from the array and redrawing the basket. This software entity (the basket) simulates a real shopping basket perfectly except that the user destroys the product rather laboriously returns it to the shelf, as they would feel compelled to do in a real shop.

9.4 Checkout page

Once the customer is happy with the set of products they have bought they can click checkout, this will take them to a page that confirms their order and the total price. This is done via a set of SQL queries which access the relevant information of each product and accumulate the total price. When this is confirmed, another SQL query is done to check the balance of the user and compare it with the price of the purchase and if valid then the deduction is made from their balance. Otherwise if no deduction is made an error message is shown.

9.5 Unimplemented features

It is necessary to discuss some features that are lacking from the prototype to give a full description of the intended product. There was not sufficient time to implement these, but they are a part of the design and would be implemented in future versions.

9.5.1 Payment update

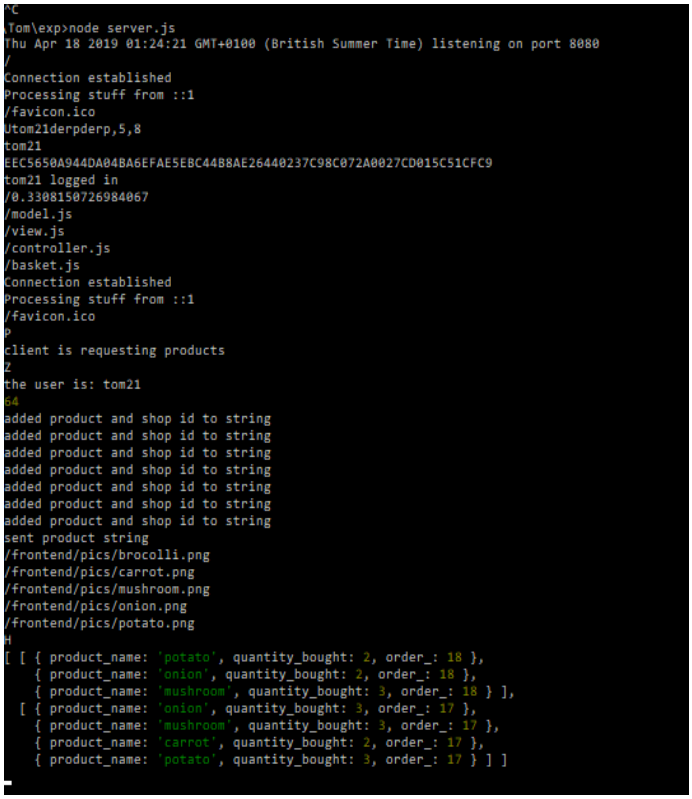
An appropriate feature must be added which accepts the bank card of the user and a monetary value in a particular range and transforms this into the credit of the user's account. The benefits of this are that customers can update their balance in bulk. Using an in-game currency would remove some of the fear of online-shopping. Technically a user should be able to put £1000 into their account, have this completely secure, and use it for the foreseeable future of their shopping without having to re-enter their card details.

9.5.2 Social aspect

Having other users present in the shop would improve the realism of the experience. Therefore the design should be (quite drastically) altered to allow for this, and for communication between shoppers. Something that represents MMORPG's communication systems would be appropriate but also a simple text-based communication system would also suffice. Some new algorithms/data structures would need to be introduced to enable shoppers to be viewable to each other, mainly the server would have to maintain a variable holding the position of every player, which would also be transmitted to every player regularly.

9.6 Server

A server was developed in JavaScript, it maintains a unique session for each user, takes messages from the clients, executes SQL queries on the database and sends messages to each client. It is about 500 lines long and some of its debugging information is visible below, demonstrating a login of the customer.



The server also implements prepared statements on SQL queries that could otherwise be attacked through SQL injection, therefore enhancing the security of the software.

9.7 Testing

There was not sufficient time for full unit testing however every component is confirmed to work and the program has been regularly executed in edge-case situations (such as simultaneous orders being placed) to try to detect and resolve errors. What has been tested is customer login, manager log in, customer registration and the loading of products from the server. Since this is just a primitive prototype, and demonstration of concept rather than actual implementation; thorough testing was not needed.

C,0.1750082383915914	TESTS.html:17
Test 1 passed; acquired a valid session id from server for the CUSTOMER	TESTS.html:21
M,0.6616835560302268	TESTS.html:17
Test 2 passed; acquired a valid session id from server for the MANAGER	TESTS.html:27
TEST REGISTER WORKED	TESTS.html:17
Test 3 passed; insertion of test-user would have executed	TESTS.html:31
P,1:brocolli,1:carrot,1:mushroom,1:onion,1:potato,2:tshirt,2:trousers,	TESTS.html:17
Test 4 passed; product string received	TESTS.html:34
C,1.5,1.5,1,1.5,1.5,9.99,14.99,	TESTS.html:17

9.8 Verification and validation

Code reviews were done frequently throughout the project and led to some changes to improve the efficiency of the algorithms and data-structures in use. The specification and the requirements of the project were also reviewed, and a small amount of unit testing was implemented. For validation UML diagrams were created and usability testing acquired feedback to assess the quality of the product, requests for features and whether the concept is viable. The main feedback was that large pictures of the products would be useful to supplement the icons and requests for a more interesting environment in which to explore.

10. Post-Mortem

This project succeeds as a proof of concept. A simplistic world and environment has been created to allow the purchase of bulk orders of products, from a pseudo retailer, by use of a gaming frontend. However, the project is limited and was not well suited for unit testing.

Fully adhering to Agile would have benefited the project during the planning phase but due to limited experience it was deemed too risky to explore this within the allocated timeframe and it was more comfortable to follow a more waterfall approach which is ultimately what was done.

The implementation of JSON objects, needed to transmit more complex objects, was significant. A consistent use of JSON for all transmissions between server and client, rather than just for large objects, would improve the code quality.

Restructuring of the code to implement design patters such as Factory for products, Observer for the basket and Command for the purchasing may improve the product quality by making the code more maintainable (and follow the open-close principle). The SOLID principles generally should have been better adhered to.

A functioning authentication system that distinguishes between users of differing authorisation levels (customer or manager) has enhanced the project. The server successfully tracks the identity of the user to the correct confirmation-of-orders page and subsequently deducts payments from the appropriate account. The user is also able to see their order history.

A technically interesting ‘next step’ would be to give the manager access to the 2D world allowing them to be able to add new shops and products easily to the system. It should be noted that this would require restructuring of the existing code.

This product ultimately acts as an initial prototype upon which its concepts can be expanded and are only limited by time and software.

11. Conclusion

Experience has been acquired in developing in HTML canvas, general web development and making a server in JavaScript. All of these act as a good foundation to build a more sophisticated product in the future, however, in retrospect a more appropriate approach would be to become proficient in a powerful game-engine and develop for that rather than creating things from scratch.

The majority of the requirements were met, however two of them were not. These are:

- Adding/removing a product must be as simple as possible for the manager.
- Purchases must update the stock of the shop.

These requirements would both be developed in a future iteration, however they contained a significant degree of complexity that would have forced development to go beyond the time-constraints.

The main lesson from the project was to ensure that as the Project Manager I explore the concepts within the structure and organisation of the plan sufficiently before ‘running-away’ with technical curiosity and required programming.

Overall it has been a good learning experience in managing a project and getting experience in developing an authentication system, a Manager’s order-review page, a 2D world filled with shops and products, a NodeJS server and a MySQL database. My confidence has grown in developing this system so that in the near-future it may be feasible for me to direct a project with other developers to implement a 3D, thoroughly tested version partially inspired by this project, or a 2D version with more sophisticated graphics and improved game mechanics.

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13. Appendices

13.1 Appendix A – PID

Project Initiation Document

Virtual Supermarket

1. Introduction

The shopping experience is highly underdeveloped. Currently the online experience involves searching for terms or browsing categories until you finally reach the desired product - then when this is complete you must repeat that many more times to eventually complete your shopping for the week.

Not only is this tedious, it is extremely inefficient and highly unnatural to normal human behaviour. When people think of something they want to purchase (especially food) they do not think of the word “apple” or “steak”, they think of the taste of it, or the image of it. Forcing the user to make this cognitive leap is potentially costing retailers millions of pounds and limiting the shopper from exploring alternative purchase possibilities. On the other hand, a virtual *experience* of shopping would be remembered, sought-after and enjoyed. Not only that but simulating the experience of shopping opens the possibilities to the lucrative worlds of game development, virtual reality and robotic control.

I would like to propose a prototype to simulate the real-world shopping experience. Users will be able to move around the environment that contains the products (and importantly *see images* of them), to place the items in their (visible) baskets and to finally purchase their products. All this updating the stock of the supermarket and the history and account balance of the user. The app will be multi-user, two-dimensional and will involve map generation, collision detection, Newtonian physics and simplistic demonstrations of robotics as part of the game.

In short, I propose a 2D shopping-game that is meant for the real application of shopping. It will simulate as much as possible the real shopping experience, and I hope it will be something retailers would consider investing in, remembering that this project is nothing more than a primitive prototype meant to explore the possibility rather than implement the actuality.

2. Business Case

2.1 Business need

Currently supermarkets offer purchases through text-based search and/or browsing, which is arguably not an experience worth remembering, thus customers are less likely to reuse the service, and this costs supermarkets money when they instead go to a local branch that is not owned by said company, motivated by necessity/location.

There is also a very serious need for this idea in terms of ethics, if customers choose to order their shopping online they are less likely to risk a car accident, furthermore they are not polluting the environment through the burning of fossil fuels. Of course, the items still need to be delivered eventually, but this can be done in a more efficient manner by the supermarket than single vehicles travelling to and from. Both of these ethical needs can be used to sell the software product, but they also motivate the business needs because they are based on the truth of the matter.

A final business need is that shops currently have closing times. A virtual shop does not require opening and closing times as it is open 24/7.

2.2 Business objectives

To make an efficient and effective virtual environment for the exploration and purchase of products intended for physical delivery, acting as a 2D prototype for the desktop environment that would ultimately be implemented in 3D virtual reality. This software product will:

a) Replace or supplement text-based search/browsing.

b) Revolutionise the shopping experience.

c) Emulate real-world shopping.

d) Make shopping efficient, effective and attractive for the customer.

e) Be extensible to eventually inform fully-automated shopping.

Project Objectives

i) To analyse current shopping systems used by major retailers.

ii) To analyse user requirements for the Virtual Supermarket that would fulfil the needs of customers who use the services in (i).

iii) To analyse potential development technologies and deployment solutions.

iv) To implement the Virtual Supermarket.

v) To evaluate the systems functionality and acquire feedback from users.

vi) To explore the present and future of Virtual Reality applications.

3. Initial Scope

Firstly, analysis of current shopping systems is important to observe where they are and are not effective. Statistics about online and offline shopping will be utilised in constructing an argument that supports the development of virtual shopping. Expected user behaviours may be diagrammed to motivate the requirements of the project.

User requirements will be elicited using observation and the development of user stories.

The proposed system will allow:

i) Customers to explore the shop floor and find

goods.

ii) Customers to place goods in their (visible)

basket.

iii) Customers to purchase goods.

iv) Managers to add new products and view/modify product, shop and customer information.

The systems functionality will be evaluated by allowing users to use the app and possibly a short questionnaire. Furthermore, the feasibility of virtual shopping will be determined using a simple two-answer poll.

The current state of the art will be explored in virtual reality and proposals will be made for effective domains in which VR can be applied.

4. Resources and dependencies

The technology that will be used in this project is freely available and thus no purchases are required on my behalf. Access to an open, programmable VR device may be beneficial to project but certainly not required.

5. Method of approach

The technologies that may be used are either Java/C#/Python, or web technologies such as HTML, CSS and Javascript for the front-end. The middleware may be made with PHP or Node.js, and the database may be in MySQL, MariaDB or Postgres. The database is likely to be relational.

Software development will involve general planning, design and prototyping followed by several iterations of development. The first iteration will deliver the core (necessary) functionality, the second iteration the highly desirable functionality and the third iteration the desirable functionality. Development may take a database-first approach, or alternatively a focus may be given to the frontend since it is a large part of the project, this is still yet to be decided.

6. Project plan

Stage	Exp. Start Date	Exp. Completion Date	Products/Outcomes
Initiation	December	Early Jan.	PID
Investigate/outline requirements	Early Jan.	Early Jan.	Diagrams of user behaviour, requirements list, decision on appropriate technologies
Initial high-level design	Early Jan	Mid Jan	Design documents
Iteration 1	Mid Jan	Early Feb	Version 1, post-mortem.
Iteration 2	Early Feb	Mid Feb	Version 2, post-mortem.
Iteration 3	Mid Feb	Early March	Final version, post-mortem
System and user acceptance testing	Early March	Late March	Test results, final system.
Assemble and complete final report	Early April	Late April	Final report.

7.1 Stage management

Stages will be managed with stage objectives, plans and reviews. At the end of each stage, the desired products/outcomes will be compared with the actual products/outcomes and all future stages will be updated, deleted or created accordingly if they were affected. Relevant documents such as Gantt charts and Activity Networks will be used to manage the order and times of the activities within each stage.

7.2 Control plan

Highlight reports, end-stage reports and review-meetings will be utilised to control the project.
Furthermore, there are risk management, quality plans and communication plans in this document.

7.3 Communication plan

Review meetings will be held with the supervisor as well as ad-hoc meetings. Software may be trialled with family/friends and online communities for general feedback and criticism.

8 Initial Risk List

Risk	**Management strategy**
Product is unsatisfactory or too simplistic	Feasible additional features will be brainstormed and developed.
Parts don’t integrate	Simplistic prototypes will be developed using all possible technologies.
Software is messy and unmaintainable	Design patterns will be reviewed and practised. SOLID principles will be sought to be enforced.
Too much test data needed to complete project	Test everything minimally, but only the key features extensively.
Schedule overrun	Features will be given priorities and developed in that order.
Difficulty learning the development technologies	Areas of difficulty will be identified and relevant literature found/purchased to get around the issue.
Mental health relapse due to stress	Relevant university resources will be utilised that can help prevent this. Meditation/selfhypnosis will be tried.
Map generation too difficult	Seek online tutorials on this subject.

9 Initial Quality Plan

Each stage as listed in section 6 will have a quality check. To quality check the requirements they will be seen to be correct, relevant, complete, achievable and demonstrable. Furthermore, HCI guidelines compliance will be used for the GUI sketches, as well as normalisation and software design principles for the database/code respectively. The main quality goal is for the product to be more effective and efficient than current implementations of shopping software. This will be tested when the product is built, and comparisons made. Relevant, statistics will show the project to be a success or failure in reaching this quality goal.

10 Legal, ethical, social and/or professional issues

This project will conform to the University Ethics Policy relating to the use of "research involving human subjects". No personally identifying information (such as audio) will be taken of anyone who trials the software. All data will be text-based and translated into a form that is useful to the project or it will be disposed of. Furthermore autonomous, informed consent will be acquired prior to getting live participants/reviewers of the final product.

The ethics and laws regarding Virtual Reality may be explored in this project, and a small discussion may take place on the potential (or inevitable?) death of the high-street influenced by the potential of this technology.

13.2 Appendix B – Highlight reports

PRCO304: Highlight Report
Name: Tom Burgess
Date: 7/2/2019
Review of work undertaken Made a prototype for the frontend where user can browse around a 2D world for products. Also made a login system that links to one User table of a database and connects to the frontend prototype. Node.js was used as well as MYSQL and standard web technologies. Planning was done ad-hoc, the main focus was to try to get something up and running. Next week will more stricly plan the project as I have an idea of its feasibility now.
Plan of work for the next week Produce design documents, diagrams of user behaviour and requirements list. Also begin adding more functionality and expanding the database. Begin to make frontend load according to the data in the database rather than hard-coded.
Date(s) of supervisory meeting(s) since last Highlight
Brief notes from supervisory meeting(s) since last Highlight

PRCO304: Highlight Report
Name: Tom Burgess
Date: 14/02/2019
Review of work undertaken Did some normalisation, created planning documents such as ERDs, Activity Diagrams and GUI sketches. Experimented with registration system and db functionality on the first prototype. Implemented the manager's system primitively without any connection to middlware.
Plan of work for the next week Make the frontend better by researching more how to create the interactive 2D world. Re-make the prototype so that it communicates properly with the middleware/database according to the planning documents. If spare time available begin planning advertisement system.
Date(s) of supervisory meeting(s) since last Highlight
Brief notes from supervisory meeting(s) since last Highlight

PRCO304: Highlight Report
Name: Tom Burgess

Date: 22/02/2019
Review of work undertaken Made registration system for customer, and also sign-in system for customer and manager which accesses different pages. Did some normalisation and changed the database.
Plan of work for the next week Plan more thoroughly, let the customer create orders from their basket. Deduct payments from the user's balance according to items selected.
Date(s) of supervisory meeting(s) since last Highlight
Brief notes from supervisory meeting(s) since last Highlight

PRCO304: Highlight Report
Name: Tom Burgess
Date: 28/02/2019
Review of work undertaken Made the checkout page where user confirms their order, also fixed a bug in the server that had problems handling simultaneous orders. Got the database working on demo PC with fix of collation-type bug.
Plan of work for the next week Try to finish previous weeks' undone work and remove anything hard-coded. Develop the manager's section. Improve the appearance/richness of all pages.
Date(s) of supervisory meeting(s) since last Highlight
Brief notes from supervisory meeting(s) since last Highlight

PRCO304: Highlight Report
Name: Tom Burgess
Date: 21/03/2019
Review of work undertaken Finished the checkout page, made historic orders visible for the customer. Made the manager's page view all orders (needs improving). Made the customer's balance visible on main page. Fixed a bug in the basket and made it so items can be removed from the basket with a single click.
Plan of work for the next week Improve the manager's page. Write unit tests. Make product prices visible when stepped on as well as total basket price.
Date(s) of supervisory meeting(s) since last Highlight
Brief notes from supervisory meeting(s) since last Highlight

PRCO304: Highlight Report
Name: Tom Burgess
Date: 28/03/2019
Review of work undertaken Considered unit tests but stalled and was unable to complete them. Diverted attention to other projects. Did not complete the recommended 30 hrs.
Plan of work for the next week Finish unit tests and write-up the project.
Date(s) of supervisory meeting(s) since last Highlight

Appendix C – Running the app

First a blank database should be created on the computer called “shop”. The computer should have MySQL server installed and running, after this the database file ‘shop.sql’ can be imported using the following command on the terminal/command-line in MySQL:

shop < shop.sql

The MySQL credentials should be: username – “tom”, password – “” (nothing/blank)

There may be a problem with collation types, if so, translate all the instances of `utf8mb4_0900_ai_ci` in shop.sql to the demanded collation.

After this, NodeJS should then be installed and then all of the modules mentioned in section 7 using the command:

npm install <module_name>

Doing this for each module will allow the server to be run using the command:

node server.js

This will run the server on the same machine on which the database is hosted. After the server is run, the program should be accessible by visiting the URL *http://localhost:8080/* in Chrome.

The login credentials for the customer are: “tom21” and (pw) “derpderp” and for the manager “tom” and (pw) “hello”.