Towards the Development of an Interactive 3D Coach Training Serious Game

Christos Gatzidis
School of Design, Engineering & Computing
Bournemouth University
Poole, UK

Keith Parry
School of Services Management
Bournemouth University
Poole, UK

Emma Kavanagh
School of Services Management
Bournemouth University
Poole, UK

Amanda Wilding
School of Services Management
Bournemouth University
Poole, UK

Darrell Gibson
School of Design, Engineering & Computing
Bournemouth University
Poole, UK

***Abstract*- Today serious games, i.e. software applications developed with game technology and design principles for a primary purpose other than pure entertainment, include games used for educational, persuasive, pedagogical, political, or health and training purposes. This paper describes the work-in-progress development of an interactive 3D training application generated using components of the Unreal game engine that facilitate the learning of various fundamental coaching methods via the interactive completion of a variety of interrelated tasks. Apart from highlighting the contribution and innovation of this approach, a synopsis of the coach training content of the serious game and its purpose is also presented here, as well as an architecture overview of the implementation of the prototype application. Finally, future directions for the completion and evaluation of this serious game are also discussed.**

Keywords- serious games, game engine, game-based learning, coach training simulator

I. INTRODUCTION

While games have been used for purposes apart from entertainment for a long time, the modern serious games movement, now worth an estimated $200-$400 million in the US alone, is today characterised by the level of complexity and sophistication behind it.

This, combined with advancing technology in both software and hardware (and computer graphics in particular) and interest from academia in conducting research in this field opens up exciting new possibilities for prototypes addressing virtual/learning/education areas never tackled before by interactive virtual reality applications.

The area of education (which was one of the first explored by serious games, even before this term was introduced) is the one that still holds the greatest potential. According to Shaffer et al. [1] serious games tackling educational issues can constitute novel, more efficient ways of learning. For example, Jones [2] argues that the multi-sensory environments often offered by virtual gaming worlds can facilitate multiple learning styles such as visual, auditory and kinaesthetic. A subset of educational serious gaming focuses on training, where users/players need to acquire a specific competence or build up a particular set of skills. Serious games provide extensive opportunities for drill and practice. In these cases, the mastering of competence and skill is most commonly achieved through repetition (as argued by Mitchell et al. [3]). This repetition can often be attempted simply because the virtual environments of serious games allow designers and educational instructors to create learning activities which could be too expensive, critical, dangerous or simply impractical to recreate physically. In this way, serious games enable new opportunities for learning that, because of their virtual reality nature, could not really be attempted in the real world.

Examples include the work by Bell et al. [4], who developed a series of virtual reality-based laboratory critical accident simulations, designed to focus on the objective of users following proper lab safety procedures. The work mainly attempts to

reinforce users remembering the experience of suffering a very hazardous lab accident longer and more vividly via virtual reality, than by a set of mundane lab safety rules, and thus conducting themselves in a safer manner in the real world.

Figure 1. Bell et al.'s simulation scenario showcasing the dangers of improper storage of material and end effect [4]

Also, another training serious game that falls under one of the categories described in the previous paragraph is Serious Gordon, an educational game created to teach kitchen food safety to workers in industries dealing with food, by Mac Namee et al. [5]. The game serves as a realistic simulation of a restaurant environment in which the player assumes the role of a kitchen porter arriving for his/her first day at work. During the game the player is given a number of different tasks to complete, each of which relates back to a list of nine induction skills such as obeying food safety signs, keeping work areas clean, demonstrating safe food handling practices and others. Activities include choosing the correct uniform for a particular job from a selection of different options, correctly moving deliveries from a truck outside the restaurant to the kitchen's various store rooms and even dealing with workplace disasters such as injury and sickness. Finally, Bouchard et al. [6] conducted a study with 11 participants with the goal of assessing the effectiveness of in virtuo exposure in the treatment of arachnophobia using a modified version of the Source (used for Half Life 2) engine. The serious game produced attempted to offer gradual hierarchies of fearful stimuli of the phobia in question, that of spiders, thus training subjects to the presence of the insect without actually exposing them to the spiders which could be potentially hazardous for their mental and physical state.

Physical activity (extending into fitness) is an area that has been covered by some specialized software applications. One of the first attempts in 1991 by Konami's Dance Dance Revolution [7] (originally released in Japan in 1991 as an arcade game, has now evolved past that to other more modern console platforms), showcases mixing physical activity with game play mechanics. For the purposes of this a special input controller consisting of a dance pad was used, with four panels: up, down, left, and right, arranged around where the player stands. In 2003, Sony released the EyeToy [8], a digital camera device for the PlayStation 2 console allowing user-interaction with specially designed games utilizing movements of the body, including head, arms, hands and leg motion. The concept of the EyeToy has found many imitators, the most famous one today being WiiFit [9].

Most importantly however, in 2005, responDESIGN released Yourself!Fitness [10] for the XBox, PC, and PlayStation 2, considered to this day the pinnacle application in this field. Designed to surpass fitness videos and also self-help books, Yourself!Fitness billed itself as "the first game title created solely to improve the health and fitness of the user."

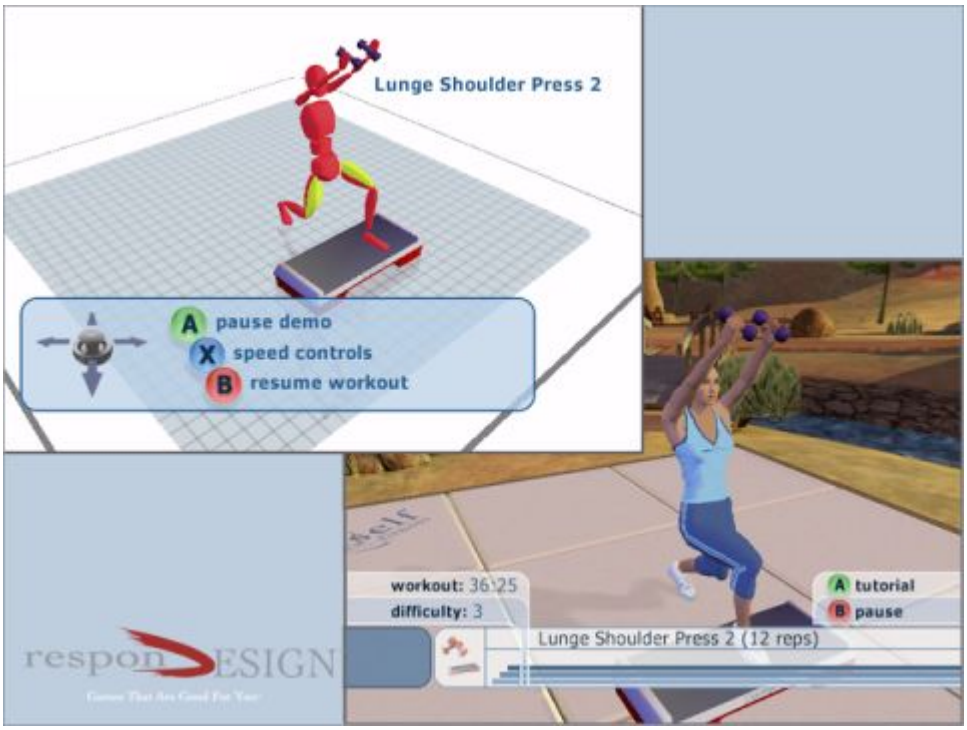

Figure 2. Typical Yourself!Fitness fitness activity [10]

Having information provided by the player, the application is then capable of generating a personalized fitness program including a virtual personal trainer called Maya who coaches the player through the various training sessions. Yourself! Fitness incorporates yoga, Pilates, cardio fitness, strength training, flexibility exercises and targeted weight loss routines amongst other activities. Finally, the application can also integrate training equipment that the user might have.

So, while there is a relative wealth of software training packages which offer ready to use coaching drills and templates (some described above), there are however no games that allow coaches themselves to practice their coaching in a simulated 3D environment. Commercially available computer games can focus on management of teams or playing a sport but there is a clear gap in the market for an educational tool addressing coaching issues for professionals trained in that field.

II. SCOPE OF THE SERIOUS GAME

"By 2012 the practice of coaching in the UK will be elevated to a profession acknowledged as central to the development of sport and the fulfilment of individual potential" [11]. The coaching simulation game proposed in this paper attempts to incorporate the fundamental elements of the coaching process into a comprehensive package, which enables trainee coaches to practice their skills in a controlled 'virtual' environment.

Sports coaching is a form of sports leadership in which identified objectives are pursued in a purposeful manner. The role of the coach is to manage the process of the athletes' learning towards improved performances; coaches are required to identify errors and then to intervene to correct the faults [12]. This process typically operates within a specific set of external constraints, which the coach must manage.

As identified by Crisfield [13], a major part of becoming an effective coach is experience and research has concluded that it takes between eight and twelve years of training to reach elite levels. This level of commitment is referred to as the ten-year or 10,000 hour rule and equates to over three hours of practice daily for ten years [14].

In the case of a novice coach who may be engaging in coaching for three hours per week it will take almost 100 years to become an expert coach. According to Fitts and Posner's model [15], novice coaches are likely to be in the associative stage of learning where practice is required to perfect the skills which they have been taught and to develop their learning [16]. However, there are issues with allowing novice coaches to practice with "live" participants (usually children). In an age where liability and litigation are becoming more common, allowing an inexperienced coach to work in this environment can be perilous.

Therefore, an interactive sports coaching game will allow novice coaches to gain valuable experience in a safe yet realistic environment. Coaches will be required to engage in whole practice, developing their decision making skills and improving as a sports coach [16]. Lyle [17] identifies the importance of decision making for a sports coach and a decision-based game will develop this vital skill. The serious game currently in development will further give novice coaches the opportunity to engage in coaching practice at times when real-life participants may not be available and to enable them to develop into expert sports coaches at a faster rate.

Sports coaching is a cyclical process that involves planning, preparation, performance, observation, analysis and interpretation, after which the process is repeated as identified by Williams et al. [18]. Reflection is a significant part of the coaching process and allows sports coaches to take ownership for their decision making and learning [19]. This game will also allow coaches to reflect on the decisions that they have made and to see the direct and indirect consequences. The virtual coaching environment proposed will not only allow the results to be seen more quickly than in real life, but will also remove the risk associated with making poor or wrong decisions. This game will enable all aspects of the coaching process to be practiced in a safe environment and will allow coaches to experiment for example with styles, decisions and methods and to see how each of these are affected by the learning needs and development of the athletes which they are working with.

The coaching game aims to cover a training year in its entirety with the planning and sequencing of training following the principles of periodisation. This will enable the coach to see how each individual coaching session fits into the long-term plan of an athlete's training schedule. Periodisation can be defined as 'the purposeful variation of a training programme over time, so that the competitor will approach his/her optimal adaptive potential just prior to an important event' [20]. This concept in the development and division of training is recognised as one of the most important concepts in training and planning [21]. At its most basic order, this coaching game will have five levels in line with periodisation theory, which will be based upon a yearly plan and will incorporate macro, meso and micro cycles, individual coaching sessions and training units [21]. The breakdown of the annual training year into cycles allows users to have control over the game, making it easier to plan and manage the training programme and ensure that their athletes can achieve peak performance throughout a competitive cycle. This fundamental skill will allow the game users to create a visual representation of the training year, which plans the athletes' development from macro to micro cycle level.

The macro cycle represents a single competitive season and will be the length of an annual training programme. It can be further broken down into preparation, competition and transition periods [20]. The coach will further divide the training periods into meso cycles, which should each have one primary purpose such as a pre-season general preparation meso cycle to develop a solid aerobic fitness base. The micro cycle is the key building block and will represent the weekly coaching schedule.

The 3D training application of the game will take place at the individual coaching session level. Each element of a session can be subdivided as a training unit such as the warm up or a specific drill. The proposed prototype simulator will replicate a non-sports specific (multi-skills) coaching session aimed at children aged between 8 and 12 years in the Learning to Train Stage of the Long Term Athlete Development (LTAD) model (as described by Balyi and Hamilton [14]). The session will be conducted in a sports hall environment and will contain 6 training units each focused on a different element of multi-skills:

1. *Dynamic Warm-up and Stretch*: This element is to prepare the body and mind optimally for the activities they will perform within the main session. It will combine pulse raising activities and dynamic stretches. Users will need to ensure that the protocol adheres to academic guidelines for a warm-up whilst ensuring correct technique and execution by the participant.

2. *Fun Warm-up Game, Domes and Dishes*: To further warm the muscles in a controlled manner and incorporate an element of fun and play into the warm up. The user will divide the participants into 2 groups. A designated area will contain a number of cones some face up (dishes) some face down (domes). Half the group will try to turn all of the cones to domes and vice versa. The user will need to control the group and set the coaching parameters to ensure that this is a safe and controlled practice.

3. *Fast Foot Ladder Activity*: Ladders can be used to develop both agility and explosive fast feet which are essential for sports performance. Participants cover the length of the ladder initially placing one foot in each ladder space. The game user will need to be aware of correct technique, for example maintaining an upright posture and also be able to identify how to progress the intensity and complexity of the activity. A suitable progression may be to move to participants moving sideways along the ladder stepping into and out of each ladder space.

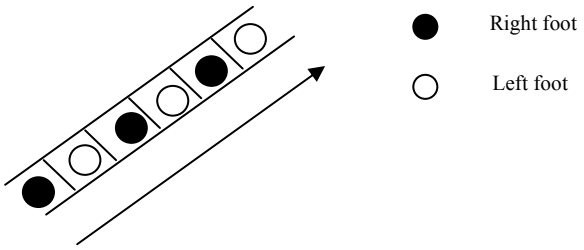

Figure 3. Initial Ladder Drill

4. *Balance and Co-ordination*: This would firstly incorporate participants standing on agility discs (inflatable rubber discs) in order to develop proprioceptive skills and core strength. The user will supervise this activity ensuring safe and effective use of equipment and suitable progression once the initial skill has been mastered. Progression may include more advanced skills on the agility disc or progression to a fit ball (a large inflatable ball).

5. *Hand-eye Reaction using Visual Acuity Ring*: To develop visual skills and accurate catching skills using a Visual Acuity Ring (plastic ring with different coloured balls attached to it). The user will supervise small groups of participants throwing and catching the ring watching for correct technique and inputting key teaching points.

6. *Cool-down*: A cool-down is essential to bring the body back to a resting state after physical activity promoting recovery and reducing the risk of injury. The cool-down will include activity to reduce heart rate and will incorporate static developmental stretching. It is vital for the user to ensure correct technique during static stretching and that stretches are maintained in line with the guidelines for developmental stretching.

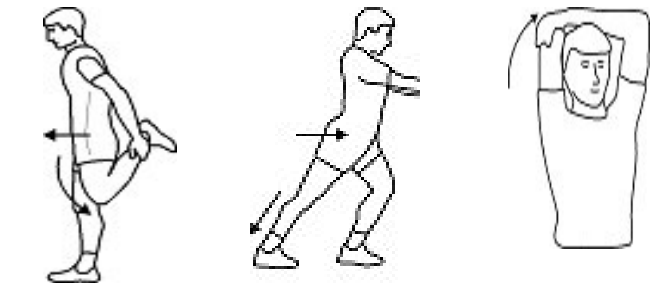

Figure 4. Exemplar Static Stretches for use within the Cool-down.

At this level the user will experience simulations of training units which reflect the coaching environment which they are likely to be working in. They will be required to plan, make decisions based on good practice and evaluate technique whilst ensuring a safe and effective coaching environment. Finally, users will be required to reflect on their sessions.

III. METHODOLOGY & ARCHITECTURE OVERVIEW

The 3D game engine that is used for the currently ongoing implementation of this research is Unreal Tournament 3 [22], a currently popular 3D first-person-shooter (usually referred to as FPS) engine. It was decided not to develop a visualization/game engine from scratch for the purposes of this project as the reusability and modding capabilities of already existing ones would

facilitate rapid development of the serious game and impressive visual results while at the same time allowing the team to concentrate on the game design issues rather than on technology-specific obstacles.

This particular game engine was chosen because it encompasses easily accessible built-in features allowing for modifications to it while retaining high quality visualization results, provided by its developer, Epic Games. The built-in features allow for producing very realistic virtual environments and also programming various parameters on top of those (by directly accessing the Unreal Tournament's SDK), particularly UnrealEd and UnrealScript, the level-editor and scripting language of the game engine respectively.

Moreover, Autodesk's 3D Studio Max [23] is also used for modeling 3D content that is to be imported in the engine, ranging from parts of the virtual 3D sports hall to character models of the athletes and coach.

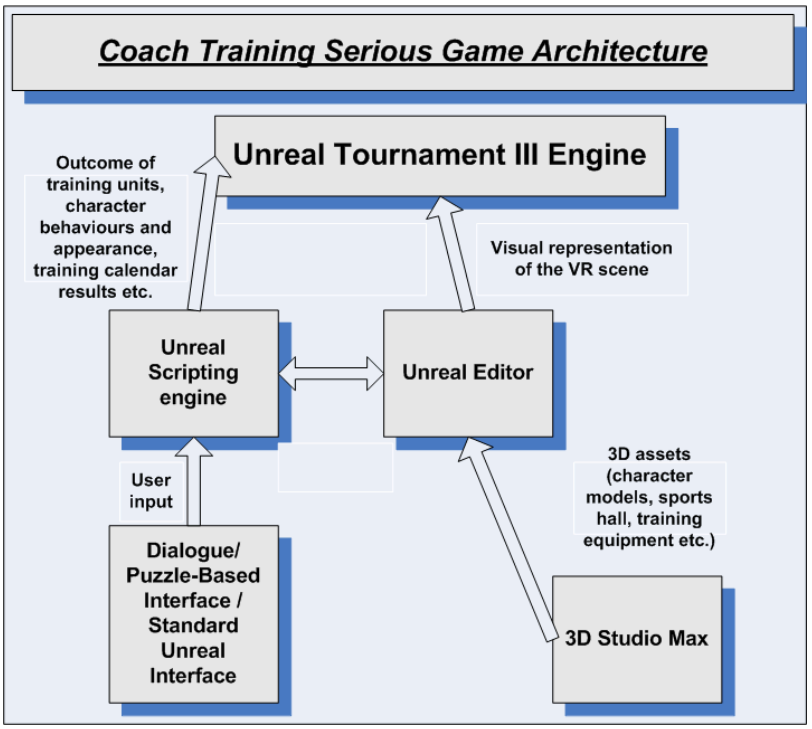

Figure 5. System diagram for coach training serious game

Both UnrealEd and UnrealScript are proving to be extremely useful tools, for accommodating the 6 training exercises, set within a calendar context. Some issues are of course arising, including the fact that model and texture assets pre-packaged with UnrealEd are too industrial (which is understandable because of the nature of the Unreal Tournament game) for use in a sports simulator. This is rectified with the development of an original range of custom textures and 3D models.

Figure 6. The virtual sports hall imported in Unreal Ed for the purpose of the training game

This has also lead to considerations for developing (using UnrealScript this time) a dedicated script to customize the visual appearance of the sports hall (different wall/floor/ceiling textures, lighting conditions, equipment of varying appearance and size) and the athletes (height, physical build, appearance, clothing) so that the training (and subsequently learning) experience could be diversified and also set under different conditions, should that be deemed necessary.

Another major issue is the fact that the hypothesize->test->revise cycle to be used throughout the bulk of the game and the 6 training units pushes UnrealScript to its limits. For example, some of the training exercises require puzzle-based interaction (i.e. picking the correct sequence of tasks in a pop-up dialogue-box during 1. Warm-up or 6. Cool-down), which meant that the interface system of Unreal has to be changed to accommodate crucial additions like that (not often found in FPS 3D games).

IV. CONCLUSION AND FUTURE WORK

This publication presents the need and also the underlying theoretical concept, as well as the first few steps towards its development, behind the production of a 3D virtual coaching simulator. The six training units described in Section II are in the process of being implemented. Together they constitute an engaging learning experience that could help coaches build their skills in an innovative manner using serious game/ modding technology that hasn't been associated before with coach training.

Following completion of the 6 training units and their placement in a calendar context (as described previously), we aim to evaluate the game from a pedagogical and a technical perspective using focus groups of Bournemouth University students, already studying coaching with traditional methods. The results will feed back into the second cycle of development of the coach training serious game in order to improve the overall learning experience even further.

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