Interactive 3D Learning Aids to improve Rugby Tactics

By

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Declaration

This dissertation is the product of my own work. I agree that it may be made available for reference at the discretion of the University of Gloucestershire

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Abstract

This investigation aimed to explore the opinions of the Bristol Rugby Club RFC to determine whether a 3D visualisation training aid would be an effective teaching/learning tool of Rugby tactics and strategies. The study consisted of two focus groups made up of five and six experienced, amateur players and club coaches in order to obtain qualitative data by way of discussion and quantitative data by way of a five Point-Likert-Rating-Scale questionnaire. An opportunity sample group of professional coaches/athletes were also incorporated and provided extra qualitative data. The quantitative data provided a statistically significant result $p<0.025$ indicating a preference for 3D as opposed to 2D visualisation techniques. Qualitative data indicated that there was a future potential for the use of 3D in sports team training. Problematic areas of the prototype were also highlighted by the investigation and will need to be addressed for further research purposes. Limitations of the study itself were also highlighted and suggestions are made for a future experimental investigation into whether 3D visualisation does indeed enhance performance.

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Chapter 1: Introduction

1.1 Overview

Around the world a great variety of team sports are played at both the professional and amateur level, with the active participating experience enjoyed by many at both an individual and team level. Ultimately, people strive for the successful achievement of their own individual goals as well as collective team goals. Such aims include ‘self-improvement’ (mastery), ‘prove ability’ (ego) and/or ‘please others’ (social approval) (Bull, 1991). Of the many factors that contribute and exert a powerful influence to such successes, particularly in the area of team sports i.e. rugby, soccer, American football, ice hockey etc, are the teams’ tactical and strategic skills. As such, each teams’ coach has the responsibility to educate, prepare and steer his/her players towards efficient and rewarding team tactics (Greenwood, 1997).

In our present modern-day digital and technological climate it could be suggested that it is in best interests of all involved that a coach is aware of the availability of all possible new technological advancements that may have potential teaching power to improve overall strategies and tactics (Meyes, *nd*, and Lloyd & Besier, *nd*). One, recent and significant advancement has been in the realms of the real-time 3D (third-dimension) graphic industry. Within this area, sport computer games have progressively evolved to the stage of virtual realism. A question that begs to be answered is whether a coach can utilize similar technology as a 3D visualisation-teaching tool to enhance sports persons understanding and performance by way of a virtual learning experience? Alternatively, it may be that current sports field training practice methods elicit equal or even better performance.
1.2 Aims and Objectives

Based on the issues raised in the literature review, the ultimate aim of this report was to propose a new and realistic rugby 3D visualisation-training tool that had the potential to aid rugby coaches to teach and enhance club team tactics and strategies. This involved employing, appropriate evaluation and sampling techniques suitable for an approximate 300-hour study, combined with the appropriate analysis of gathered data to assess sportpersons opinions and reactions concerning whether a team sport 3D visualization solution is likely to be a more effective training tool in enhancing the learning experience and ultimate performance within their already active participating learning experience.

To achieve an appropriate balance between the project aims and objectives, this research report was narrowed down to concentrate on rugby only, in order to establish a focus whilst also eliminating any variables that might be exclusive to other team sports. Although, the targeted sport is rugby it is hoped that the principles and conclusions drawn from this research is transferable to other team sports, eventually recognising the potential for future development and research into 3D real-time technology within sport visualisation.

1.3 Limitations

In order to carry out, collect data and evaluate this research project it was necessary to employ a great deal of effort and time in the creation and development of suitable 2D and 3D visualisation-training solutions for comparative purposes. Thus, time was a major limitation and as a consequence a realistic and appropriate project
development plan (Appendix A) was established. The development plan consisted of project deadlines that included regular reviews and evaluations of the prototype progress. The researcher worked to precise deadlines allocating a suitable length of time to implement suitable evaluation methods using an appropriate sample of subjects for in order to collect research data that would produce a reliable and valid report (Project meeting records, Appendix B).
Chapter 2: Review of Literature

2.1 Sports coaching using visualisation

In recent years Australian sport has demonstrated that science and psychology plays a role in sport achievement. At the 2000 Sydney Olympic games, Australia won 58 medals and credit has been widely been attributed to the Australian attitude towards sport science and has pointed the direction to which many countries are now following (Nelson, 2002). Now, within the world of continually evolving advancements in technology in sports science, ‘progressive thinking coaches’ are able to succeed in their responsibility in guiding/influencing athletes to his/her full potential (Terry, 1991). To do so, they must combine traditional methods with cutting edge sports science technology to enhance their understanding of athletic performance (Meyes, nd, and Lloyd & Besier, nd).

Over many years the video has been considered a valuable and successful qualitative tool for coaching; allowing performance and technique to be analysed in a fair amount of depth. A major disadvantage of this process was that performances could only be viewed from the perspective of the camera. Analysis of video via a computer improved the coach’s perception by simulating the motion in 3D (three-dimensional) by employing multiple camera angles viewed side-by-side and multi-frame display (www.sportsmotion.com). Despite this, the information delivered was still not a true 3D representation of what was actually going on, but further research into Sports Biomechanics and the desire to analyse motion in 3D via stick-like figures has led to important developments in sport visualisation. One successful device that has improved the performances from athletics to American football athletes’ is APAS
(Ariel Performance Analysis System), developed from 25 years of research by Dr Gideon Ariel. This is a video-based 3D motion analysis system that transforms video footage into a visual 3D representation for analysis (www.sportscience.org). More recent and becoming evermore popular are motion-capture devices that allow the direct capture of motion without video by recording the position and orientation of an object in 3D space via infrared cameras (www.vicon.com). Loughborough University, have employed similar video-to-motion techniques to create a teaching simulation package for British gymnastics coaches which offers a better understanding of the mechanics involved in twisting somersaults, through watching the 3D simulations generated on video, by digitising actual top athletes performances (www.lboro.ac.uk/departments/ps/research/gymnastics.htm). By using visualisation techniques of the types mentioned above, there have been many success stories, not least because of the help that it brings in identifying particular areas where body movement can be improved upon. For example, in the case of gymnastic simulations both coaches and the gymnast can visualise a perfect twisting somersault. Although this particular technology is aimed at the individual level of sport perfection and achievement, analysis through visualisation can also be an essential tool for the coaching of team sports.

An industry that has helped revolutionise and shape this form of analysis in team sports has been the TV sport broadcasting companies. BSkyB Sky Sports have been a particularly influential user of this technology in order to add extra dimensions to their broadcasting and TV commentary. By acknowledging the sports fan desire to analyse a sporting event and with the possibilities offered by digital television they have introduced the interactive sports channel Sky Sports Extra. This facility permits
users to select different camera angles (even a player cam), call up statistics, replay goals and highlight particular aspects at their own discretion. They have even introduced ‘Virtual Replay’ using Orad Hi-Tec Systems Ltd (www.orad.tv) technology that transforms a flat 2D video sequence of an important or contentious play into an animated 3D graphical visualisation, thus allowing the play to be viewed from any angle via a virtual camera, i.e. seen through the eyes of a referee or goalkeeper. Although, any camera angle is possible, at present the sports caster still determines the viewer’s view-port, perhaps in future digital TV will include a real-time virtual camera. Although this is not yet possible via television, it appears that QradNet Inc (owned subsidiary by Orad Hi-Tec Systems Ltd) has recognised the potential for users to interact with a sporting experience and along with Intel and Macromedia Shockwave 8.5 have developed ToPlay™ Soccer: an immersive web sporting experience which the user controls the virtual camera.

2.2 Essentials of Coaching Tactics

When participating in a sporting event at both the amateur or professional level, whilst on the whole the opposition will be of an equivalent physical condition and skill level, essential for success are the skills of thinking and decision making throughout: correct decisions could result in a score, whereas the wrong decision could result in an opposition score. Although recognising the importance and influential nature of thinking about the game and making the correct decisions, it is nevertheless the performance of this action within a split-second that’s vital for success Askew (2001). Professor Dave Collins (2002) from the University of
Edinburgh also recognises the value of high-levels of automation that are consequently universal to the sporting world;

“Sport in general is someone learning to do a skill or set of skills well under high-levels of automation.”

(Collins, 2002: url)

Essentially it’s a coach’s responsibility to educate his or hers players intellect, by training players to read the current situation of the game along with improved communication between team members which will ultimately help with the enhancement of their decision-making skills: subsequently developing ‘intelligent’ players. Although every player is responsible for making their own decisions, they will also be executing a team strategy and team tactics communicated via visual or audible signals from the team tactical decision-maker. Each player will have a role to play in executing these tactics and furthermore it’s the coach’s responsibility to prepare them using various coaching methods, situations, and exercises. Jim Greenwood (1997:pg 65) summarises the coach’s task in the education of players; “establishing high standards” and “having the players understand the principles behind what they’re doing.” For a player to understand the principle of a tactic the coach is required to provide an explanation for the following eight categories (Greenwood, 1997);

i. Timing

ii. Purpose

iii. Positioning

iv. Line of run

v. Pace

vi. Cover
vii. Alternatives

viii. Techniques

For a set-play to be performed perfectly it is necessary for each player not only to understand their own responsibilities but also those of other team members according to the categories mentioned above. This is primarily learned and perfected out on the actual training field when practising the set-play time after time: learning through repetition to achieve the cognitive effort of automatic skilled motor-learning (Fitts & Posner, 1967). The danger of this process is that in becoming skilled by repetition, the player’s performance becomes automatic and ‘robotic’ like, warranting no constructive thought or problem solving process on the part of the player. It could be suggested that this is a direct contradiction of what the 3D-visualisation training tool could offer: greater player awareness and a fuller understanding of the applied tactics within specific scenarios.

A tendency has been for the coach to create 2D diagrams of team tactics in ‘playbooks’ and then present their information regarding team tactics to the team by way of ‘flipcharts’ to demonstrate the principles behind the tactics to the semi-professional and professional players (Appendix C). However, more recent technology has become available that offers the possibility to transform diagrammatically drawn tactics into a digital format and consequently add motion to the diagrams; two examples of such tools available are Game Planner (www.gameplanner.co.uk) for demonstrating rugby and soccer tactics, and Play Manager (www.playmanager.com) for ice hockey tactics. A question that arises is whether such visualisation aids can go to the next level and transform from 2D diagrammatic learning experience to 3D real-time environment?
2.3 Using Two and Three Dimensions is Learning

When sensory information is taken, it is encoded in short-term memory and then retained in long term memory and it is from long-term memory that it can be retrieved. Short-term memory has a limited capacity as to the number of items of information that it can hold before it decays and is lost i.e. +7 -2. (Miller, 1956). To retain the trace of the original memory humans need to repeat the memory over and over again, at which point it can be stored in long-term memory. Long-term memory is unlimited in the amount of information it can hold and retrieve (Cohen, 1990). The visual sensory memory is called upon when pictorial diagrams are used: the normal method of communication that coaches use to express their tactics concepts. Firstly the graphic may be aesthetically appealing to attract the attention and maintain motivation and finally the graphic explains something that would have been difficult to describe or visualise. According to Williams, Lock, Crisp and Longstraffe (1995) meaningful pictures have a direct route to long-term memory, which suggests that CBL (computer-based learning) environments are a perfect medium for this type of learning experience. Consequently, this could be one reason why computers are becoming, if not already, a key tool in assisting teaching and learning in many aspects of today’s society. Would an animated tactical 2D diagram complement the explanations for the players more so than the original static diagram on the flipcharts? Leung and Pilgram (1995) recommend that explanations for learning complex principles are more effective through animations. Schnotz and Grzondziel (1996) on the overhand make a strong case for static pictures allowing deeper processing than animated pictures. Whilst Morrison and Tversky (2000) suggest that animated graphics communicate more information, but sometimes at the cost of clarity, resulting in not all animated graphics will be effective for learning.
Therefore, a careful scrutiny of the graphic should be performed to assess whether an animation would be appropriate for the learning experience. In the case of rugby tactics, is it feasible that 2D animation can improve player perception of timing, purpose, positioning, line of run, pace, cover, alternatives and techniques or is there a case that a virtual 3D approach is more appropriate.

Immersive and Desktop VR (virtual Reality) are used in a variety of industries ranging from entertainment to learning. The Military and the aviation industry have effectively used this technology in their training. The user becomes actively engaged in the VE (virtual environment) and learning takes place as a result of the active participatory experience. Its success in such training has led to speculations about its potential use as an effective teaching tool in other educational areas. Dede, Salzman, Loftin, (1996) and Youngblut (1998) cited in Moher Johnson (1999) are fairly recent researchers who have explored the effective development of VR/VE (Virtual Environment) technology as a support to learning.

Whilst VR adds to the motivational characteristics of learning, another, perhaps more important aspect is the notion of the sense of presence: ‘being there’ (Brna, Cox & Good, 2001). Tony Buzan (1997) has highlighted how learners’ memory experiences are enhanced as a consequence of learning to use their senses. Whitelock, Brna and Holland (1996) have proposed a theoretical framework between Virtual Environments and conceptual learning suggesting that experience gained through VR environments enhances performance and conceptual understanding. Zeltzer, (1992) offers a Zeltzer Cube model that identifies three essential components that any virtual environment must include: “a set of models, objects and processes; a
means of modifying the state of these models and a range of sensory modalities to allow the participants to experience the virtual environment”. Moreover, in order to measure and compare the effectiveness of the VR worlds it is necessary for that virtual world to contain the following: “autonomy – the extent objects can respond to events and stimuli; interaction – the degree of access to parameters or variables of an object and presence – a measure of fidelity of sensory cues that engender a subjective sense of ‘physical presence’ or ‘direct experience’” (Zeltzer 1992: url) cited in Whitelock, et al (1996). However the main difference between these virtual environments and the one to be employed in this research is the ‘lack’ of personal interactivity upon objects within the virtual world. This particular virtual environment medium was adopted with the aim to communicate the diagrammatic rugby tactics, in order to increase the players understanding and learning through ‘perception’ and ‘sense of presence’ (as proposed in Zeltzers’ third guideline: presence). Brna et al (2001) believes that VE can be used as a sensori-motor experience in the conceptual learning of any diagrammatic reasoning. However, this has not as yet been fully researched, but Brna and colleagues are of the opinion that this will no doubt change in the future.

It seems clear that there are possible benefits to be gained from experiencing diagrams in a 3D environment that enable people to view strategies/tactics of a game from different angles in real-time. However, we must be aware of its’ possible disadvantage, that is nicely summed up in the words of the 19th century artist Honore Daumiers’ definition of a photograph: it describes everything but explains nothing (Sless, 1981).
2.4 Growing Trend of Technology

In the game of amateur rugby, not every player can attend training sessions due to other commitments making it difficult for the club coach to prepare all players with the same knowledge and understanding of team tactics to ensure coherence within the team. Consequently, the coach is required to recognise the potential use of other methods for delivering such information. With increased household availability, one such method is the computer and Internet: the year 2000 indicated a sharp rise of 45% availability compared to 34% in 1998, with a third of all households having access to the Internet (Walker, Maher, Goddard, & Thomas, 2001).

Previous traditional areas of VR have relied upon expensive technology (e.g. SGI Indigo 2 workstations) to produce the real-time rendering capabilities required. In the present, such technology would struggle to keep up with current 3D accelerated graphic cards (Stout, 2002). Real-time 3D graphics are progressively becoming more realistic as can be seen in Microsoft Xbox games consoles that use the common nVidia graphics chipset. With this form of technology becoming gradually more available, along with the increasing popularity of broadband and other high-speed Internet technology there has been a boom in the real-time interactive development market. As well as the current interactive 3D developers like Superscape, Virtools, Cycore, Viewpoint, etc two other major software companies Macromedia ‘Director 8.5 Shockwave studio’ and Adobe ‘Atmosphere’ have joined this competitive market. In addition, the developers of 3D modelling software are also releasing their own tools to support this every growing industry: Alias|Wavefront Maya RTA (Real Time Author), Discreet Plasma and Gmax software. The future of interactive real-time 3D appears to be bright, although as further capabilities become available to
create interactive 3D content, either on-line or off-line, there must be a constructive justification for adopting this media.

Another emerging trend of ICT (Information Communication Technology) is in its’ application as an additional teaching tool within education. The present government has recognised the importance of ICT in education today in particular in relation to its’ potential as a learning tool to be used in a variety of subjects. In September 2000, it became compulsory for ICT to be employed in Key Stages 3 and 4 PE (Physical Education) curriculums with the following aims:

- Improve students’ skills and techniques.
- Enable students to review, evaluate and as a result improve their own performances.
- Develop student knowledge and understanding.
- Build student appreciations of movement through shift time and space – for example using different speed and angles to view a technique.

(British Educational Communications and Technology Agency, 2002:url)

Whilst it is conceivable that this is another target audience that could benefit from this form 3D visualisation technology as a teaching/learning tool, the present investigation has only considered its’ effect upon adults. As such, it is pertinent to suggest that this area would need to be further researched to establish whether children respond to this technology in the same way as adults do.
2.5 Summary

In summary, it has been established that whilst 3D sport visualisation has been effectively used in sports Biomechanics to improve athletic performance, it is also a feasible option to use it within a team sports environment. By recognising the essentials of coaching responsibilities in preparing players understanding of teams tactics/strategies and the advantages/disadvantages of presenting this information via static/animated 2D diagrams in comparison to 3D visualisation. It has been demonstrated that a ‘sense of presence’ is an influential factor for establishing enhanced explanation resulting in greater player awareness and understanding of both their own and their team colleagues responsibilities. With the growing availability of computer and Internet access within the home environment it is possible that such experiences can be experienced not only in a training environment, but also at the convenience of the amateur player at home. It is also possible that this sort of technology can be utilised within the education environment as an effective teaching/learning tool.
Chapter 3: Methodology

3.1 Approach

The availability of time and resources dictated the strategy taken for the collection of the relevant data; therefore an explanatory experimental approach was not adopted (Robson, 1993). In an ideal world the explanatory experimental approach would have been preferable in order to extract more precise quantitative statistical evaluation. For example, measurements of rugby players performance could have been recorded with the ‘Eagle Rating’ system (Bracewell, 2001) which is similar to baseball players PGP (Player Game Percentage) developed by Jay Bennett and John Flueck (1984) enabling researchers to amass quantitative data for statistical analysis. This would also involve the participation of two teams: a controlled team not exposed to the 3D visualisation training and an experimental team who were exposed to the 3D visualisation training. In order to obtain an accurate indication of individuals’/teams’ performances the ‘Eagle Rating’ data would need to be collected over several games. To record the ‘Eagle Ratings’ of thirty rugby players for each game would require a team of researchers and a great deal of recording equipment. The complicity of measuring player/team ‘effectiveness’ in such a way prohibited the researcher undertaking data collection and evaluation single-handedly in this research project. However, it warrants highlighting that in future research, this form of explanatory experimental method would be essential to extract a more accurate correlation relationship between controlled and experimental group performances (Robson, 1993). Since the explanatory experimental method was not a feasible option, the researcher felt justified in adopting an investigatory exploration method to access and evaluate the opinions and attitudes of rugby players and coaches as to
the perceived usefulness and potential effectiveness of such a training tool as well as a precursor to further experimental research towards the anticipated implementation of the product. Thus, a multi-method exploratory investigation is warranted in order to conduct and gather both qualitative and quantitative data by query/survey evaluation techniques to enhance the data interpretation (Robson, 1993 and Bell, 1999), (Dix, Finlay, Abowd, & Beale, 1998, & Hill, 1995).

### 3.2 Study Design

Experienced ‘expert’ rugby coaches/players were the representative samples utilised in a self-contained focus group method as the primary means of collecting qualitative data (Morgan, 1997). Whilst England and Finney (1999) recommend focus groups for testing multimedia concepts, Nielsen (1997), Morgan (1997) and Krueger and Casey (2000) highlight the success of such groups for obtaining a wide range of responses and attitudes that can emerge from targeted group interactions/dynamics. Whilst many believe that focus groups are a ‘quick and easy’ method of data collection, traditional qualitative techniques i.e. individual interview, survey or observational methods have not been adopted since focus groups can prove to be an efficient means of data collection. Fern (1982) performed a controlled experiment to compare individual interviews and focus groups and concluded that two, eight-person focus groups could produce as many ideas as ten individual interviews.

Key factors for the ultimate success of focus groups lies with ensuring real world, naturalistic environmental conditions promoting self-disclosure amongst the participants and encouraging group dynamics whereby members influence and in
turn are influenced by others (Krueger & Casey, 2000). Whilst supplying a valuable
data source, there are also inherent weaknesses associated with focus group methods.
The focus group design is based on a traditional ‘single-category design’ (Krueger &
Casey, 2000) in which focus groups are conducted until there is a theoretical
saturation between them. Morgan (1992) cited in Morgan (1997:pg34) “rule of
thumb”, suggests a total of three to five groups per project. Furthermore, in both
social sciences and in marketing, Zeller, (1993) and (Calder, 1977) claim that more
groups seldom provide meaningful new insights. With the current sample audience
available, there will be a minimum of two focus groups conducted. If enough
saturation exists between the two groups then a third focus group would not be
essential.

In addition to the focus group data, a small-scale survey, using a 5 point Likert-
rating-scale questionnaire was necessary to summarise and access participants
opinions, beliefs and feelings (Dix et al, 1998) (Bell, 1999) in preparation for
quantitative statistical analysis. Although advantageous, a major disadvantage is the
mutual contamination of the two methods (Morgan, 1997). It could be argued that the
group discussion may change the initial attitudes and feeling of participants and may
well contaminate the questionnaire results. To limit bias and directing the responses
of the focus group, questionnaires were conducted at the end of each 2D/3D
demonstration and discussion session. Furthermore it is worth reminding ourselves of
the focus groups goal, which is to generate data via group interaction and dynamics.
In which the questionnaire is designed as an additional data gathering method for
capturing each participant’s final attitude and feelings that transpires from the group
discussion, assisting in the analysis and conclusion of a 3D visualisation-training aid.
3.3 Research Hypotheses

A one-tailed hypothesis:

**Research Hypothesis:** Rugby players and coaches will find the 3D visualisation training aid significantly more effective as a learning tool than the 2D visualisation training aid.

**Null Hypothesis:** There will be no significant differences found in the attitude responses between 2D and 3D visualisation training aids between rugby players and coaches. Any differences found will be due to chance and random variability.

3.4 Reliability and Validity

The reliability and validity of the research project will be accomplished through the presentation of data and internal consistency (Wiersma, 1999). Reliability will be achieved with the presentation of data and supported with sufficient verbal quotations from participants to enable the readers to evaluate and assess the interpretation. A detailed description of the methods and procedure followed permits a reproduction of this research project. The Focus group methodology employed will also promote internal validity (Lewis, 1995, Morgan, 1997, Krueger & Casey, 1999). These procedures will be discussed in detail later within the report, ensuring the trustworthiness of the results and an accurate indication of the participant’s attitudes.
Chapter 4: Method

4.1 Focus-Group Interview

The quality of the data depends very much on the quality of the preparation given to the focus groups (Morgan, 1997). The next section describes in detail the preparation undertaken.

Abiding by Stewart and Shamdasani’s (1990) suggestion that the questioning route established should reflect the research question and progress from general questions to more specific questions, and applying Krueger and Casey’s (2000:pg4243) ‘Qualities of a good questionnaire route’ the question route was established. Overall, six questions were used, which appears to be within the spectrum of suitable questions suggested by academics. Krueger and Casey (2000) suggest around five or six questions and Stewart and Shamdasani (1990) propose fewer than a dozen questions, whilst Morgan (1997) suggests between four or five questions for structured groups. The sequencing of questions was an important factor for directing the focus within the discussion, providing the opportunity for members of the group to express their opinions and develop throughout the session. The sequence was determined by the ‘funnel approach’ strategy, commonly adopted by researchers (from general to specific) (Krueger & Casey, 2000 & Morgan, 1997).

In following the general to the more specific, the ‘Opening’ of the focus group, included a welcome, an overview of the research project, the ground rules and individual instruction sheets. Following the 2D and 3D visualisation demonstrations the first question was posed. Commonly the first question is an “ice-breaker” in
which each participant gives a brief self-introduction to set the mood of the group (Morgan, 1997). All participants were members of Bristol Harlequins RFC, therefore self-introductions were not necessary, consequently the ‘transition’ from the demonstration to the discussion started with the following question:

- “What are your first impressions?”

The objective of this question was to obtain an opening statement from each participant to develop awareness of the other member’s views and to indicate the start of the discussion. It was the researchers (moderators) responsibility to ensure each participant provided an opening statement, which also helped to discourage “groupthink” (Janis, 1982).

The next series of questions were the ‘Key Questions’ of the discussion and were open-ended to allow the participants to determine their own responses;

- “What do you like best about this form of 3D visualisation?”
- “What do you like least about this form of 3D visualisation?”

These open-ended questions were also designed to allow the participants to comment on the positives and negatives of the 3D visualisation tool in comparison to the 2D version. The positive questions were asked first as the transition between positive to negative is often smoother and more comfortable (Krueger & Casey, 2000).

The key questions engaged participants into an open-ended discussion; therefore the modulator took back the control of the focus group via the ‘End Question’.

- “Which of the two programs did you like best?”
This question brought the discussion to an end and ensured that the final thoughts of
the members’ concerning the two methods were captured from reflection on
comments made in previous discussion (Krueger & Casey, 2000).

These questions were pilot-tested amongst other participants with similar
backgrounds and experiences to verify that the questions were understandable and
there were no areas of uncertainty. This certified the trustworthiness of the responses.

4.2 Questionnaire

A self-report attitude survey questionnaire was constructed in two parts with all
questions based on the sensitive 5-point-Likert rating scale to indicate the level of
positive/negative, agreement/disagreement (strongly agree, agree somewhat, neither
agree/disagree, disagree somewhat and disagree strongly). Part 1, was designed as an
experimental design method to tests the subjects attitude towards learning rugby set-
plays by the means of two-visualisation systems (2D/3D) as demonstrated.

Utilisation of the combined participants from the focus groups permitted a within-
group (Dix et al, 1998) experimental design to be adopted. The participants’ were the
user group; IV (independent variable) was the style of learning (2D/3D) and the DV
(dependent variable) was the attitude measured test score from the questionnaire
consisting of five constructed statements.

Part 2 consists of three statements designed to capture in more detail the participant’s
attitudes for the extra functionality offered in the 3D environment. To avoid ‘mental
set’ responses, a negatively expressed cognitive, affective and behaviour statement
was used (Appendix D). A pilot questionnaire was sent to the project advisor and several other participants to check that the statements are understood in first person, resulting in participants more likely to give an honest personal opinion. This provides face validity to the questionnaire.

4.3 Participants

Six participants were recruited for Group A and five for Group B in line with the general consensus between academics opinions (Kruger & Casey, 2000) (Morgan, 1997). To guarantee targeted participants were used, a screening process was conducted to identify members with the following characteristics (screens):

- Screen 1: Participants must be male
- Screen 2: Between the ages of 21 - 45
- Screen 3: Members of Bristol Harlequins RFC
- Screen 4: Either a coach or an experienced senior player.
- Screen 5: All were native English speakers.

The screening selection process implemented the homogeneity of the group and made certain no ‘non-observable’ factors were present; the groups consisted of male representatives of Bristol Harlequins RFC who were either a coach or an experienced senior player aged between 21 to 45 years old. This ensured sufficient differences between the participants allowing for contrasting opinions to occur. All participants were knowledgeable and interested in the subject and each shared a general respect for each other’s skills. Each were native English speakers with no known reading difficulties and all wore spectacles if necessary when reading questionnaires and
watching presentations. The table below summarises the participant characteristics within each group:

Table 1. Focus Group Participant Summary

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Size</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Ages:</td>
<td>4 - aged between 26-35</td>
<td>1 - aged between 18-25</td>
</tr>
<tr>
<td></td>
<td>2 - aged between 36-45</td>
<td>2 - aged between 26-35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 - aged between 36-45</td>
</tr>
<tr>
<td>Experience</td>
<td>1 – Player Coach</td>
<td>1 – Coach</td>
</tr>
<tr>
<td></td>
<td>4 – Players</td>
<td>1 – Player Coach</td>
</tr>
<tr>
<td></td>
<td>1 – Ex-Coach</td>
<td>2 – Players</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 – Ex-Coach</td>
</tr>
</tbody>
</table>

### 4.4 Materials

#### 4.4.1 Equipment

The prototype demonstrations were performed on a single Samsung VM8000 Series laptop computer; Windows Me, Intel Celeron 800MHz, 112 Meg Ram, 3D Graphics Card and projected onto a projector screen (102cm by 76 cm) using an Epson EMP50 projector (Figure 1).

Figure 1. Presentation Equipment.
A Sony M-100MC audio tape recorder was used to collect verbal data. The quality of the recorded data was crucial to the success of the focus group. Therefore before performing the actual focus groups a “live audio test” was conducted. This consisted of taping and replaying a brief statement from different locations around the room on the various recorder settings:

- Lecture
- Normal
- Dictation

For optimum quality in the current environment the dictation recording setting was used plus with the recorder facing towards the focus group as shown in Figure 1 and 2 thus reducing background noise.

---

Figure 2. Focus Group Layout.
4.4.2 Environment

The Focus group interviews were performed at Bristol Harlequins RFC clubhouse in the ‘Vals Bar’, a private committee room. Participants were positioned around a table enabling full focus on the presentation and for the convenience of signing consent forms and answering questionnaires (Figure 3).

![Focus Group Environment](image)

Figure 3. Focus Group Environment.

Due to the room size constraints it was necessary to position the projector to one side as shown in Figure 2 and 3. The moderator controlled the presentation equipment, which was not an ideal solution for ensuing conduction of the focus-group discussion. One disadvantage was the location of the moderator within the room, which made it difficult for the transmitting of nonverbal encouragement to the less talkative participants.

The advantages of holding the focus groups at this location was the familiarity of the environment which encouraged participants comfort by being in their own real life environment as well as being in a convenient location. Background noise was minimal and did not appear to effect participant distraction and made minimal effect
on the audio recording device. The room has no windows limiting any visual
distractions, focusing participant’s concentration on the presentation and discussion.
The location was adequate, equally attractive for the participants and the researcher
requirements (Morgan, 1997). However, it is worth remembering that a laboratory
controlled focus group, whilst allowing greater control over the environmental
variables and rendering the results more reliable (Robson, 1993), laboratory control
also has the negative effect of producing results that are less generalisable to a
population and are prone to demand characteristics. Furthermore, participants of the
type needed i.e. a representative sample would be hard to come by for such purposes.

4.4.3 Prototype Development

For the purpose of this research project, two simple virtual training visualisation
prototypes were required and were designed to illustrate the difference between 2D
and 3D visualisation and to assist in the evaluation of the 3D concept: a teaching tool
within sports. The following guidelines were established for the prototypes
development to create validity between the prototypes:-

- Both prototypes appearance and interfaces will be identical, apart from the
  area of interest consequently directing the participants attention towards the
  2D and 3D visualisation (as shown in figure 4).

![Figure 4. Prototype Interfaces](image-url)
• Each prototype consisted of four identical set-play tactics employed by Bristol Harlequins RFC. The club coach and vice-captain submitted the tactics to be used on a special form designed by the researcher that acted as the blue print for developing the 2D and 3D animations (Appendix E).

The design process of the 3D prototype can be summarised into four steps;

i. The creation of the virtual environment was based upon Bristol Harlequins RFC and its surroundings.

ii. The development of a rugby player in the club colours, followed by the set-play animations.

Using club colours and the environment of Bristol Harlequins RFC in steps one and two adds extra validity to the prototype. 3D Studio Max, Character Studio and Photoshop were the tools used to create the above steps.

iii. The 3D models and animations were imported into Virtools, the different cameras were introduced to the virtual world and the interactivity programmed.

iv. The general interface design was developed in Flash and Photoshop. Macromedia Dreamweaver was used to link together the interface elements and the Virtools world. JavaScript established the communication process between the Flash files and the Virtools world.

Further detailed information concerning the development processes involved in the creation of the virtual visualisation training prototype can be located at the author’s website: www.ralphski.co.uk/mu303.
4.4.4 Ethical Issues

In compliance with the Ethical Standards issued by the University of Gloucestershire (2001), the nature of the investigation was divulged and informal consent was obtained from each participant. Confidentiality and the non-judgmental nature of the investigation were assured. They were told that they could withdraw at any time and that further questions would be answered during debrief at the end of the investigation. Written instructions were given to each participant and the researcher also verbally reiterated its contents to each group informing them of what was required of them (Appendix F). When all participants were comfortable, the focus group discussion began. When the discussion and data collection came to an appropriate end the participants were debriefed further and their questions were answered.

4.5 Procedures

Two focus groups containing between five to six participants were conducted at the agreed location (Bristol Harlequins RFC, Vals Bar). Each participant were welcomed and thanked for their co-operation and given identical instruction/consent sheets to read (Appendix F). The focus group interviews lasted for approximately 40 minutes and were audio recorded with the participants consent. Once every participant fully understood his or her role and rights, the focus group interview proceeded using the follow procedure;

- Welcome.
- Overview of the topic.
- Demonstration of the 2D visualisation-training tool.
• 2D rating questionnaire exercise.
• Demonstration of the 3D visualisation-training tool.
• Icebreaker question: “What are your first impressions?”
• Key Questions: “What do you like best about this form of 3D visualisation? What do you like least about this form of 3D visualisation?
• End Question: “Which of the two programs did you like best?”
• Final 3D rating questionnaire exercise.
• Concluding comments, debriefing of group results and participants invited to asked/gave comments and questions.

To ensure both focus groups were performed identically increasing the validity and reliability of the collected data, the moderator used the visual aids of flash/cue cards, which acted as the procedural templates (Appendix G). Flash/cue card instructions included:

• Overall focus group procedure steps.
• 2D demonstration procedure steps
• 3D demonstration procedure steps
• Questions

A moderator (the researcher) and an assistant moderator moderated the focus groups. Part of the moderator’s role was to conduct and keep the focus group discussion flowing. The assistant’s role was to help in the initial set-up of the environmental conditions and equipment, then in the background to act as timekeeper and audio tape-recorder operator. At the end of each focus group a post-meeting evaluation was conducted between the moderator and the assistant establishing the group dynamics and any bias from the moderator.
4.6 Data Analysis

The designed methodological approach was implemented to produce qualitative and quantitative data from the focus groups and questionnaires to enable analysis. The data collected from the focus group was analysed using the following methods.

Firstly, an abridged transcript of relevant and useful sections from the discussion was developed by repeatedly listening to the recorded audio tapes and by exercising Krueger & Casey (2000) guidelines for creating a transcript (Appendix H for transcripts). Albeit the data gathered from the focus groups was interesting and insightful, unfortunately it was probably too short and concise for a thorough qualitative analysis (further discussed in the ‘Discussion’ section of the report).

However to help the analysis and communication of the results, qualitative analysis methods were still performed. The abridged transcript themes and categories were identified using the long-table approach (Krueger & Casey, 2000) and the guidelines for coding qualitative data were employed (Robson, 1993 adapted from Strauss, 1987). The same four questions designed to facilitate discussion formed the main categories for analysis. Although, some responses and statements generated from earlier discussion questions also supported later questions. Therefore these statements were rearranged and placed under the appropriate categories/questions. The process of arranging participants’ answers from each focus group under particular categories was constantly being clarified and refined. When all responses were identified and categorised a descriptive summary was written.

The small-scale 5-point Likert-rating questionnaire attitude survey was conducted to test whether a 3D visualisation will be significantly more effective than a
traditionally 2D approach and a separate analysis was performed on each part of the questionnaire:

- Part 1: D.V. (dependent variable) being the participant scores and the I.V. (independent variable) being the systems (2D/3D). Using a two-condition (2D/3D), related design, the Wilcoxon Signed-Rank Test was selected for statistical analysis (Greene & D’Oliveira, 1982).

- Part 2: An illustrative form of presentation employed to establish user attitudes towards the extra real-time 3D features offered (Bell, 1999).

### 4.7 Opportunity Sample Group

One participant, from the first focus group who was also an RAF PTI (Royal Air Force Physical Training Instructor), invited the researcher to RAF St Athan to demonstrate the 3D visualisation training solution to a number of experienced coaches and athletes:

- RAF PTI and UEFA (Union of European Football Associations) Class Coach (Football).
- Army PTI, WRFU (Welsh Rugby Football Union) Coach and Physiotherapist (Rugby Union).
- Bridgend District Coach and RAF Rugby Coach (Rugby Union).
- Combine Services Rugby Coach (Rugby Union).
- Semi-pro rugby and ex-Leeds Rhinos player (Rugby Union and League).
- International Athlete (Running).
• RAF PTI with the following coaching qualifications; basic rugby, FA (Football Association) football, BCU (British Canoe Union) Canoeing and SPA (Single Pitch Award) Climbing.

The researcher did not anticipate this type of experienced group until it became available via this particular participant from the original focus group, but this enabled an informal focus group to be formed. However, this group did not perform under the same experimental conditions and procedures as the original focus groups, since the members did not satisfy the screening process for intended participants, thus affecting the reliability and validity of the data. Invited as a guest, the researcher adopted an informal approach to gain an insight into whether a 3D Visualisation training solution would be effective in the professional sport-coaching field. Whilst this focus group was performed in a similar way as the experimental focus groups, the session was not audio recorded. Instead the researcher wrote a general memory-based summary of the group’s attitudes and opinions directly after the discussion. Although this form of data collection has considerable potential for error, nonetheless this opportunity was not designed for analysis, but to obtain general feedback and reactions from professionals in the sport industry. (Summarised later).
Chapter 5: Results and Discussion

5.1 Results

5.1.1 Focus Group Results

The variety of experiences held by the participants of the focus groups produced a number of interesting responses and statements. What follows is a short and to the point summary, that attempts to give a broad analysis of the responses. This section is not intended to produce an exhaustive explanation; detailed responses can be viewed from the abridged transcripts (Appendix H). Despite the differences in two group discussions, many consistencies were found (see summary below).

Question 1. What are your first impressions?

The responses to this question were similar between both groups. Both groups demonstrated enthusiasm at the start with such verbal communications like;

Group A: “Brilliant”

Group B: “Fantastic” and “I think you are onto a real winner”

Both groups then became interested and inquisitive about the technology by asking questions and suggesting possible enhancements.

Group A: “You set-up plays on the pitch, what about grids? This tool could be useful for coaches learning their drills.”

Group B: “…it depends how much you are going to develop it really. You can also turn it around and say how we defend against this, and therefore we have a defensive program…”

Although the groups showed interest, it by no means suggests that the 3D-visualisation tool is the ultimate teaching tool.
Question 2. What did you like best about this form of 3D Visualisation?

Group A; liked the fact the 3D visualisation was more realistic in appearance and set-plays were brought to life. Another interesting point that was suggested by a participant was that the more you watch it, the more confidence in your ability to perform the task is developed. Group B, again formulated similar statements, however they provided supplementary meaningful responses;

“People can really relate to it…especially the clubhouse, club colours…and they are focused on it.” and “Far easier for non-technical players to visualize their own position, their character. They can’t avoid it…whereas dots mean nothing to them.”

Group B, started comparing and combining features of the 2D and 3D visualisation – those comments were moved to Question 4.

Question 3. What did you like least about this form of 3D Visualisation?

Question 3 generated very few responses and not too much discussion, both groups thought an opposition would be good, that would enhance in the learning experience.

“Concept of the move is clearly understood from that. But the idea of the defensive backs there as well will emphasise what the move is trying to achieve.”

Question 4. Which of the methods did you like best?

The two groups recognised the potential of the 2D and 3D methods as a coaching tool, however after careful consideration both groups believed the 3D method to be the best. Nonetheless, they acknowledged that the plan/overhead view for both
methods along with the diagrammatic features of the 2D method was the most effective characteristics for explaining and understanding the basic concepts. Their choice for 3D was substantiated by the fact that they were able to actually visualise the set-play, thus enhancing their overall comprehension. They also recognised that different players might prefer other views than the plan/overview and that the 2D diagrammatic features could easily be adapted on the 3D version.

Group A: “Show this move in 2D, then straight away in 3D...2D shows it clearly...then in 3D, you can see the ‘dummy’, ‘dummy’, pass...it gives you a total package.” Group B: “…you could use the 3D overhead view, but add player numbers and running angles need to be included. You can take the running angles away when you change view, but you need to clearly show running angles.”

5.1.2 Questionnaire Results

5.1.2.1 Part 1

Statistical data and calculation can be viewed in Appendix J (Data Recording Sheet). A test of difference was used since the experiment was to establish whether there was a significant difference between the self-report attitudes between the 2D condition and the 3D condition. Therefore, a two-condition, related design was used and the Wilcoxon signed-rank test was selected to statistically analyse the data. Since the calculated value of \( T \) was found to be less than the critical value, the results can be accepted as significant: \( N=9; T=4; \) Critical Value=6 with a significance value of \( p<0.025 \) (2.5%). Therefore, the one-tailed hypothesis is accepted and null hypothesis rejected.
Table 2. Showing participant total scores in the 2D condition and the 3D condition.

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Total Raw Scores</th>
<th>Participant Number</th>
<th>Total Raw Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>1</td>
<td>24</td>
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<td>2</td>
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</tr>
<tr>
<td>11</td>
<td>25</td>
<td>11</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 3. Showing mean scores of both conditions.

<table>
<thead>
<tr>
<th></th>
<th>2D Condition</th>
<th>3D Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>228</td>
<td>261</td>
</tr>
<tr>
<td>Mean</td>
<td>20.72</td>
<td>23.73</td>
</tr>
</tbody>
</table>

Table 4. Summary of results from statistical calculations.

<table>
<thead>
<tr>
<th>Number of subjects (excluding ties)</th>
<th>Observed Value of T</th>
<th>Critical Value</th>
<th>Significance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>9</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>
5.1.2.1 Part 2

A detailed breakdown of the responses from these three statements comparing the extra features of a 3D learning style can be seen in tabular form in Appendix K. Figure 5 that illustrate the results, gathered from these three statements;

![Chart](image_url)

Figure 5. Percentage of Altitudes towards key features of the 3D visualisation

From the eleven participants 82% (9 participants) strongly agreed that they could visualise the set-plays more clearly through the 3D real-life scenario, in which 54% (6 participants) strongly agreed that the different camera angles helped to gain a better understanding of the set-plays. Only 9% (one participant) was undecided whether the different cameras improved their understanding. Again 9% (1 participant) of the group felt that they could not learn the set-plays more effectively through the 3D real-life scenario, whereas 73% (8 participants) believed that their learning would be enhanced.
5.1.3 Opportunity Sample Group Summary

The group were initially impressed with the concept of real-time 3D visualisation as a coaching tool, although felt that the prototype was exceptionally basic for use in a professional game (understandable given the development time scale and the original design focus for 2\textsuperscript{nd} and 3\textsuperscript{rd} team players of a local rugby club). However, they were particularly interested in the technology and could recognise the possible potential, (verified by the in-depth discussion of possible enhancements that could be made to achieve a suitable product that they would all benefit from). One suggestion made was that a defensive line was required, which has undeniably been a frequent statement from all focus groups. They all unquestionably decided that the concept of a 3D-visualisation solution enhances the effectiveness in coaching, opposed to a 2D method. The other significant point to come out of the discussion was that everyone mutually agreed that this type of coaching tool would generally be further effective used in a classroom scenario by means of CAI (Computer-Aided instruction) opposed to a players personal CBT (Computer-Based Training) experience.

5.2 Discussion

The general consensus of opinion gained from the focus groups was that the 3D visualisation could be used as an effective training tool and was indeed preferred to the 2D version. The dynamics of the group environment led to several interesting points surfacing from their discussions. There appeared to be a general excitement and enthusiasm towards the 3D visualisation aid which further reinforced the researchers belief that motivational features are influential in capturing the learners interest: key elements in a learning environment. Whilst both groups believed that
the overhead view (similar to the 2D plan view) was the most effective view, the 3D version was preferred. This was because they believed that it would allow players to relate and transfer their experiences to the various scenarios viewed. One participant suggested that by visualising tactics/strategies in such a ‘real-life’ way could help in building and shaping players confidence to go out and perform. It could be suggested that the 3D visualisation offers enhanced communication processes as a result of players’ own perception and sense of presence, thus supporting a possible relationship between the VR and diagrammatic reasoning as expressed by Brna, Cox & Good (2001).

Some participants’ highlighted a potential weakness of the 3D visualisation by suggesting that although the 3D visualisation appeared to demonstrate tactics, the animation itself appeared to occasionally distract from explaining the key categories (i.e. timing, purpose, positioning, line of run, pace, cover and alternatives techniques). This offers support for the negative effects of animations in the learning environment as asserted by Morrison and Tversky (2000) that too much information may be available simultaneously and that the essence of the information given may be lost. However, the groups offered their own solution to this problem: the combination of the key diagrammatic features from the 2D example with the 3D visualisation (i.e. path runs and player numbers). In addition, they also all agreed that in order to fully appreciate the tactical concepts it would be necessary to add defensive players to the visualisation.
It is suggested therefore, that as 3D attempts to demonstrate a realistic visualisation of the tactic, it is also worth remembering the value of both types of 2D/3D as a teaching/learning tool that could be used in combination.

Another area of potential future research that was brought to the researchers’ attention by the ‘opportunity sample group’ concerned the style of delivering the information. They believed that CAI approach in which the information is displayed should be similar to a classroom scenario as opposed to the players’ self-exploratory CBT approach. This again, obviously warrants further investigation in the future.

When evaluating the questionnaire results’ it appeared that the focus groups on the whole recognised the possible value and success of the principles of the 3D concept. The research hypothesis predicted a significant deference between the participants rated attitude score in Condition 1 (2D) and Condition 2 (3D). The one-tailed hypothesis predicted that there would be a higher attitude score in Condition 2. Table 3, demonstrates higher mean scores in the 3D condition, and the Wilcoxon test confirms the difference between the two conditions to be sufficient: N=9; T=4; Critical Value=6 with a significance value of p<0.025 (2.5%). The null hypothesis suggested that no differences would be found between the attitudes of 2D and 3D and therefore can be rejected.

Even though many interesting points came to light within the research process, there were also problems highlighted that related to sampling, internal validity, time and environment constraints. Although the sample size was representative of the targeted audience it was limited in size so makes overall generalisation difficult. A larger
sample of rugby clubs’ would have increased the overall validity of the attitudes offered: ‘space triangulation’ (Bell, 1999). It was hoped that the groups’ compositions (coaches/experience players) would create a sufficient environment to allow for a contrast in opinions. However, it was found that the team coaches were the most dominant characters and may have had an influence on limiting the amount of qualitative data gathered. A future possibility for enhancing the group composition and dynamics would be to separate the coaches and experienced players into separate focus groups. However, upon reflection, this problem might have occurred as a result of the researchers’ own limited knowledge and experience of conducting qualitative research of this type. It’s possible that the original group composition may have been adequate for an experienced moderator who could have controlled more adequately to accommodate both the dominant and the shy/reflective participants more effectively (Krueger & Casey, 2000). However, in retrospect the researcher should have realised his inexperience as a moderator. It might have been beneficial to develop a series of ranking exercises for the participants to perform. This would have the effect of leading to further topical discussions that may have produced adequate data for qualitative analysis (Morgan, 1999, and Krueger & Casey, 2000).

In terms of the questionnaire, it would have been pertinent to conduct a pilot study of the questionnaire for the purposes of item analysis, thus improving the quality and reliability of the questions. In addition to avoid ‘mental set’ responses, an equal number of negatively and positively expressed cognitive, affective and behaviour statement will be used (Robson, 1993).
In conclusion, although there were problems and errors with sampling, internal validity, reliability, time and environmental constraints, all of these can be improved upon. The qualitative comments from participants revealed several areas, which could prove interesting for continued future research in this area. Modifications to the 3D prototype are required to reflect a more suitable learning tool and the methods of delivering this information to amateur or professional players requires further investigation.
Chapter 6: Project Critical

6.1 Evaluation of Project

The project on the whole was incredibly ambitious and was completed effectively within the timescale through efficient project management techniques (Vaughan, 1996, England & Finney, 1999). One effective project management feature that was established and functioned especially well, was the progress development website. This was set-up to facilitate the distance communication between the researcher based/working full-time in Bristol and the Project Advisor at the University of Gloucestershire (Cheltenham). The website was regularly updated with sufficient prototype development progress reports that provided the project advisor with an insight into the processes. Most importantly it kept the advisor updated with the project progress.

The original purpose of the project was to evaluate the effectiveness of 3D virtual training aid as opposed to the traditional 2D version, by examining the response of the user when he/she are given the freedom to view the content in a dynamic 3D environment. However, as previously discussed, it soon became apparent that these objectives were impossible to achieve within the timescale and resources available. As a consequence the researcher changed research direction: from an explanatory to an exploratory approach with the aim of evaluating and assessing team sports persons opinions and reactions regarding whether a team sport 3D visualization solution would be effective. Apart from this all-original project objectives have been achieved in this project (Appendix L for original proposal).
6.2 Evaluation of Research Process

Preliminary literature reviews, specifically into 3D visualisation within sport coaching proved difficult suggesting that there has not been a great deal academic research into this topic. Therefore a broader literature review around the topic was performed. This produced a vast amount of books, journals and Internet sites of which offered the researcher a greater appreciation and understanding of sports biomechanics, visualisation, coaching and analysis, along with real-time 3D as an active-participating learning experience. Although, theoretical support added to, and was inspirational for the accomplishment of this project, time limitations meant that the review of literature was performed alongside the prototype development. At times this meant that the value of the information of these theories that could have contributed to the prototype development were not implemented. If this project were to be replicated in the future, this very basic prototype would be improved by the application of these theories.

In retrospect, with the time constraint of the research project the method adopted was appropriate, however there were flaws in the design experienced throughout the study that have been highlighted in the ‘Discussion’ section. If the study were replicated in the future then these enhancements would be taken into consideration, further improving the design and ensuring more reliable validity data for qualitative analysis.
6.3 Personal Evaluation

This has been a personally worthwhile project since it has united two great interests of the researcher: interactive real-time 3D and rugby. It is also promising in the suggestion that the technology proposed has the possibility for further development incorporating fresh and exciting ideas for eventual implementation as a coaching tool. Furthermore, it was a personally challenging and enjoyable learning experience both in technical and academic terms. Technically, previous knowledge and skills acquired through university modules and work experience required further enhancement. This was particularly noticeable with low-polygon character modelling and animation (relatively new concepts), whereby Maestri (1999), Kelly (1998) and Gauthier (2002) referenced material proved to be essential in learning these skills. A variety of problems occurred when exporting the 3D models and animations from 3D Studio Max into Virtools, this required problem solving skills to overcome these technical hitches. Although it was gratifying to solve these problems, in the end they did influence the prototype development progress. The initial plan was to develop ten 2D and 3D rugby set-plays, which in retrospect was possibly too ambitious. After cautiously evaluating the development progress at key stages within the project development time plan, it was reduced to four set-plays. Awareness of timescales and deadlines within the project made it possible to select and revise realistic targets throughout the research. One criticism would be that the development progress within the first semester was slow, due to other university module commitments. This resulted in the development progress taking longer than initially anticipated, resulting in the testing of the prototype commencing later. Therefore the report write-up was behind schedule. Perhaps the write-up could have been organised more
efficiently by starting sub-sections earlier, although in retrospect it’s difficult to foresee where this could have been performed.

The research project has been personally rewarding and successful in fulfilling the project aims. It would have been satisfactory to establish evidence for suggesting that a 3D Visualisation coaching tool improves a players understanding and ultimate performance via an experimental strategy. However this was impossible to achieve within the time frame. Perhaps if the researcher progresses with further studies in a Masters Degree this could then be performed.
Bibliography


Appendix A: Project Development Plan

Initial Plan
- Prototype Development
- Literature Collection
- Literature Review
- Plan Methodology
- Testing
- Analysis & Write up draft
- Final Edit

Actual Plan
- Prototype Development
- Literature Collection
- Literature Review
- Plan Methodology
- Testing
- Analysis & Write up draft
- Final Edit

Oct | Nov | Dec | Jan | Feb | Mar | Apr | May

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Appendix B: Project Record Meetings

The following section contains the records of meetings with my project advisor.
Appendix C: Sample Rugby Tactic Diagram

(After Greenwood, 1997)
Appendix D: Questionnaire Example

The following section contains a sample of the completed questionnaires.
Appendix E: Bristol Harlequins Tactics Blue Prints Diagrams

The following section contains a sample of the blue-print rugby tactic supplied by the

Bristol Harlequins Club coach and vice-captain.
Appendix F: Consent Sheet Examples

The following section contains a sample of the completed consent sheets.
Appendix G: Focus Group Procedure Flash/Cue Cards

Welcome
Handout ‘Consent Sheet’ for signing

Summary of Focus Group

Overview of the topic
To assess amateur sportspersons opinions and reactions concerning whether a sports 3D visualization software product is likely to be an effective training tool in enhancing the learning experience and ultimate performance of the amateur sports user.

Demo 2D Visualisation Training Tool

Plan:

PLAY 1  -  Basic Description
PLAY 2  -  Play back Controls
PLAY 2  -  Speed Controls
PLAY 3  -  Play

2D Rating Questionnaire

Handout Questionnaire:

Allow 5 minutes to answer,

Quickly review results

Ask any follow up questions on results.
Demo 3D Visualisation Training Tool

Plan:

PLAY 1  -  Basic Description + All Camera (NO FREE CAM)
PLAY 2  -  Fix, Scrum Half Cam, Plan + Play Controls
PLAY 3  -  Fix, Plan, Front, Rear + Speed Controls
PLAY 4  -  Fix, Plan, Fly Half Cam, Free Cam

3D Visualisation Training Tool Questions

Questions:

What are your first impressions?

What do you like the best about this form of 3D visualisation?

What do you like the least about this form of 3D visualisation?

3D Rating Questionnaire

Handout Questionnaire:

Allow 5 minutes to answer,

Quickly review results

Ask any follow up questions on results.
Compare Questions

Questions:

Which of the two methods did you like best?

Conclusion and Questions

Brief summary of focus groups results

Ask participants if they have any questions.
Appendix H: Group B Abridged Transcripts

The following is the abridged transcript for Focus Group B based from the recorded tape of the session. The moderator statements and actions will be presented in bold and italic. All comments will be single-spaced and double-spaced between speakers. The following icons will represent: ☺ laughter within the group and ☃ to indicate a group agreement on a statement. If some of the words are unintelligible, will be represented by three periods ( … ) .

What are your first impressions?

Fantastic.

I think you are onto a real winner

Where do we buy shares?

☺

Is it possible to add a defensive line?

胗

Can penalty moves be done as well?

All these things are possible but what about the general concept?

Concept of the move is clearly understood from that. But the idea of adding the defensive backs will emphasise what the move is trying to achieve.

Good for 2nd and 3rd team players for showing the standard moves…when at training a move is called to be played. Most players don't know where to be…this gives them an insight.
It depends how much you are going to develop it, are you just going to demonstrate what Trophy is, what a Carlsberg is, what we are going to run of a lineout or a scrum. It shows what you want to do. But it depends how much you are going to develop it really. You can also turn it around and say how we would defend against this. And therefore we will have a defensive program if you like. You can organise your defence against attacking situations like this. Like who would come in to cover the full-back, when would everyone step across, what would the blind side winger do. However it’s a fantastic idea.

I could watch this 20 times quite happily…looking at something different each time…what’s this player doing…and then this player…

What did you like the best about this form of 3D visualisation?

It’s better to see players and seeing the dummy than the circles in the 2D one.

People can relate to this. It’s a good thing to show the move. People can really relate to it…especially the clubhouse, club colours…and they are focused on it.

Being able to focus on a player.

The aerial view would be your most effective view.

Can you change the camera view to looking down, but still at an angle?

Yes, (camera angle changed to about 45° to the pitch)

Yes, that a good view, that’s the one.
I would use the aerial view the most.

For Attacking and defensive.

You can put in your attacking and defensive lines on this view.

**Is there any advantage of using the 3D aerial view than the 2D view?**

Yes,

Far more easier for non-technical players to visualize they're own position. Their character. They can't avoid it…whereas dots mean nothing to them.

Maybe a mixture of both.

People will use it in different ways. Some may prefer to watch it front on.

The aerial view is good, but need other views as well, you need as much as you can, you might not use it but at least its there.

**At what levels can this be used?**

I think this can be used at all levels.

Minis to Bath

For what happens on a Saturday afternoon to be converted into a 3D image…because the game especially at top level is about analysis and what went wrong and what we should have done. Its going to be easier for a coach to explain to his side that this is
what we actually did…through decision making but what we should have been doing is this.

Extra interaction for coaches to move players around would be required.

Maybe demonstrate different scenarios through players multiple decision making.

**Would you use this coaching solution if you had the facility?**

If it was me personally, I would yes. At whatever level the game is played at, it’s about analysis of how you play. The set patterns you set out to play…

You can save a lot of time by showing each player their position, angles to run, where to cover before going out and doing it.

**What did you like the least about this form of 3D visualisation?**

I’ll like to see defensive players included.

🔍

**Which of the methods did you like best?**

You got to keep all the options. Open play, free play, Ariel view, front on view…

So 3D is better than 2D?

Yes.

🔍
## Appendix J: Questionnaire Part 1 Data Recording Sheet

Table showing the participant scores and Wilcoxon Signed-Rank Test Calculations:

<table>
<thead>
<tr>
<th>Participant</th>
<th>2D Score</th>
<th>3D Score</th>
<th>Difference (d)</th>
<th>Rank of d</th>
<th>Rank +</th>
<th>Rank -</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>24</td>
<td>-7</td>
<td>7 ( - )</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>25</td>
<td>-2</td>
<td>4 ( - )</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>24</td>
<td>24</td>
<td>0</td>
<td>Omit Tie</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>23</td>
<td>22</td>
<td>1</td>
<td>2 ( + )</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>17</td>
<td>20</td>
<td>-3</td>
<td>5 ( - )</td>
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<td></td>
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<tr>
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<td>24</td>
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<td>2 ( - )</td>
<td>2</td>
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<tr>
<td>7</td>
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<td>23</td>
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<tr>
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<td>-10</td>
<td>9 ( - )</td>
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<tr>
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<tr>
<td>11</td>
<td>25</td>
<td>24</td>
<td>1</td>
<td>2 ( + )</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Total: 228 261 41

Mean: 20.73 23.73

‘d’ is the difference between participants 2D and 3D score.

The difference is then ‘ranked’ in order of magnitude from the smallest rank to the largest ignoring the plus and minus.

The ranks are then separated into ‘positive Rank’ and ‘negative rank’

The value of T is the smaller value out of the positive and negative ranks total.

N is the number of participants not including ties.

The level of significance for T was then looked up under a statistical table of ‘critical values of T at various levels of probability (Wilcoxon)’

P<0.025

*Greene & D’Oliveira, 1982*
Appendix K: Questionnaire Part 2 Results

Tables of results from Part 2 of the questionnaires:

I could learn the set-plays more effectively through the 3D real-life scenario.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Totals</th>
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<td>18.2%</td>
<td>18.2%</td>
<td>54.5%</td>
<td>100.0%</td>
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</table>

I could gain a better understanding of a specific tactic by being able to visualise the move from different camera angles.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Totals</th>
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<tr>
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<td>9.1%</td>
<td>36.4%</td>
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</tr>
</tbody>
</table>

I could visualise the set-plays more clearly through the 3D real-life scenario.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
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Appendix L: Project Proposal and Terms of Reference (TOR)