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AGON: MIXED REALITY-BASED APPLICATION FOR ENHANCING THE LEARNING OF TACTICAL ELEMENTS IN AMERICAN FOOTBALL

AGON:LIITREAALSUSEL PÕHINEV TAKTIKALISTE ELEMENTIDE ÕPPIMISE LAHENDUS AMEERIKA JALGPALLIS

MASTER THESIS

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AUTHOR'S DECLARATION

Hereby, I declare, that I have written this thesis independently.

No academic degree has been applied for based on this material. All works, major viewpoints and data of the other authors used in this thesis have been referenced.

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MASTER's THESIS TASK

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AGON: LIITREAALSUSEL PÕHINEV TAKTIKALISTE ELEMENTIDE ÕPPIMISE LAHENDUS AMEERIKA JALGPALLIS

Thesis Main Objectives:

    1.1 To find out the opportunity space for emerging technology in American Football Training.

    1.2 To investigate coach and athletic relationship and dissect component to focus on

    1.3 To understand coaching philosophy and concept of the playbook for proposing appropriate tools to enhance the learning ability of tactical elements.

Thesis tasks and schedule:

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ABSTRACT

The essence of learning tactical elements in American football comes from understanding the game's philosophy and strategy. Furthermore, coaches must adequately assess those skills by creating game-based scenarios and clearly defining the purpose. When a player fails to interpret the game philosophy, the player struggles to develop tactical awareness. Hence, affecting player motivation and performance and weakening coach and athletic relationships.

Therefore, the thesis investigates a variant of issues that exist between coach and athlete which obstruct players from improving tactical skills. A design methodology is used that first goes through a literature review, several interviews with the user, and field observations to understand coaching methods and training practices aligned with the professional league and other semi-professional and college-based football.

Secondly, valuable insight from the first step is analyzed parallel with existing and emerging technology to conceptualize an appropriate working solution for infield training. Thirdly, the final outlook of the solution is refined through feedback from coaches and players.

The design outcome of this research is a mixed reality-based application that facilitates learning of game philosophy through visual and audio feedback mechanisms. The application is presented by repeated engagement of players and coaches. Therefore, making the concept valuable and technologically acceptable for broader adoption in football training soon.

CONTENTS

PREFACE

My first learning experience of football come to exist when I was doing my undergraduate research on 'Designing of American Football Throwing Machine'. Since then, my love for the sport begins.

Throughout the periods, the football game strategies have changed a lot, and technological capabilities too. That inspired me to look for technological intervention in this field and an initiative for the future possibilities of football training.

This research has been prepared for the fulfilment, of course, MSc in Design and Technology Futures. Furthermore, I want to thank all the faculty members for their constant guidance and support.

Firstly, I would like to express my gratitude to supervisor Janno Nõu for allocating time week after weeks for counselling me in the thesis process.

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1.   Introduction

American Football, commonly known as gridiron football, is often described as a modified version of rugby and soccer. The sport, which needs players to pass the ball using hands and throwing over the white grids, was popular in an ancient Greek called Episkyros (Craig, 2002, p. 101). Epsikyros was the source of entertainment in Greek society. During which time, the game became a massive success that the Roman empire embraced a form of play in the name of Harpastum (Craig, 2002, p. 102). Nevertheless, both games were violent. The player needed to display robust physical ability and did not need to memorize tactical aspects of games.

Besides, American Football is induced with many tactics as it goes through constant changes over the past centuries. The pioneer of American Football, Walter Camp (Crouch, 2015), was the first to introduce sets of rules like improving tackling methods to distinguish between American Football and rugby. During the 18th century, when football was getting popular at college levels (Weathersby, 2016), Camp experienced the need to establish rules and regulations to minimize the chances of collision between players.

Because the game was played rough and with high input of physicality, Camp took the initiative to introduce new precepts in 1880. That allows players to play their position safely by creating open space. He introduces the possession-based theory (Goldstein, 2018), allowing the game to start from scrimmage and ball handover principle if a team fails to score points in consecutive attempts. The development of such a system lead plays to become open. As a result, long passing, running, and tackling (below waist) were widely seen in the field. Afterwards, he invented quarterback and safety positions, which takes football in a new dimension of play from scrimmage to the openness of creativity and innovation of new play systems.

Therefore, modern football has become more tactical with various formations and alignments. Players need to learn their roles and be aware of different positions. Although technical parts are heavily emphasized, players have found it challenging to discover a tactical aspect. Players have to spend a long-time learning games-based skill when it has not been taught early and assessed by the coach. As a result, they suffer from low performance in games and become victims of injuries. Since football demands both physical and mental abilities, finding the right way to play football is a crucial part of life for any athlete.

1.1 Target group

The target group of the thesis is the offensive team which comprises a positional player like Wide Receivers, who are required to deal with an intense amount of tactical information on the fields. The research work is also appropriate for young or new players and draftees who must integrate the core tactical elements of the game in a daily training scheme.

Since the coaches play a vital role in shaping athletic skills, the research aims to provide coaches with the support to deliver strategies and tactics to the team effectively. Hence, the study seeks to understand the coach and athletic relationship, game philosophy, and integrated communication mechanism. Targeting footballers need to improve the tactical elements and games in the first phase of skill acquisition.

1.2 Football gameplay

Football is a dynamic sport with multiple variations. The games are played between two teams with an equal number of 11 players demanding different physicality and skills. The offensive team attempt to score a touchdown in a football game, bypassing the prolate spheroid-shaped ball into the defensive end zone. The offensive consists of a quarterback, five offensive linemen, and a combination of running backs, wide receivers, and tight ends, depending on the play type (Greg, 2021).

Similarly, the defence team is organized into three different formations. There is a defensive tackle in the defence line, defensive ends followed by linebackers and endmost safeties, and cornerbacks. Furthermore, special teams must punt the ball and protect and cover the punt once it falls towards the opponent's half. All these positional players have a specified role to play and must maintain strong disciple both physically and mentally.

The special team starts the game by kicking the ball toward the opponents' end zone, allowing opponents to run with the ball by gaining the yards. The play starts from where the opponent's ball is covered by lining up 28 cm between offensive and defensive teams from the line of scrimmage. After that, the quarterback calls off the play based on the information provided by the coach. The terminology used by the quarterback contains strategic communication, which is only understood by offensive players that help players to be aware of their roles. Relying on the play-calling, quarterbacks decide whether to go for the rush or passing or trick (fake) play. During this action, offensive

linemen guard the quarterback inside the pocket from advancing the central defensive. It gives the quarterback time to pass the ball to wide receivers or running backs.

Likewise, the tight ends distract defenders from opening the route for a wide receiver to runs down the field. If the defenders widen, this creates an opportunity for running backs to run with the ball to gain the yards. As the quarterback holds the ball during every play, the number of defenders got a slight advantage in number. Moreover, to make the game more exciting, defenders sometimes use blitz formation by adding an extras man on the defensive line to pressurize the quarterback to create a sack. On the other hand, the defender intercepts the ball, blocks, and tackles the player, especially the offensive players carrying the ball. This strategic battle keeps continuing during every play.
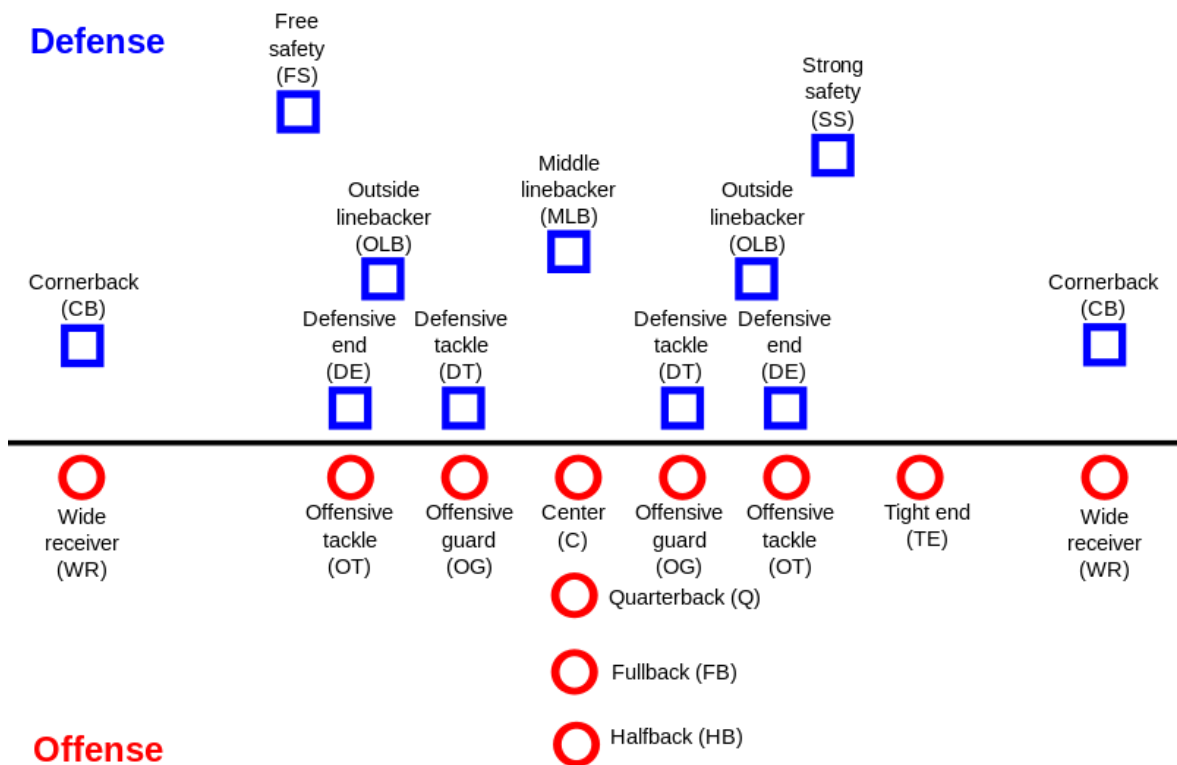

Figure 1.1:I-formation with postional names

1.3 Objective and scope

Over the past years, different sports equipment is developed to train the athletes. The majorities of such training kits are specialized more on improving individual physical performance than enhancing personal tactical skills. Similarly, research has shown that players who do not participate in game-approach training are less likely to acquire the critical skills to perform well (Gearity, 2012).

Those critical skills involve mental processing ability that might be limited in players because of injury barriers related to minimizing training time, mental fatigue while overtraining (Diogo et al., 2017). Additionally, lack of skilful positional coaches (Gilbert, 2017). Coaches familiar with the traditional teaching method incline more on improving technical skills than game tactics. Adaptation of conventional training methods hinders individuals from learning tactical aspects of the game because of difficulties creating actual training base scenarios.

Furthermore, as football is getting competitive, it has compelled coaches to keep updating their training schemes. Consequently, players are needed to learn extra strategies to gain an advantage over an opposing team. Mastering those strategies helps players to develop positional awareness, cognitive skills and enhance decision-making skills. Moreover, Players who do not know the system have to spend much time in training. In addition, new players in a transitional learning phase must deal with heavy pressure while learning new schemes. In contrast, new training tools are provided to players to enhance learnability. However, they are limited due to their multifaceted and spatial requirements.

This research investigates the utilization of training tools among elite football teams. It seeks spaces for emerging technology in athlete training. The author hypothesizes whether there is a need for new training equipment to help players learn various playing schemes and plays. The research also concentrates on key areas to take advantage of new training equipment and how the emerging technology will create values among users. The study focuses mainly on understanding the coach's philosophy and player's needs and discovering existing technology to develop a desirable solution for the users.

1.4 Motivation

Learning American football is challenging and frustrating at the same time. Player often complained about struggling to understand essential elements of learning tactical skills. In comparison with learning technical skills or fundamentals such as catching, throwing, tackling, running.

Similarly, the playbook, a tactical tool that coaches use to convey game strategy to players, is harder to comprehend. Its two-dimensional layout is challenging to learn and does not offer visuality. Less knowledge of spatial awareness and cognitive and decision-making skills causes a lack of consistency in play. Thus, leading to the lack of team performance.

Furthermore, coaching assessment tools are lacking to evaluate tactical learning constitutes by offensive philosophy. The only helpful tool that allows the player to learn their skill performance is going through a video recording for analyzing their movements. In the pipeline, the coaches have to upload the videos, split them, and go through the frames to understand their ability and facilitate communication with players. By doing so, coaches have to spend much time going through these videos and comment on individual tactics. Hence, delaying feedback can affect the player's motivation to adopt the training plan and actual game performance.

2. Methodology

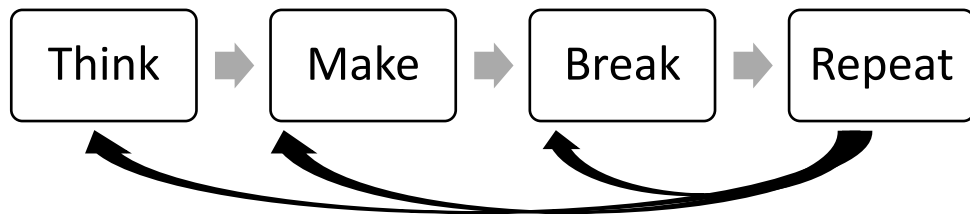Think ➡ Make ➡ Break ➡ Repeat

Figure 2.1:Methodology steps

This research uses the non-linear and iterative design process of 'Think, Make, Break, Repeat.' The methods were proposed by Tomitsh and Wrigley Martin Tomitsch and Cara Wrigley, 2018 -A Handbook of Methods (Tomitsch, 2018). Using this method helps to get a holistic understanding of user situations, generate ideas, and get feedback on emerging technology for developing the final prototype. Moreover, if necessary, repeat the process. This technique is efficient and effective in coming up with innovative solutions that fit user needs. This user-centric design methods consist of three primary approaches.

2.1 Think

The first phase is the learning process, where information about the user is collected. The question-related existence of the problem is discovered. In this process, a solid understanding of problems is necessary, and it is built up by exploring the problem space. This phase starts from the left side by identifying the problem. Including asking a series of questions about why the problem exists. Why it has not been solved, who is involved, and what others have tried.

The thinking part of the learning phases is initiated by following four primary schemes. The first scheme is a "Literature review." It deals with getting an integrative understanding of the American football systems by analyzing textual information from amateur to professional sports. The literature review constitutes knowledge accumulated from football coaching books, sports journals, watching videos of training and games, following football trends, looking for a similar pattern in other sports, and pieces of evidence from players and coaches discussion. This section aimed to understand the difficulties of learning American football tactical skills in early phases. It includes concepts of playbooks, ongoing trends in football plays, and practice barriers.

The second scheme is "User Research." The research is carried out by using qualitative interviews. The qualitative method is convenient for systematic collection, organization, and interpretation of textual information. The users participated through online-interviewed, and semi-structured follow-up questions were asked for opening up conversions. After that, some questions are shared with the potential users in different online media such as American football groups on Facebook, scouting agencies.

The interviewees were actively involved in American football—the interviewees were six head coaches, nine players, and two sport-therapists. The interview question was prepared, emphasizing understanding the user's mindset, coaching experience, technique and game strategy, frustration, and problems. The interviewed players and coaches include amateurs to semi-professional football teams. The interviewed adult players were experienced and learning athletes and coaches from the US and Europe. The interview was recorded to extract valuable data. During this phase, the author also associates himself with coaches and players by visiting training fields and personally talking with players and coaches.

The third scheme is "Field observation." The author participates and observes players training and practising in the training fields. The main aim of the section was to get familiar with football training and understand the playing system in more depth. Player's training and practice methods are documented by visiting one of the American football clubs in Estonia, "Tallinn Kings." Furthermore, varying coaching philosophy used in offence play was also studied by analyzing training videos. By doing so, valuable information about the importance of communication between coach and athletic is collected for helping to learn and develop tactical skills.

The fourth scheme is Technological research. This research aims to analyze various market products and ongoing trends in American Football. The section explores opportunity space in different training tools that might become valuable technology to enhance learning. Thus, this paper explored both present and future technology to purpose effective learning material for players in practice.

2.2 Make

The second block in the figure is the making process. It is used while picturing and developing ideas and prototyping solutions for the end-users. The systems are interconnected to the 'think block' because the output from the first stage is used for building the final design outcome. In this stage, the gathered data are synthesized to come up with a validating point of view. This point of view is called a design brief, which creates an opportunity to focus on product development. At this point, it is the right place to adopt the six design principles(Affordance, Constraints, Consistency Feedback, and Visibility) mentioned by Don Norman in his book "The Design of Everyday Things" for bringing up proper user interaction with digital products. Using these design principles opens the door to investigate various ways or possibilities to solve user problems. Through which one option is necessary to accept as the final solution for testing in the real world.

2.3 Break

The third block is the 'Breaking process,' where ideas are put in front of the user to generalized the final concepts. This step is beneficial for improving and refining the final product. During these steps, previous ideas might be surpassed as new ideas emergence while learning from the user. The primary purpose of this section is to collect as much user feedback to prepare for the technological path of success and failure until innovation or ideas that satisfy user need is developed.

2.4 Repeat

The final block is the "Repeat process." Some earlier steps are iterated again to gain new insights. Rather than finding the perfect solution, this step aims to solve complex problems by quickly testing different methods and ideas with users to generate innovative solutions. The repeat phase is based on improving software and hardware capabilities and validating some missing steps in the design process. For example, during the research period, asking a question and getting feedback from the coaches and players are repeated several times while visiting the football field during team three days per week training.

2.5 Conclusion

The process mentioned above underlines the core design principle tools essential for a designer to develop an innovative solution to bring experiential and satisfactional changes in user life. 'Think, Make, Break' are interdependent blocks that mean the outcomes from one step affect possible results from one process. However, there is no definite step to follow one specific linear path. The process can be iterate with the repeat loop whenever new ideas appear during the design process until the desired outcome is met.

3. Think

3.1 Literature review

American Football, which holds the notion of agon and alea (Caillois, 1958), is arguably the most tactical sport in the world. It blends the philosophy of chess requiring predictivity of movement of different physicality in real-time. That is why football has been looked at as one of the most strenuous sports to learn (Dib, 2020). Traditionally, plays in football were more physical, and emphasis was given on players' physical attributes. So forth strength-based training, an improvement on the diet is heavily developed, and new rules are also set to protect the player. However, in modern football, the paradigm shift from physical to more mental modes has influenced players' playing style, games theory, and tactical ability to learn football.

As football keeps growing, the leagues become more competitive because coaches and players become familiar with the number of games played. Similarly, playing with the system in which opponents are aware is proven useless in gaining a competitive advantage over opponents (Brinson, 2015). It enables coaches to improve and adjust the game's plans to compete with various plays. Thus, records of individual roles, sports, and games strategy are collectively kept by forming the playbook.

3.1.1 Playbooks

Playbooks contain blueprints of team strategies to be used during offence and defence play. Flores and O'Connor (2005) emphasize that these strategies make up the popular game theory. According to them, football game theory is divided into field position, scoring a touchdown, ball control, big-play approach, and combining winning ideas with the running or passing. Firstly, as the name suggests, the field position stresses keeping control of the field to slow down the opponents and waiting for opponents to make errors (p. 11). "Play it safe and avoid mistakes, and football is a game of inches "are some of the thought processes of field-type positional coaches (p. 13).

Similarly, coaches favouring ball control theory focuses more on safe offence play by gradually covering the yards. With the big-play approach, the coach focuses on instant touch down by throwing long balls and trick plays. A long pass threat is more common on the big play approach, making ball control games more effective because it opens the defensive lineman (p. 14).
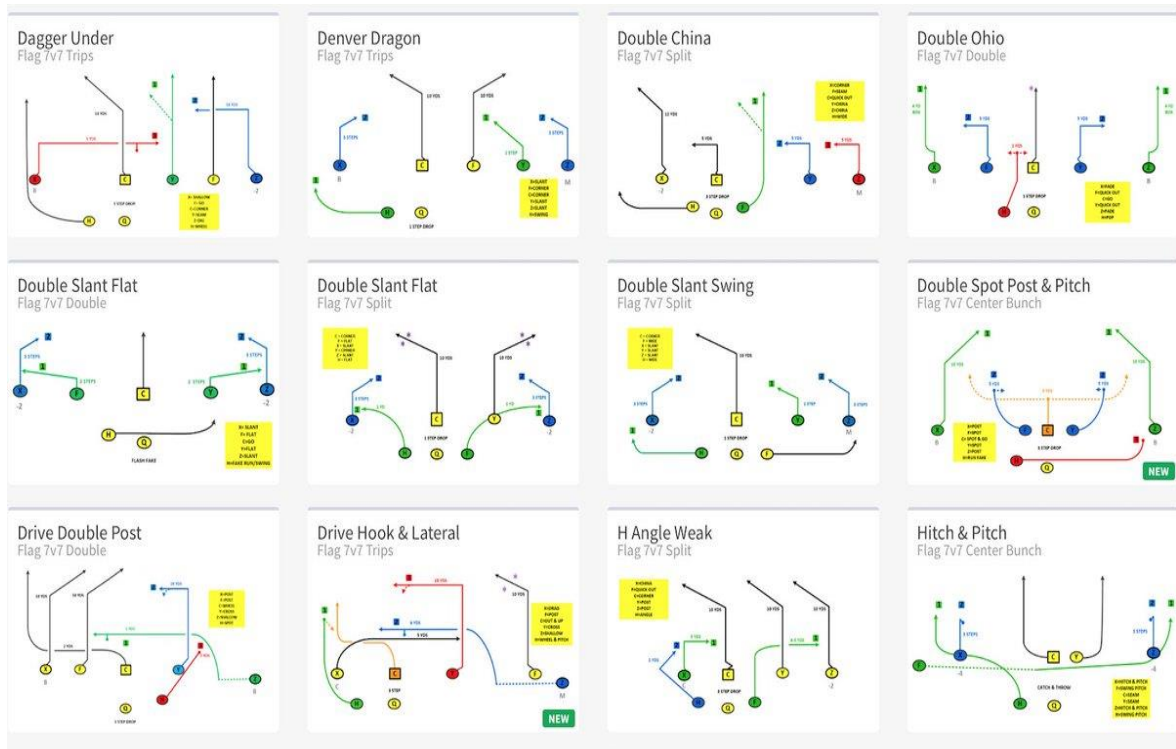
Figure 3.1:sample of playbook with terminologies

(Playbooks, 2017)

The playbook is a game plan that consists of individual roles and different plays. Every play consists of a sign that allows the coach and player to communicate. In the football community, the uses of Signs have cultural significance. For example, 'O' and 'X' represent offensive and defence, respectively. Generally, a sign is a combined piece of 'signifier' and 'signified' (Saussure, 1998). The 'signified' distinction between the thing or concept and 'signifier' represents the thing doing the representation.

Analogically, players are denoted by circle and square, and routes with arrows symbol in Figure 3.1. Similarly, each play is represented with a name or terminologies that signified positional roles. There is no specific length for calling the player neither categories. It all depends upon the coach how he wants the names of the play to be called to have a mindful impression. Some coaches prefer lengthy descriptions to make play terminology understandable. In contrast, others add more words to make play-calling sound good. So, players have no other option than to learn those signs or the form of language of the game.

The size of the playbook varies according to the level of the competition and age group of players. In the professional league, it is well above a hundred pages. For example, a

detailed playbook with roles, positions, motions, and rules can be thousands. Nevertheless, only the specific formation goes above two hundred pages (NFL Offense Playbooks, n.d.). Depending on the weekly plan and nearing of competition, the team usually chooses between "75 to 100 pass plays for a game and 15-20 running plays" (Farmer, 2016). In other words, in the extended game period of three hours and a chaotic situation of mental complexity, the player has to accomplish multiple routes out of hundreds of unique plays.

3.1.2   Trends in Football

Passing and rushing are two ways to striker the touchdown in American Football synonymously the only way of winning football. Historically, American Football is considered more a rushing game. During this play, the running back rushes the end zone by carrying the ball to score a touchdown. Many coaches have now prioritized passing play in the offence strategies because the defence is getting more robust and are well experienced in different systems. Therefore, over an extended period, more passing play over rushing play has been in the spotlight. It was a faster way to tackle blitzing defence and move the ball.

Nowadays, the National Football leagues (NFL) and Superbowl are called the passing leagues because of the wide adaptation of the passing system and its winning rate in past decades. In addition, specific rules favouring offensive players have promoted passing play strategy, allowing coaches to create and take different strategies decision (Cunningham, 2017).

"I think a lot of that has to do with the rule changes to make passing easier. It is becoming more efficient. And the data on the stats passing is just a much more efficient way of moving the ball than running right now." (Michelman & Nguyen, 2019)

According to Nyguen, the NFL staff writer wrote for "The Athletic," that the team does not need to make a heavy investment in the run game to win the games. Except emphasize testing the limits of passing and using the pass to set up the run (Nguyen, 2019). Similar data has been presented by Dr Ed Feng, highlighting efficiency metrics (yards gains per attempt) for passing as higher during the games in NFL. The team with the given strategy is more likely to win (Feng, n.d.).

Furthermore, coaches prefer passing play because touchdown is more like to be accomplished with less talented players as it depends upon the ability of the quarterback and the receivers. As this type of play comes up with different play variations, it allows the offensive team to gain an advantage over a strong defence team. Under those circumstances, the team depends on a talented quarterback and receiver to effectively set up passing play. Thereby, the margin for errors such as interception or incomplete pass is less. Which help the team can gain extra yards in each consecutive play.

3.1.3   Tactical elements

To become a complete athlete, players need to learn both technical and tactical skills. Technical skills are a basic physical movement that the player executes while performing sport-specific actions to achieve the desired results. For example, technical skills are usually emphasized during the training period to improve motor performance, like throwing, catching, running. On the other hand, tactical skills are actions and decisions acquired by the player to solve any problematic issue to get an advantage over the opposing team (Martens, 2012, p. 151).

Mastering the fundamentals is an important thing, whether playing in an amateur or a professional league. Those fundamental skills are frequently associated with motor learning separating tactical elements necessary to play football. The core tactical element in football is learned through memorizing and understanding the language of the playbook and translating it into decision making.

The complexity of the playbook is learned through periodically improving both technical and tactical skills. The first processing tactical decision-making is separated from the field. The process happens when the player needs to memorize the playbook. Later, the entire sequence is completed when making the right decision in the games.

However, to improve tactical skills, coaches must create a game-like environment rather than repeatedly repeat the same solution during training. An essential thing that the coach accent here is the "Repetition without Repetition" model theory (Bernstein, 1967). According to the idea, player skills improve by engaging players in solving problems.

Correspondingly, on successful coaching, Martens (2012) describes a game approach that coaches can adopt to empower decision-making skills. The game approaches in training follow by using three methods: teaching during play(shaping play), evaluating players in practice (focusing play) and creating challenges during activities (enhancing play) (p. 156). The shaping play facilitates the manipulation of different game variables to develop game-like challenges. Similar focusing play emphasizes the development of critical elements of the game like decision-making. Furthermore, the enhancing play repeated the process by adding an extra competitive level for progressive player learning. Hence, learning a coach's strategies means acquiring tactical skills, which is vital for improving practical skills.
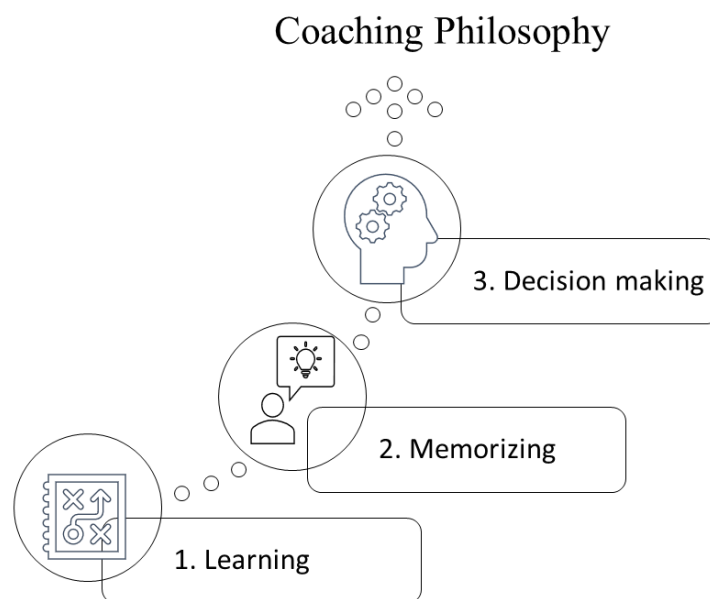
Coaching Philosophy

Figure 3.2:Core Tactical Elements

3.1.4   Learning playbooks

The playbooks are drawn up based on coach philosophies. Every coach uses their philosophy, theory, process, and tactics to influence players' roles. The level of influence continuously varies according to the team's situation and type of player. It is up to the coach to help the players improve their performance or even push them to lift the trophy. The former American football coach, Don Shula, once quoted on his coaching philosophy, saying, "it is determining the player's talents and giving them every weapon ." Therefore, the playbook can be considered a weapon for every player to fight the strategic battle within 100 yards.

It is not just the rules or manual, but it is a complete strategy. The deciphering of the playbook requires an understanding of different beliefs held by coaches. According to Morelli and Velez, 'Coaches configure their unique coaching philosophy by orientating the three belief types as conductors, managers, and innovators' (Morell & Velez, 2016). The conductors are "a coach who believes he/she is skilled at guiding, directing, and influencing a group's behaviour." Coaches acting as conductors are more focused on team development and setting up a commons ability to work together as collective goals (p. 78).

Likewise, Coaches that appear to have manager beliefs are related to developing the individual athlete and highlighting the group members' unique talent (p. 79). Also, an innovator belief is concerned with creating a uniqueness of technique, strategy, or organization, hoping that developing the scheme will provide a competitive edge over opponents. Morelli and Velez admit that each belief type is not independent of the other but rather acts as a driver for one another, periodically completing a loop in particular contexts.

"To me, playbooks are like going to a Chinese restaurant," Chiefs coach Herm Edwards.

"It is about the size of a dictionary, Maybe a little bit thicker than that." former Michigan Statewide receiver Bennie Fowler (Priyadarshi, 2021)*.*

"The game is more mental than physical," Bobby Wagner, Linebacker)

"It is complicated, especially since most teams change up their plays(you cannot call same play again) from game to game." (Brian Russell, former NFL safety)

The learning process of the playbook can be open into two stages. One is memorization of every role and understanding the concept. The second is more about the application of those concepts to actual games. Players need to memorize each play from books which constitute hundreds of plays. Suppose the players do not remember what the terminology means or still remember language but forget to react. In that case, they will likely suffer a heavy defeat.

The learning curve of football concerning player learning and performance rate is not constant. The new player and drafted players joining a new team struggle to get acquainted with new play types. Besides, it takes years of practice to be influential playbook players. In a semi-professional football, the playbooks might not be complicated as NFL strategies but learning the terminology, remember the cues are the crux of the matter. Also, with less training time and frequent inexperienced situations, the player needs to rejuvenate the play's logic from Time to Time. It is not just the new learner, but even the good athletes find it challenging to learn the playbooks (Smith, 2018).

Moreover, the playbook is diary-like or the size of the dictionary. It acts as proof of covenant between coaches and players (Merrill, 2007). Whether it is attempting to score a touchdown or prevent it, everything in football is preplanned. Although technical skills are required for players to perform well, tactical skills are being tested during games. Consequently, teams must dedicate much time to learn game-based skills.

A professional player likes Tom Brady, who has won seven Super Bowl know the value of mastering playbooks. According to him, rookie's player needs to invest time studying the playbooks to improve the games (Laine, 2020). Also, Brady stated that learning a new playbook is the toughest for him because it required a lot of time and energy to prepared mentally for the games.

Additionally, players are assessed with the intelligent test in professional football. The NFL uses this test to understand the decision-making skill of players. An individual who scores higher than the average point is more likely to get an opportunity to play in NFL (Crouse, 2019). Good test scores are usually associated with the player's success and considered starting lineup for any position. Although obtaining higher points on the test does not count as a good player. It necessarily helps the coach determine players' ability to learn tactical skills in the long run. The tactical skills necessary to practice

include reading the defence lineup, reacting to overpressure from the defence rush, deciding when and where to move, and anticipating the opening.

3.1.5   Practice Barrier - injuries

Football players are limited to training tactical skills in the game-like scenario because of American Football's nature. It is complete contact or collision sport where the defence needs to tackle to resist the offensive from scoring. Due to this, injuries rate in American Football is higher than in most of the major sports (Sports Injury Statistics, n.d.). According to the study carried out on ten thousand high school footballers, the injury mainly occurred when players were being tackled (24.4%) and tackling (21.8%) (Marcy A et al., 2012). Also, injury analysis over 142 American football players in amateur leagues concluded the higher risk of injury during training (Geßlein M et al., 2020).

A similar study has shown that high magnitude head injuries are significantly higher for practice than games. They mainly result from intentional head-to-head contact between perimeters players in youth football (Alois et al., 2019). Furthermore, coaches and players frequently work together to improve tackling injury among the players. The lack of players' tackling experience and responsibility to acknowledge each other's safety has delayed other players from learning tactical skills in practice.

Every year, NFL has made various efforts to protect players during games and practice (NFL, 2021). Besides, American Football has received lukewarm support from the media. Cases such as deaths due to concussions and fatal injuries have been topics of political discussion. It has raised the question regarding social acceptability. Over the years, movies such as 'Concussion' 'All the Right Move' are made about football injuries to raise public awareness. Although the schemes discourage youth participation in high school football in the US over the last decade, the injuries trends are still rising (Pielke, 2020).

Some coaches have also adopted a training plan to minimize injuries by either increasing a training time or decrease contact-based training. The Wisconsin Interscholastic Athletic Association conducted a comparative study before and after the implementation of new rules. The data revealed that 'the rate of a sport-related concussion sustained in high school football practice decreased by 57% after a rule change limiting the amount and duration of full-contact activities, with no change in competition concussion rate' (Pfaller AY et al., 2019).

Similarly, overuses injuries are also another factor that needs to be addressed while teaching playbooks. The European Society of Sports Traumatology research states that salaried football players sustained high injury incidence in football. Because in a semi profession, experienced players have to put much effort in the training field. As a result, this leads the player to mental exhaustion, and players cannot make the right decision.

The case might be slightly different in professional football. The salaried player who has a high contract is kept protected by teams and preserved for the games. Any injuries sustained by those players mean heavy lots of investments for the team. Those players have to spend more Time training alone with a positional coach, reading playbooks, and analyzing videos. It might be why the practice injury rate was higher among players who are not playing professional leagues (Iguch et al., 2013).

The injury and practice time is the paradoxical model. Suppose the players train more in a contact sport. In that case, injuries are more likely to happen. However, if the players are not preparing enough, this might create dangerous physical situations (Harris, 2019). Additionally, the player faces frequent injuries after returning from a minimal gap in practice (Hewett & Myer, 2011). Professor Keith Stokes from the University of Bath's Department stated that a long gap in practice would increase damages. Usually, training helps players gain technical skills, but practice enables players to learn tactical skills and further enhance their performance.

While learning a playbook, players practice their reaction and response time. It is where players devote most of their time and energy. Two types of reaction time are pretty common in football, auditory and visual. The auditory reaction time helps the player quickly react to playbook terminology (Sors, Fabrizio & Prpic, 2018). Visible reaction time supports the player in reading the defence lines or formations (Eroğlu & Şenel, 2006).

Improving these skills is advantageous for a player in quickly initiating motor agility because motor agility is developed by having a good response time. The study has shown that improved reaction and response time help players reduce the risk of injury (Engeroff T et al., 2019). Similarly, minimized reaction time has proven beneficial for decision-making and helps athletes a competitive edge in competitions. However, teaching those tactical skills requires experienced coaches.

3.1.6   Practice and coaching

The etymology of the word 'coach' is tracked back into the medieval age called 'kocs,' which refers to the special carriage used for completing a journey faster and safer. It draws an analogy as "coaching is not just a way to reach your destination but also the best and most elegant way to travel" (Morell & Velez, 2016, p. 12). In terms of American Football, the core coaching process can support and guide athletes to adopt the playbook's game theory.

The 2D visualizations of the playbook prevent players from retrieving basic spatial information. To perceive that information correctly, players have to frequently practices following the instruction provided by coaches. A new study has confirmed that repeated practising with good intensity improves a player's ability to perform specific tasks that the athlete was learning (Hambrick et al., 2021).

Simultaneously, the coach's poor teaching restricts the player from perceiving useful information in applying playbook strategy, resulting in poor performance. The coach has to create a proper scheme for helping the player to become a good athlete. So that player does not develop a poor habit or technique. The irregular use of muscles overlong period leads to overuse injuries. During a sample study conducted by Kerr and his team (2021), among players drawn from different educational programs with no coach educational program, the injury rate was higher.

This evaluation study suggests that the coach plays a crucial role in minimizing the overuse injury rate among players and improving player's ability to learn playbooks.

The skill levels of coaches make much difference in helping players learn tactical skills. Inexperience coaches usually do not emphasize the practical skills necessary for the game because traditional coaching has mastered the fundamentals and then practising other skills. Mastery is a delusional concept, which obstructing coaches from adopting a game approach in teaching methods. According to the sports experts, players need to be taught reading the game in early phases than advanced ability. Because reading the games enhances their awareness, decision-making, and the consistency and pace of their tactical acts (Schumacher, 2020).

Another factor that limits coaches from teaching tactical skills is a lack of knowledge. Years of playing do not correlate with coaching experience because most coaches underestimate the time it takes to learn and implement the game approach in the

coaching method. In an Australian football team, the researchers investigated game approach coaching to reflects coaches and player's experience through conducting semi-structured interviews. The research evidence that 'the *Game Sense approach takes time to learn, require more excellent instructional knowledge and game understanding by the coach so that it is not misinterpreted as small-sided games'* (Pill, 2015). Some teams do not have good coaches to teach specific positions, especially quarterbacks (Football Canada, 2018).

Similarly, teaching playbooks required tactical anticipation of games. Coach creates situational awareness in playbooks that need to communicate with players properly. Ubukata and Nishihara examined the current method's coaching cognition behaviours among American football coaches in Japan (Ubukata & Nishihara, 2020). Their plans imply having three different proficiency levels of coaches (beginner, less experience, experience) to comment on game videos, and then comments were analyzed. They found out the experience coaches cognitive remarks were more insightful in describing both offensive and defensive alignments, arrangement before and after play. In contrast, beginner and less experienced coaches missed the importance of reading the opponent's position before initiating the play.

3.1.7 Conclusion

Modern football requires a balance of both tactical and technique skills. An essential skill needed to perform the physical movement is learned in the initial phase. However, learning tactical skills early-stage is crucial for players to build confidence and perform well in games. Tactical skills are an essential aspect of American football players in lots of ways. Learning tactical skills such as reacting quickly and decision-making to perform motor skills helps players minimize the risk of getting an injury. Football, which is considered a game of inches, requires a high level of precision to play. Minor errors from one player in the games can cost a lot for the teams.

Since tactical skills are learned by going through playbooks, many players struggle to get the gist of strategies that need to be implemented. Besides, playbooks have many variations where players need to understand their roles and make a mental map of opponent positions. Thus, the learning process has been complicated for the new player to get familiar with the system. Players have to get in touch with the coach quite frequently to know if they are doing their duties well, but this is often impossible. It takes much time to advise a team that consists of more than thirty players. As a result,

the player is left with only one option, depending on the training schedule and practising in fields.

To teach a playbook, a team needs to create a game-like scenario or mimic the actual play. However, coaches usually limit the time to learn the tactical skills by allocating less time for the scrimmage. Football is a collision sport, so getting injury is higher when more player is practising together. Preferably, some coaches build a game system with few players to teach a game approach in a training session. In such training, players are limited to uses total capacity. However, American football players must train at high intensity because it helps players develop skills during repeated training and reach their full potential.

New players are not fully aware of the use of terminology in football. One team playbook is full of such callings (word used to initiate play) and how and what to instruction from the coaches. That means player inter-communication between coaches and player are very important for a player to learn football complicacy. It is only in the coach's good hand; they can know and master the tactical skills. Moreover, coaches and players need to be aware of the methods they teach and the benefits of using teaching methods. Lack of coach's experience is proven to hamper player's lives. Therefore, players and coaches need to adopt the proper training methods and tools to improve individual liability.

The trend of football-playing style is more inclined towards pass plays because of the defensive line getting more robust and has enough experience to slow down the onrushing ball carrier. In contrast, offensive players need to be aware of their positional space and be fully prepared to execute any plays. Since the passing play is getting famous, having the best quarterback duos and wide receivers are essential to lead the team toward victory. These players must have a good tactical understanding of games to avoid incomplete passes without fumble or interception. The amateurs or young players who do not know football in their High school life often find it challenging to understand this connection between quarterback and wide receiver. Philosophically, "friendship based on utility (Aristotle)" or get inflow during a game.

3.2 User Research

3.2.1   Coaching and practising

This section includes interview data collected from coaches and players. The interview questioned was asked based on the present context of American football in semi-professional leagues. The recorded interviews are indexed into playbooks and coaching practice based on the interviewee's answers. Some of the results are coded here to gather relevant information necessary for developing the final solution for the users.

"In my new playbook, we have ten plays that can run out of 35 formations. So technically, that is 350 plays not including motions, shifts, tagged routes"- Trevin Kain Howard: Wide receiver

"Many times, you are required to know more than one position. You cannot just look at the playbook and focus on one guy. Then, the same play can be run 100 different ways depending on formations, motions. It takes years of practice." - Trevin Kain Howard: Wide receiver

"We have 150 plays that players need to learn during practices. Defence and Special Teams have their playbooks." - Peter Homberg: Coach

"It is not easy to understand and it with arrows. Everything is written down. When you make a playbook, if it is a circle, it will remain as a circle. But you should write what goes around it."- Christian Heister: Coach

"Different ways to call plays – it should be easy for players to learn. However, it does not depend on how you do it. But you find the system to learn it quickly and what they have to do in the field."- Christian Heister: Coach

"The language used. There are lots of different terminologies that newbies do not get straight away, plus different words that mean the same thing depending on where you are."

"Players have to sacrifice much time to learn how to play tactical parts of football. Some players play more than two years, and they can barely get playing strategy."- Amanda Humphrey: Player

The best way to communicate tactical skills in American football is going through playbooks. The learning experience of playbooks is easy when coaches can properly convey proper instructions to players. For experienced athletes to read the playbook

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means interpreting tactical options. It is done by drawing up every play's mental map and processing information while reading it. The tactical options are the anchors, which are connected to decision-making skills. It is a sign or cue that helps players carry specific technical tasks or movements in the fields.

"Every person develops differently. Explain the why, how, what and connect that to the drills we do. Let players get responsibilities from the level of knowledge" - Peter Homberg: Coach

Athletes who are in a high professional league might easily navigate those cues with repeated practice. However, it takes years for new players to improve the ability to read and process information just by looking at playbooks. An ideal practice session for a team is when players can learn different plays in a week. Also, coaches need to find a proper balance in the player's technical and tactical progress while training and practising. Strength-based training in the offseason and preseason should not hinder tactical learning time.

"Lots of repetitions! The more repetitions, the more muscle memory is created. It is where learning takes place."- Spencer Ferrari-Wood: Coach

It is believed that tactical skills are learned by developing enough understanding of tactical options. As football is a team sport, learning a tactical skill is not easy as learning technical skills. There are many books and video recordings about teaching technical skills such as the kinematics of throwing and how to improve body mechanics. Still, tactical skills are taught based on theory. It is considered that this theory is memorized by practising in the fields and getting in contact with coaches. So that players are responsible for interpreting existing philosophy in every play.

"The most important is to measure technique with video analysis and then measure progress with the same exercises over time. For WRs, the ability to analyze their running patterns. For QBs, the ability to analyze their reading patterns."- Peter Homberg: Coach

"I always try to show my players themselves on video. They can see their mistakes, and it makes it easier for them to resolve them." - Spencer Ferrari-Wood: Coach

The coach can only evaluate the tactical skills of players in game-based practice or during the scrimmage. It has been seen that coaches use a camera to record the player's movements because it is laborious and often impossible to spot a tactical error through naked eyes. Besides, the cameras need to put in the proper place to cover up the

player's movement. Using only one camera fails to deliver the information explicitly. There are multiple viewpoints to analyze player's situations.

"I try to study the rules of American football the best I can, which helps me spot errors in real-time with the naked eye." - Spencer Ferrari-Wood: Coach

For instance, the cases such as occlusion, actions having away from the camera field of view inhibit delivering proper feedback necessary for tactical skills. Besides this, providing real-time feedback is delayed because it takes time to analyze a recorded practice video. Coaches need to trim appropriate frames, label individual player performance, and grade the multiple videos during scouting. However, it is also essential for coaches to provide instant feedback. Improper and lack of instant feedback weakens players' performance because players become less motivated to learn tactical skills (Ariafar et al., 2013). An added benefit of recorded video is that it supports athletes to learn through mistakes. It enables players to see themselves on video, through which they can analyze and resolve their errors (Fernandez-Echeverria et al., 2018).

"Players are using videotape to analyze their movement."- Marcus Flach: Coach

Nevertheless, mistakes result from poor choices that can be pinpointed with experienced coaches in good quality videos. Nevertheless, the athlete's performance errors are mostly related to slow information processing, which results from a lack of knowledge (Tulis et al., 2016). In other words, to learn the playbooks effectively, players need to paid attention to acquire this knowledge and awareness of tactical options.

Tactical options are available to players in two ways. One is just by reading a playbook that is knowing individual responsibility and figuring out when to react. Furthermore, another is reading the opponent's alignment, which helps the player process the information quickly and reduces movement time to gain an advantage over opponents. As a result of this, the coaches and players agree that football is reaction time.

3.2.2   Important of Reaction time

"Football is reaction time." - Maarti Poom, president of Tallinn Kings

 "Time is significant and critical; he is throwing the ball because he thinks the receiver will be there, which means he needs to understand other's skills." - Spencer Ferrari-Wood: Coach

The reaction time is the time interval between perceived external stimulus and triggering of body movement (Martens, 2012, p. 229). The external stimulus involved in football is primarily visual and auditory pieces of information demanding players to perceive. Then the sensed signals are processed by brains allowing the player to respond during plays. The reaction time is divided into two levels based on several perceived stimuli. If there is only one signal to a process simultaneously, it is called a simple reaction. This action is common to a wide receiver during the practice who needs to listen to quarterback calling to perfect the routes' time.

It is more about memorization level (memorizing playbooks), which plays a significant role. Hence, it helps the runner react quickly to the auditory signals. When a player has to make the right choice out of different information laid on the field, it becomes difficult to respond swiftly in the game's approach practice. Such reaction time where players need to exhibit decision-making skills is called complex or compound reaction. The complex reaction is correlated to hike's Laws (Soegaard, 2020). Reaction time is directly proportional to the number of stimuli present. It is applicable for players who want to process both the visual and auditory signals to interact with plays.

Studies had shown the elite player has good cognitive abilities than non-athletic (Arslan & Shadmehr, 2017). A good quarterback's cognitive ability analyses defence alignment and find the right target to throw the ball to a wide receiver. Possibly it has to be done without interference. The case is also similar for a wide receiver while training with defensive players. He must analyze the field to spot open space to run and what is expected in every play called a quarterback. According to one of the famous cognitive psychologists, Joan Vickers' mental abilities are improved by improving two skills, "the quiet eye" and "predictive control.

The "quiet eye" is "the ability to maintain a level and strong gaze on a distant object for a usually long period." Unlike other sports, players have to frequently demonstrate fixation or tracking of an object in American football. This object can be static or the movements of players or balls in the field or all together. The complexity of fixation varies according to the specific tasks required to perform by the players. Based on the gaze control framework, the quiet eye work by focusing on three types of motor tasks: targeting, inceptive timing, and tactical tasks. As for the tactical job, "fixation perceive the pattern of moving objects and persons, before performing an effective movement or play."

Similarly, according to Vickers, every information gathers from the quiet eyes is the beginning of the next move to make a critical decision by players. This brain's ability to proceed with the knowledge and anticipate the next move is called "predictive control." The difficulty of learning predictive control or the second level of tactical skills, which involved complexity, arises from a lack of practice and observation. It is stated that inexperienced athletes do not have a fine-tune mental map that can match up with retrieve information accumulated by quiet eyes.

As a result, the new player fails to make a quick decision that can help them to minimize errors in the games. Previous studies have shown that the Decision training model is an effective tool for improving player motor movement. The coach can use this model to enhance the player's decision-making skills in three steps. Firstly, highlighting the cognitive skills (pattern recognition and memory of plays) and using a mental trigger (reaction time, quiet eyes), and finally selecting decision-making tools such as providing feedback and getting familiar with variable positions (Vickers, 2007).

It can be said that the playbook is not for reading but practice because playbooks are created by coaches thinking about the perfect world, a team with stable and effective learners. However, this is not always true in the real world. There are players of different ages, experiences, uncertainty, and visual ability. All of these factors play a crucial role in learning tactical skills. When there is lacking knowledge in technique and training, mental and physical errors are generated in football, leading to a risk of getting injuries during practices. There is a distinct separation between training and practices. The training can be individual drills mainly focused on technical skills, but the practice is more about mimicking actual gameplay.

"Especially when there is physical activity behind it, your maximum effort starts to decrease after the first try. For example, 1,5h of practice is almost in the perfect timeframe. If we raise to three hours, his focus after two hours will be all over the place."- Maarti Poom

In a traditional approach (warm-up, training, then practice), practice might be skipped because of tiredness or not taught at all, but the practice has its significance. It helps players know what is coming, build up confidence, handle pressure from the opposite teams, and mentally prepare for its intensity. Although injuries during games are uncontrollable or inevitable because of the possibility of getting a tackle and more players, learning tactical skills helps minimize the risk of getting an injury.

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"Rule is all for this know where to run and how to run. If play cannot memorize playbooks, injury comes more from defen der attack him are not ready"- Priit Teniste: Sports therapist

"Most players are not aware of what is coming, and Team thinks they are strong enough and prepare that one level they are not prepared for the intensity and what comes from opposites teams" Priit Teniste: Sports therapist

"You think that there is more injury, but more people are playing the games" -Paul Kazimierz: owner Warsaw Eagles club

"Most injuring was because people do not play the games that they are supposed to play." -Spencer Ferrari-Wood

Tactical skills are improved by learning from each other play or perfecting time between each other. To illustrate, most of the semi-professional team practices less than three days a week and prefer to build their games on imported players, especially quarterbacks. It helps coaches formulate an offence games system relying more on the quarterback where there is a possibility of passing play and different routes to run for the receivers. In such gameplay, the quarterback looks for good ball placements at different distances run by receivers. The quarterback's ball placement ultimately impacts the receiver's plays as in the playbook or vice-versa. Because receivers play for quarterbacks, and the quarterback plays for the playbook.

The quarterback needs to be on the same page with the receiver to put the ball in the right spot before the receiver hits it. They need to think two steps before the receiver makes the run. The quarterback needs to know every step of the receiver, whereas the receiver must anticipate the quarterbacks' movement. From a positional perspective, quarterbacks have tons of advantages compared to other players on the team. Physically quarterback has some advantage over another player because of the offensive lineman protecting him to get enough time to throw the ball. Moreover, this delay in throw is advantageous for the receiver to perfect the timing with the quarterback.

Most coaches emphasize team development and focus more on progress than team perfection. The training session generally consists of a fixed setup; Warm-Ups, conditioning, individual position drills, position drills, play-based segment, and feedback. Coaches focus on two things; play-based is a more significant part closer to the season, and individual position drills more substantial offseason.

"I think some former coach is good for the junior team, but as a coach, you have to open to ready to learn."- Paul Kazimierz, Warsaw Eagles

"It is important to broaden the perspective. I was taught to tackle like this, but he does not know how he was running, and now he is teaching to many people." - Spencer Ferrari-Wood, Coach

"European coach understands the situation of player better. For example, then American coaches who only have experience with high school football or college football." - Paul Kazimierz, Warsaw Eagles

Also, most imported players take the role of mentors in coaching. Most of the critical decisions are made by the coach, whether it is about the club's future or building a Team. Spencer Ferrari-Wood (an American coach, speaker, writer) points out some possible shortcomings of coaches in most semi-professional football. According to Spencer, many former players who become coaches lack coaching experience and proper knowledge of teaching. Some coaches limit themselves to adopting new methods for what they have learned already being as a player. Every year, defensive and offensive skills keep on improving. Hence, coaches need to rethink their game philosophies or need an appropriate tool to ensure that it suits the duos of receiver and quarterback.

3.2.3   Conclusion

Learning the playbook is difficult for the playbooks, but improving tactical skills lies in monitoring reaction times because of the complexity involved. Tactical skills are dependent upon the mental process of visual and auditory signals. The less time it takes to perceive the information, the faster the decision-making skills. Besides, evaluating the time it takes to react to external stimuli is the best way to help athletes train themselves. Coaches create playbooks. Suppose the player can easily perceive information from every play and interacts with them in a game-like simulation. In that case, it can help the player quickly reactor to available tactical options such as timing reaction time and improving cognitive abilities. Furthermore, selecting a suitable feedback mechanism will allow the player to boost confidence and motivate them to train purposefully.

3.3 Field observation

The section introduces how players are practices and how it is adopted in different. During the last months (before covid made a ban on playing), I visited the Tallinn Kings football training field and observed how players are training. The coach's feedback mechanism and player training and practice session were analyzed.

Figure 3.3:Scrimmage, quaterback calling play

Figure 3.6:Stance

Figure 3.5:Running routes

Figure 3.4:Turning

Figure 3.7: Catching

Sõle Jalgpallihall

Tallinn King is one of the American football clubs (other Tartu Titans) in Estonia. The club has been active for the last twenty years. Throughout this stage, the squad has gone through several changes by adopting various plays and philosophies. Even though American football is not a major sport in Estonia, the country has produced experienced players like Magus Hunt to play in American National Football League (NFL). Likewise, Tallinn has created an opportunity for a young player (Ülar Tiitma and Ott Eric Ottender) to pursue football in higher leagues.

Today, the club is run by experienced players and coaches. Furthermore, the team is looking to play the Finnish league next year and compete in the European Football league. The club teaches American football techniques and tactics to young players to reach their full potential for upcoming years. Usually, the club's teaching time is divided into three times a week for about one and half hours of training in one day.

For this research, "Tallinn Kings" players serve as the best model to gain rightful insight into American football training. Even though training time might not be comparable with professional football in America, coaching philosophy is the same as most countries in Europe. That is, teaching game theories is quite common to college-level football. Because coaching philosophy directly impacts player performance and learnability of tactical skills. The team training schemes and practice setup were observed.

The players get to scrimmage in the training session by doing some twenty minutes of muscle stretching and fixed exercises. The team follows a particular structure used by many teams, such as the L-Drill, Shuttle Drill, 40yd Dash, High, and Board jumps, push-ups per Squats to strengthen the upper and lower body. After doing some individual drills, the team starts to follow regular offensive and defensive drills based on their positions. Similar progression has been used across all levels of American football for a long time. During the scrimmage, whole players gather to practice plays from the playbooks. The offence and defence have to use their playbook.

The quarterback calls the terminology, and the receiver has to make a run in every plays. The practising keeps on going until the final plays have been called. The stand camera records the movements of the players. A team uses these videos for analyzing performance, and the coach comments on the player's account or shares the videos privately with players. This process is time-consuming for the coaches, and delivering real-time feedback is difficult without properly assessing athletes. The post video

analysis of recorded tape mainly results in irrelevant feedbacks. It has to do with the quality of video and how many moves that camera can track.

It has been noted that coaches are eager to evaluate player progress. However, the only means of the evaluation criteria is to rely solely on observation. Aside from coaching experience, the coach uses the information received through naked eyes and spot-on error analysis to assess if the passing philosophy he has implemented is suitable for players. It will remain an extra collection for the playbooks if the details cannot be preached and interpreted to players. If players do not remember correctly, proper feedback is not provided when players make critical errors during practices.

"For example, if they explain in detail how they want us to run the routes and stuff" - OTT Eric: Wide Receivers

"I would like to know how they are running routes whether they will match up with the time and see open space" - Peter Homberg: Coach

"Feedback is essential. The coach can give direct feedback to avoid small errors become habits. I analyze via video and same tests over the season" - Peter Homberg: Coach

"Strength and conditioning are imperative in American football. Analytical tools might help provide valuable information to help inform me to make a good decision"- Spencer Ferrari-Wood: Coach

Even though training for weeks, players experience difficulty memorizing plays. In the theory session, the player generally learns about the coach's philosophy and sets together to do a video study. Furthermore, 'X' and 'O' and lines are drawn up on the whiteboard to provide a briefing on system theories. Player difficulties are that it lacks the demonstration to learn the new concepts quickly. Some players would like to get more information from the coach and visualize playbooks in the fields or observer how the games are developing.

Similarly, players are using wrist coaches, digital playbooks, and online pdf to understand their roles. Still, players were concerned that it might help them to learn theories in a manageable way. However, do not inform players whether the decisions and movements made by players are effective.

Additionally, the players' critical factor is that they want to see their progress and believe that it will improve their sense of belonging, volition, and confidence. Similarly, players admitted that practice sessions are mentally challenging because they need to minimize errors and avoid injuries. Therefore, the possibility of training with full strength during scrimmage limits them from improving passing consistency.

After exploring training and practices and teaching methods and regularly meeting up with coaches and players, some helpful insight into complex plays has been discovered. The coaches were asked what their expectations were and what they would like to see from the players during offensive play. It has been found that coaches want to improve passing consistency in players by perfecting routes' timing. However, the coach could not monitor player routes by using only cameras. (President of the club) Poom and Holm (Head coach) agree that evaluation tools might help players run routes properly.
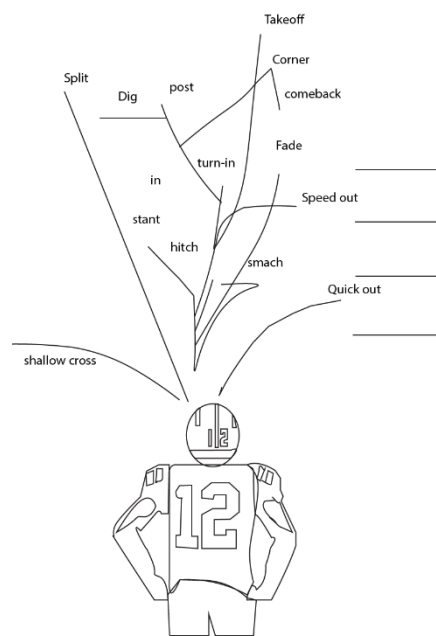
Figure 3.8:Routes tree for Wide Receivers

Furthermore, the coaching philosophy plays a significant role in improving the relationship between quarterback and receiver. Similarly, the quarterback's ability helps coaches create an offence games system that enhances the receiver's performance. Suppose the quarterback has good cognitive and anticipation skills. In that case, the chances of pass play are high, so the varieties of routes for the receivers. In that case,

a quarterback needs to know the receiver's possible path. In contrast, the receiver does not need to anticipate the quarterback's movement a lot.

Before every play-calling, the quarterback read the defence position and inaction, uses gaze tracking methods by analyzing two or three player movements in the field. The first two players generally include one receiver and linebackers; if this option is unavailable, the quarterback shifts their vision to another receiver. Those abilities take longer to develop, and mistakes are expected when they have to process all of this information to make quick mental decisions in a split of seconds.

Similarly, from a positional perspective, quarterbacks have tons of advantages compared to other team players. It can be said that quarterbacks are physically protected because of the offensive lineman protecting them from getting more time to throw the ball. On the other hand, in practice, the receiver can wait for the perfect ball from a quarterback to improve their catching coordination. Alternatively, follow easy steps of perfecting their route since catching the ball comes from information perceived from eyes. Routes run by the wide receiver are called to be perfect when they do what is expected on the playbooks, and it matches with the throwing time of the quarterback. Therefore, the receiver needs to react quickly and maintain routes in every play.

"The Golden Rule for Rhythm Passing to us is that the QB must be set two steps before the receiver makes his final break." Everything is taught in steps. When you grade the film the next day, you can count. For example: "Hey WR, the QB is taking three steps, and I told you to take five steps, and you took 7. No wonder the rhythm was not there". (Campbell J. , 2017)

"If you give a receiver a second to get started. He can get a yard for every tenth of a second after that. If a guy runs a five-yard out, he can get down there and break in 1.5. If he runs a ten-yard out, he can do it in 2.0. If he runs a 15-yard comeback, he can do that in 2.5." (Campbell J. , 2017)

3.3.1   Offensive philosophy

According to coach Bill Renner, consistency in passing improves when the quarterback does not have to make conscious decisions inside the pockets. So, in the practices, most of the team works to match the quarterback's drop-back footwork with the receiver's route footwork. The receiver will run its specific routes and turn when the quarterback is ready to throw the balls. The modern philosophy of passing play comes up with most of the variation. Most of the passing play used today to train athletes is the precursors

of the west coast offensive. An American Football Coach, Bill Wash, invented the west coast offence in 1979. Since then, the passing play has been famous in most of the leagues. Wash's main idea was to pass the ball between the quarterback to the receiver at the right rhythm and minor mental work.

Similarly, the coach Peter Holmberg explains that Tallinn Kings uses the offensive play that obeys Wash's concept. By drawing upon Wash's philosophy, many coaches have elaborated the idea in modern football, mainly emphasizing quarterback footwork's timing. Passing consistency is achieved when there is the coordination of quarterback drop back footwork within the receiver routes footwork.

The time frame within which the ball is delivered must set by the coach to evaluate the player's performance and improve coordination. According to the quarterback, footwork varies depending on the offensive formation. For example, the quarterback might take 3-steps (1.3 to 1.8 seconds) for the short routes and 5-steps (about 2.3s). For the rookies, synchronization of footwork is most challenging to learn during skills acquisitions.
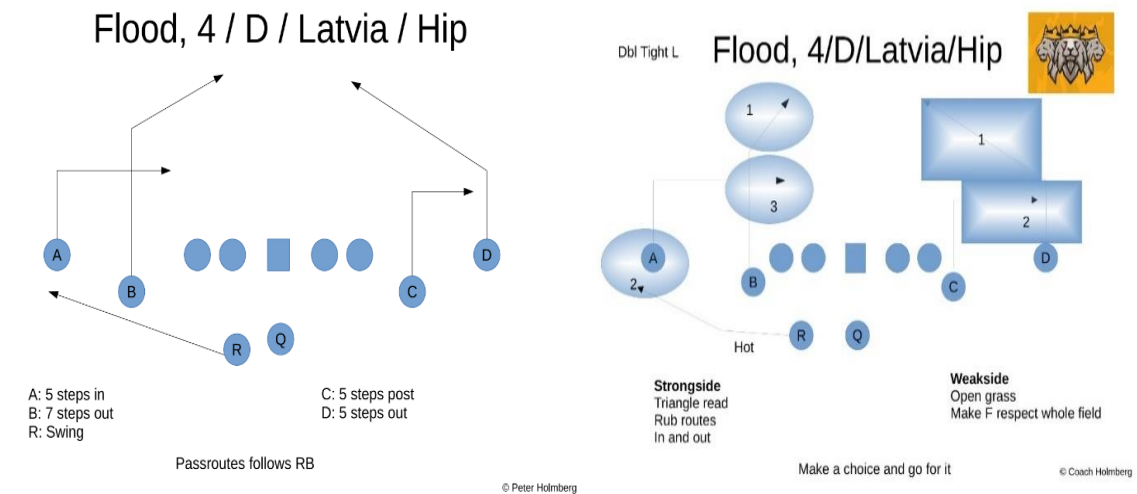

Figure 3.9:Offensive plays of Tallinn Kings(like westcoast)

Furthermore, the timing of footwork between the duos depends upon the opponent's alignments. A blitz or a defence rush is a defensive team tactic to sack (interrupt ball from the hand of a quarterback) quarterbacks. When the ball is snapped, five or six more players rush towards the quarterback by giving pressure to the offensive lineman. In response to that, the offensive used pass protection techniques to match out the given play. In that case, the receiver needs to follow the concept of sight adjustment.

The philosophy relies on "if a defence blitzes, the quarterback and receiver must both — on the fly and after the snap recognize it and adjust routes accordingly" (BROWN, 2011)

A base play might look like all the receivers running the routes downfield in a system reliant on' sight adjustment' to combats blitzes. If the defence shows blitz, the receivers must break off their ways to give the quarterback somewhere to throw the ball. Modern defences consist of multiples variations, and relying on the "sight adjustments can result in bad reads by receivers and quarterback alike, resulting in sacks and interceptions.

Therefore, coaches built-in 'hot routes' or short passing routes are introduced for receivers as a possible solution to encounter blitzes. Therefore, memorizing terminology and a qualitative relationship with a coach and delivering appropriate feedback improves the playbooks' learning process.

3.3.2   Communication between coach and players

"But I saw coaches getting burn out and other problems while coaching and wanting too much or just making wrong decisions." - Marcus Flach, Coach

Coaches use the playbook as a means of communicating tools. It is often a linear process of transmitting concepts, theories, messages from coaches to players. Poor communication deteriorates the coach-athletic relationship by impacting player performance (Kassing & Infante, 2009). According to Laswell's communication And Shannon's transmission model, the communication will be effective when the player can interpret the message sent by coaches. When the player can decode the concept, theories from the medium in which instruction has been scripted like playbooks, good communication in the linear transmission perspective caused the desired effect.

Also, communication is the medium to exchange meanings. Coaches channel the game theory during playbook sessions, whereas the player needs to extract practical purposes from the construct signs. The interpretation of such a message various according to the players, but the expected result should be the same. Proper communication helps strengthen the coach and player's relationship and share ideas that might assist the player in establishing their identity.

3.3.3 Important of feedbacks

However, there is always some noise (false interpretation) and environmental factors (lack of demonstration), hindering players from adopting the plays. The coach's responsibility is to respond to such noise and ecological characteristics to reach their full potential. The way coaches act to player's circumstances using verbal and nonverbal responses is called feedback[page 16]. Positive feedback on schedule is the only way to complete(cycle) linear communication model because, through this repeated process, players can improve their learning ability.

A strengthen coach-athlete relationship has been seen as a determinant factor for improving feedback and player learning capabilities. The correctional study conducted among 301 student-athletes concluded that a good relationship with a coach could foster students' motivation to learn the schemes (Junior & Team, 2020).

Similarly, during the experiment conducted with sixty coaches, the coaches who have to acquire the knowledge of athlete empathy can only provide accurate feedback (Lorimer & Jowett, 2010). Furthermore, studies have confirmed that positive visual feedback can help improve motor learning skills and test the learner's skills level (Yamamoto et al., 2019). Additionally, appropriate feedback can help athletes promote safety in the games (Dieën, 2013) (Harris et al., 2020).

Feedback's delivery system varies according to the training phases and coaching experience (Nash et al., 2016). In the playbook session, the coach set the goal and communicate with the player using signs and symbols. Coaches provide direct feedback when players learn technical skills or perform individual drills like taking two-step drops and moving arms properly. Feedback can also be provided based on the classification of tasks. For example, players might be asked to run in the specific routes or throwing the ball at the players.

Furthermore, the other way of providing feedback is based on the video analysis of team movements. Player movement errors are pointed out by showing video sequences to the player. However, demonstrative input and the outcome of personal reflection are less emphasized in the practice session.

Accurate feedback helps the player improve the ability to perform specific tasks. However, at first, coaches need to find the input required based on individual preference. Robert J Mason and his team conduct an exploratory investigation to analyze

video feedback sessions between six coaches and six football players from the Australian football league club (Mason, 2020). The group recorded one-to-one video sessions and provided feedback. The last team compares the effectiveness of the video feedback session with a player. Out of thirty feedback messages given to players, players can only recall six per cent of messages from fifty per cent of summarized feedback.

Individual feedbacks are less when there is a higher number of players are playing in the fields. Providing more concrete and positive individuals will help new learning follow the guidance of coaches to develop technical and tactical skills (Pål Arild et al., 2017). To that, players need time to create scenarios where they can learn to master those skills. Extrinsic feedback is common when coaches spot errors and new instructions are provided to solve those problems in player movement (motor learning),

However, feedback provides by inexperienced coaches can lead to fundamental attribution error. Likewise, intrinsic feedback is also necessary for the player to self-evaluate themselves. Research has shown that the key to improving young player's engagement in the skill learning process relies on maintaining their intrinsic motivation (Miao S et al., 2020). To enable intrinsic feedback, the player needs a tool that helps them independently develop by getting a sense of actual play. Such devices are essential in learning difficulties due to physical and mental fatigue in training so that players can find an appropriate time to practice with themselves.

3.3.4   Conclusion

The complexity of learning playbooks is due to difficulties in interpreting the coach's philosophy. Although the instruction is provided in different cases, players misinterpret the concepts and start performing unrelated movements during practices. Similarly, in the coordination training, players fail to react and adapt the skills appropriately due to a lack of demonstration and appropriate feedbacks. Video-based feedback sessions are used as an evaluation method. However, it results in too late for players to correct the errors and memorize for the next session. As a result, players feel motivated during practice time.

Furthermore, tactical skills are complex for the coaches to evaluate because it requires proper evaluation tools that deliver feedback in real-time. It is immediate enough to provide solutions that overcome the errors in players' movements and minimize the risk of injury. Also, the input needs to be reasonable not to create any cognitive bias and

errors but helps players enhance their performances. By analyzing American football training and underlying offensive philosophy, it is observed that coordination training between quarterback and receivers is a priority of any team (than other defence). Also, for the player to participate and improve their games within the time frame is difficult due to a lack of knowledge to learn tasks independently. Players fail to maintain the same amount of pace as the individual learning capacities vary.

3.4 Advent of Technology

The rise of performance-enhancing technology has narrow down the gaps for a new learner to potentially reach the elite level. The so-called training equipment is widely accepted in major industries such as medical, rehabilitation, military, sports, and several other sectors. Likewise, in American football, the use of technology in training is seen in the broader context of whether it is a club decision to keep players safe or improve player's abilities. The use of technology has assisted athletes to stay fit at the highest level and compete in the professional league.

Technological improvements have brought changes in training practices like replacing several old training equipment. Compared to other sports, football is considered highly competitive and harder to learn, and often risky to get injured. The effects of adaptation of performance-enhancing and safety tools during training have been positively noticeable. As we are heading towards the future technological innovation has open the door to overcome hurdles that have been impossible for years. Therefore, it is only a matter of time when this technology can find a suitable place to shine in the realm of American football.

3.4.1   Infield Training

1. Football Throwing Machine

Figure 3.10:American football throwing machine

(Jugs Football Throwing Machine, n.d.)   (Vasic, 2021)

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- **Jugs**

The concept of the American football throwing machine came into existence in 1988. And it is still popular these days. It is a manual throwing machine as it required input from two people to train an athlete. The introduction of the device revolutionizes the training practice and development in the game. The team needs fewer quarterbacks who have a problem with repetitions and mainly focus on the receiver to improve hand-eye coordination.

- **Monarc Seeker**

Seeker is an upgrade version of Jugs pitching. It is a semi-automatic robotic quarterback that provides the capabilities of throwing six-ball at regular intervals. It tracks athletes' positions based on a pulse antenna and pulse clip sensors placed on the receivers. The device helped to improve the hand-eye coordination of receivers.

Philosophy - The amount of the ball quarterback throws might affects the receiver's performance. Because during the practice, a quarterback has to throw balls to a receiver in each route and make sure everyone can catch the same amount of throws and throws are perfect. Heavy loads of throws are also nasty for the shoulders, and therefore it saves time for a quarterback. Training or practice time needs to be used favourably for both quarterback and receiver on such issues.

2. **MVPs**

It is a mobile virtual player; a dummies model controlled manually to simulate the player's movement on the fields. These mobile robots help defensive linemen to learn tackling without injuring other players during practice sessions.

Philosophy- injury protection and increase efficiency of tackling for defensive players.

3. Wearables

- **Qbit**

It is a wearable technology that enables quarterbacks to train their eyes. The device is worn on the head of the quarterback. The quarterback receives real-time feedback based on which direction he is looking. Such as far-right, right of centre, left of centre, or far-left—an app guide quarterback based on the playbooks. (Lemire, 2017)

Figure 3.11:Qbit model

Philosophy – Useful for a quarterback to improve cognitive abilities (The product is still in development or No further instruction about a product)

- **Notch**

Its wearables system contains several modularity sensors attached to the body to represent the three-dimensional motion of motor movements like arms and legs. It includes an inbuilt alert system to notify the user with vibration to identify critical areas that need to correct during muscle movement. It is helpful for athletic

Philosophy – enhance motor performance or learning

- **Zeep 2**

This device consists of wearable sensors attach to the gloves of the golfer. It is used by the learner to analyze GOLF swing with a professional swinger. The device gives the data parameter of various values such as club path, tempo, hip rotations, hand speed. The three-dimensional movements and video analysis of swing are done through ios apps. It is an easy and on-range practice tool that can be used anywhere at any time.

Philosophy- perfect the body movements to match the swing.

3.4.2　Outfield training

1. Wearable

Three main virtual reality applications have been identified as helpful training tools for quarterbacks. All of them are developed to fulfil the same reasons: improving the cognitive abilities of quarterback by immersing in realistic/virtually recorded videos. (Welter, 2019)

Figure 3.12:Virtual reality for Quaterback training

- **SIDEKIQ**:

The software platform of SidekIQ was introduced in 2013. Later the in 2015, the mobile apps were made available for Android and iOS users to try it out with virtual reality headsets.

- **QBSIM**

Followed by SIDEIQ, in 2016 Sports Virtual training System company bring another quarterback simulator tool to combine real-world repetition like that dropping back in the pocket, throwing a real football) within the immersive environment

- **STRIVR**

It is a virtual reality device used to improve player performance. This VR technology helps athletes get mental reps off the field when they cannot be in the areas. There are rules around how longs a player can practice and physically allowed to be on the practice

field during NFL season in sports. With the help of this tool, the player can get mental reps that are valuable. The VR experience helps players prepare for the game by testing the zone on 360 views from pre-recorded footage. The device requires installation on the fields, and there needs to be a coach to provide feedback.

Philosophy – Repetition helps to build a mental map for performing, promote safety, preparation for games

2. Online software

- **Hudl**

Hudl It is online software that provides capabilities to analyze the practice and games recorded video. The program gives the user access to upload a video clip of the games and track and comment on the plays type, formations. It also allows for managing playbooks and team members. The report of analysis done using marking tools is shared online with players.

- **First down**

It is digital playbooks that help to save time for coaches without the need to write or look for whiteboards. A Team can manage thousands of playbooks or can create and keep playbooks on the system. The playbooks contain some instructions but do not provide detailed information on user data.

3.4.3   Ongoing technological development

Monitoring athlete data during training has been an essential aspect of the life of athletes. For a long time, training records were marked on the diaries and notes by coaches or players to verify player's readiness for the game and measure the athletic progress every day. Nowadays, the availability of improved sensors like the global position system, accelerometer, gyroscopes, or inertial measurement Units (combine sensors) has provided conditioning practitioners with accurate data to get an in-depth understanding of the athlete's life. Similarly, those data have been used by sports scientists, sports therapists, and coaches for understanding motor skill learning of players and creating proper coaching methods. Also, the accessibility of individual

performance data and real-time feedback has beneficial for the player to stick with the training plan (Hooren et al., 2020).

Similarly, a device with integrated sensors to collect the right amount of data from individuals has been helpful in different sectors (like rehabilitation patients) to deliver the right amount of training loads. Moreover, individuals have used these data to maximize their performance skills, monitor their physical capacity, and take precautions against injuries.

The data monitoring system is available in various ranges depending upon the task and accuracy of movements. The two subsystems that are commonly used are marker-based and marker-less. The marker-based system includes wearables (wireless suits) or modular sensors or colours marker required to be attached to athletes' bodies while analyzing the motor movements (Khan et al., 2020). Based on the measurement statistics, athletes receive real-time feedback through vibration, sounds, or augmented information on the screen about motor performance. A marker-based sensor like a micro-electromechanical system (MEMS) is used when complex movements are involved, and high precision is required.

Similarly, the markerless sensors are done by using motion-sensing cameras. The data from the camera are inference-based on the sequence of frames that are useful to analyze joint motions in real-time. Concerning it, the colour-based marker attached to the body is called a hybrid data monitoring system. Those coloured patches are analyzed by using computer vision technology to distinguished kinematic movements of the motions

With the increase of computation power, artificial intelligence algorithms have gained popularity in many devices. The improvement in machine learning and deep learning (a subset of machine learning) architecture and the immense amount of data to train AI models have given possibilities to extract and identify advanced patterns from scenes to create human-like decisions. Whether it is speech, facial, and gesture recognition or identification and classification of the object, the ability to provide a machine with a human-level of intelligence is still on the rise.

3.4.4 Promising technology for future

Human beings have constantly been gathering information from the two-dimensional interface in the digital era, far away from how the data is perceived in the real world. The field of vision allows humans to perceive the existence of an object. Furthermore, the senses interpret an object in a particular space in a time as absolute. Moreover, suppose those objects are interactable that can be touch and feel and manipulate. In that case, they can change the perception through which we view reality.

People can commonly see, hear, and touch is altered by the technology, for example, using the filter on the photo and listening to music. As a result, the human being has created a new reality by integrated technology in life.

Technology has been used in the natural and digital world continuum to bridge the gap between the two worlds. To creating this proper vision of perception and making sense of the natural world, and interacting with the real world, many tech giants like Microsoft, Apple, Facebook are working toward the future.

1. Spatial computing

Spatial computing has been a hot topic of discussion for the future. With the rise of HoloLens, Magi leap and HoloLens two information delivery system has reached to next level.

Spatial computing is the type of computing that is no longer limited to the dimensions of the device's screen. Rather than that, it would be capable of doing computing on a much larger scale without restrictions of the dimensions of the device's output channel, i.e., a screen.

It all started with the birth of the first personal computer amid the late 1970s where the systems did not possess a graphical interface. Still, soon the advancements took progression, and that was no longer the case in the 1980s. Then after that, the smartphone in the midst of 2007 took the world by storm, and most of the devices that we often use are the mobile ones, as the modern-day smartphone. Now, to expand on it, the day and age have come for spatial computing.

Spatial computing possesses both the hardware and software ingenuity to create a seamless balance between the real from the digital. It enables the user to close the gap between the virtual and the real world. For instance, human beings would interact with

digital objects as if they were not inanimate digital objects. Much investment is going into spatial computing because the world demands it in a high amount —one of the core reasons behind it being the pandemic. The premise of the new day and age of spatial computing is that it will always be available for usage. Whenever we need it, it will be readily available. For instance, if we decide to watch a football game, we can watch it real-time using spatial computing. Players can see the movement of the ball and the players without any dimensional restrictions of the streaming component.

In the world of spatial computing, many terms and advancements are being brought into action. Augmented reality, abbreviated as AR and MR, whose complete form is mixed reality and virtual reality. There are various terms and implications for those terms. However, they fall under the same umbrella called XR or extended reality. AR overlays the information on the screen, which helps provide instruction.

On the other hand, VR lets the user escape from reality by immersing the user in the virtual world. At the same time, MR blends the digital world to the real world or vice-versa. The realism that mixed reality has created is made possible with the help of spatial computing, which means humans have the power to interact with digital objects.

2. Visual development

It is assumed that the predominant form of spatial computing will come from the user viewing the world in an altered state. Using visual components, which are considered to go in displays and headsets that cover the eyes without hindering sight, a clear example of this would be Google glasses and Microsoft HoloLens. The typical pattern can be seen everywhere. Especially in the world of technology, after something new has been created, people will try to improve upon it, which is assumed to happen soon. HoloLens is limited in terms of resolution, colour, and a more comprehensive view.

Apple and Magic Leap step into the innovation game. Soon, that gap will close because they have already put their research and development work into creating better options for spatial computing. To illustrate, the second generation of HoloLens, which has a greater FOV and good processing power. Similarly, according to the creator of HoloLens, Alex Kipman, HoloLens 3 is launching in four years with an infinite field of view (Anderson, 2019). Besides, big tech giants like Google and Facebook are already using these to expedite the process and bring forth scalability and innovation.

3. Networking and the innovation of 5G

Spatial computing will require many data. All the digital assets are assumed to be hosted in the cloud because the present-day computer is not the most ergonomic. We must factor in many things, like when we use spatial computing devices. It must be acknowledged that they will be pulling in many data and uploading more extensive data because making it immersive makes it compact. With the advancements of networking in the modern-day and age, the world of technology is looking forward to a State where internet connection is not an issue and limited.

It all is about to come to fruition with the help of 5G. The benefit of 5G is that it can speed faster because the devices that possess spatial computing require many data. Furthermore, it would be the ideal route to ensure its success. Many developed countries have already started to implement 5G. Right now, it is still in its infancy, and the adoption rate is limited. Still, as time progresses, it will reach full adoption. Many stadiums and cities have started to add infrastructures that aid 5G, which is a plus for spatial computing and strengthens its move towards the public.

The additional information needed to consider here is that 5G offers many merits. Still, our current devices are only capable of using a limited amount of those exponential speeds. The new wave of technology allows Qualcomm, a major chipmaker that creates much innovation by adding additional sensors to aid spatial computing. Similarly, Apple has made the most powerful processing unit such as M1 and A11 Bionic processors with 5G enabled on its mobile device.

4. Innovation of sensors

Often when a device is designed to project digital objects into the real world, it is used by someone who has never used it. They tend to lean towards grabbing the digital asset that is showing up in their field of view, which happens to be an example of where the world of technology is heading. It is assumed that it is going to be possible with the help of spatial computing. Many companies have already started innovating in such fields because they are fully aware of providing such advancements to the public.

The innovation of sensors is a broad spectrum because it consists of voice, sensation, and the visual field. For instance, the controllers that come with the HTC Vive already come equipped with vibration motors that make it feel real and directly experience the

user. Furthermore, the same is the case for the Tesla suit, which allows the user to feel cold and warm sensations in the previous day and age. Still, due to more innovations happening in the modern-day and age, it is possible.

At the current state, the components used to cost a lot, like advanced sensors, are available in a fraction of the cost and can be implemented in various spatial computing equipment. Similarly, a mobile robot equipped with less expensive LiDAR (light detecting and ranging) is paired with mixed reality glass to alert the military about the environment (Reardon et al., 2020).

The rise of Artificial intelligence has speared it to mass adoption. For example, the Google Assistant provided by Google can hold conversations with people. The recent software update to Apple computers allows it to be used simply by using voice controls. All of which is possible with the help of sensors designed to grasp information and provide the desired output. In contrast to it all, another good addition to sensors is explicitly intended to interact with the eye. Because an eye is like one's fingerprint and its implications are grand, spatial computing mainly relies on visual view. It has seen implementations in touch and sound to aid everyone.

5. Mapping

The central concept of spatial computing will bridge the gap between the digital and the real world. Mapping will aid it by creating a digital version of the natural world to bridge the gap. Digital objects are brought into the real world. However, they still need to react and respond to the surrounding things to make it a good experience, and mapping is the right innovation. It is based on visual sensors and sensors that can sense the vibrations like a standard smartphone already equipped with many sensors. For instance, Uber, the massive ride-sharing app, has begun to collect data using the mapping innovation. That tell which roads have potholes based on the data provided by the phones of the Uber drives.

It can lend a helping hand in the context of this research because the players will have to pass through different terrains and obstacles. When a device is with them, it will map the difference in speed and where one might have blundered. The main goal of mapping is to create detailed maps of the environments to estimate changes and use them to better humanity. An excellent example of this would be from a company called Visalia which maps the factory floors. The way they plan to use it is during the training of their

new staff. The other benefit of it would be that it would aid the architects to decipher the right place to input their creation. The same would be the scenario for the athletes who would want to practice.

6. A shift towards a new computing architecture

The current state of the world is that it is reliant on big data centres where we are relying on only one source of data. Data centres everywhere, but if a data centre goes down, it will affect millions, precisely the aspiration behind the big tech giant's innovation. For instance, instead of having a server far away and having a vast latency, having a small data centre nearby while having the central data hub in the primary location is best. It is good that we might see faster internet speeds, but what good is it? Suppose data centres cannot overcome the latency.

In that case, sure, many computers are going serverless and are hosting things on the cloud. However, they are still an ongoing pursuit of decentralized data centres where users will not be limited to the only data centre in their surroundings. Instead, it is assumed that data centres will be all around but not on a large scale but on a smaller scale, where one server will do a particular task. The other one will do a specific job in one particular location.

Before, this was not possible, and now, there is cloud computing. The new step forward is assumed to be a new computing architecture standard where reliability is at the pinnacle and latency is limited. Such advancements aid spatial computing because extraordinary computing is all about interacting with data, either uploading or downloading data.

7. Various decision systems

The idea behind the decision system is that machines intelligence to make better decisions on human behalf, reduce the strain of mundane tasks, and optimize scalability. The most used term in this field is deep learning, where we have controlled learning and uncontrolled learning. Supervised learning provides a data set in a controlled environment for the machine to learn from the environment. The uncontrolled one is the opposite, where the device is asked to implement and analyze the data. When these learning methods are used, they will aid in spatial computing. When we use spatial

computing, the system will automatically determine the best route for sensors, connectivity, and longevity.

Additionally, various decision-making systems like AI can decipher data quicker than humans' average time. It will aid every field because it is assumed that the data can provide decisions that state the correct answer to a solution. In the case of the athletes, the system will pinpoint which athletes need to practice more and in what field they need to focus. The main ideal idea is what good are sensors and equipment if there is no proper decision system to determine where those resources need to be utilized.

4.   Make

4.2 Design Brief

"The playbook is about memorizing a procedure, but specifically a description of a procedure. The challenge is memorizing the playbook but having to translate that memorization into the action on the field. Two different brain systems." (Redish, 2019)

"When you imagine a visual scene, your visual cortex is active. And when you imagine doing a motor action, your motor cortex is active. There is a process called 'consolidation' where, with enough practice, a deliberative sequence can be translated into a procedural one. This takes a lot of practice, both internal (imagination) and external (physical, real)." (Bowen, 2017)

Goals drive new players who want to improve their technical and tactical skills, but the 'goals without the timeline are considered dream' when not planned correctly. Needs drive every individual goal, but only the one who sticks to the training plan can achieve it.

For the designer, user needs are the pillar to bring ideas to the table and creating concepts that solve the problems. It is believed that user needs determine the success of any product or opportunity for creating concepts. Therefore, the input factors that makeup user needs are accumulated by analyzing the methodology section systematically.

The conclusion drawn from literature reviews, interviews, and training observation is considered parallel with various technologies to explore opportunity space to improve experiential learning for the athlete. The keys insight that makes up the design brief are highlighted below:

A. Learning playbook

Every individual has a different ability to learn the playbooks. Learning playbooks is the key to success for athletes looking to perform successfully in professional leagues. Players need to develop the habit of consuming the information from the playbook effectively. So that players can memorize the playbooks and maintain consistency during plays. Remembering the roles and performing the movement pattern naturally from the different plays gives players an opportunity and exposure to play in the highest level of football.

B. Coach and athletic relationship

When players are not evaluated adequately based on their performance and knowledge, they will not correctly use executive movement skills. Overall, it is frustrating for the team and coach when players do not meet the expectations encoded on the playbook. In such a situation, performance monitoring and proper communication become cofactors for enhancing coach-athletic relationships. Similarly, the instruction and guidance from coaches are equally important along with when a player is getting a sense of skills in early skill development phases. However, too much information and cognitive bias have been seen to have a negative impact on the life of a player. Minimizing false perception can help players connect to the coach's philosophy and reliably adapt to the new play system.

C. Errors in the movements

The fundamental movements that make up technical skills are taught in every school of coaching. The only difficulty for new players is that they dedicate much time to mastering those fundamentals and, therefore, keep aside the vital skills needed to perform during games. Because football is all about reaction time, the typical error in a practice session that can be seen repeatedly is maintaining consistency in footwork timing. Having an ability to react quickly to different routes from playbooks and anticipate the opponent's alignments gives a competitive edge for new players to outrun defensive schemes.

A new player is limited to learn and perform those skills on the fields as the risk of getting injured is higher when movements are not appropriately executed amid chaos. Also, the team must consider mental fatigue that restricts the player to practice with the team as this kind of circumstance is frequent in the traditional coaching method. It is too much for the player to remember and applied skilled within an hour of training when the movement needs to be noticeable.

The performance difference between elite football and non-athlete is that elite footballers must follow the play's system. The repeated errors are pretty standard when players do not remember the terminology from the playbook and play without the system. Such repeated errors lead to frustration and deter players from fulfilling their goals. So, independent learning by being in a system with relevant information is required to improve the skills.

D. Feedbacks for iterative learning

Extrinsic and Intrinsic feedbacks are essential for a player to help continues training and perform well in games. Feedback is a powerful tool that helps to improve decision-making skills by reducing any possible errors arising from movements. An appropriate amount of feedback increases the player's ability to understand playbooks and perform the actions effectively. Also, proper feedback is the source of motivation for overcoming injuries and enabling continuity in training. When feedback is not delivered at the right time, unwanted movement and patterns are stored in memory. Those skills disconnect players from improving consistency in play (Perfecting the timing in the different scenarios). Therefore, the user's need is to have a unique feedback mechanism that can be acquired based on task requirements.

The outcome from the design brief

Based on the key points mentioned in the design brief, some of the valuable components to conceptualize the final solution are considered. The main goal of the concept is to correct the routes of the wide receiver by providing appropriate feedback and helping players stick to the training programs.

The analogy of the concept is formulated as follows.

Firstly, the user must understand his role whenever he hears the playbook's terminology based on the defence alignments or offensive playbook's structure. Secondly, the user needs to interpret the information to decide what routes to run (routes tress for effective learning). Thirdly, the user needs to be informed about the path he had taken, and if possible, the correct routes need to be displayed to the user. Fourthly he needs to visualize appropriate that help him to enhance his performance while making routes like speed, yards coverage, and footwork time or run time. Finally, as football is a team sport, users need to feel connected to the system by adequately understanding coaching philosophy and bring consistency to the system.

The universal system model is considered for the conceptual model of the process.

A. Input System

The first input comes from the playbooks when players memorize the play and processing the information. Those reaction times during processing are beneficial for players and coaches to understand the behaviour of the movements; that is, wide receivers need to be aware of quarterback footwork time. As mentioned in the playbook, it is time(footsteps) with which the wide receiver needs to match. The second input comes from the receiver itself, the movement data such as yard coverage, timing, and reaction collected by sensors based on individual learning ability.

B. Processing System

The numerical values gathered from the sensor need to correlate with manually inputted values by coaches while creating a playbook to feel connected to the coaching philosophy. Based on two reliable data, the processor needs to process the information faster to pick up movement errors like incomplete routes, wrong routes, or over-run routes. This information helps create a back backend for delivering immediate feedback for the user. The system can compute the information faster can provide also provide relevant data in real-time.

C. Storage System

Furthermore, the system needs to have storage modules. The input and output of the data need to be processed faster and store in the system for reviewing later. The storage data are helpful to monitor the progress of individuals and the efficiency of the passing system. Performance can also be stored in the cloud system. Then it can be made accessible to a respective person like coaches.

D. Output System

After the user data bypass the processing layer, the error that appears on the movement is differentiated. Suppose the results seem to deviate from the accuracy range. In that case, the user is alerted about his actions by providing the different information attributes.

E. Feedbacks

The two types of feedback, visual and audio, are essential for improving the receivers' running routes.

- **Visual feedback**

1. Route visualization

Spatial points formed by initial movement data need to be generated to alert the user when he fails to make the proper route decision. The immediate visualization mode can be enabled once the user has performed the route running within seven seconds.

2. Data visualization

When the monitoring data (speed, coverage) need to provide in real-time when making the run. So, the user can adjust this variable to perfect the routes.

3. Playbook visualization

An additional visualization level enables the user to learn the routes or playbooks effectively to visualize the screen-based playbooks in the real world. So, the player can get aware of spatial allocation and coverage on the fields. Also, the player needs to get a sense of movements and alignments.

- **Audio Feedback**: The set piece should be close to the ear so that the user can hear the delivered audio (speech, voice) precisely. Audio feedback is crucial to communicate playbook terminology and give vocal sound when the user makes movement errors.

4.2.1   Conclusion

The outcome from the design brief is taken as the building block for the final concept. The previously drawn insight from the learning playbook and feedback mechanism is prioritized to enhance movement issues for receivers to address the idea adequately.

4.3 Conceptualization

The problem identified in the design brief required a complex system to solve because of the multifaced nature of American football. Therefore, before diving into the final solution for the user, the problem is evaluated using the self-determination framework (Campbell J. , 2021). The self-determination theory is used in coaching practice by considering three environmental factors that help fulfil athletes' psychological needs. The views examined that players could improve skills learning techniques when the psychological requirement is fulfilled (Spence & Oades, 2011). Those three factors include Autonomy, Competence, and Relatedness (UK Coaching Talent and Performance, 2019).

1. **Autonomy stage (Learning playbooks)**

In this stage, players need to have the freedom to practice individual skills required to enhance games. The user must choose what they want to learn and how they want to do it.

2. **Competence (Errors in the movements)**

Mastery in performing a task is achieved when an individual seeks to control errors while learning techniques. When the receiver is running route, the player will learn about plays and positional roles that guide him at different levels, making him feel challenged.

3. **Relatedness (Coach and Athlete relationship and Feedbacks for iterative learning)**

Athletic must feel connected with the team and coach. So that individuals can learn from coaches and team.

4.3.1 Understanding the element

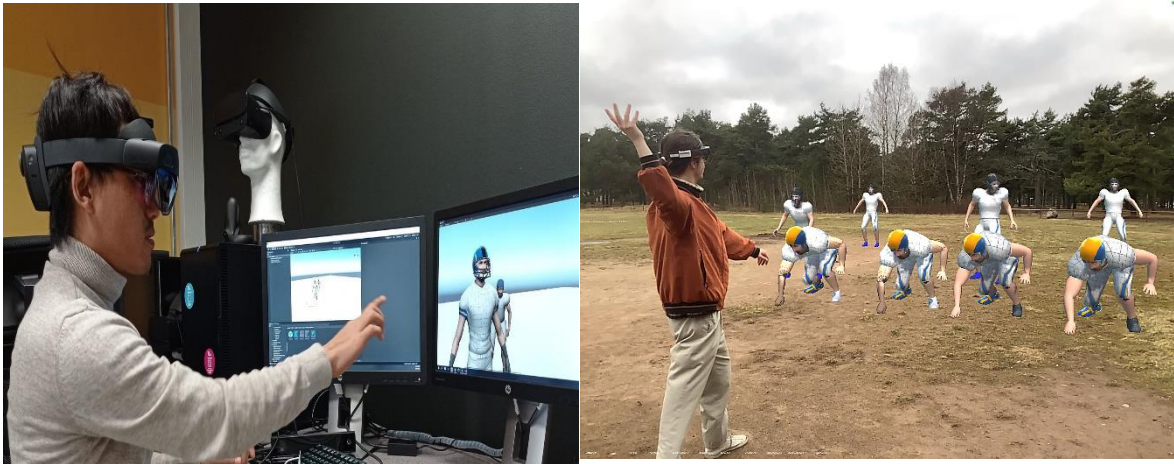Figure 4.1:Testing Microsoft based MR glasses(Hololens)

To better understand the element, the author first tested Microsoft Hololen1 and Hololens2 glasses. These mixed reality glasses are currently the most potent head-mounted display available on the market. Because of a limited number of mixed reality glass, the first generation of HoloLens was rented from Tallinn University. The second generation was tested inside the lab of Tallinn University of Technology.

The reason for choosing these mixed reality glasses is because it is currently the most potent head-mounted display available on the market. The main difference is that Holense1 is more about 3D augmented reality with fewer features to interact with, whereas Hololens2 is thoroughly mixed reality-based, which allows users to interact with contents. Hololens2 has enabled research mode, which means IMU sensors data can be used by research to determine a device's movement in real-time (Pollefeys, 2020).

A mock simulation of the concept was created using a unity-based game engine to understand the device's working principle. Later, those simulated scenarios and applications were used to get feedback from the user. The final concept aims to deliver a tool for coach and player. These two interrelated concepts were purposed for fulfilling the user's need and the possibility of improving further. The Agon concept is designed with the help of American football coaches and players by embracing their feedback and expectations and acknowledging previous studies.

4.3.2 Designing Agon: Mixed reality-based application

The first module consists of a mobile application that is useful for designing the playbook and evaluating players. Unlike most digital playbooks, the prototype lets the coach put the timing, yards coverage, notes for players on desired plays. Based on coach Peter and Martti Poom's suggestion, those data (like reaction time) are set as evaluation criteria.

"First thing that comes to mind is the notification time'. "peep" right before the run, and the player turns as soon as he/she hears the peep; this will build the reaction time."

"It will be like cheating if a player can see every route in the field; the user will depend on that,"

This application allows coaches to navigate screen-based playbooks with their relative information on the field in real-time using a device (tablets or iPad) camera. The application is helpful for both the coaches and the players.
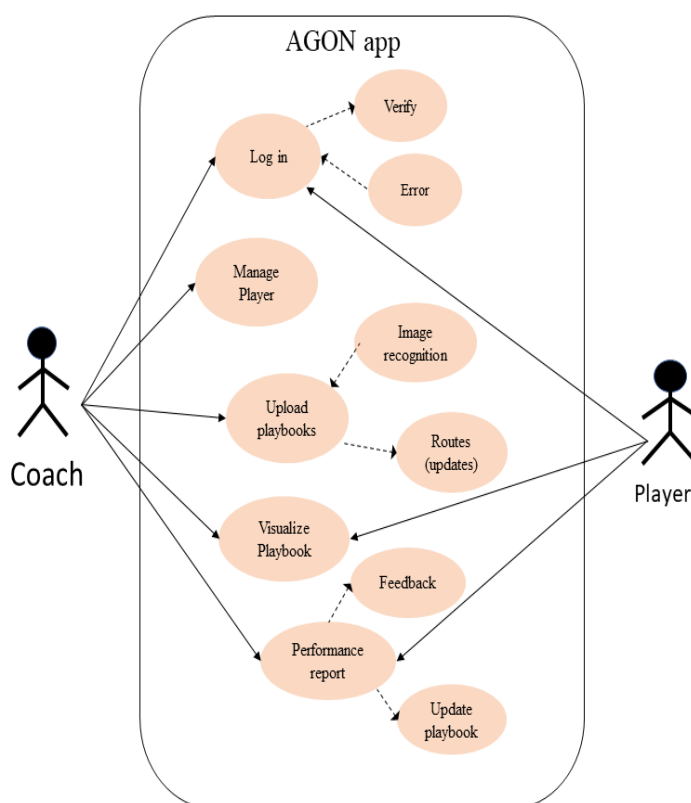
Figure 4.2:Use case diagram

Only the coaches can access the feature like manipulating and managing the playbooks and visualization of individual player data and seeing the progress of the whole team. The player can only review stats of practice or a history of personal improvement on the secondary level.

The main aim of designing 'Agon' is to fulfil the fundamental element of learning tactical skills. The communication platform is included on the app to excel the relationship between coach and player with the uppermost belief of bringing playing consistency.

Main feature

    A. Easy playbooks creation

This application enables the coach to create plays faster and more efficiently. Sometimes ideas come from paper or whiteboards while drawing playbooks. Translate those ideas into a digital format take time. The ideas can be inserted on Agon's platform with an image detection algorithm.

capture image	⮕	Image detection	⮕	upload playbooks	⮕	Manupulate

Figure 4.3.3: playbook creation process

The coach can use the device (touch screen) camera to capture the drawn images. The image recognition system will suggest the detected patterns (like squares, circles, and arrows) resembling the player and routes based on route trees. Then the coach can upload the detection playbook directly on the system.

If necessary, to easily manipulate those detecting patterns, the user can use the benefits of the touch screen to assign numerical parameters and routes from the database. Furthermore, a user can create new plays using design toolkits from the app, such as a circle shape label as "WR" based on the positional role's wide receivers.

    B. Visualization

A team can review the playbook by projecting player position in the actual field. This helps coaches and players visualize the player's alignment and positional information in the area, like which route the player needs to take. A similar feature is added to the mixed reality user interface as well. Using this visualization capability will enable coaches to check players' alignments and information layout in the real space.

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Figure 4.4:Visualization offens system

C. Team management

Coaching is incomplete without the communication between coach and player. Therefore, the system is designed to connect players and coaches. Through the platform, a team can preview weekly plans and upcoming events. The system then allows coaches to share the training schemes with the player based on that coach can see the player progress on the leadership.

2.   Head-mounted Mixed reality headsets – integration of feedback

The second module contains a mixed reality-based head-mounted device that the player uses during the training phase. The inbuilt sensors on the device like GPS and IMU will track the position and movement of players. Similarly, the headsets are embedded with a speaker, microphone with a speech recognition algorithm that facilitates user communication with headsets. The presence of such sensors is best suited for enhancing the learning ability of new players.

Unlike the other AR glasses, a mixed reality headset does not require additional processing power. It uses a holographic processing unit to process all data from the camera and sensors in real-time (Warren, 2016). Hence, the output from the requisite

data collected while running is display to the user as visual and audio feedback to correct his routes.
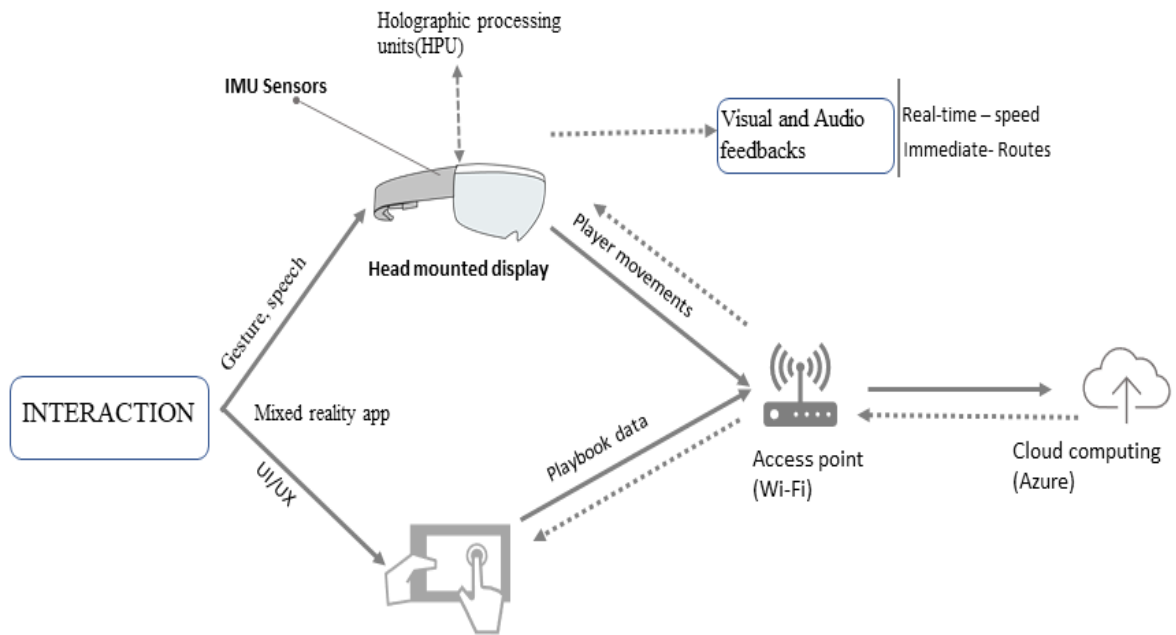

Figure 4.5:System architecture

4.3.3   Main Features

The user needs to first connect the mixed reality headset with the internet and then open the "Agon" application. After that, the user needs to open the quiz section and start playing. The quiz consists of many plays that the coach has assigned to the player to practice during the weekend. Then the application will guide the player to the initial position (line of scrimmage) to take the stance. Once the player takes his place, the device will ask the user for voice confirmation, for example – "say, I am ready." Consequently, the device will start calling the terminology from the playbooks like "cowboys." By hearing that terminology, players will try to complete the routes.

While running, the sensors display real-time feedback about sprint speed captured and displayed on the screen. The device will calculate the player's movement regarding whether wrong or correct route and inform the user about his errors through audio feedback. Soon after, through visual feedback, the user will see the actual path he needs to take. Then the user will go through other plays.

Every player's movement will be monitored, and those data will be sent to the mobile device. The coach can then view the reaction time for the player to run and see the accuracy for route running. These data will help coaches evaluate their philosophy. It will be helpful to see player's progress and determine motivational factors.

4.3.4   Possible user scenarios

- **Coach**

Mike is a coach and offensive coordinator of the team `KNIGHTS CLUB.' His primary duty is to teach offensive strategies to the players and manage team profiles. Mike frequently experiences the circumstance that his players have difficulties learning the tactical elements, which inclined toward his game philosophy. Similarly, the team struggles to teach new tactics to upcoming players because of limited time for coaches and players to be on the field. In addition, the team has taken injury prevention measures to minimize game-approach teaching, which weakens players to understand of game tactics.

Since tactical learning was more about mental processing, it is challenging for Mike to translate decisions made by players to the actual movement in the fields. Therefore, Mike sought to evaluate tactical elements based on his input on the playbooks and correctly identify how players react in different game scenarios.

- **Player**

John is the wide receiver who has training on the same club and enrolled in the team a few months back. He has to get acquainted with new tactics by learning a new language from scratch. Although John had already memorized several other playbooks, this new system is different because of new terminologies and regular plays adjustment from the coach. Therefore, John is demotivated and feels a lack of confidence to train with the team. He thinks that the coach's regular fine-tuning creates a lack of time to master those plays. Hence, affecting other players who are doing well in the same strategies and adding extra pressure.

- **Getting Started with Agon**

Mike heard about one of the startups called "Agon." The company provides a mixed reality-based application for the American football team that bridges the gap by interpreting tactical details into the field in real-time. Mike became interested in trying these tools and like the features that facilitate the adoption of core tactical elements in an early period of skill acquisition.
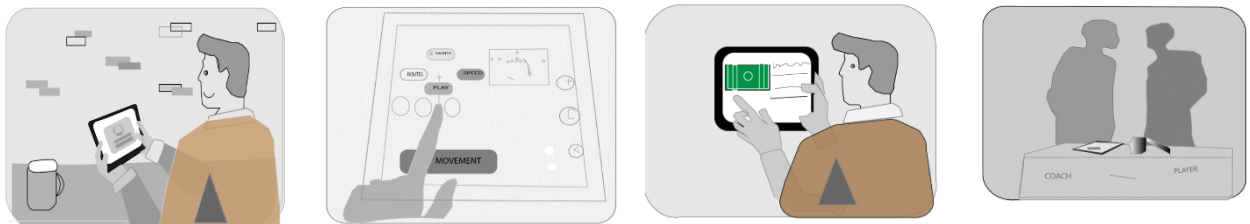
- **Pretraining-phase**

Figure 4.6:Login to the system, Input data, Upload playbook and Assign to player(left to right)

Mike receives the instruction on using the features such as creating, uploading, managing, and sharing playbooks and using MR headsets through a step-by-step video user manual. Mike makes an account and starts adding the playbook database according to the team's language.

Mike invites the player to join the Agon application. After completing approval, Mike handout John the Agon system to try out for a month.
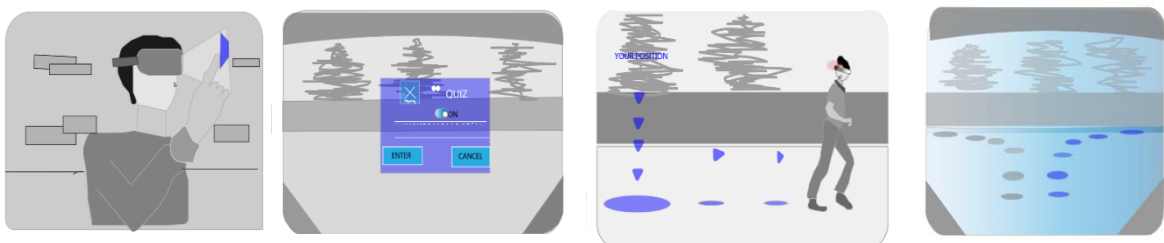
- **Training phase**

Figure 4.7:Wear a headset, Select the quizz mode, Run route, Get the feedback(left to right)

John took the mixed reality headset on the field. He wears the headset and opens the MR application. There John sees two options with play and visualizes mode for practising playbooks. Through playbook visualization mode, John could analyze how his team will line up and the possible scenario for defensive alignments and what action he must do.

Similarly, through play option mode, John saw there was a quick option. John chose the quiz option, and it simulates the scenario of the actual game based on the plans assigned to him. John started to practice his movement through play-callings and quickly received feedback about his actions and decision-making. After twenty minutes of training, John was able to obtain information about his success rate. Those data are then stored in the system.
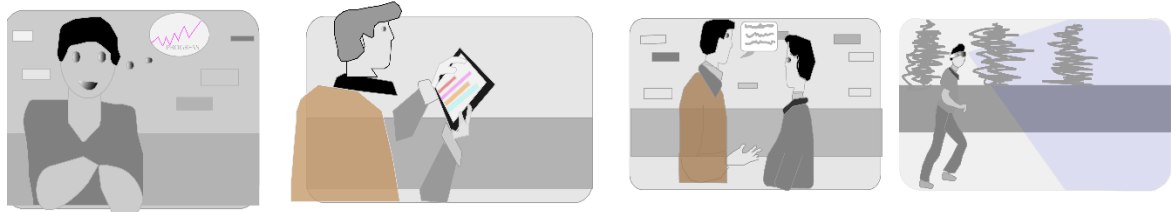
- **Post-training**

Figure 4.8:See the progress, Monitor players status, Reevaluate philosophy, Train again(Left to right)

John was able to visualize his weekly process and where he needs to make extra efforts to improve his learnability.

Similarly, after the players have completed their training, Mike was able to monitor his player stats. Those data allow players and coaches to have proper communication about improving tactics.

Furthermore, Mike got the opportunity to evaluate his philosophy to bring the core tactical elements such as learning the playbook, understanding the situation, and actual decision-making.

On the other hand, it motivates a player to practice sets of skills repeatedly in an indulging fashion of the spatial realm by timely binding athletes with the coaching philosophy. Hence, building confidence to succeed in every game.

4.3.5 Conclusion

Agon is a mixed reality-based application that enhances player's performance. It is facilitating the adoption of core tactical elements in an early period of skill acquisition. AGON is the first attempt to combine mixed reality applications by interpreting memorization of tactical details into the action on the field in real-time through consolidating visual and audio feedback.

Agon provides an opportunity for the player to practice sets of skills repeatedly in an indulging fashion of the spatial realm by timely binding athletes with the coaching philosophy. Hence, strengthening coach and athletic relationships, uplifting player motivation, and building confidence to succeed in an actual game.

5. Breaking

5.1 Summarization of feedbacks

Figure 5.1:Getting feedback from the users

"If rookies start and want to learn the playbook when they enter in some team. then this could help" - Martti Poom

"Playbooks are confidential. You need to also think about that."- Martti Poom

"At the moment, most tools are static, it does not interact with the outer world, but if this tool could read the speed and calculate the distance, you can add route programs. Out 2. Hitch 3. Slant 4. Corner 5. In 6. Fly. It will perfect for improving running routes" - Martti Poom

According to the coach and player feedback, these tools will benefit the players who want to learn playbook terminology and perfect routes. For example, when the team enters into the new unit or moves from college football to a professional team, it will quickly help him grasp the new playbooks' concept. The team's terminology varies

depending upon the routes coaches use to train the players. Therefore, this tool can be used as a suitable tool for communicating coaching philosophy to players.

"When I was first learning the playbook, some routes were straight on the playbook but were to be run in a curved way on the field. It looks promising"- Karl Erik Kala, wide receiver

"I love the process of how you have done. The leaderboard if I am the last guy, I will try more" - Peter Holm, Head Coach

A player is benefited from having access to their performance data because it serves as a tool to motivate players during the learning phase. Furthermore, it saves time for coaches to evaluate a player based on their performance and results. This tool helps put the player in situations where they do not have to wait for video feedback or practice. A new player can see the route they need to take through visual feedback on the field.

"Quarterback and receiver have an agreement. It is a team sport; you have to comply with what the quarterback or offensive coordinator instructs so that you can run the routes correctly" - Mauno-Martin Blond

"As I understand, this tool will help the player to run routes perfectly and train independently. I would say seventy-five percent of work is already done here to help receivers." -Mauno-Martin Blond

Football is a team sport, and there is an agreement between receiver and quarterback. Acquiring essential tactical skills like reading the plays and developing knowledge to execute efficiently are valuable assets that are equally crucial for both receiver and quarterback. For the quarterback to track the positions in the dynamics of plays, it requires serious brainpower. Therefore, there is an agreement between quarterbacks and receivers. The advantage of using an arrangement is that the quarterback does not need to see or need to find where the receiver will be open in the field. They both know that they do not need to see each other, but they are connected by route timing. If the wide receiver forgets routes, he will miss up, and then he needs to restart and memorize the playbook in any case. Besides, receivers cannot run the way on their own.

Similarly, memorizing the playbooks is essential, but having to do that independently is the next step. It can help the receiver train alone in the field. This tool fills the demand of independent learning without a quarterback to throw the ball. To be an effective receiver, a bridge between learning playbooks and doing it on the field needs to be proper. It is like doing above an average player. However, another important thing is

taking your hand out, seeing the ball, and finally catching the actual ball. Furthermore, this area is missing now.

"This will also be good to Quarterbacks because Quarterback can see when and where the receivers come open."

On the contrary, Ott Eric (wide receiver) admits that running a route is more crucial than catching the ball. According to him, actively thinking while running and catching a ball is rare because everything moves fast. It needs to come up with muscle memory. Capturing the ball is not a problem (he needs to see the tip of the ball) but maintaining the timing is essential. Furthermore, he pointed out that the visualization part is helpful for quarterbacks too. According to him, if the quarterback can simulate a throwing movement or throw a virtual ball thinking a player is running on a given play, they will be able to see when and where the receivers can come up open by showing similar visual feedback about the receiver's routes.

Visualization of opponent setup and their movements on this system is another factor that is considered helpful for quarterback and receiver. In the opinion of Maarti Poom, the visualization needs to be more inclined with defensive plays. Similarly, Peter Holm claims that defence player movement is based on zone or man coverage. In zone coverage, the defence players (or Holo characters) should man-mark the runner, and in zone play, they need to cover the zones in which the player is supposed to run. It means this kind of visualization of the defence system is helpful for players to recognize a similar pattern in the game. Therefore, the player can process faster information allowing them to make the correct decision. Furthermore, the poom emphasizes that this tool is essential for learning playbooks for new players or an athlete seeking international exposure.

5.1.1 Conclusion

According to the potential user, visual and audio feedback is an essential part of this concept as it facilitates individual training. The players believe that a quiz-like setup and access to the personal training data will evaluate the player's fundamental tactical skills. And having spatial awareness of where to run based on the playbook on the field will be an extra add-in for player skills improvement
Similarly, visualization and simulation of the concept on the field will help the coach to make critical decisions while creating a playbook.

Furthermore, the team identified the importance of Agon for improving the engagement of coach and player in various systems. The tools can enhance the experience of learning playbooks and the impact it has on the relationship between quarterback and receivers. Furthermore, the discussion lead is also based on making the system more interactable and solving some complexity involved in the games by fully leveraging the power of mixed reality glass in the future.

5.2 Refining

The key points from the feedback were essential to enrich the potential of mixed reality-based applications in American football training. Elements from the feedback session are consolidated to embrace the training field tool. Therefore, creating an opportunity for adopting this application for the broader users.

The key elements that could make the agon best suited as a training tool are as follows.

Playbooks are confidential

The application requires a proper login system. The primary user (Coach or club manager) will decide the login process of the user. The player is given access to the application based on the contract with the team. So that when a player left the club, he will not be able to access the application anymore. That means only the registered user will have the opportunity to use the application.

Play Session

The practice session is augmented with two more sections.

- **Challenge mode**

The challenge session aims to enable the player to play with holographic characters. This application will best propose the defence strategy on an input offensive playbook that coaches have created or uploaded. So that, when the player decides to try to take a challenge, the player will be positioned with his offence team and application, recommended opponents(holographic characters). Ball motion is added to be placed based on the area that the receiver needs to be at the given time while running the routes. Similarly, to provide the player with the immersion experience, the ambient(crowd) noise is added with the possibility of recording their play.

To provide the next level of gaming experience, the defence players will track the player's movements and perform decisions such as blocking and tackling the player. When the player is tackled or hit by a holographic character, the player will get visual feedback through flicker or blurring of glasses, creating a disturbance in the vision. If the players often get hit, the device suggests players restart the game or wait for

seconds. Therefore, making such scenarios will enable the player to sense the game and build up reaction time.

- **Training mode**

The application will allow the player to create their training schemes. Those training schemes are what players do on the fields during training times. The player will set up training equipment like an agility ladder and cones on the field. The glass will display visual information about repetition and time to perform the drills based on their movement pattern. This feature works as extra add-ins to make 'Agon' a complete football training application.

5.2.1   Main values

Coach
- It is a new learning experience to evaluate player performance.
- Manageable playbooks and see the plays and player progress.
- Key to success.

Players
- Good tactical understanding.
- Build up confidence with repetition.
- Proper time management.
- Perfecting passing games
- It helps the player to stay in shape.
- Less chance of getting injuries.

5.2.2   Conclusion

The break section aimed to get the user feedback on the adaptation of mixed reality applications in the future. The study provides that there is an opportunity for mixed reality-based technology in football training.

Based on the user's opinion, the adaptation of such a device will improve the learning ability of the player. Learning playbooks is a complex thing to do in American football,

especially when it takes time to learn, acquire that knowledge, and apply it on the field to different things.

Hence, the application closes this gap by providing a new tool for experiential learning by aligning with appropriate visual and audio feedback. Furthermore, the potential of using interactive characters and features of setting up individuals of the device will further increase the value of the product in the future of football training.

Figure 5.2:User interface for coaches

Figure 5.3:Head mounted display interface

6.   Repeat

Agon is the concept designed to aware the player of the essence of games. By applying mixed reality-based applications, the concept increases play's enjoyability with an additional layer of independent learning. The information exchange platform opens up the door for coaches and players for everyday discourse on game strategies. Similarly, consistency and physical fitness are the winning factors for the team. That is what everybody loves to see and enjoy in the games. Nevertheless, it should not be compromised with mental pressure while learning tactical elements in the changeable coaching environment.

The spatial requirements confine the learning process of tactical elements. Whether learning a playbook from the whiteboard or digital two-dimensional screen, a human's ability to perceive and translate information to actions is delayed and separated. Additionally, every individual capacity of thinking is different. Moreover, without enough material to convey the correct information, it is harder for coaches and players to avoid the problem and learn through the mistake.

Therefore, Agon's innovative solution connects the brain to body movement by minimizing disturbance while learning game strategies. It improves the reaction time by limiting memorizing, understanding the terminology, and lousy decision-making concerning required performance in real-life scenarios. A professional athlete dreams of synchronizing the brain's capability with body parts to orchestrate fully embodied terminological movements.

That is where Agon plays a role in transforming digital space into a meaningful space where the ideas can be perceived quickly. Furthermore, it helps the players visualize a character's movement and playbook structure in the actual area, providing real-time feedback. So, using Agon is the new platform for upcoming athletes and coaches to improve the learnability of game tactics.

6.1 Future work

The final product will be launched to the market by going through an iterative process. That means some of the primary methods will be repeated while performing user testing or in the process of improving technological capabilities.

From a technological perspective, integrating software and hardware properties of applications will be the main focus in the future. The first and shortest milestone in the product development cycle will be building the user interface and visualizing the proof of concept of the model.

For the business side, the solution will not be limited to only American football. However, it can also be used in other sport like rugby and flag football. Similarly, the concept can be adopted in another recreational sports market. In addition, some inspiration can be considered for future development based on the current uses and ongoing research on mixed reality-based applications in several industries. For example, some companies like tremble use mixed reality-based applications on their construction site to deliver real-time visualization of 3D content in the real world.

Recently, Microsoft has signed a billion-dollar agreement to develop an Integrated Visual Augmentation System headset for military training (Jimenez, 2021). Similarly, army researchers are testing AR glass to visualize environment data collected by a mobile robot to decide follow-on action based on environmental changes (Reardon et al., 2021). Furthermore, the improvement of mixed reality-based applications has also been an opportunity for training professionals (Walko & Maibach, 2021). Moreover, researchers are developing a head-up display for driver's safety by presenting holographic information onto the driver's field of view and alerting the driver about distant objects, speeds, and fuels (Skirnewskaja, 2021).

From the design point of view, the Agon creates a new meaning for learning tactical elements in American football. It carries the potential of incentivizing wider audiences to try out American football in an enjoyable fashion and bring out meaningful social interactions.

In the team sport, the opportunity to improve skills by being in self-discipline and independent learning which help player to train more and further encourage others to become active participants. Similarly, Agon enhances management skills for coaches. It

is difficult for a coach to talk to every player and evaluate their tactical learning and manage plays to help coaches try different strategies. Lastly, Agon can be developed as a collaborative tool for multiplayer so that every offensive team player can train together with them.

6.2 Recommendation

There is some limitation that is needed to be considered while developing this application in the future.

First of all, testing the final prototype with a broader audience has not been done due to limited physical contact. It implies that the final prototype was not ready because of the restricted time for lab testing. In the future, the sensor's accuracy will be calibrated using data fusion methods (Caron et al., 2006). At this stage, it is vital to decide whether an additional sensor is required.

Secondly, current state-of-the-art mixed reality headsets are limited by the field of view, which means some of the proposed features required additional efforts from the team developed. However, the trend shows that the capabilities of head-mounted devices are increasing. In addition, third-generation of the headset are coming in the market with better infinite filed of vision. Likewise, Apple plans to launch mixed reality glass in 2022, which will be cheaper, lightweight, and high-quality visualization than existing mixed reality glass (Vipulpatil, 2021).

Thirdly, Agon is primarily designed to help the player to provide a tactical understanding of games. On the Contrary, Agon's application falls short of the human factor to resist the player's movements. However, it can be taken as an opportunity to integrate a touch experience by using haptic feedback devices such as wearable gloves, suits for complete athletic training. Similarly, the current concept of the Agon learning rate can be helpful for the player who is recovering from injury and limited to train with others. Additionally, it can be beneficial for new learners who are just getting started with American Football and want to build up some confidence before diving into actual games.

Furthermore, the gaming industry uses artificial industry to fuse games object digitally with the natural world (Venture City, 2020). The building of AI-based non-player characters will be an add-on for the future. To develop an AI model enormous amount

of video data of games is required. So that characters can make strategic decisions based on human input (Starke et al., 2020).

6.3 Conclusion

The repeat section highlights possible steps for developing the Agon application by underpinning the research objectives mentioned above. The research, which was intended to discover opportunity space for emerging technology, shows that mixed reality-based applications will be a new opportunity for football training. Similarly, the core element of tactical skill is learned through a mental process. The problem faced by athletes is to translate tactical elements into actions. Therefore, the focal point of this research was to improve athlete performance by bringing fluidity in between mental and physical processing. In addition, enhance management skills for coaches to facilitate effective communication of game philosophy.

The popularity of Mixed reality or Spatial Computing technology is expanding, with major companies investing in research and development work. It means the values of Agon are most likely to grow in the future. Furthermore, to make it functional, the main area to cover for this project is developing proper software and integrate it with consumer-available mixed reality headsets. There might still be scopes for improvements to bring back and redesign some of the functionality that fits the user's meets. Therefore "Think, Make, Break" can be repeated by tackling the mentioned limitation in the product development lifecycle, underlying with design and technological principle.

7.   SUMMARY

This thesis aims to explore the opportunity space for emerging technology in American football training. The study begins by presenting coaching philosophy and the current trend of passing play where the receiver needs to make a run by choosing the correct routes at the right time. Then the study delves into opportunity space to identifies frustration faced by players while learning essential tactical skills. Those challenges combine both coaches and players atmosphere like reading the playbook and decision making and lack of consistency in consecutive play.

The literature review then points toward American football's multifaceted and complexity by introducing the importance of reading playbooks and the difficulty of memorizing it because of hundreds of plays and new terminologies often used by coaches and teams to call these plays. The player cannot practice alone because of the nature of games. Besides, there is a need for someone to evaluate their elements of tactical skills acquisition. However, the tactical abilities during practice are not adequately facilitated because of the risk of injury (limiting the training time) and coaching and experiential difference.

Furthermore, the lack of visualization and demonstration narrows down the opportunity for players to learn and memorize and grow to be influential playbook players. The semi-structured interview formulates further support the difficulties of remembering playbooks. The problems faced while maintaining reaction time and perfecting the routes for quick decision-making. The field observation section highlights the use of precursors of coaching philosophy and the communication gap between coaching and practice. It is noticed that delivering feedback is essential to motivate players to train more and improve their tactical skills. However, entirely relying on video-based feedback mechanisms creates cognitive bias and degrades athletic and coach relationships.

The design outcome of the thesis is a mixed reality-based application called Agon. It consists of a mobile app and mixed reality glass (possibly tablets and hololens2) with built-in sensors. The user will use mobile interfaces to upload, create, share, see progress and visualize the playbook content in the real world. Similarly, the Agon application allows coaches to communicate with the players based on the weekly plan.

A player can train on those plays by wearing the head-mounted headsets in a quiz format. The visual and audio feedback will guide the player to learn the required tactical skills. While training with a head-mounted, players must demonstrate route memorization based on the play-calling terminology received through an audio signal from the headsets. The player will then start running the routes. During the action, the player gets real-time feedback on speed and time of movements, and immediate feedback about the correctness of the route or actual route is displayed from the plays. Then those data will access by the coach to improve the player's performance. It will help coaches to better monitor player progress and evaluate his philosophy.

In the future, the main point will be improving the hardware capabilities and developing the AI algorithm to integrate an intelligent opponent's playing system. Bringing out this kind of system will be helpful because it provides a completely immersive experience for the user. Similarly, Mixed reality-based team collaborative training is another critical step an Agon needs to focus on to stay competitive in the market. The multiple interconnect headset that works on the same plays will enable the player to connect and socialize more. Furthermore, the product will be delivered on the market with repeated testing and integrating series of features like 'quiz, visualization, set up training drills, challenges' respectively.

The vital part of this research is to highlight design process is non-linear and to show that user participation is necessary to develop the final product. While getting feedback from the user on software and hardware development, the result has been positive, which indicates that Agon will be helpful for future tactical skills training. Therefore, fulfilling the possibility of launching mixed reality-based technology in football training.

Summary

Käesoleva töö eesmärk on uurida areneva tehnoloogia võimaluste ruumi Ameerika jalgpallitreeningutel. Uuring algab treeningufilosoofia ning praeguse söötmismängu trendi esitlemisega, mille puhul palli vastuvõtja peab jooksma, valides selleks õigeaegselt korrektse teekonna. Seejärel süveneb uuring võimaluste ruumi ja tuvastab pettumuse, mida tunnevad algajad mängijad, õppides hädavajalikke taktikalisi oskusi, näiteks mängustrateegiate lugemine ja neist teadmiste omandamine ning mängude ajal õige otsuse tegemine järjepideva mängu tagamiseks.

Seejärel osutab kirjanduse ülevaade Ameerika jalgpalli mitmekülgsele keerukusele, tutvustades mängustrateegiaraamatute lugemise tähtsust ning info meeldejätmise raskust sadade mängude ja uute terminoloogiate tõttu, mida treenerid ja meeskonnad nende mängude kirjeldamiseks kasutavad. Mängu olemuse tõttu ei saa mängija harjutada üksi, lisaks peab keegi hindama tema oskuste omandamist. Samamoodi ei rõhutata treeningu ajal taktikalisi võimeid vigastuse saamise ohu tõttu (mis piirab treeningu aega) ning treenerite olemuse ja kogemuste erinevuse tõttu.

Pealegi kitsendab visualiseerimise ja demonstreerimise vähesus mängijate võimalust õppida ja meelde jätta ning saada edukateks mängustrateegiaraamatu mängijateks. Poolstruktureeritud intervjuud kinnitavad täiendavalt mängustrateegiaraamatute meeldejätmise raskusi, kuna mängustrateegiaraamatu õppimine on jalgpalli kui reaktsiooniaja kontseptsiooni ja reaktsiooniaja täiustamise otsuste kiireks tegemiseks ülioluline. Välivaatluste osas tuuakse välja juhendamisfilosoofia kasutamine ning suhtluslünk juhendamise ja praktika vahel. Leitakse, et vahetu tagasiside edastamine on hädavajalik, et motiveerida mängijaid rohkem treenima ja parandada taktikalisi oskusi, selle asemel et tugineda täielikult videopõhisele tagasisidele, mis loob tunnetuslikku kallutatust ning halvendab sportlaste ja treeneri suhteid.

Lõputöö tulemus on liitreaalsusel põhinev rakendus nimega Agon, mis koosneb mobiilirakendusest ja liitreaalsuse prillidel (võimalik kasutada ka tahvelarvutid ja HoloLens2) koos sisseehitatud anduritega. Kasutaja kasutab mobiililiideseid mängukirja sisu üleslaadimiseks, loomiseks, jagamiseks, edusammude nägemiseks ja visualiseerimiseks reaalses maailmas. Rakendus Agon võimaldab treeneritel jagada mänge mängijatega nädalaplaani alusel.

Pärast seda saab mängija neid mängustrateegiaid treenida testivormis, kandes pea külge kinnitatud peakomplekti. Visuaalne ja heliline tagasiside suunab mängijat õppima nõutavaid taktikalisi oskusi. Pea külge kinnitatava seadmega treenides peavad mängijad demonstreerima marsruudi meeldejätmist helisignaali kaudu saadud mängu terminoloogia alusel. Seejärel läbib mängija antud marsruudid joostes. Tegevuse ajal saab mängija reaalaja-tagasisidet liikumiskiiruse ja -aja kohta, lisaks kuvatakse vahetu tagasiside marsruudi õigsuse või reaalse mängukirjelduses oleva marsruudi kohta. Treener pääseb nendele andmetele ligi, et parandada mängija sooritust. See aitab treeneritel paremini jälgida mängijate arengut ja hinnata tema mängustrateegiat.

Tulevikus uuritakse võimalusi riistvara täiustamiseks ja algoritmi arendamist 'targa tegelase' integreerimiseks vastasmängijana ning muid kriitilisi simulatsioone tegelike mängustsenaariumite loomiseks.

Toode tarnitakse turule korduvtestide järel ja integreerides rea funktsioone, näiteks 'test, visualiseerimine, koolitusõppuste seadmine, väljakutsed', lähtuvalt kasutajatest.

Selle uuringu oluline osa on rõhutada, et disainiprotsess on mittelineaarne, ja näidata, et lõpptoote väljatöötamiseks on vajalik kasutajate osalus. Kasutajalt tark- ja riistvara arendamise kohta tagasisidet saades on tulemus olnud positiivne, näidates, et Agon on tulevikus taktikaliste oskuste koolitamisel kasulik ja toeatades jalgpallitreeningutel segareaalsusel põhineva tehnoloogia kasutamise võimalikkust.

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9. List of figures