**Augmented Reality Snooker Training Aid: Start-Up Scoping Report**

***Executive Summary***

The following report outlines a start-up opportunity for a new, premium training tool for cue sports, such as pool, snooker, and billiards. Utilising Mixed Reality (MR) technologies, we aim to produce and provide a new system for wearable Head Mounted Display (HMD), such as the Microsoft HoloLens, to reduce the time taken for beginner and amateur cue sports players to improve their game skills, such as hitting, potting, or positioning game balls. The system is targeted towards individuals with a high disposable income who will be able to buy it either directly or through an affiliated distributor, as well as selling our system to existing pool and snooker halls to expand upon their current equipment.   
For this system, a bespoke software solution has begun development but needs finalising and additional user testing. This will include staged agile development, interim user testing, quality assurance, and finally a final product release. We aim to secure a capital investment which will allow us to continue system development, before marketing and launching the system initially in the UK market, with plans to expand into the Chinese market in the near future. A partnership with an HMD manufacturer, such as Microsoft, would also be beneficial to reduce the product cost and overhead of the physical hardware our system is based upon.

***Evaluation of Potential Opportunity***

Although having a low entry curve to the sport, with many people playing casually in a pub or dedicated pool hall, cue sports can be one of the most challenging and time-consuming sports to improve upon and succeed at. Training often requires countless hours of individual work in order to improve and become consistent at. There are many aspects to the game which require training, as indicated by my interview with the previous president of the University of Bristol Pool and Snooker Cub (UoBPSC) (see Appendix A), such as potting, cue ball positioning, break building, and complex/spin shots. Individually, these skills require a huge time commitment to improve upon, and this is before playing any games against people which is vital for skill development(PRO\_SNOOK\_BLOG). However, the backbone of the sport, and most important skill to develop is hitting and potting balls accurately(Appendix A, Q4).

In terms of actually developing said skills, there are currently only a few options at present. First you can perform potting and technique training drills(CUE-DRILLS), but this method provides no real feedback on what you are doing incorrectly. Secondly, you can pay for a professional coach who will give form and technique feedback, but will still require many hours outside of these sessions to improve and develop, not to mention being expensive – up to £120 per hour in some cases(TERY-1TO1). Additionally, many hours of game time will also be required in order to combine these skills correctly and effectively.

New and amateur players tend to struggle most with consistently hitting and potting balls, as this takes a lot of time to develop due to their lack of experience. Through the training methods described above, a lot of repetition and trial-and-error is needed in order to improve and maintain this skill, even for somewhat competent players. With accuracy being the most important skill for a pool or snooker player to have, being able to develop this as quickly as possible will allow players to succeed in matches and improve the other aspects of their game much quicker and more easily. Therefore, this demographic is likely to see the most benefit from using our product, compared to semi-professional or even professional players who would already have good, consistent accuracy and would train in other areas of the game, such as cue-ball positioning or spin shots.

Due to the high price of the HMDs the system uses, our target demographic within new, amateur and frequent players should be focused people with a high disposable income, who may potentially have a private snooker/pool table or room. However, as mixed reality headset technology improves and competition between companies increases, we should see a decrease in headset cost. Already, we can see competition emerging between companies such as Microsoft, Google, Epson, all of which have released their own mixed reality head mounted display(SLANT). With reduced cost and wider availability we will be able to widen our target demographic to people with less disposable income.

Additionally, existing high-end snooker or pool halls where the clientele will expect the newest and best equipment, such as the Northern Snooker Centre in Leeds(NORTHERN-SNOOK-CENTRE), could be a valuable extension of our client base. Targeting such establishments would increase brand and product exposure within their client base for free, as well as allowing consumers to try the product before they buy it, reducing the chance for unhappy customers and returns.

With cue sports becoming as popular as ever, it is vital that action is taken now in order to succeed with this opportunity. Snooker especially is beginning to regain the national popularity that it had back in the 1980s, with over 25% (17.1 million)(WST.TV) of the UK population (66.8 million)(OFFICE-NAT-STATS) having watched the 2020 World Snooker Championship Final; up from 11.8 million in 2019(WST.TV). Additionally, over recent years snooker has soared in popularity in China, largely down to government aid and the recent successes of professional players such as Li Hang, Marco Fu, and Ding Junhui(SHOCKPEDIA)(UNITED-LANGUAGE-GROUP). With the majority of amateur players in China being white-collar workers between ages 16-35(SHOCKPEDIA), entering into the Chinese market would undoubtably see an increase in demand for our system as this perfectly fits with our target audience. Furthermore, there have been recent attempts by the World Confederation of Billiards to have snooker included in the sports played at the Olympic games(BBC-SPORT-OLYMPIC), with hope that a 2028 bid will be successful, again showing that snooker especially is regaining popularity world-wide.

When it comes to the technology the system will use, the Mixed Reality (MR) market is set to be one of the fastest growing over the next five years, with the market valued at $553 million in 2020 and set to rise to over $5.81 billion by 2026. The gaming and entertainment sectors are set to be the major driving force behind the MR market’s growth(MORDOR-MR), so entering into this MR market sector would allow us to contribute and benefit greatly from the market’s success. Looking at similar technologies, the Virtual Reality (VR) market was valued at $17.25 billion in 2020 and set to rise to over $184.66 billion by 2026(MORDOR-VR). A big driving force of the VR market growth has similarly come from the gaming and entertainment sector, meaning there is proven success and large growth within an alike market and sector to the one we will be entering.

Additionally, approximately 2.25 million gaming enthusiasts currently have their own VR equipment(STEAM)(STATISTA). With MR seeming set to follow a similar trend as VR in the coming years, we can see that consumers are willing to pay for new emerging technologies despite their high price tag. Acting now and establishing a brand at the start of the new technological trend will allow us to succeed and be most profitable, cementing our need to act now.

***Value Proposition***

A - Our idea for a new innovative training tool for amateur cue sports players is to overlay helpful graphics onto the table that the player is using. Said graphics would be aiming lines to help increase accuracy in hitting target balls and potting them (such as in Figure 1(Appendix C)), useful session statistics such as pots made(Appendix A, Q6), a ‘snapshot’ function allowing players to easily reset the ball positions exactly to practice the same shot consistently(Appendix A, Q6), as well as indicators to suggest the next best ball to play in a game situation. In combination, these features will help improve and maintain a player’s accuracy in a more interactive and effective manner than traditional training techniques.

B -

C - We can be sure our product will improve a user’s long-term accuracy quicker than existing solutions for several reasons. Firstly, and most importantly, the user will most likely be using the device whilst performing standard training drills we talked about earlier. This means that at the very least, they will be gaining as much as they would be if they didn’t train using our headset. Secondly, due to the real-time feedback and accuracy assistance out product provides, initial user testing has shown the user’s accuracy to increase at a quicker rate compared to current training methodologies. Our results show a 90% increase in pre-set shot accuracy when wearing the headset compared to the user playing the same shots without the headset. Additionally, a 50% increase in shot completion without headset use was seen 2 days after user’s performed three 30-minute training sessions using the headset across one week. This is compared to shot completion rates without headset use after three 30-minute training sessions NOT using the headset performed over a week. Furthermore, from existing research in Augmented Reality (AR) assisted sports training(Stefani Palmieri), we can see the effectiveness of using AR within sports training, solidifying our findings of long-term user improvement after using our system.

D -

* IDEA
  + Develop a mixed reality application for a Microsoft Hololens in order to decrease the amount of time it takes new and novice cue sports players to increase their aiming ability
* HOW
  + Using computer vision techniques and the HoloLens hardware, the wearer of the headset will be able to see shot guide lines on the table in front of them. These lines correspond to a ‘hit marker’ on the cue ball which indicates where to hit the ball.
* WHY VALUABLE AND FOR WHO
  + Valuable for any amateur or new player as it will reduce the time taken for them to develop their accuracy – a major part of the game.
  + It will also increase enjoyment in the game due to players becoming successful and scoring points straight away rather than after an extended period of training or play time. The novelty of the cutting-edge technology used will also attract users and increase enjoyment.
* HOW BETTER THAN OTHER
  + Other solutions use projectors above the table to display guide lines and information onto the table. This means that it is hard to move, and only compatible with that table.
  + My device is completely mobile and can be used with any table (with the appropriate markers/QR codes). Allows for freedom of movement as well as system portability.
  + User experience can be tailored to the user as they are wearing the headset, and so customisations can be made for each individual user as they play

***Impact***

* NECESSARY STEPS
  + Develop prototype and progress to a final polished solution through an agile development cycle
  + Test device to ensure reliability, stability in a wide range of lighting environments, and compatibility with a large number of pool and snooker tables
  + Source capital investment for development cost and venue set-up
  + Recruit business and store managers (my expertise lie in the development side, so I can lead this), as well as promotion, website etc
  + Try to attain partnership and/or support from Microsoft to reduce the cost of headsets and help lead development of head mounted display technology
* MEASURABLE IMPACTS
  + Have prototype by end of month, beta system, investment, Microsoft partnership by end of Q2, final system by end Q3, Store open and launch by start Q4

***Appendix A – Interview Questions***

Below are the interview questions I sent to the former president of the University of Bristol Pool and Snooker Club, along with their responses (in red). No identifiable or sensitive information was collected, and consent was received from the individual prior to asking the questions.

Question 1: Do you perform training drills either alone or with others?

* Yes
* No

Question 2: Do you think training drills are an important part of snooker and pool development?

* Yes
* No

Question 3: If you answered ‘YES’ to question 1 or question 2, what technique do you (focus on the most) / (think are the most important) when training? Please select all that apply

* Hitting the targeted ball
* Potting the targeted ball
* Positioning the cue ball optimally for the next shot
* Break building
* Safety shots
* Complex / Spin shots

Question 4: Which one skill do you believe is the most important to train and develop to see the most improvement?

* Hitting the targeted ball
* Potting the targeted ball
* Positioning the cue ball optimally for the next shot
* Break building
* Safety shots
* Complex / Spin shots

Question 5: Would you like the idea of using a head mounted display when training that provides feedback and guidance on your shots whilst you play?

* Yes
* No
* Maybe

Question 6: What features or visual guidance would you find useful for such a device to have?

I think it would be very useful to have some sort of memory function - take a snapshot of the table before taking a shot, so that if you want to replay the shot for some reason, you can set it up again exactly. I think another good feature would be some ability to record statistics, i.e. % long pot success, etc.

Question 7: What would you be willing to pay for such a device?

* £0-£250
* £250-£500
* £500-£1000
* £1000-£2500
* £2500-£5000
* £5000+

Question 8: Would you ever pay for pool or snooker training?

* I have in the past
* Yes
* No
* Maybe

Question 9: How much would you consider paying for training? (Per session)

* £0
* £0-£10
* £10-£20
* £20-£30
* £30-£40
* £40-£50
* £50+

Question 10: Would you ever go to a Virtual Reality arcade or Virtual Reality experience recreationally?

* I have in previously.
* I would like to.
* No

Question 11: How much do you think (per hour) a Virtual Reality arcade or Virtual Reality experience should cost?

* £10-£20
* £20-£30
* £30-£40
* £40-£50
* £50+

Question 12: Who do you think would benefit most from such a system? Please select all which apply.

* New players
* Amateur players
* Club players (Play regularly as part of a club)
* Semi-Professional players
* Professional players

***Appendix B - Terminology***

Below are some useful explanations of cue sports specific terminologies.

* **Snookering**
  + Forcing the cue ball into a position such that the opposing player cannot hit a valid object ball directly – meaning they must first hit a cushion before a valid object ball to avoid a foul.

Graphical user interface

Description automatically generated with medium confidence***Appendix C - Figures***

Figure 1 – Example of augmented graphic feature the headset would display. (MASHABLE)

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