AE2 Commander: simulation and serious games in the online cultural heritage space

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In 2009, the School of Computer and Security Science, Edith Cowan University, won an Ian Maclean Award to research the role of computer simulation in the archives online space.[1] *The grant was used to build an authentic World War I role-play game called* AE2 Commander, *based on the exploits of the World War I Australian submarine* AE2.[2] AE2 Commander *is being used to research the application of serious gaming technologies and methods in the archives online space and to foster understanding of how original sources might be used as part of computer simulation and serious gaming.*

In this article, the authors explore the application of computer simulation and gaming technologies to archives online.

Keywords: computer simulation, gaming, archives, historical simulation

Introduction

In the 1970s, advances in information processing and visualisation technologies led to the first successful application of computer-

generated imagery (CGI) to a creative task - movie making. Contemporaneously, the possibilities of CGI for entertainment and learning began to be explored on a new generation of computing device known as the 'personal computer'. As CGI matured on personal computers, it spawned a new software industry in computer simulation and video gaming. Mass adoption of the Internet in the 1990s provided a ubiquitous, affordable network platform for multi-player online gaming. In its various forms, on personal computers, the Internet and purpose-designed gaming platforms, the video gaming industry has matured. In 2008, it is estimated to have generated $54.5 billion in revenues worldwide.[3] By market share, the largest sector consists of three-dimensional (3-D) games, rendered on screen as two-dimensional (2-D) graphic information.

These developments have spawned new thinking about the strategic use of games and simulation online. In the cultural heritage space, how new interactive technologies (including games) can be used to connect and engage with users is being actively explored. E-learning has been a major focus of this exploration. For example, National Archives of Australia's (NAA) virtual reading room (Vrroom) is a topic-based e-learning resource in 2-D based on digitised copies of archival sources.[4] In partnership with the Learning Federation, the NAA is using Vrroom to embed archival sources and learning into the Years 9–12 secondary curriculum.

A further evolutionary step in e-learning with archives is suggested by the potential to apply CGI, 3-D visualisation technologies and the methods of computer games and simulations to authentic learning tasks grounded in the archives domain. Games-based learning (GBL), also known as 'serious games', is about 'leveraging the power of computer games to captivate and engage end-users to develop new knowledge and skills'.[5] The *AE2* project is seeking to explore and evaluate the potential of serious games in the archives online space.

Computer simulation, serious games and archives online

Computer simulation and video games are characterised by combinations of immersive user interaction, role-play, software art, gaming and visualisation. The user experience is inherently

constructivist, with meaning and understanding emerging from 'in-game' experience and user reflection on these experiences. Unlike the 2-D online exhibition space, the experience of computer simulation and gaming is seldom linear, never passive and often rich with user interaction and feedback.

CGI in 3-D furnishes the basis of a global entertainment industry built around platforms such as Microsoft's Xbox 360 and Sony's PlayStation PS3. Games can be single user, multi-user, or multi-user played across the Internet. In-game environments can be fixed and limited to situations or contexts, or expansive and extensible, as seen with virtual worlds. Although entertainment genres dominate, games can also be *serious* – designed for learning or some other *serious* application. Emergency services, military training, corporate education, healthcare and education are established markets for simulation and serious games.

Historical simulation, which sometimes uses or references digital surrogates of archives, can be serious, entertaining or both. *Historical sims* describes a genre of computer games and simulations designed around historical events or historical processes that can blend elements of games, simulation games and training simulators. An example of an event-based game is the award-winning *1066* in which the player assumes the role of the hapless King Harold Godwinson defending Anglo Saxon England against the Normans.[6] Microsoft's *Age of Empires*, on the other hand, explores the processes of empire building and colonisation in the Americas and in the ancient world.[7] Most historical simulation involves considerable attention to accuracy and authenticity in the recreation of models and environments by designers. Historical simulation can be lucrative for game developers. Kee et al. report that *Civilization IV*, released in September 2005, sold over six million copies in the six months following its release.[8]

Design approaches to authenticity vary from game to game in terms of historical conditions and constraints. Where constraints are relaxed, players have more freedom to create their own historical narrative. Whereas some game designers go to great lengths to get the detail of CGI models, environments and even narratives accurate in terms of the documentary record, others are more pragmatic and may discard

authentic constraints where they work against engagement and entertainment. The relaxation of constraints can be controversial:

> Not surprisingly, some historians and educators have attacked the game industry for its inadequate engagement with the facts and its inappropriate irreverence for the past. And not surprisingly, the industry has responded by limiting its claims ('it's only entertainment') and pointing to its positive effects ('players are rendered so enthusiastic about history that they actually read about it').[9]

Entertainment and the more 'serious' field of e-learning suggest a stakeholder community spanning mainstream video gaming, corporate training and education. However, archivists are becoming active in the space. For example, 'context of creation' enthusiasts have recently moved to embrace CGI to recreate environments of records creation. Lehane sees the recreation online of 'places of creation' as an evolutionary next step in the documentation of context.[10] The recreation of 'places of creation' not only involves new opportunities to engage archival users, but can also provide a new user interface for information retrieval. 'Places of creation' seeks to overcome a possible weakness in current approaches to context where the documentation effort provides:

> a limited amount of contextual information about the persons, administrative structures, and functions prompting the initial inscription of the records, rather than about the related societal, procedural, record-keeping, and organizational culture contexts, or the unexpected and anomalous features of 'the way things work to shape the initial records inscription' - to use Elizabeth Yakel's pithy phrase.[11]

From a theoretical perspective, these developments are suggestive of the growing influence of postmodernism on archival theory and practice. Cook[12] and Nesmith[13] have commentated on the potential of postmodernism to breathe new life into archival theory and practice. In an article that reviewed the implications of postmodernism for archival thinking on context, Nesmith explored implications of postmodernism for activities of reference, public programming

and description. Whereas traditional concepts in these spaces have emphasised information retrieval, connecting users with records and providing information about records, postmodernism adds the dimensions of:

- helping users understand the context of creation, including processes of creation and archival actions; and
- researching and re-presenting the 'multi-faceted' nature of contextuality.

In another Ian Maclean Award project, called The Visible Archive, Whitelaw applied cutting-edge visualisation techniques to large archival data sets, providing new ways of exploring and understanding the relationships that give individual records their context.[14] With The Visible Archive, features of Web 2.0 online experience found application in the online space:

> A response to the opacity of the traditional text-based interfaces for accessing archives, The Visible Archive proposes a number of alternative views of the holdings that include tag clouds, histograms and interactive sketches that highlight the relationships between various sub-collections. This methodology draws from statistics and software art and deploys this thinking in an information science context.[15]

Game space: serious games and e-learning

A logical, next evolutionary step with CGI is to investigate the potential of full-blown computer simulation and gaming in the archives online space. But there are obstacles. In the design and execution of computer games that take their cue from reality, some kind of trade-off between the need to create player immersion and engagement on the one hand, and authentic environments and experiences on the other, seems almost inevitable. Viewed from the perspective of historical simulation, Kee et al. frame this problem as one creating effective overlap between 'good history' and 'good gaming'.[16]

If a game is to be effective in e-learning, it must also entertain. For a serious game with learning objectives, designers talk of the distinction

between 'education' and 'learning' - too much of the former may lead to a game that disappoints. In a well-conceived educational computer simulation or *serious game*, Meiers argues that 'the learning process itself is a significant part of the fun'.[17] Self-direction, immersion, engagement and interaction also work to create learning potential. Kee et al., citing work by the learning theorist James Gee, conclude:

> Good video games provide excellent forums for learning because a player experiences the world in a novel way, joins others and works with a new group, develops resources for problem solving, and views the environment (in the game, but in other domains as well) as a design space that can be engaged and manipulated.[18]

A significant literature exists that purports to demonstrate superior learning outcomes with well-constructed computer games (Ritterfeld et al.;[19] Bulger et al.;[20] Donlinger[21]). To promote effective learning, game designers have developed a repertoire of learning strategies that aim at exploiting characteristics of gaming environments. According to Filho and Latham, these include:

- *Self-direction.* Students are presented with goal-oriented problem-solving tasks that promote focus, but are afforded a high degree of self-direction and control over the nature and pace of the learning experience.
- *Engagement.* The challenge of a game can cause the student to invest emotionally in the outcome. Games are unpredictable, and surprises draw out the student's creativity. The rich context and lifelike environment engage the student's interest and deepen the learning experience.
- *Interactivity.* Interactivity encourages participants to learn processes ('how to') by trying, failing and making corrections. This demonstrates the consequences of decisions and actions. In some cases, students will also be encouraged to compete and collaborate with others to accomplish specific goals. Success in games is based on learning activities.
- *Multimodality.* This combines learning styles and intelligence that traditional training programs don't often acknowledge

or reward. It is also capable of delivering learning content differently, for example as text, audio or even actor-based animation.

- *Adaption.* In a well-constructed game, a student's progress and performance can be tracked and the game configured to maintain the appropriate balance between tedium (too-easy activities) and frustration (too-difficult challenges). This leads to longer attention spans, improved attentiveness and positive feelings.
- *Real-time feedback.* Analytics data, such as tracking and scoring, enables students to compare their performance with previous efforts, and with the results of others, thus boosting the power of competition.[22]

Case study in serious gaming: *AE2 Commander*

In design terms, many of these ideas can be seen to be at work in *AE2 Commander*. The project team was presented with a unique opportunity to explore learning strategy and the application of serious gaming methods in the archives online space. An important challenge concerned the representation of archives and manuscript sources held by the NAA and the Australian War Memorial (AWM). The question of how these could be used as part of learning strategy and implemented in ways that enriched but did not detract from the gaming experience was an important one.

The AE2 *in history*

Although less well known than the exploits of HMAS *Sydney*, the *AE2*'s campaign in the Dardanelles in 1915 is celebrated in the annals of Australian naval history. On 25 April 1915, the *AE2* began a mission to attack Turkish shipping in the Dardanelles Strait. On the same day, Australian and Allied Forces landed on the Gallipoli Peninsula. The *AE2* was the first allied submarine to successfully penetrate an area of the strait known as 'the Narrows'. Over a period of five days, it harassed Turkish shipping – disrupting the delivery of reinforcements and sea operations in support of Turkish land forces on the Gallipoli

Peninsula. The *AE2* encountered various challenges - traversing a minefield, coming under fire, attempted ramming by torpedo boats, and two groundings. After being holed in battle by the Turkish torpedo boat *Sultan Hissar*, *AE2* was scuttled by her crew in the Sea of Marmara on 30 April 1915. Today, *AE2* is a protected wreck. The wreck of *AE2* was located in 1998 by Turkish marine archaeologist Selçuk Kolay.[24]

Archival and manuscript sources

Archives and manuscripts that relate to *AE2* not only document the prologue and mission, but also the mission aftermath. Following scuttling of the submarine without loss of life, *AE2*'s crew were captured by Turkish forces. *AE2* prisoners endured a long period of captivity ending with their eventual repatriation in 1919. Poor food, overwork, inadequate medical care, and abuse resulted in the deaths of four of *AE2*'s 32 crew. Referencing the NAA's holdings, *AE2 Commander* also tells the story of this less celebrated chapter of the history of *AE2*.

The first stage of game development involves developing the concepts that will make up the game. For *AE2 Commander*, this involved detailed familiarisation with the *AE2* mission, and the history of the *AE2* and campaign in general. Archives and manuscripts relating to the *AE2* are distributed between NAA and AWM. AWM holds mission accounts including the official report, written by the captain, Lt Cdr Henry Stoker after his release from captivity,[25] and the diaries of *AE2* crew members HJE Kinder[26] and JH Wheat.[27] While the official report provides a clear breakdown of events, the diaries add colour and mood to the story. They also contain important information about command and control of a World War I submarine, as well as some operational parameters used in the game (such as periscope depth, maximum safe operating depth, speed submerged).

NAA holdings describe the pre-war history of the submarine, some operational aspects (for example, *AE2*'s grounding at Port Mudros on 10 April 1915),[28] but are more extensive in their description of the captivity and eventual release of *AE2* prisoners of war. Notable holdings include a series of plans, drawings and specifications of *AE2* lodged with the Construction (Engineering) Branch of the Navy Office [NAA: MP551/1, 109/2] and reports of the Australian Naval

Representative in London [NAA: MP472/1, 5/19/2520]. Using the avenue of communication opened by the Foreign Office with the American Ambassador in Constantinople, the Australian Naval Representative attempted to get a series of questions answered by Turkish authorities concerning *AE2* POWs. Efforts were made to ensure the health and well-being of prisoners, inclusive of basic necessities such as food, clothing and access to money. Attempts were also made to establish arrangements for communication, enabling prisoners to stay in contact with family and support groups.

From a foundation of primary and secondary accounts, the design team began to generate ideas for game play. Two deliverables have emerged from this work – a 3-D serious game and a 2-D online exhibition that functions as a host website for the project and a 2-D learning resource in its own right.

Learning strategy

AE2 Commander 3-D places the player in the role of submarine commander. The player also has the task of controlling the submarine in an authentic environment as it undertakes a mission based on an authentic scenario from 1915, namely, to successfully negotiate Turkish minefields and to penetrate the Narrows at Chanak. This feat was achieved by the real *AE2* on 25 April 1915.

Designed as a serious game, with constructivist pedagogy, the player must first learn to control the submarine. Using archives and manuscripts for intelligence, the player must also devise a successful strategy for carrying out the mission. Problem solving involves scanning documents for information on optimal depth for the passage, the maximum safe operating depth of the submarine, optimal speed for the passage and constraints such as endurance under water. Incorrect strategy can result in losing the game.

Tasks range across Bloom's taxonomy of cognitive domains.[29] To master submarine controls, the player must recall instrument and control detail, understand its function, and synthesise and apply this knowledge to dive, surface, navigate and maintain submarine trim. The primary sources here are the Kinder and Wheat diaries held by

AWM. For example, the Kinder diary describes in detail the operation of the hydroplanes and their role in surfacing and diving: 'When the boat submerges, the bow hydroplanes force her under to the required depth and the stern hydroplanes keep the boat level' (p. 7). The Wheat diary describes the maximum safe operating depth of the submarine, a parameter variable for the game.

Knowledge garnered from archives and manuscripts is also analysed, evaluated and synthesised to come up with a mission strategy. Effectiveness of the strategy is evaluated through feedback via alerts, a vitality meter and onscreen action. The archival texts once again are primarily supplied by the official report on the mission compiled by Lt Cmdr Stoker, and the diaries of *AE2* crew members Kinder and Wheat.

Cognitive flow is a concept from game design that describes factors (antecedents) that shape cognitive behaviour, use and experiential outcomes in gaming. According to Killi and Lainema, where a game is well designed, flow state of the user involves elevated concentration, autotelic experience, loss of self-consciousness and a sense of control (see Figure 1).[30]

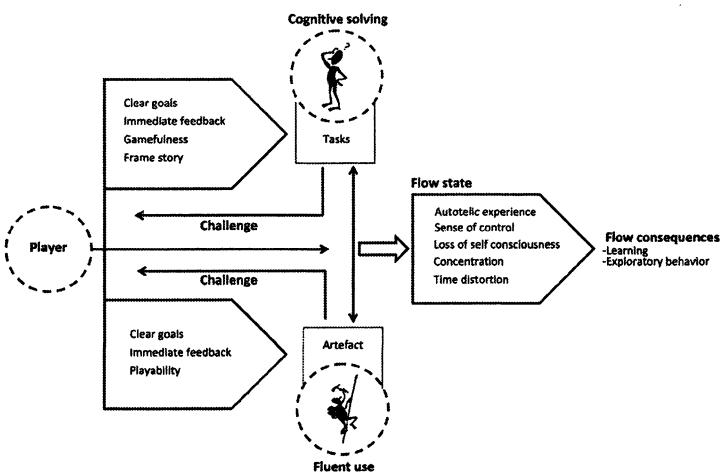

Figure 1. Elements of flow in an educational game context (Killi and Lainema)

Taken collectively, these aspects of flow describe player engagement with a game. Learning outcomes and engagement with *AE2 Commander* are assessed outside the gaming environment via analysis of web access logs and a sequence of questions contained in a survey that also tests user reaction to both software deliverables. Data gathering and analysis across both the 3-D and 2-D deliverables also aims at shedding light on whether user interaction with digitised copy of archives and manuscripts shows any different behaviour between the 3-D and 2-D environments.

Game overview and development components

As a university-based project, *AE2 Commander* is being produced on a limited budget compared with commercial computer games, which can cost in the order of millions of dollars. For this reason, there are many limitations to what has been produced. For example, no funds were available to implement multimodality – avatar narration of archives and manuscripts has been achieved only at the level of text.

Fortunately, mature tools exist that can be used to reduce development effort and cost in other areas of production. Whereas several years ago a large proportion of game development consisted of writing code to draw graphics, perform collision detection, and other low-level functionality, the advent of the game engine has made development of games more accessible. The *AE2 Commander* project uses the Torque 3D game engine.[31]

A game engine acts as a framework, providing functionality that is common to many games – such as drawing 3-D graphics, playing sound, and allowing user interaction. The generic game engine framework is taken by game developers who then add to it the content specific to their game. This content can be broadly divided into assets and game mechanics code. Assets are the visual and aural components of the game, produced by various artists. The game mechanics code, written by programmers, defines how the game operates. For example, when wishing to implement a submarine simulation:

- a 3-D model of the submarine is created by an artist;
- the game engine draws the submarine on the screen, and can

simulate basic physics and collisions according to the laws of physics; and

- the game mechanics code, specific to a submarine, can then be written to increase the 'density' of the submarine - for example when the player opens the ballast tanks, raises the periscope, or fires a torpedo.

A variety of game engines exist, with individual feature sets and price points. Table 1 lists some examples of the features that were needed for *AE2 Commander* along with the means by which they were realised with Torque 3D.

Feature	Realisation
Time of day simulation	Included in Torque 3D
Basic ocean and water simulation	Included in Torque 3D
Submarine simulation	Implemented in script
Animated menu components	Implemented in source code
2-D text and image overlays	Included in Torque 3D, extended in script

Table 1. A sample of features and their mapping to the chosen game engine technology (Torque 3D)

As an example of an effect achieved 'out of the box', Figure 2 contains a scene from the game at three different times, representing night, dawn and afternoon. The time of day was an important factor in the *AE2* mission - World War I submarines were primarily surface craft and could spend only a limited time under water, with limited navigation aids when submerged. As enemy sighting of the submarine in the narrow Dardanelles Strait was an ever-present danger, long durations on the surface (necessary to charge batteries by running diesel engines) were performed under the cover of darkness. As the ability to move and animate the sun and moon comes from the game engine, no extra implementation effort was required and this important requirement for mission realism was realised at no extra programming cost.

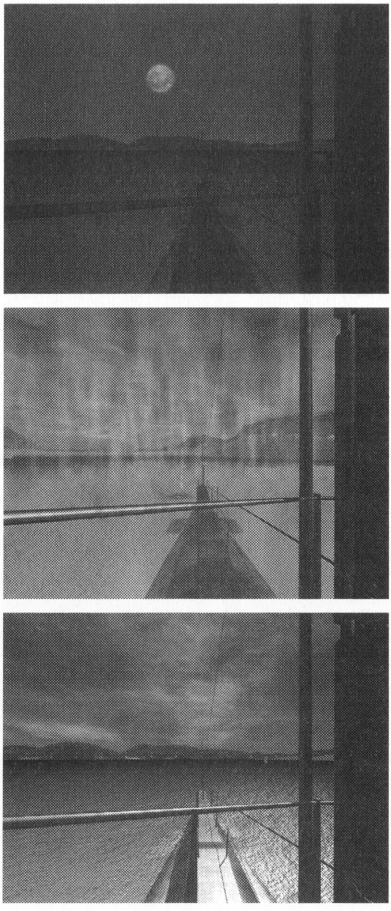

Figure 2. A day–night system has been actualised into the game; the screenshots shown indicate appearance of the same scene at night, at dawn and during the day

The game development process

From the Stoker, Wheat and Kinder accounts, the project team concluded that the mission could be divided into a number of episodes. These episodes make up game levels, each with its own individual goal. The episodes chosen for the game are detailed in Table 2, with focus placed on developing the initial two episodes.

Episode	Event	Aim	Win condition
1. Entrance	*AE2* entered the straights on the surface at night	Get as far as possible on the surface before dawn, or being spotted by searchlights	Dawn breaks with *AE2* operational
2. Mine run	The *AE2* dived under a minefield	Travel at the right depth to avoid mines, surface periodically to maintain bearings	*AE2* through minefield
3. Narrows	*AE2* penetrates the Narrows	Surface and fire on enemy shipping while avoiding enemy pursuit and grounding	*AE2* through the Narrows

Table 2. Levels chosen for the game base and associated win conditions

Once the initial game-play ideas were in place, the process of construction could begin. This consisted of creating the environment and implementing the actors and game mechanics. As 'engagement' and 'fun' are often elusive elements, the process of game development needs to be iterative. Stacey and Nandhakumar refer to this as a loop of the phases '(re-)conceptualise, (re-)design, (re-)code and (re-)play-test'.[32] Following such a process, the game is built up in increments. Similarly, assets such as 3-D models, menus, and textures need to be developed iteratively. A game typically starts with 'rough' placeholder assets in order to test game-play early, with final models of appropriate detail created once game-play decisions are made. This has two major advantages: (1) placeholder assets are faster and cheaper to produce and (2) because high-detail assets can be constructed after game-play

decisions are made, effort is not wasted on assets that are eventually discarded if the game-play involving them is cut.

The setting

Reconstructing the Dardanelles Strait terrain has been performed using data from the US Geological Survey.[33] This freely available data gathered from a Shuttle Topography Radar Mission (STRM) consists of a set of height values at 90 metre resolution (distance along the earth between height values is 90 metres).[34] Appropriate landscape colours and textures were determined by examining photographs of the locations. A screen capture of the landscape in Torque 3D is shown on the left of Figure 3, with a similar section from Google Earth shown on the right for reference.

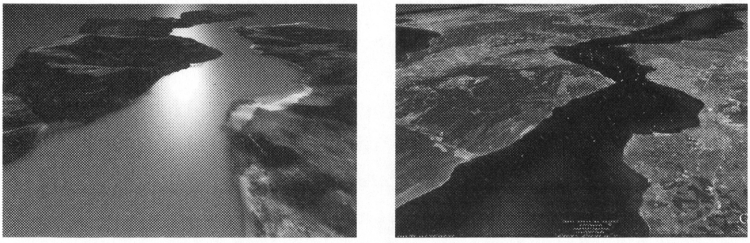

Figure 3. A section of terrain from the game shown on the left, with a corresponding image from Google Earth shown on the right for reference

Important in the setting was the location of the Turkish fortifications, present on both sides of the straights. Most of the permanent fortifications of the day still exist in some form. Online geographic tools such as Google Earth are invaluable resources, providing placement and structural information regarding the buildings. Only a limited view of these structures from a relatively large distance is possible from the waterline as they were built to avoid sighting by attackers. As such, only low-detailed models were required. Figure 4 shows an example of the modelling that took place, comparing a reference image from Google Earth with the final 3-D model of Cimenlik Castle (Cimenlik Kalesi).

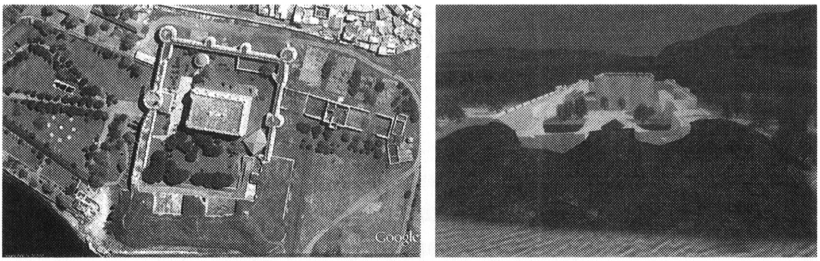

Figure 4. Cimenlik Kalesi – reference image on the left (from Google Earth), low detail model on the right

The actors

Actors in the game are the elements the player interacts with, including the *AE2* submarine along with various hazards, such as enemy mines, guns, craft and searchlights. The actors are the most important visual elements in a game, as these are what the player focuses on. As such, the creation of main actor models, the *AE2* submarine and its controls, along with enemy mines, was undertaken by hired industry professionals. Strategic use of such outsourcing was done to obtain quality results in a shorter time frame. Staff and students were given the task of creating the actors that appeared at a greater distance (and hence needed less detail). Work of this kind included gun emplacements, and the creation of placeholder models for actors where modelling was outsourced.

Figure 5 shows the final *AE2* and controls, both outsourced to hired industry professionals.

In the game, the *AE2* is controlled by the player, who has the ability to manoeuvre the submarine using the motors, rudder, hydroplanes and ballast. Controls for these are reproduced on the screen as a heads-up display (HUD), a common way of presenting information to the player in games where such elements are overlayed on top of the action. The look of *AE2 Commander* HUD elements is based on the corresponding elements on the *AE2*, realised as faithfully as possible given the constraints of screen space and limited records of some of the details. In order to make the controls more intuitive, they are all

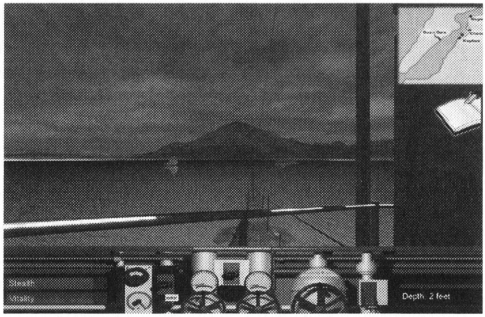

Figure 5. The final submarine and controls

operated using the mouse (rather than function keys that the player would need to remember). When the player places the mouse over a control, it highlights (by increasing in size slightly) and the state of a highlighted control is manipulated using the mouse scroll wheel. Using the scroll wheel to change state results in a more natural mapping to the submarine instruments - the player flicks the scroll wheel to flip a switch, and the turning of the submarine hand wheels to actuate steering and hydroplanes is achieved by turning the scroll wheel.

Other actors in the game are controlled by relatively simple logic. The searchlights travel through predetermined paths across the water - when the submarine finds itself in the light it is considered spotted by the game. In turn, when the submarine is spotted, guns from the forts aim at the submarine and open fire. The accuracy of the fire is controlled to avoid ending the game unexpectedly, allowing some warning so that the player can dive. The mines, which are anchored to the bottom, have the ability to destroy the submarine if hit directly. If the submarine is at a safe depth, the mooring chains of the mines merely scrape across the hull (as they did during the actual mission in 1915).

The narrative

While the setting and actors provide the opportunity for player interaction, the narrative (or story) guides the player through the mission, so that the setting is explored and actors encountered in a

meaningful and directed way, rather than at random. The narrative is sourced from the archival sources identified and acquired in the course of the project, in the main from the official report and diaries discussed previously. Overall, archive and manuscript sources are rich in detail, providing a chronological account of submarine construction and commissioning, the *AE2* mission and its aftermath.

In order to produce a compelling narrative, the accounts have been decomposed and structured, so that information is gradually presented through the game. The information in the documents can be broken up into three types – mission-specific, *AE2*-specific, and crew-specific – each of which is necessary to guide the mission.

Mission-specific information consists of time, geographic location, and the event taking place. Mission-specific information is useful to put the *AE2* in the right place at the right time in the game, although the information can vary because of the accounts being documented after the mission (with original ship documents sinking along with the *AE2*). An example is the event of the *AE2* entering the Sea of Marmara (referred to as the Sea of Marmora in the day) on 26 April 1915. According to the official report, *AE2* 'proceeded into Sea of Marmora, which was entered about 9 am'. In the diary of Kinder this is described as occurring at about 6 am[36] and the diary of Wheat has the same event happening at 9.40 am.[37]

Crew-related commentary gives an indication of the atmosphere during the mission. For example, Kinder recounts an encounter with the mine mooring cables, as being 'enough to stop one's heart beating to hear it sliding over the steel deck' (p. 24). This type of information is very useful when creating a game that has the right mood and dramatic tension. In addition to presenting written information such as this in dialogues, the designer can use visual and aural cues and an appropriate ambient soundtrack, all working together to communicate the intended atmosphere.

As mentioned, the existing budget for the project involved a project feasibility stage decision to use digitised copy of archives and manuscripts for gathering operational intelligence, learning submarine controls and discovering the authentic history of the *AE2*. Because of cost, the more usual option based on avatar narration has not been

available, reducing multimodality with undeniable consequences for engagement. Other budgetary constraints have affected our ability to produce authentic sound effects and to achieve comprehensiveness in terms of submarine detail. To date, no sources have been identified that describe the calibration of a World War I periscope, making recreation of periscope views problematic.

Further iterations of the game are possible that may overcome these problems. A creative idea here is to produce the game as a collaborative venture between Turkish and Australian sponsors. The discovery of the wreck of *AE2* in 1998 by Turkish marine archaeologist Selçuk Kolay and subsequent dialogue about how best to preserve and foster the heritage of *AE2* provide a context for further iterations of the software.

Conclusion

AE2 Commander aims at exploring the transformational potential of serious games in the online archives space. It is also exploring strategies for using digital surrogates of archives and manuscripts in a game environment. Improved understanding of these issues is likely to yield a more mature perspective on how gaming can enhance the user experience of archives online. Whether gaming will ever become a common user experience of archives online is an interesting question. *AE2 Commander* has been made possible by a new-generation software tool (the Torque 3D game engine) that reduces the cost of creating authentic online 3-D environments. Torque 3D is also supported by an extensive code library and powerful scripting language, both essential to low-cost games production.

Affordable, powerful tools promise well but are only one dimension of the problem. Problems of expertise and limited budgets suggest that dialogue and alliance-building with the gaming industry are required to achieve professional outcomes that are strategically advantageous to archival sponsors. At a theoretical level, space for further initiatives is being created with the growing influence of so-called postmodernism on archival theory and practice. If Cook and Nesmith are correct in their assessment of the importance of postmodernism in breathing new life into archival theory and practice, then *serious games* presents as a serious opportunity to progress the postmodernist hypothesis.

Endnotes

[1] National Archives of Australia, 'Ian Maclean Award: a research grant for archivists', available at <*http://www.naa.gov.au/about-us/research-grants/ian-maclean/index.aspx*>, accessed 5 April 2011.

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