HCI Design Brief

Project: *GolfPro*

Panther Golf

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1 Introduction

1.1 Purpose of this Document

The purpose of this document is to explore the requirements, define the scope and initiate further research into the development of the GolfPro project which is aimed at assisting amateur and professional golfers to increase their golfing competency and enjoy the most out of their golfing experience. This documents aims at initiating the foundations for a software solution of the abovementioned techno that provides a niche technology in terms of usability through seamless human computer interaction.

The name of the Client has been aliased as “Panther Golf” and the product will be referred to as “GolfPro” in this document. The solution path to developing this technology will be researched by exploring the design requirements for presenting a realistic golfing experience in virtual reality as well as exploring the audience to whom the technology is targeted towards.

The main focus of this document is to utilise the appropriate Human Computer Interaction analysis tools that will identify the needs and preferences of the clients for this technology. This information will be used to derive usability objectives to commence further research and development based on this design brief.

Quality design begins with in depth research and analysis followed by iterative development and testing to meet these objectives. This document breaks down the design brief into nine sections, the document explores the target audience ,usability objectives, design, prototype, user involvement, testing, the accessibility of the technology, the domain of the proposed design and emerging technologies and their respective impact on the proposed design.

In order to tailor the correct solution this document will explore the target audience to whom this product is intended for, and research the user group and define an agreeable archetype which all users can be generalised with. After a user profile has been developed it is necessary to take into account the human factors that are involved in interacting with the system interface to ensure that the design can accommodate for these factors. Apart from human factors of sensory perception, haptic feedback there are also user preferences and tendencies that will need to be accounted for in the design process which will also be discussed in this document.

After identifying the target audience this document will deal with the usability objectives that are required to satisfy the user audience. The findings for usability objectives will then feed into design choices. The design will be used for an initial prototype, which will be the basis of the first iteration.

1.2 Scope of this document

This document investigates the technical design requirements, human usability requirements and in the process serves as a template to design a suitable product for its users that satisfies effective human computer interaction.

The product is a virtual reality application that aids the user in developing their basis in golfing skills by assisting their putting and green scraping skills which is an area most novice golfers struggle with in the beginning. Mastery of these two core skills will make golfing both an enjoyable experience and allow amateur golfers to look into a competitive career. The Technology will consist of a virtual reality head set that is synchronized with a golf ball and putter with built-in transducers such as accelerometers that feed information to the virtual reality headset in real time.

The GolfPro will be designed for user of all experience levels from novice to professionals. The GolfPro will be available in two modes, the first is the “simulation mode” where the software is used with a virtual reality head set that is paired with a golf club or field mode where the system is also paired with a golf ball in a selected indoor putting field where the field is also mapped into the virtual reality headset. The software system designed is to be compatible in virtual reality or augmented reality.

Virtual reality is technology that provides an interactive computer generated experience that emulates the respective experience in reality by simulating auditory and visual sensory stimulus. This document will focus on the virtual reality aspect of this technology using a virtual reality headset and compatible golf equipment mentioned above, the purpose of this project is to make a first in designing such technology that can record performance in software format for assisting the golfer in improving their golfing skills by assisting their aim, angling, putting force as well as improving their green-scaping perception.

This technology is designed to be responsive and interactive to the user with minimal technical experience. The user is assumed to have the basic technical skills such as using a smart phone or a personal computer. The research in this design brief is concerned with developing a realistic technology that can be utilized by amateurs and professional golfers who would like to train in specialized augmentation fields to focus on aspects of their golf skills for competitive performance. The scope of this design brief focuses on integrating virtual reality equipment with the mentioned golfing equipment to produce data that can provide visual assistance through markings on virtual reality as well as data records that can be stored locally or on an online repository.

The data generated should be able to provide feedback to the golfer, the storage format is aimed at being compatible with smart phones and personal computers.

This document aims at developing a system that interfaces hardware realistically in a virtual domain that is compatible and easily rendered by human physical, sensory, and cognitive factors. Further research can be conducted into further developing this technology for use in sports science.

1.3 Background

Golf is club-and-ball sport which players use various types of clubs to hit balls into a series of holes on a course in as few strokes as possible. There are four major types of golf clubs each used with respect to the trajectory required based on distance, terrain and required accuracy.

There is no standard playing field for golf, therefore coping with varying terrains on different golf courses requires the golfer with a strong all-round golfing skills as well as an intuitive perception of the field to apply their skills.

There are various types of golf terrains including fairway, rough (or “long grass”), bunkers (or “traps”) and various hazards (such as water or rocks) and there can be a multitude of ways to hit each hole in any given terrain.

Putting is an important skill area in golf as it makes up 40% of the strokes in a game on average, therefore in order to lower the scores faster putting is an essential skill in the game of golf. A proficient golfer needs to be able to able to hit putts more solidly and start them on the line the player has chosen.

Another area of weakness found in golfing is misreading the field and thus missing shots, this accounts to 60% of lack of performance in golf. The remainder of this is due to technique 34%, and the ground surface only accounts for 6%.

In the beginning of a golf game the driver is used to start from the tee box, however lowering putting scores and hitting shots accurately using green scaping is critical for lowering scores, green reading or scaping is a skill that involves reading the field and its slopes to accurately set up an aim line, this is a skill area every proficient golfer must have to lower their scores overall.

This design project aims at developing a software solution that can be used in conjunction with virtual reality and augmented reality technology that will utilise a practical methodology for reading putts using Grober’s mathematical formula for target selection and optimisation.

The use of this equation in a virtual environment aims at providing users of all experience levels to improve their golfing skills in a realistic simulation with life-like haptic and sensory feedback at the convenience of the user regardless of location. This technology is intended to give the user a realistic experience without visiting a golf course.

This project aims to assist several types of users, these include amateurs who are seeking a realistic experience, competitive players who would like to practice in their own time and space or professionals who like to focus on a specific area of their skillset such as putting, green reading or long range driver shots.

This system is particularly practical as it provides a realistic experience in virtual reality showing four key icons on the VR screen, the source destination line, the aim line and a resulting trajectory line for a given putting force used by the golfer which is also animated on the screen. The software will provide storage of previous games, game replay, statistics and performance feedback. This system can be used as a supplement to field practice or as an orientation training for beginners in golf.

2 Audience

The target audience for this product is everyone in the general public regardless of occupation and income and background. Users who have nominal sensory abilities and basic motor skills to drive a golf club and visually track the golf ball are most suited to using this technology.

All users regardless of prior experience in golf including first timers who are interested in starting golf with the assistance of software aid, up to professionals who would like to fine tune their golf skills are all within the domain of the intended audience for this product. Parental guidance is recommended for users below the ages of 18.

This product is aimed at everyone who is willing to improve their golf skills or play golf in a realistic setting, users are expected to have nominal sensory perception and basic computer literacy to start the program.

Target Audience Attributes	Eligibility
Age	Nine years and over (Parental guidance advised for under 18 years of age)
Sex	All genders
Education	No education level required
Knowledge of technology	Basic Computer Literacy
Income	No minimum income
Occupation	N/A
Location	N/A
Keywords:	Fun, professional, amateur, min-golf, putt putt, green scaping, practice, putting skills, hobby leisure.

Table 1:Table showing the target audience

2.1 Human Factors

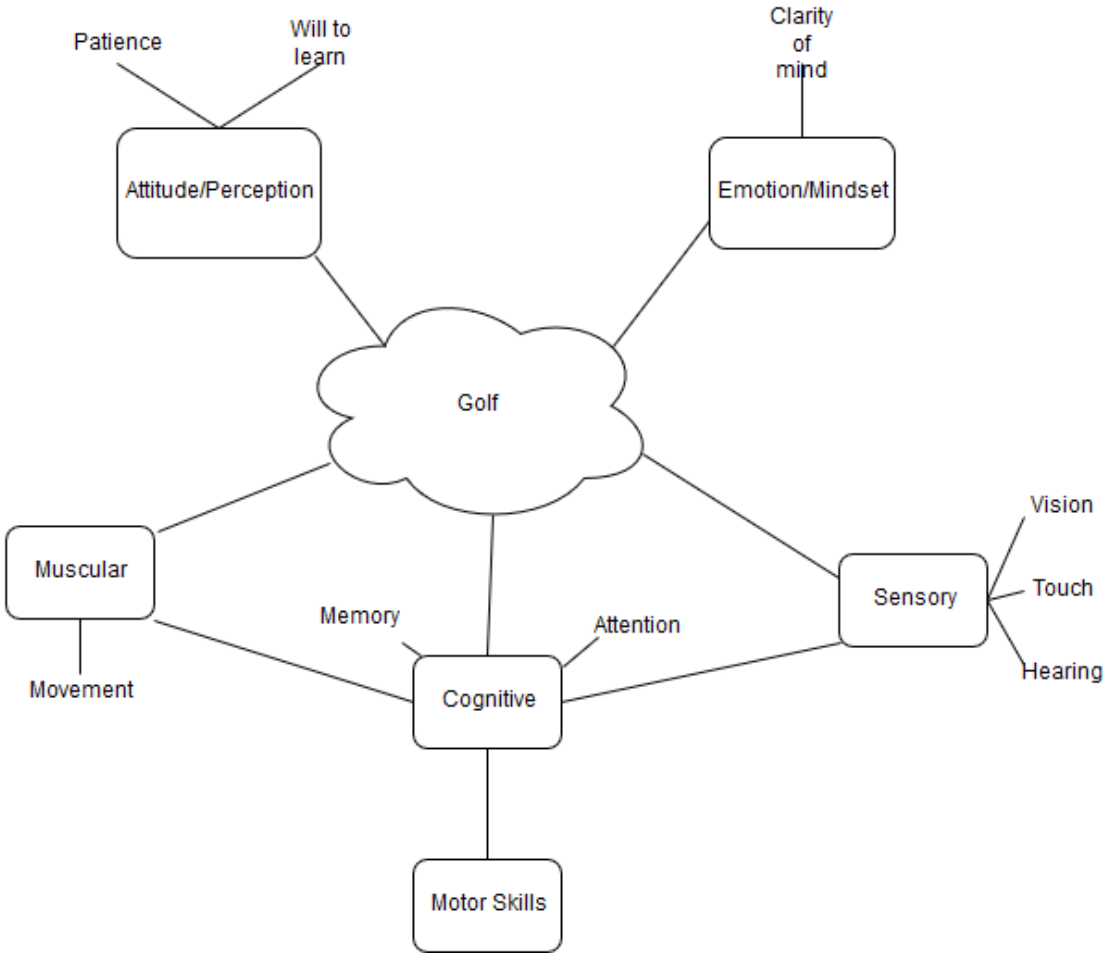


Figure 1: Human factors involved in golf

A part of understanding the user audience and providing optimal human computer interaction for the target audience requires an understanding of how the audience will interact with the technology.

The target audience covers a broad range of people with a basic level of technical understanding and a basic level of health to carry out basic basal level activities. This means anyone who has a healthy level of sensory and cognitive faculties will be eligible for purchase and use of this product.

The human factors identified in this design brief are catergorised into six: attitude/perception, Emotion/mindset, sensory factors, muscular capacity, cognitive capacity and motor skills.

Sensory factors include vision, touch and hearing. Vision is required to visually perceive the target as well as to track the golf ball. Hearing is also another sensory factor, sound provides tangible and correlative feedback, thus sound

effects are necessary to provide the user a lifelike simulation experience when using the GolfPro system. Finally, touch is another important sensory component as the force used to strike the golf ball at different ranges can change significantly, thus touch also provides tangible feedback.

The sensory transducer components of this system need to be realistic enough to correlate with the dynamic of an actual game such that a realistic results that can pass turing tests are produced.

The next important human factor is cognitive factors. Cognitive factors include attention and memory. In order to assist user cognition, graphical user interfaces will require high definition rendering with graphical objects organised in a user friendly manner to assist the user in retaining focus. This focus will also assist the users memory retention. Further emphasis on graphical layout will be made in sections 4.0 and 5.0.

Muscular capacity to swing a golf club is also a required human factor to use the GolfPro System. This is particularly important as the Virtual reality system will be paired with a golf club with built in accelerometers and actuators that weigh the same as official clubs used by professionals.

The human factors mentioned thus far lead to the next human factor, that is motor skills. Motor skills is the capacity to coordinate muscular movement in tandem with the activities of sensory perception and cognitive processing.

For this reason it is important to design the system so that it appeals to the human senses in the most fit magnitude (brightness, volume and motion) in the appropriate quality in synchronous timing to allow effective processing by the users cognition. Secondly the layout of the graphical interface during simulation needs to follow design guidelines in order not to tire, confuse or distract the user.

The other two human factors include mindset (or emotion) and attitude (or perception). Mindset is concerned with the clarity of mind and attitude concerns patience and willingness to learn. Proper design that caters for sensory muscular and cognitive factors will support the mindset and attitude of the user.

Keeping an awareness of the mentioned factors will ensure satisfied users with a positive attitude and mindset towards this technology regardless users purpose, hobbyist or competitive.

2.2 User Research

- Who will use your technology ?
    - What are they like ?
        a) What human factors are critical for them to interact with your technology ?
        b) How do they work ?
        c) What do and don't they like ?
        d) What do they need ?

User research is critical to design technology that factors in the user, as the user is the person who will decide whether the technology is usable or not.

In order to satisfy users it is necessary to provide technology that consists all the threshold attributes and fulfill all performance attributes above satisfactory level as much as possible as defined by the Kano model, to elicit maximum user satisfaction. The excitement factor in this project is the ability to simulate a real life golfing experience in the users preferred time and location.

In order to identify an implement all threshold & performance attributes in this project it is necessary to find out who will exactly use this technology.

The next question is (a) *What human factors are critical for them to interact with you technology*?, this has been identified in section 2.1. Followed by (b) *How do they work?* , this has three parts: the rules of golf, Grober's mathematical formula that will be nested into the software algorithm and lastly the human factors which have been discussed and the strategies to cater for these. These will be further discussed in sections 4 and 5.Finally the important question is (c) *what do they like?*, and (d) *what do they need ?*. In order to explore these the best strategy is conducting site visits to the golf courses and interact with potential users, and selecting an even distribution of sample participants that is roughly representative of the whole of potential users to participate in focus groups would be highly recommended.

3 Usability Objectives

The level of usability that is aimed to be achieved is to have the player use the GolfPro as though it is an extension of their limbs with no required technical skills.

The GolfPro system aims at allowing novice golfers to have fun while sharpening their golfing skills without any cognitive workload besides adjusting the putting force and mastering green scaping. The usability can be defined as having the average person with average experience and knowledge to be able to use this technology using their natural innate intuition. This is critical as the user is the ultimate decider of whether this item is usable or not.

In order to elicit the usability objectives as an activity of this design brief, site visits were conducted and interviews with potential users were made, the findings with respect to the expected usability attributes are as follows:

ID	Usability Objective			Usability Attribute
	As a…	I want to be able to…	So that….	
UO-001	User	See high quality graphics	I may get a realistic golfing experience	Quality
UO-002	User	Hear realistic sound effects	I may obtain realistic tangible feedback	Quality
UO-003	User	Have the golf balls trajectory and movement pace updated on the VR headset in real time when using augmentation mode.	I may further my putting skills in a realistic setting.	Quality
UO-004	User	Play this reality game without any lags.	I may get a realistic experience.	Quality
UO-005	User	Pick a variety of golf clubs.	I can use different momentums at different distances in the game.	Options
UO-006	User	Be able to pick from a variety of golf courses.	I can keep engaged and test my skills	Options
UO-007	User	Be able to pick multiplayer mode.	I can compete with others.	Options
UO-008	User	Have a portable system.	I can use it in my home, office or any other place.	Convenience
UO-009	User	Use the system easily with no required training.	I don't pay for something expensive that I may not be able to use or be bothered to use.	Convenience

UO-010	User	Have a system with long battery life.	I may be able to play several golf games.	Specification
UO-011	User	Use the software on a smartphone, tablet of PC.	Use the item whenever and wherever.	Specification
UO-012	User	Be able to save my performance in a file.	I can review it, share it and perhaps get feedback from others.	Specification

Table 2: Usability objectives based on findings from site visits and focus groups

3.1 Usability Tool

In order to achieve the usability objectives listed in the section above, the first thing technologists need to consider are the human factors mapped out in section 2.1.

For technology to be deemed usable it must be compatible with little or no experience with technology besides basic computer literacy for the day in age, this way the deliverable of this project can be considered “human friendly” in the sense that it addresses the human perceptions without any additional training or cognitive load being employed.

The chosen usability tool to elicit the usability objectives in table 2 was to conduct site visits to three golf courses in Queensland and meet with an evenly distributed sample of golf players ranging in experience and how new they are to golf in general as well as age. Over the course of three weeks a set of discussions were made in focus groups.

Questions about the prospect of the proposed design was asked to the participants. Participants were encouraged to share their insight and rank the importance of several sample of usability objectives on a scale of zero to ten. Zero meaning not important whatsoever and ten to mean must be present in the design.

The focus group consisted of 20 people of whom 17 were actively engaged. After the three week course of time usability objectives that scored between seven to ten were extracted and tabulated into table 2.

The findings of the focus group were that two personas could be derived, the first persona called “Anna” and the second persona “John”. The Anna persona is referred to as the base persona, this persona overlaps Johns persona to a great extent, her persona is the main persona that can be used to represent the target audience. However producing two personas in this case was considered appropriate for marketing purposes. Anna prefers to use the system in simulation mode, John on the other hand is competitive, he prefers to use the system in field mode (as augmented reality), but uses simulation mode when he cannot go to the specialized indoor GolfPro venues due to his schedule. The user scenarios for both Anna and John can be found below:

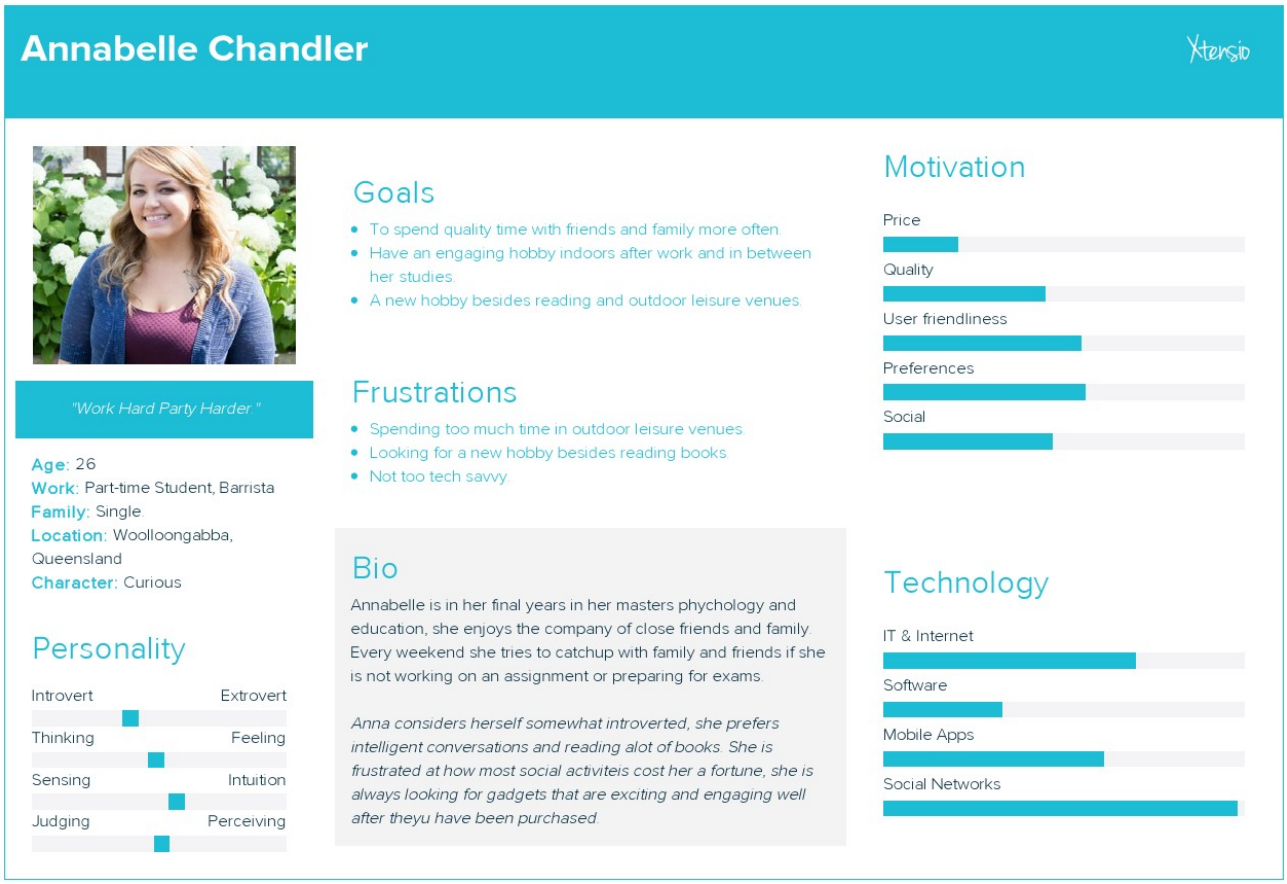


Figure 2: Persona for Anna

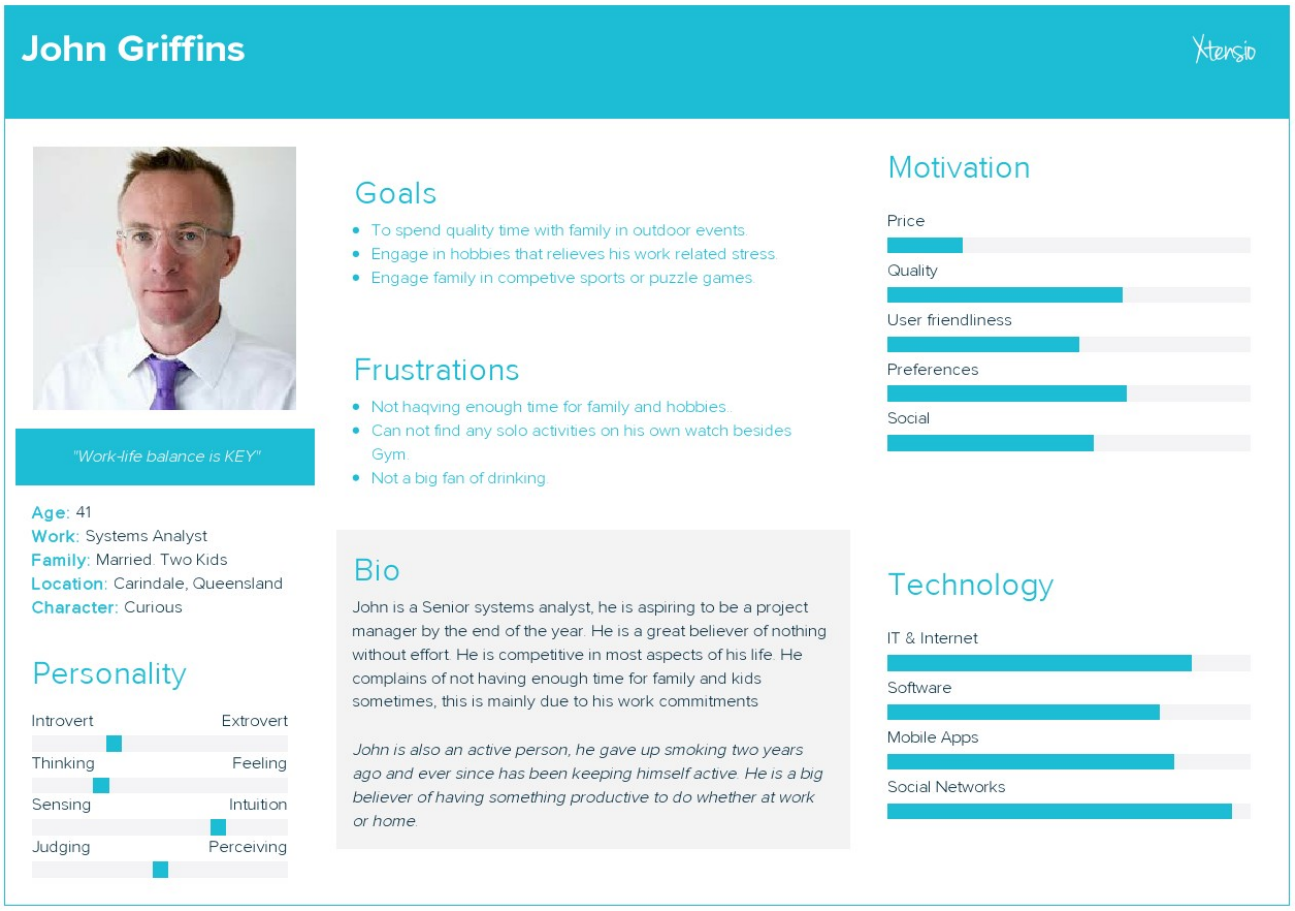


Figure 3: Persona for John

4 Design

4.1 Visual Design

The design of this system is on two parts, the first is the application section, this is the part where the user starts the GolfPro system and sets their preferences before using the system. The second part is the virtual reality screen shown in section 5. In this section the focus will be the first part.

The first part of this program has two screens before entering the virtual mode.

The navigation mechanisms are using the “Back”, “Next”, and “Exit” and “Start” buttons (ie. B1,B2,B3 and B4). On a mobile application however the generic swipe gesture to the right and left for next and back respectively will also work.

The layout of this software is quite basic and intuitive, this system only requires basic level of computer literacy. The whole screen is the main content column, this system places more emphasis on the virtual reality experience aspect in both modes of the system.

The system has four dialog panes (DP1, DP2, DP3 & DP4) used before starting the game. The screen is evenly distributed elements to allow the user to visually scan with ease.

Each page consist of the company logo (L1), “Panther Golf”, and the name of the software (L2), “GolfPro”. Every page has a golf field background of the screen as the theme of the software.

On the first page the user prompted to enter a name followed by three navigation buttons, “back”, “exit”, and “next”. The second page has three dialog panes, the review pane (DP4) is smaller and to the left of the screen as it would be the least used pane.

The golf course selection pane (DP2) has an image icon as a button, this button displays the image of the selected golf course, this was intended for user convenience.

Before the game or training starts the user must select either “simulation mode” or “Field mode” (in DP3) before clicking on start (B4).These buttons are also icons as the intent of this software is to make the five senses and basic human intuition the only prerequisite to use this system.

All the navigation buttons are oval shaped and centered in the screen in the main content column. System help buttons such as settings and help (B11 & B12) are round and right justified as they will be least used buttons, this was decided as a consistency pattern after a card sorting activity.

In the figure 4 and 5 the representation of the system is a wireframe. In the fully implemented system the text fonts in the buttons are to be different from the text fonts in the dialog panes, however the buttons and fonts in both screens will be consistent so the user can associate each font and button with its respective role.

The foreground icons such as the four panes (DP1, DP2, DP3 & DP4) will have sufficient contrast to the background with balanced brightness.

The number of colors will be kept to a few vibrant colours that relate to the golf theme, white and green, while the borders of the panes will be black. This layout will ensure consistency throughout the application and avoid too many colors and complementary saturated colors or brightness that will force the user to put effort to focus and get fatigued.

Lastly as part of the design, each button press will be accompanied by sound effect, the sound effect feature can be muted or lowered in volume using the setting button (B12).

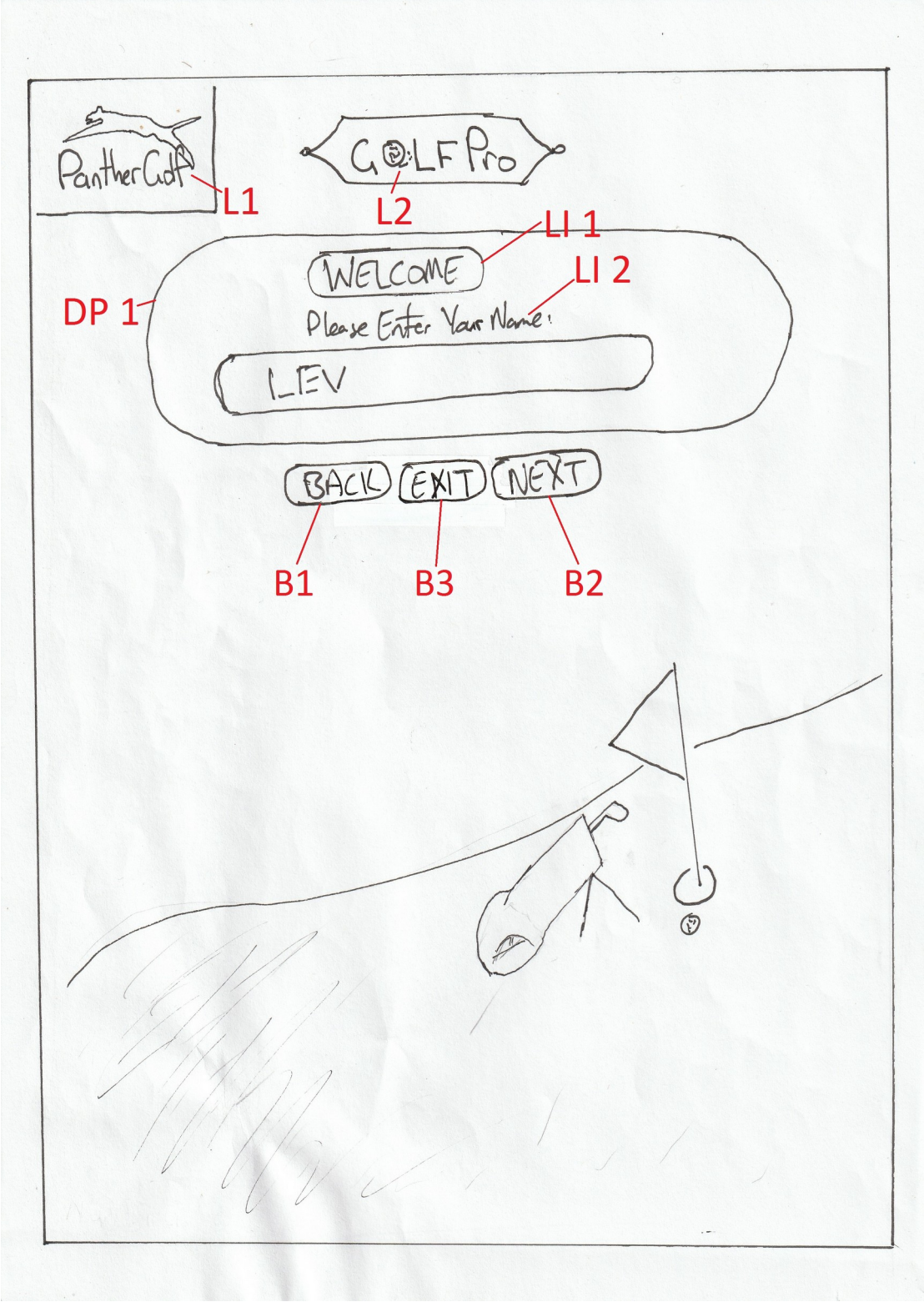

PantherGolf
L1
GOLF Pro
L2
LI 1
WELCOME
LI 2
DP 1
Please Enter Your Name:
LEV
BACK
EXIT
NEXT
B1
B3
B2

Figure 4

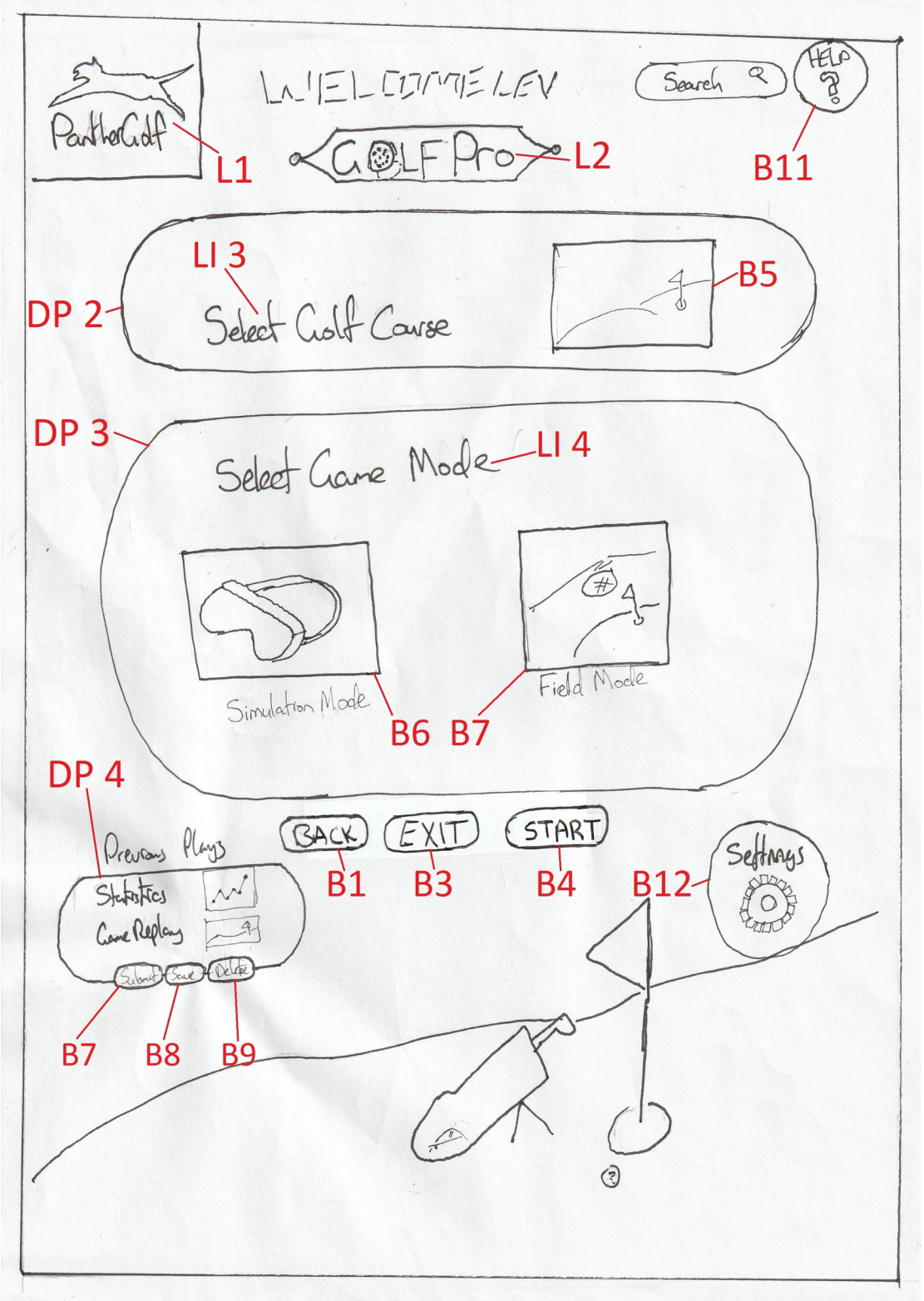

PantherGolf
L1
GOLF Pro
L2
Search
HELP
B11
DP 2
LI 3
Select Golf Course
B5
DP 3
Select Game Mode
LI 4
Simulation Mode
Field Mode
B6
B7
DP 4
Previous Plays
Statistics
Game Replay
Submit
Save
Delete
BACK
EXIT
START
B1
B3
B4
B12
Settings
B7
B8
B9

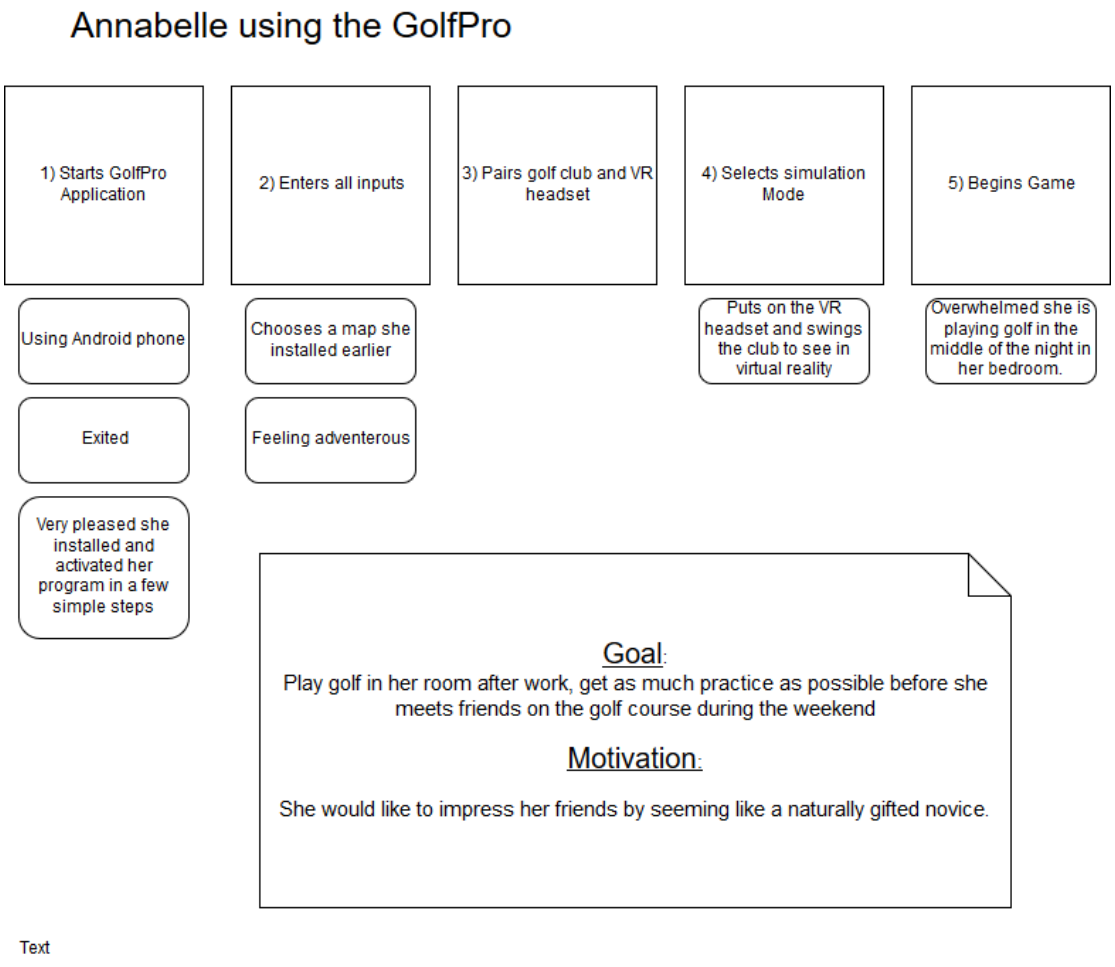
Figure 5

5 Prototype

The philosophy behind the design principles for the graphical user interface has been explained up to this point in section 4. The idea of this project is to place emphasis on the virtual reality side where the dynamics are mapped in direct correlation with reality. The colour definition and contrast of objects in the virtual reality should be an experience exactly as that of nature as far as the human sensory perception is concerned.

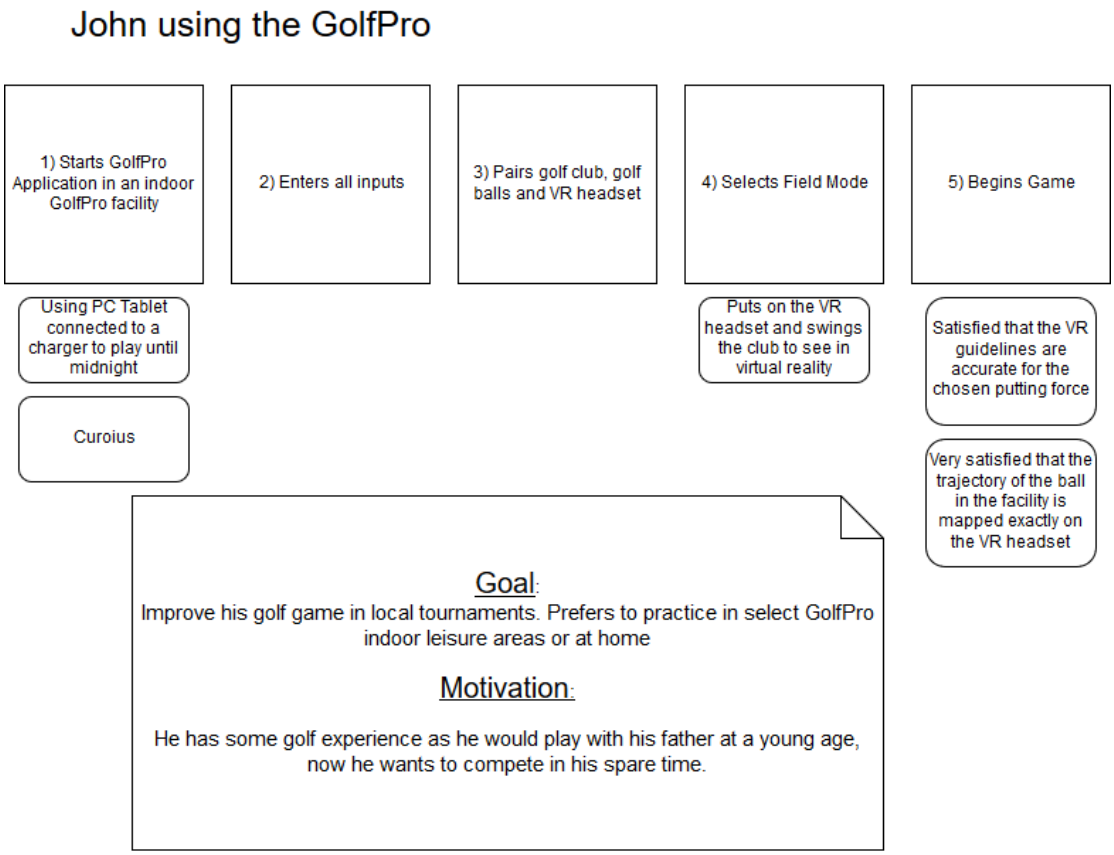
This product is designed for anyone who is interested in golf, whether they are curious amatuers or proffessionals who want extra practice by practicing on off the field in their spare time.

Both John and Anna go through the graphical user interface shown in section 4 until they can start to play in virtual reality or augmented reality. The scenarios below demonstrate this for both of them:



Text

Figure 6



Text

Figure 7

After both Anna and John have started the GolfPro, the system assists both of them with their putting by showing a displacement line between the golf ball and the hole (A), the aim line (D) that is given for every respective putting force chosen unless a striking force that is too great is selected (B), and the resulting trajectory of the ball after all the mentioned elements are combined (C).

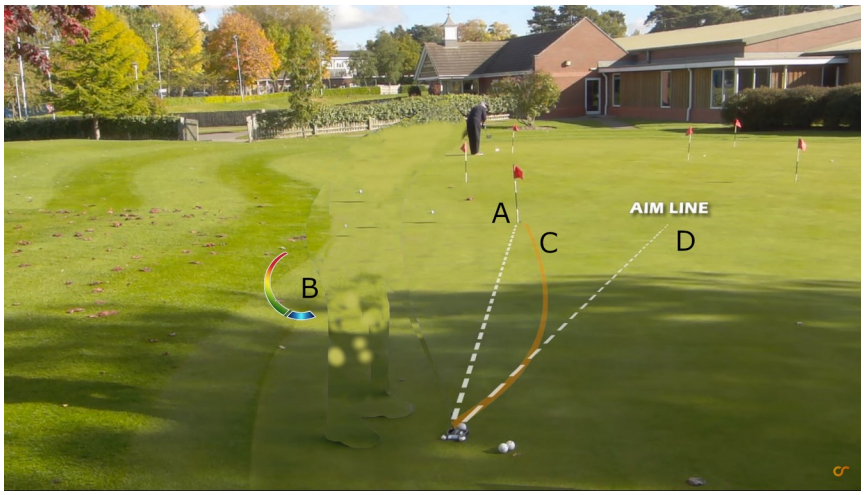


Figure 8

6 Discussion – User Involvement

Describe your approach if you have used actual participants in your work so far – what worked, what didn't, and what did you learn?

How would you involve the user in your project if you did have access? What effect would that have on your approach? What would that change about the way you have worked?

The development of the design brief until this point has been the ideation/initiation phase in determining user requirements as well as technical requirements to form a design solution which has a conceptual model that fits with the conceptual model of the target audience.

The target audience were identified in this brief by conducting site visits and interviewing people with an interest in golf, these people were given questionnaires and the results was to identify the types of potential customers whose archetypes were modelled as two personas, *Annabelle Chandler* and *John Griffins*. As the findings where not unipolar.

Below is a table that describes the tools used with potential users to elicit system requirements.

Goal	Technique used	Result
Virtual reality Screen design	Task analysis	Virtual display in Figure 8
Obtain desired user experience.	Site visit and interview	Scenarios Figure 6 and 7
Design a graphical user interface for the VR system.	Focus group and card sorting.	Graphical user interface shown in Figures 4 and 5

Identifying target audience.	Site visit and interviews	Personas in Figures 2 and 3
Identifying Human factors involved on the user end.	Site visit and focus groups.	Human factors identified in Figure 1.

Table 3 - Table showing User Participation

The next phases of development and testing will require greater levels of involvement to ensure developments are made according to the findings elicited by user engagement. The assessors of product quality and meeting of user needs will be the user themselves, the idea is the conceptual models implementation satisfies the users' mental model, the focus of this project will be to keep a sample of users with full participation in the development process. The aim of this brief is to suggest that users who fit the target audience of section 2 and relate to the archetype of the personas developed in this brief to be consistently and actively involved in the design process from initiation to building and deployment within the roles as informants and design partners.

This brief further recommends to involve users who fit into three categories defined as category A, category B and category C. The categories mentioned are as follows.

Category A:	Official representatives from Golf Australia the governing body for the sport of Golf in Australia. (see www.golf.org.au)
Category B:	Completive golf players who are members of golf Australia.
Category C:	Users who fit into the personas of Annabelle and John.

The reason behind this user categorization is to ensure that design decisions are made where the design team's conceptual model is assessed against the mental model of potential category C clients as well as ensuring the proposed technology (i.e. target system) design conforms with the official sport of golf and hence the proposed involvement of category A and B users. This selection criteria will ensure the end product is suitable to amateurs and professionals to assist in green reading and putting. These Catergories will be utilized in section 7, testing.

The design practicalities is that the dedicated work area is the VR laboratories and actual golf fields to compare both virtual and field experiences. Participant support should start with system induction and letting users of all categories to immerse themselves with the design iteration without any or minimal interruption (for trials that will be discussed in section 7).

The desired user involvement across all the stages of development regardless of the project life cycle chosen is summarised in the diagram below.

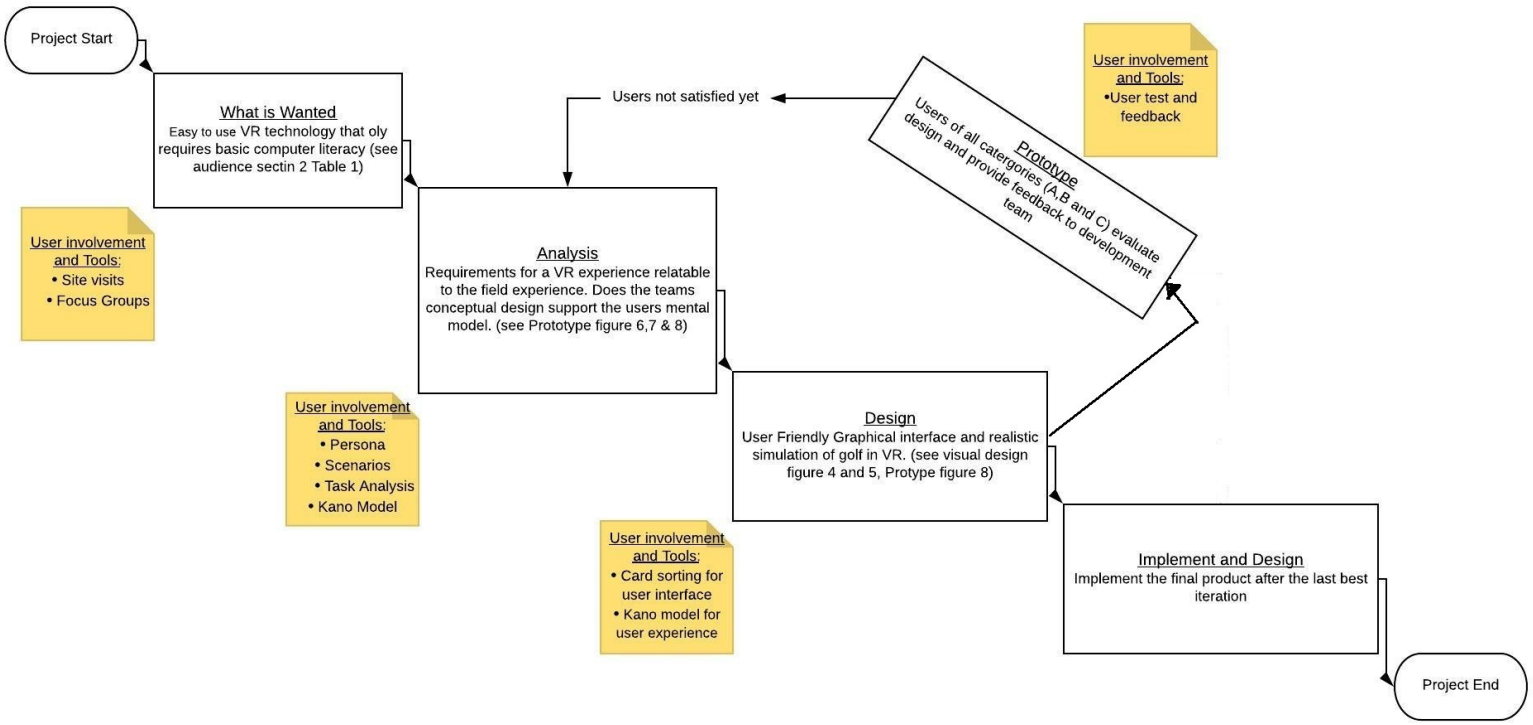


Figure 9 - User Involvement throughout the development process

The goal of involving users in all stages of product development is to ensure all basic, performance and excitement requirements are met:

Attribute Type	*Identifier*	*Description*
Basic	B-01	Device is easy to turn on and operate
	B-02	Satisfactory quality pf VR headset as compared to contemporary VR technology.
	B-02	Golf club is built according to quality standard as genuine contemporary golf equipment
Performance	P-01	Long lasting battery life
	P-02	Easy to set up and use
	P-03	High quality graphical display
	P-04	High quality image and sound rendering
	P-05	Realistic weight and feel of device
Exciters (delighters)	E-01	Deploy ability and usability anywhere and anytime
	E-02	Realistic golf experience in virtual reality
	E-03	Game statistics that analyse user performance

Table 4 - Table showing factors in the Kano Analysis

Also represented in the diagram below:

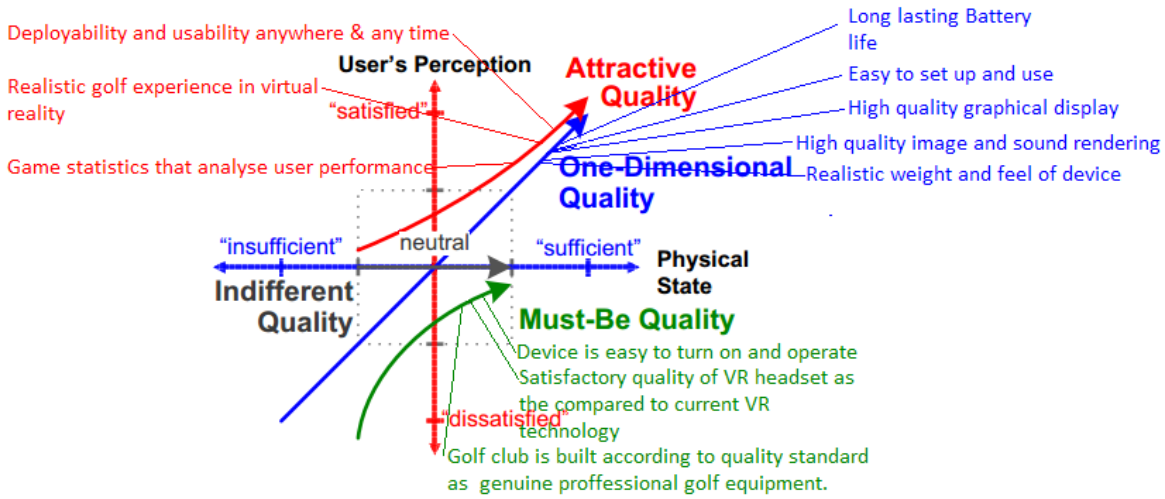


Figure 10 - The desired Kano analysis of this product design after product release

7 Testing

7.1 Test Plan

Detail your testing plan for your design, following the approach outlined in the module book and covered in the workshop. Develop an evaluation consent form for your sessions and include this as an appendix – there is a sample template available on the course site. Your test plan should include:

- Testing purpose and goals – why are you testing this product at this time? What do you want to achieve? This can be written at a high level.

  for example: Identify obstacles to enrolling in courses through the enrolment site.

- Participant characteristics – who will participate in your evaluation and testing activities? How many people? What roles do they represent?

  for example:

Characteristic	***Desired number Of participants***
Undergraduate Student	*11*
Postgraduate Student	5
Total number of participants	*16*

- Method – describe the approach you will take: how will you carry out the testing, how will the test session run? Include
  - a description of your approach,
  - an outline of the session and session timing
- Task list – this is simply a prioritised list of the specific tasks that the participant will complete. It should include a task description, detail around the materials needed for the session, a description of task success, and any benchmarks, such as timing.

  for example:

Task	Select courses for enrolment
State	Website with three tabs leading to course selection
Successful completion	Participant selects correct courses
Benchmark	Participant selects courses appropriate to their major and prerequisite state, with no errors.

- Data to be collected and evaluation measures. This can include measureable attributes such as error rates and time to perform a task, as well as experience aspects such as the participant's opinions and ratings. Select data measures that suit your research questions.

  for example: To answer the question "What obstacles do students encounter as they complete their course enrolment, whether through a desktop or a mobile device?", I will collect data for:

  - Number of steps to complete task
  - Number of tasks completed with or without assistance
  - Number of 'false starts' and steps involved
  - Appropriateness of enrolment functions to the participant's tasks
  - Perceived amount of time and number of steps
  - Usefulness of terms and labels

The testing of this product will be catergorised into two components the first will evaluate human interaction factors and the second will test the technical factors.

7.1.1 Human Interaction Factors

7.1.1.1 Test case HF-1: Sensory and Haptic feedback

- Testing purpose and goals

  Evaluate the sensory and haptic feedback the game provides to the user.

- Participant characteristics –

  Category C users to represent Consumers

  Category B participants

Characteristic	***Desired number Of participants***
Category C participants	*20*
Catergory B participants	*5*
Total number of participants	*25*

- Method

  Category C users will participate in every prototype phase to give constructive feedback. Category B participants who are proffessional representatives will participate in the initial phases and the final phases before the last iteration is developed into being the final product. Category B participants can be involved more depending on the feedback required for each identified issue.

- Task list

  Task Play a round of golf
  State User has entered the virtual reality mode of the game
  Successful completion Participant feels the system feedback is adequate and realistic
  Benchmark Participant reflects their experience based on several real life golf experiences before and after testing the system.

- Data to be collected and evaluation measures.

  How realistic was the feeling of the VR game, how does it relate to the experience of the real golfing experience.

  - Putting experience
  - Green scaping experience
  - Trajectory of the ball
  - Visual effects in the VR game
  - Sound effects in the VR mode

7.1.1.2 Test case HF-2: Design layout of the interface

- Testing purpose and goals

  Visual and audio elements are easy to be rendered and processed by the human eye and hearing. Menu layouts, texts, button positioning does not confuse the user.

- Participant characteristics

Category C users

Characteristic	***Desired number Of participants***
Category C users	*20*
Total number of participants	*20*

- Method

  Users will be asked to play the game and answer a questionnaire. This will be followed by an interview to include opinions and issues not covered in the questionnaire.

- Task

Use the system from start to finish with a focus on user friendliness

Task Setup and play the game using the menus shown in figures 4 and 5.
State The system is powered on and ready for the user to start.
Successful completion Participant feedback is positive, questionnaire feedback provides constructive insight.
Benchmark Participant reflection suggests the system is designed to be intuitive requiring no assistance to get started.

- Data to be collected and evaluation measures.

User satisfaction rating, criticism and feedback in the questionnaires and interviews.

  - Understandability of menu and options.
  - Understandability of the system flow.
  - Task completion with no or very little assistance from the observer.

7.1.1.3 Test case HF-3: Learnability of the system

- Testing purpose and goals

  Identify obstacles to using the system without or with very little assistance from the observer.

- Participant characteristics

  Category C users, one group who is given an induction on how to use the system and another group with no induction.

Characteristic	***Desired number Of participants***
Category C users (induction training)	*10*
Category C users (no induction training)	10
Total number of participants	*20*

- Method

  One group will receive an induction on how to use the system. The other will receive no training. Both groups will be observed by an observer to use the system. The next phase of the session will be a group interview of all the users.

- Task list

  for example:

  Task Set up and use the system
  State The device is closed and packed in a box.
  Successful completion Users can independently unpack set up and use the system
  Benchmark Participants provide confirmative feedback in the group discussion regarding the ease of use for the system.

- Data to be collected and evaluation measures.

  User satisfaction rating in quantitative feedback using nominal, interval, and ordinal measures in questionnaires.

  Qualitative feedback by making statements of each aspect of the system in the group discussion with the observer

  - Time taken to complete the task
  - Number of times user asked assistance from the observer.
  - Time taken for each section of the process in the application.
  - Correlation of results between both user groups.

7.1.1.4 Test case HF-4: Realistic Experience

- Testing purpose and goals

  Evaluate the realism of the user experience during simulation.

- Participant characteristics

  Category B and Category C users

Characteristic	***Desired number*** **Of participants**
Category C users	*10*
Category B users	10
Total number of participants	*20*

- Method

  Two types of users, the professional competitors and hobbyist will form the sample space of users.

- Task list

Task Play golf in the simulator.
State The field the simulation conditions for all users in both categories are the same.
Successful completion All users complete the given simulation tasks.
Benchmark Participant from both categories unanimously agree on the experiences of the simulation in terms of graphics rendering, sound effects and responsiveness of game elements.

- Data to be collected and evaluation measures.

Observers notes on users observations as well as participant responses to the user during the prototype trials.

  - User reactions observed.
  - Participant reactions and expressions during trials.
  - User feedback given observers are analysed.

7.1.1.5 Test case HF-5: Physical Usability

- Testing purpose and goals

Examine the usability in term of the physical properties of the VR headset, remote golf club.

- Participant characteristics

Characteristic	***Desired number*** **Of participants**
Category A Users	*5*
Category B Users	*5*
Category C Users	*10*
Total number of participants	*20*

- Method

Official member of Golf Australia, competitive golfers, and users who fit the archetype for the two personas in figures 2 and 3 will play the same

simulation scenario and access the ergonomics weight and feel of each physical device during the game play.

- Task list

Task Play golf on the virtual system.
State Virtual reality conditions are same for all users (the field and the task required) as well as the physical equipment.
Successful completion The given task is completed.
Benchmark Participant finds the ergonomic aspect of the physical elements of the system ideal in terms of the feel, weight size and it respective impact on usability.

- Data to be collected and evaluation measures.

Observers record user responses during prototype trials, the value of their feedback is also weighted based on the category of the user. That is category A and B represent the professional domains and category C users represent the general consumers.

  - Observations of sports scientists
  - Comparisons between the feedback of all user categories.

7.1.1.6 Test case HF-6: Usability for users with special needs.

- Testing purpose and goals

Identify attributes of the gain creators and pain relievers of GolfPro system and identify any required gains or relievers.

- Participant characteristics

Characteristic	***Desired number Of participants***
Category B Users	*15*
Total number of participants	*15*

- Method

Organise a sample audience with various disabilities and test for settings that can accommodate users with sensory issues. And adjustable equipment cater for users with physical disabilities.

- Task list

  Task Select users to partake in the VR simulation task.

  State Devise is not powered on nor set up.
  Successful completion Participants can independently set up and use the system without any assistance from the observers.
  Benchmark Participants of the selected sample can report satisfaction as members of test cases for HF-2 and HF-5.
- Data to be collected and evaluation measures.
  - User feedback during workshop discussions.
  - Questionnaire scores
  - Reports from observers during the field task
  - Comparison of results from previous prototype iterations

7.1.2 Technical Factors

7.1.2.1 Test case TF-1: Accurate Golf Simulation

- Testing purpose and goals

  Evaluate the correct implementation of Grober's Formula with in the golf simulation as well as visual guidelines in the design (as shown in figure 8)

- Participant characteristics –

  Category A participants

  Category B participants

  Development Team

Characteristic	***Desired number Of participants***
Category C participants	*3*
Category B participants	5
Development team	2
Experts	3
Total number of participants	*13*

- Method

  Category C participants will the assessors in every prototype phase to give constructive feedback above Grober's formula with respect to green scaping. Category B participants will be the participant who will do the testing, all five testers will be testing in multiple trial and use the sample data to judge the correctness of the implementation of Grober's formula implementation. The development team will observe the feedback provided by participants of both categories.

- Task list

  Task Category B participants play several rounds of golf
  State Different land scopes factoring in the physical variables by select experts.
  Successful completion Experts correlate data, and provide feedback to testing team.
  Benchmark Category B users finds direct correlation between the real life and VR experience.

- Data to be collected and evaluation measures.

  Data samples in the physical reality compared to data sampled from the virtual reality.

  - Number of samples with direct correlations
  - Anomalous samples in both data
  - Reasons for anomalies.

7.1.2.2 Test case TF-2: Realistic physical feedback to users.

- Testing purpose and goals

  Built in transducers provide timely and realistic feedback to the user relating to the game dynamics.

- Participant characteristics

  Category B participants

  Category C participants

Characteristic	*Desired number Of participants*
Category B participants	*15*
Category C participants	*5*
Total number of participants	*20*

- Method

  Users of both categories will be asked to play the game at the end of each prototype, a field game and a game in virtual reality. Participants will be asked about their experiences. The session will end in a group discussion.

- Task

  Trial the VR systems physical, audio and visual feedback.

  Task Setup a field and virtual reality trials on different types of fields.
  State Virtual reality setup and specific golfing fields are chosen.
  Successful completion Questioners and feedback to observers are positive or constructive feedback, consistent feedback.
  Benchmark Category B participants unanimous opinions.

- Data to be collected and evaluation measures.

  Category B users technical feedback input and Category C users' insights.

  - Physical vibration with respect to actual putting force indicated in the VR.
  - Magnitude of sound and visual effects with respect to the game dynamics.
  - The above mentioned values in VR compared to the findings on the field.

7.1.2.3 Test case TF-3: User input reflection in Virtual Reality

- Testing purpose and goals

  User input accurately reflected into virtual reality in a timely and realistic manner that correlates to the user relating reflecting real life game dynamics.

- Participant characteristics

  Category B users, only professional and competitive participants as this activity requires quantitative analysis.

Characteristic	***Desired number Of participants***
Category B users	*10*
Total number of participants	*10*

- Method

  Category B participants will trial the game during the sessions mentioned in TF-2. In the same manner as the above case the users will provide input with respect to the rendering of input provided to the application.

- Task list

  Task Category B users to play several rounds of golf in reality and in virtual reality with input rendering in focus.
  State The device is set up all games are recorded for later review.

Successful completion Users have a clear unanimous feedback of the level of success and or constructive feedback to the development team.
Benchmark Satisfaction by professional and competitive golfers with respect their input to the game being processed accurately and correctly.

- Data to be collected and evaluation measures.

User satisfaction rating in quantitative for each type and aspect of the input to the system.

Qualitative feedback by participants indicating their observations and recommendations for following iterations of the product.

  - Proportionate reaction in the virtual reality in terms of graphics audio and game dynamics with respect to the users input.
  - Accurate magnitude of sound and visual effects with respect to the users input.

7.1.2.4 Test case TF-4: Synchronisations between VR headset and remote golf club

- Testing purpose and goals

Evaluate the synchronization between integrated hardware devices.

- Participant characteristics

Characteristic	***Desired number Of participants***
Development Team (players)	*5*
Development team (observers)	3
Total number of participants	*8*

- Method

  Ensure integration of all hardware reflect in synchrony after the issues relating to TF-2 and TF-3 are resolved.

- Task list

  Task Developers test the synchronization of devices the players are involved in using the device, the observers are recording and analyzing the subjects.
  State The virtual reality is setup, the simulation has commenced.
  Successful completion The allocated players complete several rounds of golf and note their reflections.
  Benchmark Players and observers discuss findings and develop a strengths, weakness, opportunities and threats analysis.

- Data to be collected and evaluation measures.

  Findings are to be categorised as strengths, weakness, opportunities and threats. Each finding is to be ranked in the level of important to the scope of the design.

  - Findings noted.
  - Findings categorized and prioristised with respect to importance.
  - All prototype analysis outputs are fed in as inputs to the design of the next iteration.

7.1.2.5 Test case TF-5: Battery life long enough to last several games

- Testing purpose and goals

  Examine the longevity of the battery life in comparison the length of a typical golf tournament.

- Participant characteristics

Characteristic	***Desired number***

	Of participants
Category A Participants (Observers)	*2*
Category B Participants (Players)	*5*
Total number of participants	*7*

- Method

  Official member of Golf Australia, competitive golfers to partake in a golf tournament scenario. Category B participants will partake in the virtual tournament and Category A participant will be the observers.

- Task list

Task Virtual reality system set up to the tournament scenario.
State Virtual reality is on and operating
Successful completion The given task, being the tournament is completed.
Benchmark Category A and B users are observed by the development team. The development team is informed of the findings.

- Data to be collected and evaluation measures.

Category A and B participants express their finding, opinions and suggestions to the development team.

  - Observations, feedback and suggestions are recorded.
  - Findings are presented as backlog items for the next development iteration.

7.2 Test Results and Analysis

Provide a summary and analysis of your test results. Detail dates of tests, participants, test results, and notes relating to the outcome. Include quantitative and qualitative results as needed in summary form. Include pictures of people evaluating your designs/prototype from your testing sessions in an appendix. Include scans or photos of your completed consent forms in an appendix.

Results of the Human Factors and Technical factors are mutually intertwined. The results and analysis of each case needs to be fed back into the design. As shown in Figure 9.

7.3 Findings and Recommendations

Review your test results for your initial design against the needs of your defined audience and the goals you established in section 3.

Give your findings and a clear list of recommendations for revisions to your design.

The test plan in section 7.1 need to be implemented, the findings need to be addressed in the design phase of the next iteration as shown in figure 9 to produce a resulting product that meets or exceeds the standard set in figure 10.

8 Discussion – Accessibility

What are the accessibility implications for the product that you have designed?

How easy would it be for someone with accessibility needs to interact with your product?

What might you need to change?

This section of the design brief deals with the needs of a specific set of people in the target audience with reduced or impaired capabilities.

The human factors identified in this design brief (section 2.1 Human factors) include sensory abilities such as vision, auditory, touch, physical such as muscular capacity and neurological such as motor skills.

The aim of this device is to ensure accessibility of this product to people in the target audience (section 2) who would need or want this technology. This design philosophy leads into inclusive design where users are supported regardless of their circumstance. A 2015 survey from the Australian Bureau of statistics estimated that 4.3 million Australians, or 18.3% had a disability, furthermore the survey also found that 15.1% of Australians were 65 years old or over.

The accessibility factors that will need to be considered in this project include auditory (hearing), visual (sight), Neurological, Physical (movement), Handedness, cognition, and ageing. These will be discussed below.

Accessibility issues with respect to hearing can be addressed by volume control for the least case scenario, other design guidelines include device compatibility of the VR headset with hearing aids. An additional support to users with hearing impairment will be the visual guidelines that assist picking an aim line for green scaping (see figure 8, Section 5) as well as the vibration feedback provided by the compatible golf club that relates the magnitude of putting with haptic feedback.

The next accessibility factor is vision, the virtual reality headset is required to include display settings that support colour blinded users. Image scaling options will be useful for people with short or long sightedness. Other visual aids include the adjustment of brightness and contrast to suit the individual users' viewing preference.

Physical capability involves length dimension and mass of the golf club and the size and fit of the virtual reality (VR) headset. To accommodate for these accessibility requirements the VR headset needs to be adjustable and compatible with a variety of compatible golf club ranges that can pair with the GolfPro system. However the minimum dimension of the golf clubs will need to conform to regulations advised by Golf Australia.

Neurological accessibility includes the nervous system being able to utulise motor skills in coordination for composure and aiming. The system has an aim line, a displacement line and a resultant trajectory line to assist the sharpening of motor skills. This technology may even become an aid to assist patients diagnosed with neurological disorders to sharpen and train their nervous system.

Handedness deals with whether the user is right handed or left handed. Selecting the dominant hand and putting stance is a basic required specification or a must have attribute in the context of a Kano model.

Cognitive accessibility factors can be addressed by including a speed adjust functionality for the VR technology to help users cognitive processing. Another option is to include step by step tutorials to prepare the mental model of the user to align with the conceptual model of the VR game. Additional assistance with the help of adjusting the above factors mentioned may assist the user if they have any effect on the cognitive processing of the person.

The above mentioned features provide personalized adjustment such that the player can adjust all aspects of the golfing experience besides the game dynamics that dictate realistic elements such green-scaping and putting technique. The final accessibility factor required to be considered is ageing.

Ageing is a phenomenon that affects several faculties outlined in 2.1 Human Factors including vision, hearing, dexterity and mobility. The emphasis of this brief is to lay the design foundation of a VR technology that simulates the golfing experience as played in reality meaning users can enjoy golf in their own space and time (even at night time) and competitive golfers can have off-site training sessions. All of this will be possible with the preset settings. Aged users can set the device as mentioned above to cater for their personal needs

such that the user settings can compensate for their abilities. The fact that this technology will be virtual reality will be a pain reliever for user who have concerns with mobility.

In order to build in these features mentioned into the design, the development team will have to involve people with accessibility concerns into its user centered design paradigm mentioned in section 6, Discussion – User Involvement, or at least access such people in each phase of analysis, design, prototyping and testing.

9 Discussion – Domains

The domain of this product is predominantly home and recreational use with an emphasis of realistic golfing experience. Due to this realistic simulation, this product may be adapted by coaches, athletes and manages. This technology may be expected to be integrated with athlete data management software systems one the technology becomes well-known.

The user domain of this technology can be expected to include hobbyist, golf training centers as well as professional and competitive golfers.

The technical domain of this technology includes smart phones, that is namely Android and iOS devices at this stage in time.

The required flexibility or adaptability of this technology is to work with most smart phones that have the specified storage and processing capacity.

As golf is a game with known equipment and set rules means the GolfPro product cannot be used outside of the context of golfing.

This technological innovation is expected to gain popularity by a wide domain of consumers as it will be built upon a familiar market of smartphone and virtual reality technology.

The setup of GolfPro game begins on a smart phone using familiar touch screen technology, virtual reality and a motion based controller golf club similar to the Nintendo Wii controller that is present on the current technology market. This product is a simple innovation that combines existing technological paradigms with complex algorithms to support golfing experience in the users own time and space.

The familiar basis of this technology is expected to gain consumer interest as the users' mental model will be in close alignment with the conceptual model of the technology due to its development on existing technological domains.

This technology will be built upon familiar interaction interfaces, therefore it will not introduce any complexity due to unfamiliarity.

The required flexibility of this technology is compatibility with well-known operating systems (iOS & Android) and usability on these systems given the specifications such as memory and processing requirements for the system is met.

The device will be introduced to the market for social and hobbyist users to gain major market popularity among users to ensure the device also targets golf enthusiasts as well. This is achievable as the potential target audience covers a wide spectrum of users of varying age groups, singles, couples, families, novice and experiences golfers (see section 2).

The analytics capacity of this software maybe utilized by professional and competitive golfers. The adoption of this technology is unlikely to be adopted by allied health domains for physical therapy use to assist in patients' coordination and motor skills.

This technology can be used for both recreational and training purposes, for this reason this product is expected to appeal to a diverse target audience identified in section 2 of this brief. The aim of this product is to be usable by anyone and anywhere as the design itself is mobile as detailed in the scope of this brief (section 1.2).

Although the technology can be used for recreation the design itself is a simulation of real golfing experience, therefore the challenges in golf as found in real life will be present in this with visual assistance shown in figure 8. Due to this reason the adaptation of this product for professional training centers is highly possible.

This technology is expected to be familiar and relatable to users as it draws upon existing technologies into a single product, these namely include smartphone platforms, touch screen interaction, virtual reality and a compatible remote control golf club with built in accelerometer and vibration actuators.

The innovation of this product will combine existing technological domains with realistic graphical simulations of golfing, this will present a familiar mental model of the product to the users that align with the conceptual model of the product design.

10 Discussion – Emerging Technology

Identify one emerging technology and describe how it could transform your product.

What would you like to do with your product if there were no constraints?

The proposed product of this design will consist of technologies from existing domains as mentioned with a topology including smartphone, VR headset and a remote golf club in a new topological setup with established interaction techniques using existing technologies for a new simulation concept.

The proposed design does not introduce any changes in the way people interact with technology, but instead draws familiar technical experience in playing golf on a new platform that was previously not possible.

This technology is similar to other head mounted virtual reality software but only different in the fact that is paired with a remote golf club which maps motion in physical reality to the virtual domain to reflect golf dynamics based on the put force, swing and physical vibration for users' haptic response.

This product incorporates the latest interaction techniques and allows the same physical setup of golf without the golf course, this new way of interaction is both ergonomic, practical and most of all realistic as the virtual game imitates the real life experience. This mentioned topology of the GolfPro allows the most efficient way of using natural human experience, or the ideal human computer interaction without any learned skill that will challenge the mental model of the user that exist from the traditional understanding of golf.

The design of this technology utilizes elements from existing domains in a new topology for a completely new application of existing technology. This design introduces a well-known game concept into a new application in a digital domain, utilizing the same concepts used in traditional golf. Hence users will recognize and understand how to expect to use the proposed product.

The challenge of this technology is that although the components of this technology all come from known domains. The setup of this technology is quite new with a remote controller being paired with a virtual reality headset. Although VR technology, motion sensing remote controllers are established, however integrating these two for a realistic life like simulation of a well-established sport will be a first in overcoming integration challenges to provide a realistic golf experience.

The success of this product is highly probable as it consists of existing technologies within its design topology. Virtual reality and motion sensing technology are gaining momentum to becoming mainstream, therefore the present technology market should be mature enough for an early majority of consumers as defined in the Rogers adoption model to take interest in this product in a short period of time as there is very little unknown grounds in the domains of technology involved in this design.

This product will create a new domain of integrating the aforementioned technologies to create the proposed product. The current technologies that will be used to create this new product to create the intended realistic golfing

experience is a design decision that will ensure customers are comfortable with using this new product. This design does not introduce a new cutting edge technology platform but rather integrate technologies in existing domains with innovation. The nature of this new domain is to utilise software engineering techniques to integrate the abovementioned hardware.

The design is aimed to be a unique innovation considering the audience at first by building in specifications based on the identified human factors (section 2.1) and research about the audience (section 2.2). This design draws attention on user experience by considering the user's interaction with this technology as part of the design philosophy of this brief, this can be seen in *Prototyping*, section 5, and *user involvement* in section 6.

Prototyping and user centered design (section 6) will allow the development team to ascertain what the technology does well and what limitations it has.

In conclusion with continual testing and a constant effort to try new things will allow the technology to fulfill the conceptual model that will be most in tandem to the users mental model of this technology.

"Technology is ethical when it helps people reach their fullest potential; when it improves their quality of life, makes them happier and more fulfilled, and gives them the freedom to choose what they want to be. We consider the interests of people living here and now, but also the interests of future generations, other living creatures, and the preservation of the environment."

The Ethical Technologist

■ David Tuffley