Boccia, o simulador
Hugo Alexandre Farinha Guedelha – hugoguedelha@gmail.com

Abstract
These past few years have witnessed a sharp increase in the number of handicapped people who practise sport. Whether this sport is done at a competitive level or just as a leisure time activity, this increase in the numbers of disabled athletes is a reality. Therefore, and because of the limit of their physical capabilities, providing help to these athletes is not only important but also necessary if they are to achieve their full potential in their particular sport.

This current work was based on an already existing simulator and the main goal was to improve it and extend. The application is on the field of games directed at people with special needs: the Boccia game. The earlier simulator was analysed and studied in detail regarding its implementation and functioning, after which some conclusions were drawn and improvements recommended.

The aim of this thesis was put forward a number of improvements which were needed. In the analysis process some interviews with specialists and Boccia players were carried out. These interviews were important because they allowed us to interact with real players and to perceive their true needs and problems when interacting with the real software interface. The graphic interface and usage were also considered in order to make the interface a more user-friendly, comprehensive and straightforward one.

This software simulator is intended to be a useful tool for Boccia players, in the sense that it could enhance and develop further their existing Boccia skills.

1. Introduction and objectives
When we look closely at our society, we can see that we have increasingly become more sensitive to people with disabilities and their needs. As such, we consider that it is very important to develop simulators, so that these people can become active members of society and not be marginalized. Sport can play an important role in such integration. [Guttman 76].

The objective of this study is to develop a computer simulator (PC game), with all the rules of the Boccia game, making it as close to reality as possible, both at the sound level and at the visual level. In addition, it aims to improve the proficiency of the athletes and players during the game.

Two levels are considered in this study: ethical and practical.

1.1. Ethical level
As far as the ethical aspect are concerned, we want to motivate disabled people to practise sports and to compete without restrictions or exclusion. An active participation in sport improves the psychological balance of disabled people and helps them become an integral part of society [Guttman 76].

On the other hand, we can, through this work, promote this sport, Boccia, which is not very well-known.

1.2. Practise level
As far as the practical level is concerned, the aim of this thesis is to develop and expand the existing work [Abreu 06]. A first prototype was presented to some athletes and coaches, who suggested a number of alterations. The aim of this project is to introduce corrections and make these modifications to the game, making it as close to reality as possible.

1 Boccia is a variation on Bocce, an Italian game similar to bowling usually played on a long earth-floored court.
This paper is divided into six sections. The first includes the introduction and sets out the objectives of the study. In the second explains the main rules of this game. In the third analyses several games and simulators for people with disabilities and how these helped us. The fourth explains how this type of simulators can help those athletes. The fifth presents the steps and justification for the final implementation. Finally, in the last chapter, conclusions are drawn.

2. Boccia

This game is usually played by people with physical disabilities. In the beginning it was almost exclusively played by people with cerebral palsy in wheelchairs, although today anyone can play it. However, at a competitive level only disabled people can play it, as this game was originally meant to be played by disabled people only.

The Boccia game, regardless the apparent difficulty of its rules, is in fact quite simple, especially when one actually plays. Nonetheless, people with severe physical impairment may encounter some problems, mainly when throwing balls. In this case, the rules allow these athletes to use auxiliary devices, such as a ramp, leaks or a gutter.

Boccia is a competitive sport that can be played individually, in pairs or in teams of three players [Boccia Rules] at a competitive level or as a leisure time activity. It is played on a court under well-defined rules. The objective of the game is for the players to throw balls as close to the target ball (the ball that works as reference – white ball in figure 1).

The equipment consists of six blue balls and six red balls for each team and the white target ball. The balls have a set weight and dimension, according to International Boccia Committee rules.

The game starts with the target ball (jack) being given to the first player at the beginning of the first frame \(^2\). The referee tosses a coin and the winner selects the balls: the red or the blue. The player who plays with the red balls throws the target ball. If there is a foul when throwing the target ball, it will be the turn of the next player to throw it.

The player who throws the target ball will throw the first coloured ball. After throwing the first ball, and if no foul is committed or if the ball doesn’t go outside the court, the next player takes his/her turn to play.

After this the next player to throw the ball is the one whose ball is the farthest from the jack; the game proceeds until all the balls have been thrown.

There are specific rules for scoring, just like in any other sport. A point is given for each ball nearest to the target ball in relation to the opponent’s balls. If two or more balls of different colour are at the same distance of the target ball, both players or teams get the same amount of points, one point per ball.

At the end of the number of frames, the points obtained are added up and the team with more points is declared the winner. If there is a draw, there is a play-off to decide the winner.

![Figure 1 – Example of a game situation.](image)

\(^2\) Frame – the different sets which make up the game. The game ends only after all the balls have been thrown.
3. Simulators and existing games for deficiency people

This chapter describes the principal projects which we researched and studied in order to develop this project – the Boccia simulator. Our aim was to present an overview of the several types of game and simulators that exist today and how these can help us improve the design of our own version of the game.

After a lengthy investigation, we discovered that there were very few games specially designed for people with disabilities, even though it has already been demonstrated that this type of game can help the disabled develop their capabilities at different levels [North 97], such as motor level, cognitive level, psychological level, communicational level, among others.

When we refer to computer games made for disabled people, we usually find the following three: the Boccia game, which already has a prototype, the Tangram game and the Tic-Tac-Toe game. These are reviewed in the next subchapters.

At the interaction level between the computer and disabled people, we investigated how we could make this interaction easier, so that disabled people could play Boccia without encountering any problems or difficulties. In fact, today there are already several devices available to that end, namely the usual ones – mouse, keyboard – and other special ones – sweeper, pointers and trackers. These devices should be used according to the disability of the player.

3.1. Boccia’s game

All main questions about the prototype have already been analysed and covered elsewhere [Abreu 06], so it was important to obtain all the vital information to help us do our work. Thus, this previous prototype was the basis for the development of our own work. We evaluated some of the existing work, namely a number of suggestions put forward by therapists and the athletes themselves [Bruno 06] and drew our own conclusions which we used to carry out our work.

3.2. Tangram’s game

In every game for disabled people it is very important to adapt the way of playing to the type and level of their disability, i.e. it is important to carry out research in order to find ways remove any barriers and make these games fully accessible to all those who have some sort of physical impairment and enable them to play the game to their best ability. This means that it is imperative to try to make these games as easy and restraint-free as possible, so that they are truly accessible to all.

On the other hand, there are several technologies to develop the game, all of which have advantages and disadvantages. In our case we have utilized the OpenGL library, because there was the need to keep the game independent of applied hardware variations.

We can conclude, therefore, that the study of this game was very important in as far as such programmes/games can play a vital role in helping disabled people overcome, to a certain extent, their disabilities and they add to their entertainment [Pereira 04]. Furthermore, this study shows how important the inclusion of disabled people in society has become nowadays, this being the reason why we developed this game using the correct technology to meet their special needs.

3.3. Tic-Tac-Toe game

After examining this work by Pereira (2004), we concluded, once again, that it is important to adjust this work to the type of disability of the person who is going to use it. Thus, we realized that the interface is an important device to simplify gaming and make it easier to use. Making the interface interactive adds to the motivation and enjoyment of the players. We took these two major aspects – the need to adapt the game to the person playing it and the features of the interface – into consideration when we developed the Boccia.
4. Trainings and contribution to improve in real game competition

To find out how beneficial Boccia could be for the performance of the athletes in real life situations, we contacted some players and associations. We sent a letter by e-mail to a number of players and national and international Associations of Boccia. One of the main contributions we received, and which helped us to reach at some of the conclusions that we are going to describe, was that of Greg Polychronidis, one of the first champions of Boccia worldwide (http://www.gregpoly.com). We exchanged ideas and opinions with him over the Internet.

We discussed with him the question of the importance of the game as a means of improving disabled people’s agility and fitness, at two different levels: the practical and the strategic levels.

4.1. Practical level

At the practical level, it is known that the balls are made of different materials and there are about thirteen kinds of ball. Since they are handmade and may have different thicknesses, athletes have to become accustomed to them, weigh up the force needed to throw them accurately (in case they are thrown with the hand), decide where on the slope to place the ball (when using gutters) and to be aware of other factors, namely the uncertainty of the direction of the ball. This is one of the most difficult aspects to get right through training and consequently it becomes difficult to fully adapt this game to Personal Computers.

4.2 Strategic level

The strategically level is easier to reach on a computer simulator than the practical level. The PC game can be used to train the distance at which to throw the balls, or to help the athletes estimate the force that they must use in relation to the distance that they want the balls to reach. Athletes can train this on the computer to obtain the optimum level of force needed, as the precise force to immobilize a ball in a particular position is quite difficult to determine.

Another very positive contribution of the PC game is the simulation of game situations. For example, the balls can be placed in a specific position and later the athlete can train the best tactics for that particular game situation.

It is more straightforward to devise a game with the purpose of practising and training the strategic side of the game rather than the practical side. However, one must always be aware of the different characteristics and reaction of the balls; for instance, lighter balls go farther than heavier ones. Simulated situations of the game can be used as training sessions in which athletes can train their best stroke (specialization) as well as train their reaction time before the situations.

5. Boccia, the simulator

In accordance with the predictable modifications and with the analyses of the already existing games, we obtained more data and aid to effectively improve the archetype of the existing Boccia game. Besides having helped in the accomplishment of our work, as far as they helped us identify the essential aspects for its development and progress, these data and aid have also proved to be important in helping us to better understand the process of rehabilitation of the people who play these games. In this chapter we describe the implementations carried out in order to arrive at the final result.

5.1. Interface

The efficient choice of the interface is a relevant aspect in the development of a simulator. It is therefore necessary to adjust and to improve the interface that is going to be used. One of the essential aspects that we have come across is how to choose the adequate interface for people with disabilities.

One of our main concerns was to try and improve the relatively less positive aspects of the interface of the original game. The most important aspects that were not in accordance with the requirements are explained later.
5.1.1) Button grouping

Buttons which perform related tasks must be grouped. The first prototype had separate buttons which performed similar tasks. Example of this is the fact that the direction buttons and those controlling the force with which you throw the balls were placed apart – while the direction buttons were next to the hand that makes the throw, the buttons for the selection of force were placed at the bottom left-hand corner, as it is shown in figure 2.

After analysing this and considering different alternatives, a final decision was taken. Basically, we suggest that there should be four different sectors, as follows (see figure 3):

Sector 1) Grouping buttons for throwing: In the first prototype the bar to control the force used to throw the balls was placed at the bottom, next to the clock and other buttons (see fig. 2). We decided to place that same bar next to the hand and all the other buttons which perform a similar task.

Sector 2) Exit button: previously this button was situated next to the net button, but in the new version of the game there is no button with a similar task, thus there is only one button in this sector.

Sector 3) Buttons with the characteristics of the game: Figure 3, from left to right, the name of the player, the available time for the frame at play (by a player), the amount of balls left and the button for general view.

5.1.2) Button Labels

One of the necessary requirements for a good interface is that it should be easy to understand. Thus the less explicit buttons to the players must have something that identifies them. The inclusion of an inscription on some buttons explaining what they perform is important, particularly on those more complicated tasks and can only become obvious through the image on the button.

We compared this idea with the first prototype and concluded the following, as shown in figures 4 and 5:
Sector 1) there was no need to include any labels, because the action associated with each button is explicit in the respective images (directional arrows).

Sector 2) The exit button shows the inscription “Leave”.

Sector 3) The time button is made clearer through the inscription “mm:ss”, indicating minutes and seconds, respectively.

Sector 4) To the general view button was added the inscription “General View”, the mode through which the player can see the positions of all balls on the court.

5.1.3) Unnecessary Information

One of the most important rules in the interface is the importance of its simplicity. Thus, when unnecessary buttons and information exist, they must be removed. That was suggested during the evaluation of the first prototype. The small window in the right lower corner, which represented the frames per second, was removed because of that. As well as the “net” button, this, in the prototype, did not have any type of associated action. Therefore we concluded that it would have also to be excluded.

The following figures (6 and 7) reflected what we finish to describe.

5.1.4) Information about the player

Another important feature of any good interface is that it should display the identification of the player who is playing at any particular moment. In the prototype, as it can be seen on previous figures, information about the player was not available. A solution to this problem was reached by placing a window for the name of the player next to the images of the remaining balls, as shown on figure 7. This figure shows that it is possible to check the name of the player who is playing.
5.1.5) Global view button

In the evaluation of the first prototype, it was suggested to show an overhead image, to give an overview of the court and the situation of the game at a particular time, in order that the players could assess the strategic position of the balls in the game. This would also make the computer game closer to a real game, because in the real game the players can ask for time out to check with more detail the position of the balls.

It was decided to place a button with an image of an eye at the bottom right-hand corner of the screen, near to all the other game characteristics. This way when this button is pressed, a screen appears at the top right-hand side of the original screen (red player, shown in figure 8) or at the top left-hand side of the screen (blue player, figure 9) to show the position of the balls at that particular moment on the game. To make this screen disappear, you only have to press this same button again.

![Figure 8 – Global view, red player](image1)
![Figure 9 – Global view, blue player](image2)

5.1.6) Confirmation of share

A significant aspect of an interface, which must always be taken into account, is buttons for confirmation. Thus, it is important to always have a confirmation box for those situations that can alter the state of the game. In the original Boccia game it was enough to press the button exit (or the Esc keyboard key) to leave the game. This situation may often mislead users who, once they have pressed this button, will not be able to come back to the game. To prevent this situation, a confirmation box was created to protect players pressing the exit button unintentionally and losing everything they had done up till then. This box is shown in red on figure 10.

![Figure 10 – Confirmation box](image3)
5.2 Likeness to reality and rules of the game

One of the most important aspects we thought should be modified was the little similarity it bore to the real game. Consequently, we carried out researches in order to make this game resemble reality as much as possible. To that end, the original game was modified at three levels: sound, visual and the game’s rules. Given that the main aim of this type of simulator is to mirror reality or be consistent with it, we tried to make the following necessary adjustments to the original game in order to achieve such similarity with reality.

As far as the sound effects were concerned, a new sound for the collision of the balls was introduced. Thus, when the balls collide, the simulator emits a sound effect similar to the sound that occurs in the real game.

As to the realistic appearance, our time priority was to modify the movements of the balls, namely at the collision between them. After analysing and studying the best way to make the collision between balls more realistic, we succeeded in reaching an improved final version. The greatest improvement that players will notice is basically the movement when the balls collide. In the new version of the game, when the moving ball strikes the one that is stationary, the latter is pushed out to a different place, with specific amplitude, depending on the angle of the collision.

In respect to the rules of the game, some had been overlooked when the original game was designed.

5.3 3D features

3D features are another important aspect to make the game similar to reality. Thus, and in accordance with the analysis carried out, the conclusion was reached that it would be necessary to substitute the representation of the hand in the game. However, none of the 3D representations for an hand we found met the requirements, and therefore we decided to leave the hand unchanged, i.e. we decided to keep the existing 3D hand (fig. 11).

![3D hand object](image)

Figure 11 – 3D hand object

5.4 Interactivity with the Therapist/Coach

For this new version of the game we considered important to include a new dimension to the game, in which the Therapist/Coach could choose to place the balls at certain positions. The intention being that the players have then to find a way to solve these game situations and develop particular skills.

The initial solution proposed consisted of, making a screen visible on which the users could modify the positions of the balls or place new balls, while playing. This proposal was later abandoned, because it seemed rather confusing, particularly due to the fact that once the players adopt a certain strategy of the game, that strategy has to be adhered to until the end of that game. However, this rather complex hypothesis led us to a much less complex and confusing alternative which consists in having a button called “game situations” on the very first panel of options, the one where we can choose the configurations, multiplayer, game plan, etc, as shown on figure 12.
A panel of game situations was designed, which appears when the respective button is pressed (see top right-hand side button in figure 12).

The screen of game situations shows six balls of each colour and the white ball (figure 13), the purpose of this being to be set them on the court and “to invent” new game situations.

An image of the court with the same colours and the same perspective as the one represented in the simulator itself was used. The purpose was to obtain a greater coherence and cause little confusion to users.

In the panel of creation of game situations (figures 13 and 14) three new buttons were added:

1) Button “To come back”, to enable the player to return to the initial panel of the game;
2) Button “new”, in case the player intends to create a new game situation. This returns the balls to their original positions;
3) Button “to play”, used either to start the game or any new situation of the game, created in the meantime.

Figure 14 shows an example of a game situation, in which the balls have been set at a particular place on the court.

To that end, an entire interface adapted to this way of playing the game was devised and designed. However, when the play button is pressed, the player enters the simulator, however the function to place the balls in the chosen place has not yet been implemented.
6. Conclusions

After careful analysis of our research and the modifications carried out, we can conclude that the initial goals have been reached, in so far as the new version of the game represents a substantial improvement on its predecessor. One of the most important aspects of our work was to develop an interface that could be easier and more understandable to the user.

In addition, we have managed to make the game closer to reality than before, both at the sound level and the visual level, aspects that had not been considered in the original game.

We have also designed a new way to play the game, which allows players to select particular situations and game strategies, which can then be worked upon together with therapists and/or coaches.

In our opinion, the great originality of our work is that it has made the game much easier to play and to understand by the greatest majority of people who use this simulator – the disabled. In fact, we believe our final work is much clearer and much more flexible than the previous one, at the same time as it respects the related rules of the interface referred to during the development of the project.

7. References


[Carvalho] – Carvalho, R., Carvalho, J., “Manual Boccia”, edição área fotográfica e artes gráficas do projecto de formação profissional da APPC, Lisboa.


