Combining Educational MMO Games With Real Sporting Events

The Game - Barcelona World Race

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Abstract—**The concept of the Massive Multiplayer Online (MMO) game is well established, with several multimillion euro productions (such as World of Warcraft and Eve Online) demonstrating the appeal of the genre. Yet few, if any, of these games bring any aspect of real-time, real-world data into the game. Sporting events, such as the Barcelona World Race sailing regatta, increasingly provide such live real time data, which can be integrated within a game environment to create a MMO competition between 'virtual' competitors and 'real' competitors. This paper presents the planning, design, implementation and overview of an educational MMO game to accompany the Barcelona World Race 2010/2011, and discusses the differences in design and implementation for games of this type.**

Keywords-component; MMO games, events, races

I. BARCELONA WORLD RACE 2010/2011 – THE GAME

The Barcelona World Race is one of the world's highest profile sailing races. During the regatta, a series of double-handed (two-crew) sailing vessels sail non-stop around the world, competing to see who can arrive back in Barcelona in the shortest period of time. Although some outside assistance is permitted, this is subject to a series of regulations and penalties – the overriding goal of the regatta is to enable teams to sail independently around the world, without stopping for supplies or repairs.

Almost all large sailing regattas have embraced multimedia as a method with which to promote and publicise the race. In recent years, running a parallel 'virtual' regatta – essentially an online multiplayer videogame, allowing players to 'sail' a virtual boat and compete against other real players – has become an essential part of the promotional effort of every regatta. These MMO (Massive Multiplayer Online) have now become so successful that they have become an expected addition to all regattas.

For the Barcelona World Race 2010/2011, the race organisers, la Fundació per a la Navegació Oceanica de Barcelona (FNOB), one criticism of the existing games in market was the lack of a true relationship between the game and the real event, especially with regards to the possibility of running the game in parallel the event, during the same time frame. FNOB's desire was to commision a game that attempted to mimic the real event as closely as possible, and provide some form of tracking of the real-boats' progress. To this extent, they commissioned the development of a game that would:

1. Research new methodologies of gameplay that allow an MMO sailing game to run successfully in conjunction with a live event (particularly, the Barcelona World Race 2010/2011).
2. Develop educational components that would draw in new players to world of sailing, and attempt to educate players on several of the key issues currently facing the maritime environment.
3. Provide a solution for the game to allow rich 3D graphics within a typical web-browser, a functionality that was lacking from existing MMO sailing games.

In this paper, we describe the research and development tasks taken in creation of this game. After briefly presenting the related work, the paper discusses how standard game design models had to be modified in order to create a successful MMO that runs in parallel with a live event. This, in conjunction with the development of social aspects within the game, is the principal contribution.

The paper then briefly discusses the educational aspects of the created game, before focusing on technical challenges. The two main development challenges were, one; the creation of stable, multiplatform 3D graphics engine that was capable of running in web browsers, and two; the implementation of highly robust game server capable of dealing with tens of thousands of users.

We then discuss the final interface design, before drawing a series of conclusions related to the differences between 'traditional' MMO design and 'event-based' MMO design and development.

II. RELATED WORK

A. Virtual Sailing Games

In the field of MMO sailing games, there are two main commercial products, Virtual Regatta [1] and Live Skipper [2]. While the two differ in terms of visual style, in terms of bullet-point functionality, both are near identical. They feature:

- The ability to sail a 'virtual boat', including a series of tools for setting course, choosing sails, setting autopilot etc.
- No requirement to be permanently connected; the games are essentially strategic, and encourage players to connect periodically, over a series of weeks, to make adjustments to their boats (as opposed to being connected and actively playing 24 hours a day)
- A 2D, browser based map interface that shows the positions of various boats within the field
- The ability to view the current wind in any part of the world, including the forecast for the forthcoming days (wind state is either real or simulated, depending on requirements of the regatta)
- Methods for adding and tracking 'friends' within the game, allowing competition between groups of players

While both games setup regattas that run concurrently with real events, neither makes any effort to add an educational component, and neither features any 3D graphics. Both games typically have several regattas running concurrently, and analysis of the ranking statistics on their respective websites shows that participation numbers in the regattas can vary widely, from a few hundred in minor regattas to 20-30,000 in major races. Both feature highly professional interfaces and webpages, and vibrant community forums.

B. *Academic*

In the last decade, academic research into videogames has increased both in terms of content and quality, particularly in the field of MMO games [3] [4]. SteinKeuhler and Williams [5] were some of the first to create the link between the MMO games and the 'third place' first envisioned by Oldenburg [6] in 1999. The concept of a 'third place' is that it should be a 'home away from home', where external rank, wealth or social standing should have no effect. SteinKeuhler and Williams conclude that MMO games create a new form of 'third place' featuring social interactions which, while not usually providing deep emotional support, typically are capable of exposing individuals to a diversity of world views.

In terms of MMO design, Ducheneaut, Yee, Nickell and Moore [7] deconstruct the design of World of Warcraft (WoW), one of the most successful MMO games of all time. Their conclusions are that, in game design terms, WoW is an evolution rather than revolution, building as it does on established game design tenets from predecessors (most notably Everquest). They also question whether the MMO will ever change radically, given WoW's history and success based on a pre-established formula.

In term of technical development of MMO games, Chen, Huang and Lei [8] present an excellent analysis of network traffic for online games, showing that the traffic graphs have distinctive features of strong periodicity, temporal locality, irregularity, and self-similarity.

Several textbooks have been written about game design. For an overview of design at a reasonably abstract level, without too much focus on individual code implementations, the reader is guided to [9].

III. MODIFIED GAME DESIGN FOR SIMULTANEOUS EVENTS

To create an effective game that runs in parallel with a sporting event such as a sailing regatta, there are several issues of basic game design that must be taken into account, if the game is to work at all as 'a game'.

A. *Realism vs Difficulty*

At its most basic level, a game which intends to mimic a real event must be considered as some form of simulation. This inherently leads to a problem, as Sauvé et al. note [10]: "Simulation does not necessarily involve conflict or competition, and the users are not trying to win, as they are always doing in a game". Yet a race (such a sailing regatta) is indeed a competition, and the game design must make steps to increase the appeal of the competition (the 'game') to users, while still maintaining a level of simulation in order to tie it to the event that it accompanies.

This trade-off has particular consequence when deciding the target audience for the game. Figure 1 shows a circular chart where the area of the circle represents the number of players. It is assumed that a more 'hardcore' simulation-style game will appear less to casual players, whereas a more accurate simulation will please the smaller (but vocal) community of people who are dedicated 'online sailors'. The challenge for the Barcelona World Race game was to build a game that would appeal to players of existing sailing games, but also draw in a set of users who previously had no experience or knowledge of sailing.

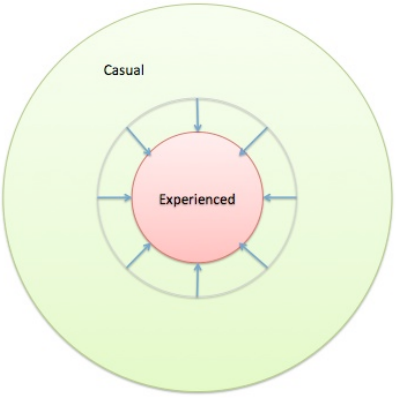

Figure 1: Area graph showing differences between numbers of casual and experienced gamers

It was decided at an early stage that the game should be more of a 'game', than a simulation. The reasoning behind this decision was that, although one of the objectives of the project was to teach users more about sailing world, if the software was too complicated it would not appeal to novice users, and not gain a large following. In particular, we decided that we should create the game '*polars*' (spreadsheets specifying how fast the real boats are capable of sailing under given wind and sail conditions) based on real ship data; yet we should not attempt to simulate accurate the effect of mainsail 'reefing' and keel angles, which are complex sailing issues that require in depth sailing knowledge to master.

This work was only possible thanks to the sponsorhip of the organisers of the 2010/11 Barcelona World Race, Fundació per la Navegació Oceanica de Barcelona, http://www.fnob.org .

Other online sailing games ignore the reefing issue completely due to its complexity. Yet, given that reefing is an important action to be taken on any sail boat in high winds, it was a factor that we wanted to include in the game. As a result, we created a minigame out of the reefing issue, with very simple rules, in order to teach novice sailors the basics of this complex issue. The advantage of this approach is that it teaches 'casual' players the importance of the issue, in a fun and engaging way, while also appealing to the more experienced players, as it is the first online sailing game to tackle the issue at all.

B. Difficulty Curve

The traditional difficulty curve of a typical videogame is represented in Figure 2 (adapted from [9]). This curve is a well-established tenet of game design and has been proved to be highly effective at motivating the player to continue playing, in order to finally 'beat' the game. However, the difficulty curve of any game based on a real event will be heavily affected by the nature of the event. In the case of the Barcelona World Race, the difficulty curve has a very steep initial curve, followed by a wild (and almost random) difficulty depending on the prevailing wind conditions and competition levels, then a rather anticlimactic return to Barcelona after 3 months of play.

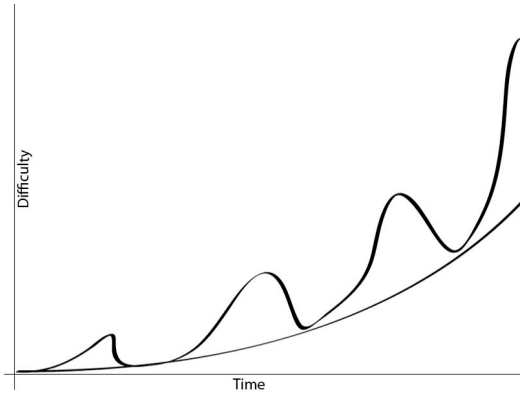

Figure 2: Standard game difficulty/time graph

As a result, games following real events must take into account this difficulty level distribution and attempt to add other aspects to the gameplay that attempt to distract the user from any unwelcome jumps in difficulty. For the Barcelona World Race game, we decided early on that we should maximize the social aspect of the game (see Section IV below) in order to foment as much competition between players as possible, as this natural competition overcomes many shortcomings in natural game difficulty. The game also featured a series of 'Feats' (similar to Xbox *Achievements* or Playstation *Trophies*) – awards given to players for completing certain tasks within the game that were not related to the main race (such as passing by a certain geographical landmark, or managing to sail above a certain speed).

Furthermore, we wanted to add some sort of shorter challenge within the game, in order to break up the 3-4 months over which the race would run. The real Barcelona World Race is split into several stages (called 'Trophies'). Although the boats never actually stop sailing, the first boat to complete the stage (by passing a line of coordinates) is awarded the 'Trophy'. We modified this idea for the game, splitting the entire round-the-world race into a series of stages, and ranking the players based on the time taken to complete that stage. Note that this provided a neat solution to the issue of how to motivate those virtual sailors who registered for the game after the actual race had started (and thus their boat started in last position in the rankings). The separate trophies were ranked according to *time taken to complete the stage*, and thus was completely independent from the ranking of the global race.

Finally, we were able to control the difficulty of the 'reefing' minigame (mentioned above) to a certain extent during the course of the regatta, thus modifying the difficulty curve if we felt that the difficulty was rising to unplayable levels.

C. Incorporation of event data

For a game that runs in parallel with a real event, the more real data from the event that is incorporated with the game, the greater the sense of immersion provided to the player. In the case of the Barcelona World Race game, there were three sources of data from the 'real' race that could be used, telemetry data from the real boats competing in the race (e.g. rough GPS position); real weather conditions and forecasts from the official Barcelona World Race meteorology service; and live contact (videos, calls, and emails) from the real skippers provided during the race.

Of these three, the inclusion of the rough location of the real boats (updated every 30 minutes) was an obvious method to increase the immersion of the player. With the estimated location of the real boats included in the game map, players were able to see exactly how well they were performing against the real boats, adding to the sense of competition – although, of course, players were not really 'competing' in any real sense of the word, as the game was not trying to be anything approaching an accurate simulation (see section III.A above).

Using real wind data was an important addition that added to the immersion and attraction of the game. It did, however, raise an interesting question about what consists 'real' data. The official weather data was collected by the meteorology service at t=0; these terabytes of raw observation data were processed in order to generate the report on the 'current' weather, and also the forecast for the forthcoming days. This processed data was made available to the game four and a half hours later (t=4.5hrs). However, this meant that the 'current' weather in the game was actually the weather measured at t=0; and thus there was an unavoidable delay of 4.5 hours between the weather in the game and the conditions faced by the real boats. Although various possible alternatives were discussed (including the possibility of using forecast data as 'real' data in the game), it was eventually decided to accept this unavoidable delay, given that all virtual ships were facing the same conditions, and that the game was not intending to provide an accurate simulation anyway.

The game made special effort to include as much contact from the crew on the real boats as possible. The game interface was designed to easily show the latest email contact from each

boat, and a system of 'Points of Interest' (POIs) was developed, using Keyhole Markup Language (KML), to add to the game map. The use of KML allowed media rich POIs (including images, audio, and video) to be inserted into the game interface at any point during the course of the event, and this allowed players to see regular multimedia clips of the real boats and the real conditions at various places around the globe.

IV. Social Interaction

There has been much research done into the social elements of MMO games [3] [4] [5], and it is clear that the social aspect is the driving force behind the success of many successful MMO games. When designing a game to parallel a real event, several opportunities arise in order to drive interaction and competition between users. Existing methods, such as lists of 'Friends' (contacts with other players that are saved between active gaming sessions) are standard in all MMOs, including existing online sailing games such as Virtual Regatta and Live Skipper. Friends lists are a key aspect in an MMO as they allow users to directly compete against friends and peers. In the Barcelona World Race game, we wanted to go beyond the 'passive' friends list, and enable in-game communication in order to foment competition and interest. As a result, a Twitter-like messaging service was developed, allowing users to post short (140 character) status messages within the game interface, which would automatically appear in the 'logbook' section of all the 'Friends' of that user. The messaging client was extended with a familiar addressing service – prefixing the character '@' before a player username sent the message to that player, regardless of whether they are a Friend or not.

In a further effort to boost social interaction and increase the immersion of the players, the game website presents a series of infographics that use statistics from the game to present interesting information. For example, the homepage updates daily with the 'Weekly Game Leaders' – providing statistics from the last 7 days on subjects such as who gained most places in the global ranking, who posted the most number of times in the messaging service, who had achieved the most number of Feats etc. This is supported by a multimedia rich website and message board/forum, which all registered players can access and post to.Finally, during the build up to the start of the regatta, social media played a vital role in creating interest and buzz for the game. An official Facebook page for the race was set up and a pre-registration Facebook application was developed, allowing potential players to choose their boat name, sail colours and basic boat configuration. As section IX below concludes, this approach was highly successful. Twitter was also integrated very tightly into the game interface. The RSS feed from the official Twitter account of the virtual race committee was used to inject race information and updates directly into the 'Logbook' of each player within the game interface, which allowed near instant communication between the race committee and all the players. For a game mimicking a real event, this instant communication is a vital method to update players with any changes to the course or even rules.

V. Educational Compontents

One of the objectives of the game was to introduce the world of sailing to wider audience, and also highlight several of the current issues facing the maritime environment. The POIs system (introduced above in section III) was to prove an ideal vessel for the introduction of educational aspects of the game. The educational department at FNOB provided a series of short texts, either describing geographical or maritime features, or highlighting current issues relating to pollution and the environment. The KML-based nature of the POIs allowed each comment to be associated with a GPS location, so the comments can be marked in the correct place within the world map. In addition, a comprehensive general tutorial was produced for the game, which emphasized elements of real sailing. Teaching in experienced users the basics of sailing was one of the core objectives of the project – the combination of the tutorial and the interface design (see section VIII) below addresses that.

VI. Browser based 3D graphics

One of the initial technical challenges for the development of the game was the stipulation that it should feature 3D graphics and should run fully within a standard web browser. After analysis of the state of the art in this field, the decision on how to achieve this objective was simplified into a choice between one of three options:

1. Flash 3D – given that the vast majority of browser based games are implemented in Adobe Flash, this was a clear option
2. WebGL [11] – would provide the possibility of running native OpenGL code in the browser
3. 3rd party plugin – such as Unity3D [12], Google O3D [13], Microsoft Silverlight [14], or a custom plugin

In making the decision on which tool or API to use, there were two chief concerns; one, the existence of a proper 3D pipeline capable of multipass rendering; and two, ease-of-distribution of any results. After some initial tests, it was clear that Flash 3D would not be sufficiently powerful to display the required quality graphics, and WebGL is not supported by all browsers (in particular Microsoft Internet Explorer).

Figure 3. Screenshot of the in-browser 3D engine

Thus, we decided to use a 3rd party plugin, in particular Google's O3D. Although Google has now stopped active development of the plugin (in a drive to support WebGL) it is still available to download as a plugin for all major browsers, and is now very stable. The plugin API allows developers to

create complex 3D scenes in javascript, while referencing shaders that allow direct access to the GPU. It also supports multipass rendering, which was of vital importance to us. Multipass rendering facilitates many post-processing graphical effects, such as reflections and weather effects, which are crucial for the creation of 3D scenes based largely on the open ocean.

A screenshot of the result is shown in Figure 3.

VII. Creating a Robust Server Architecture

From a purely technical point of view, the creation of a robust server architecture is the most important aspect of a successful MMO game. The server architecture must be capable of managing thousands of simultaneous game client connections, while also executing the back end calculations required for the game logic (in this case, to control the movement of the boats within the virtual race, to calculate race rankings, and to support the ancillary features of the game such as the in-game messaging service).

For the Barcelona World Race game, we created a server that was completely independent from the client, so that completely independent client implementations (such as iPhone applications) would be able to connect independently from the main browser-based client. To restrict non-authorized applications from connecting, we implemented a unique token based authorization system for each client session.

A. *Server Backend*

The server backend for the Barcelona World Race game consists of a series of databases containing player information. Multiple databases are used in order to reduce the risk of overloading. The main database stores the current position, sailstate, and heading of each boat, along with a global weather map. An update process sweeps this database, calculating the new location coordinates (in latitude/longitude) according to an equation of movement and a time *t*. The equation takes into account all the factors in the game that could affect the speed of the boat, while *t* depends on the time since the last update for each boat. The update process typically takes a second or two for up to a hundred thousand boats; but the time taken is increased as more queries are made from the database (client connections, for example).

A second database in the back-end stores user information such as passwords and preferences. A further third database is used to store historical information for each player (such as the route their boat has taken). This historical information can take up quite a lot of storage space within the database, which is why it is kept separate.

B. *Server Frontend*

The server front-end for the Barcelona World Race game consisted of a series of Apache web-servers and load-balancers. The exact configuration was managed by a commercial company, Nexica [15], and detailed description of it is beyond the scope of this paper.

VIII. Interface Design

Although the 3D graphics provide the main visual attraction of the game, they offer limited ability to genuinely plan a multiday ocean voyage. Thus, it was also necessary to develop a comprehensive and intuitive 2D, map-based interface, to allow players to sail their virtual boats effectively.

The main interface for the game was created via a series of paper prototypes, non-functional mockups, functional mockups and complete prototypes. Figure 4 shows a series of screenshots demonstrating the evolution of the interface interface. Figure 5 shows a screenshot of the final interface.

Figure 4.Top-Bottom, Left-Right; a very early mockup; the very first playable version of the game; an alpha version used for the Vuelta a España regatta game; one of the mock-up options for the final interface

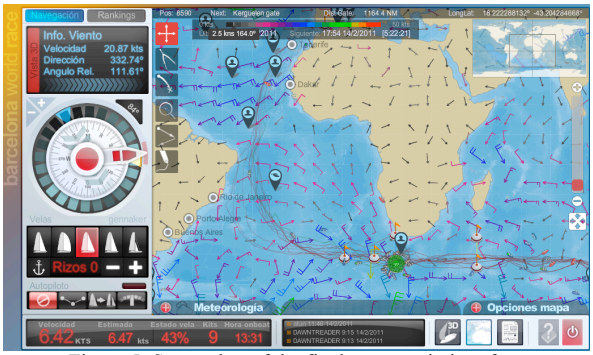

Figure 5: Screenshot of the final game main interface

The final game 2D interface is the product of over a year of development and testing, and presents all the information required by the player (wind, bearing, sails, autopilots, POIs, real ships, friends rankings) in a straightforward and logical way. Although explanation of all the interface features is beyond the scope of this paper, the development of a key component, the *compass*, is indicative of the whole process.

The compass is one of the most important aspects of the interface design. Of all the controls, it is the one that occupies the most screen space, and the one that all users will use regularly. As the screenshots in Figure 4 show, the compass started as a mockup image. It then developed into a basic functional prototype, and gradually several components for visual feedback were added: moving chevron indicating

prevailing wind direction, then graduated colour bars to provide quick visual indication of estimated speed, before finally coloured markers around the rim, showing the directions of the next control-gate within the race.

Although initially planned to be a mixture of HTML, Javascript and Flash, the final interface was implemented entirely in Flash and Actionscript, which is overlayed with an O3D element when the 3D graphics are activated by the user.

IX. Results and Conclusions

A. Race statistics

The Barcelona World Race game started at exactly the same time as the real regatta, at 12.00GMT on the 31st of December 2010. The game was open for registration and public beta-testing for two weeks before the event – this proved to be invaluable in ironing out several bugs before the start of the race proper. On February 18th 2011, the lead boat in the virtual race crossed the half-way distance mark (12,964 nautical miles). Table 1 provides some game statistics recorded at this point.

TABLE I.

Barcelona World Race Game Usage – 18th February	
Total registered users	36,961
Total active users[a]	21,224
Average connections/hour	3,786
Total in-game messages sent	489,427

a. Measured via number of users who successfully completed first stage, Barcelona-Gibraltar

The table shows that, of the total number of registered users, at the time of measurement, 57% of regular users had played the game with a reasonable frequency. While this figure may seem low, given that the game is free to play, and registration was made as easy as possible (either independently, or via Facebook Connect) we considered this to be an excellent result. We were further encouraged by statistics from the 'Live Skipper World Race', launched in direct competition to the Barcelona World Race Game, which had a total number of registered users of 1,910. Although the Live Skipper game lacked the drawing power of being 'the official game', we were under no illusions that had the Barcelona World Race Game failed, the Live Skipper competing race would have had a much greater following.

B. MMO Game Design for Real Events

Our experience in developing the Barcelona World Race game has lead to abstract a series of conclusions that should be borne in mind when developing MMO games for real events.

1. *Games for real events require a different design approach*: The balance of simulation vs. playability, and the uneven difficulty curve, require a flexible and non-standard approach to basic design
2. *Browser based 3D is a reality*: Despite ongoing PR wars between different proprietary plugins, it is clear that browser based 3D graphics are now an established part of the internet. The Barcelona World Race Game was a not a triple-A, multimillion euro project; and the fact that such a relatively small project were capable of developing high quality browser-based 3D graphics is indicative of the level of the currently available technology.
3. *Social Interaction is a vital aspect*: While this conclusion is hardly novel, the results of the game (especially the near half-million in-game messages, and following on Facebook) add to the growing body of evidence that shows that in-game social interaction is vital in order to create a popular game.

In terms of future work, the entire data of the game (history logs, timings, sail changes, messages) is stored in the main game database. This store constitutes an excellent source of information that can be data-mined for trends are patterns of play. This should not provide interesting research data, but also give a strong basis for development of the game for the next Barcelona World Race, in 2013/14.

Acknowledgment

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