Computer Graphics Through the Screen of Strategic Studies Group

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Abstract

Australia's second oldest gaming company, Strategic Studies Group (SSG) was established in 1982 and has been successfully making strategy games for the past thirty years. (Keating, 2014a; Chown, 1997) In that time there have been massive advances in computer graphics technology. From four colour machines to 8-bit colour display, through to millions of colours today. From tiny displays to screens being able to display HDTV and larger. The visual environment for games development and the techniques used to create graphics can be illustrated by examining some of the games that SSG have made over this time. This research paper will critically examine the development of computer graphics and techniques through the screen of SSG. Through a series of interviews with games developer Roger Keating, co-founder and current CEO of Strategic Studies Group; producer Gregor Whiley, art director Alister Lockhart and artist Fiona Chatteur (née Kerr), the history of games graphics, technologies and techniques and their influence on game play will be examined.

1 Introduction

Strategic Studies Group is Australia's second oldest computer gaming company. It was formed after Roger Keating, "a mild-mannered New Zealand maths teacher" (Humphrey, 1983) who was a teacher at Cranbrook School in Sydney decided to leave teaching to make computer games after his first game was published in 1979. Keating developed seven computer games through his own company Keating Computer services in 1979 through to 1982, which were published through the US company Strategic Simulations Incorporated (SSI) (Keating, 2014a). He contacted Ian Trout to become a game tester, who, after some analysis suggested that they start their own company together - and Strategic Studies Group was formed in late 1982, although the paperwork was formally completed in July 1983 (MacGibbon, 1984; Keating 2014a). Trout, who was a keen military history buff and proprietor and owner of Napoleon's Military Bookshop in Sydney. The bookshop was renowned for its collection of board and role playing games. (Keating, 2014a; Swalwell et al., 2014).

Keating, a games programmer, became Senior Vice-President of the company and Trout, a keen gamer with 15 years experience in the games field, became the games designer, creating the complex game play and scenarios for the games. Trout was President and Chief Executive Officer (CEO). The company was both a developer and publisher - not only did they write the code for their games, they were also responsible for publishing some of their titles (Keating, 2014a; Trout, 1985).

2 Early years - Apple II and Commodore 64

Their first game, Reach for the Stars, was originally conceived as a project where SSG would do a version of Stellar Conquest (Thompson, 1974) - but due to a breakdown in negotiations, the company decided to make their own game. Released in 1983, Reach for the Stars marked the beginning of what Alan Emrich (Wikipedia, 2014b) was later to call the 4x genre of games -explore, expand, exploit, exterminate. (Keating, 2014a; Trout & Chatteur, 2001).

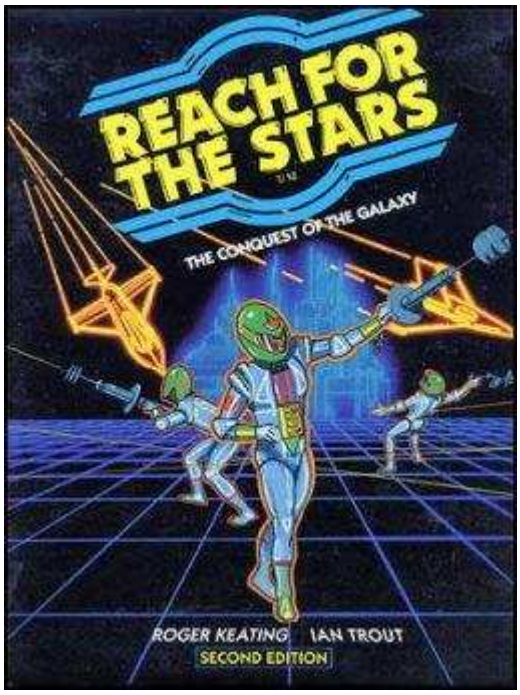

Figure 1 Reach for the Stars box art (Trout & Keating, 1983)

In the early days of SSG, Keating was both artist and programmer. The graphics capabilities of the Apple II machine, which was the original platform for Reach for the Stars, were minimal. The Apple II+ boasted a four colour display and 48kB of Random Access Memory (RAM) (Table 1).

The Apple II computer had 64kB of random access memory (RAM) available - they were 48kB machines, but 16kB was hidden, which Keating accessed through machine language (Keating, 2014a) "which means it runs extremely fast - faster than most overseas-developed simulation games" (MacKenzie, 1983). The screen took up 2kB - there was essentially about 4kB of the machine which could not be touched. Keating got rid of the Apple

operating system by writing his own, and managed to free up about 60kB of the memory so it could be dedicated to the game (Keating, 2014a).

Apple][+	Specification
CPU	MOS Technology/SynerTek 6502
CPU Speed	1 MHz
Bus Speed	1MHz
Register Width	8-bit
Data Bus Width	8-bit
Address Bus Width	16-bit
ROM	12 kB
Onboard RAM	48kB
RAM slots	1st expansion shot could be used
Maximum RAM	64kB
Video	6 colour at 280x192 pixels; 4 colour at 40x48

Table 1: The Apple II+ was made from June 1979 to December 1982 (Apple History, 2014)

Reach for the Stars was also released on the Commodore 64, a platform whose operating system could not be tampered with. The top 16kB of memory on the Commodore 64 could be flipped out, by flicking a switch, turning it into memory that could be used in the game. It technically wasn't a 64-bit machine. This made programming for the C64 more of a challenge than the Apple II (ibid).

Commodore 64	Specification
Processor	MOS 6510 or 8500 1.023MHz
Memory	64kB RAM (with 38911 usable under BASIC)
ROM	20 kB
Video	320x200 16 colours; 4 colours 160 x200 pixels

Table 1: Commodore 64 was released in 1982 and discontinued in 1983. (C64-wiki, 2014)

Although it was developed for the Commodore 64, Reach for the Stars remained essentially an Apple II game. It was programmed in machine language, so porting between the two machines relatively easy, the graphics were identical, despite the differences in graphics capabilities between the two platforms (see Tables 1 & 2). The pixel size of Apple II was 280 x 192 and C64 was 320 x 200 (Whiley, 2014).

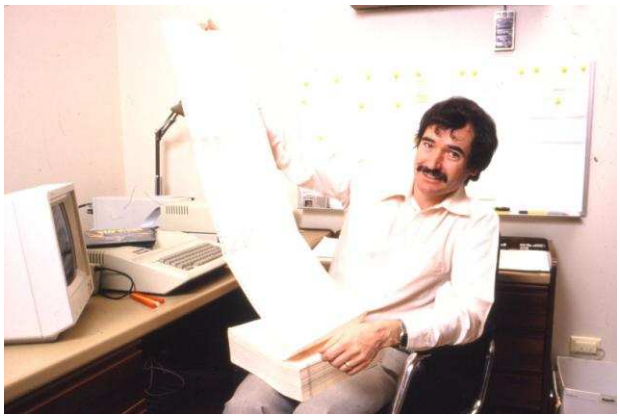

Figure 2 Roger Keating with a print out of the entire codebase for Reach for the Stars circa 1983

In 1982-1983, when the game was developed, there was little or no process or facility to produce computer graphics: there were no graphics file formats per se. Reach for the Stars had four colours which were generated by pixellating the screen, using machine code. The colours were either a 0-1 combination for black or white, or a combination of 2-bits for a colour, with up to 4 colours available at any one time (Keating, 2014a).

The developers designed the graphics using grid squares on paper that were shaded in with pencil. The size of the graphics were limited to a 16x16 pixel grid. Once designed (e.g. a simple tank or a spaceship) the graphic was then coded into a database, using 1s and 0s. These database elements were then placed on the screen by programming. The graphics took days to write in machine code, but were very fast when played (ibid). Keating compared programming in assembly language to "running against a brick wall and learning to like it. Each arithmetic calculation has be tailored to the module in which it is used. Any generalized routines would slow the game down and thus be unacceptable" (Keating, 1986, pg. 2).

"Much of programming in a game involves the shifting of data from one place to another, even screen displays, etc. The routine on the facing page (for the Apple II family) will split the text screen and is a good example of the type of project that should be tackled to get used to the skills that will be required in a computer game." (ibid)

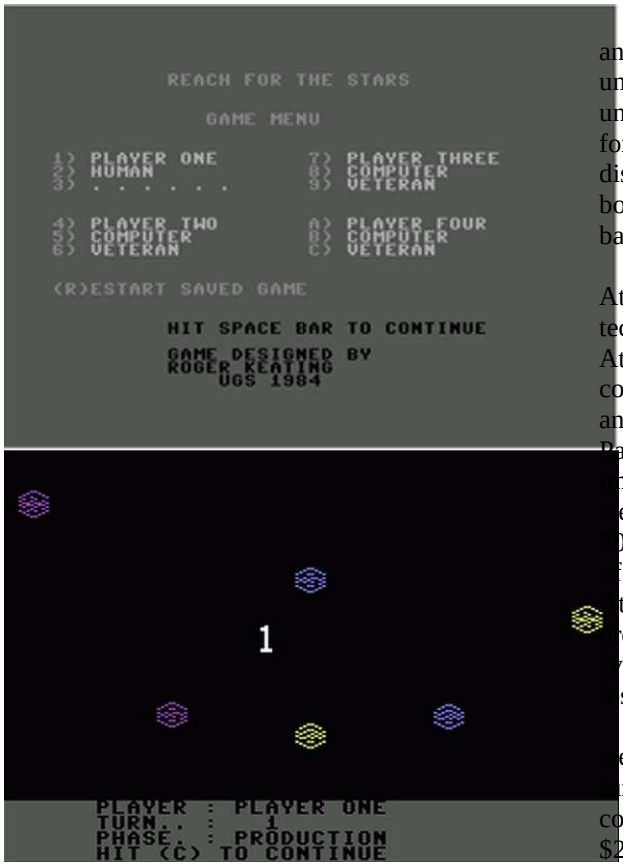

Figure 3 Reach for the Stars screenshots (Strategic Studies Group, 1983)

At the time, there were two approaches to computer games design. One approach was to push the graphical elements, and at the time the Commodore 64 was capable of 16 colours, the Apple II was capable of better colouring, but the process of creating the colours was much more complex, as it had only 6 colours available at any one time. If the game concentrated on graphics, more than half of the processing power would have been used, leaving little room for complex game play. SSG took the view that game play was the core of a game, and therefore kept graphics to a minimum.

Reach for the Stars could be played by up to four people, "any or all who can be played by the computer" (Webster, 1983, p. 54). Keating at the time described the subtlety of the computer system was to provide "games where they interact with people. The computer supports the game environment and offers assistance to the players, but does not appear as a monolithic opponent." Often it was "difficult to decide which of the players is the computer" (ibid). Keating stated that this was not important, establishing the subtle complexity of interesting game play was the key element.

"War is something in which a human is in his element, he is aggressive, intuitive, often brilliant, sometimes stupid. To get a computer to behave like that is very hard because it means taking routines and trying to turn them into intuitive devices" (Keating in Humphrey, 1983).

The four AI players in Reach for the Stars were named after Australian politicians of the time (e.g. Bill Hayden was 'The Drover's Dog'). The AI and strategy took up to 60% of the available processing power (Keating, 2014a).

Reach for the Stars was a very popular game for SSG, and sold extremely well, at around 300,000 to 400,000 units over time, including the sequels, with around 60,000 units sold of the first game. In the 1980s the games sold for $50-$60, with the costs of media (5 1/4 inch floppy disc, manual, cards, box) at around $5. Because SSG was both a developer and publisher, the profits formed a solid base for future games development for the company.

The success of Reach for the Stars was at a time when Atari - who were the leaders in games console technology, was seeing a massive drop in sales. In 1982 Atari's sales were down 50% (Laird & Jamin, 2006). The computer gaming business for Atari crumbled in 1983 and one of the games blamed for this downfall was the Pac-Man port to the Atari 2600 games console, implemented by Todd Frye, who was given only six weeks to achieve this task. (Melissinos & O'Rourke, 2012). Pac-Man was originally a console made by Namco of Japan, in 1980, and was immensely popular, but the Atari port was a disaster. Atari made the mistake of producing more Pac-Man cartridges than there were systems available for playing the game - a formula sure to lose money (Laird & Jamin, 2006).

The losses felt by Atari and also Mattel's Intellivision were at a time when the games industry was undergoing a fundamental shift from console games to personal computers. In the dark days of 1983 when Mattel lost $225 million, following the massive losses by Atari the previous year, the Commodore 64 home computer sold 17-22 million units (Laird & Jamin, 2006). The Apple II sold its millionth unit in June 1983 (Stengel, S., 2014). By creating games that could be played on both the Apple II and the Commodore 64, SSG was able to capitalize on the market shift to the more versatile computer platform.

Subsequent games developed by SSG for the Apple II platform and Commodore 64 included:

- Carriers At War (1984)
- Europe Ablaze (1985)
- Battlefront (1986)
- The Halls of Montezuma (1987)
- Decisive Battles of the American Civil War Vol 1. (1987)
- Battles in Normandy (1987)

(Sipe, 1988)

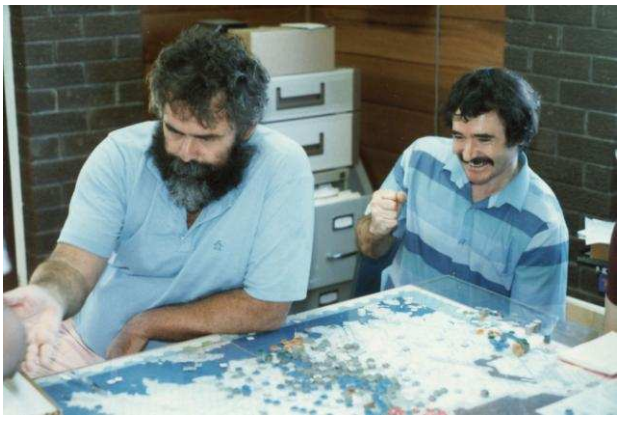

Figure 4 Trout and Keating working on a hex-based grid map (circa 1985).

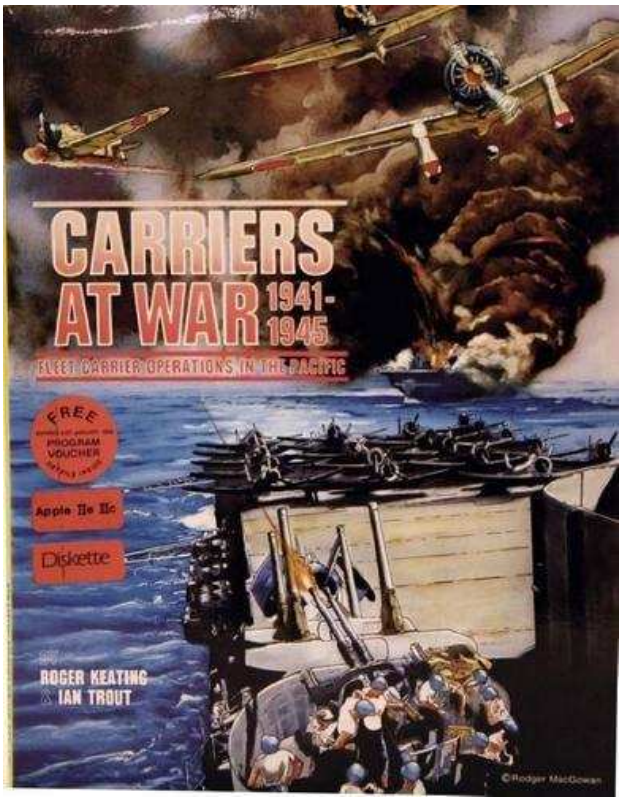

Figure 5 Carriers at War box art (Strategic Studies Group, 1984).

Carriers at War (1984a), like Reach for the Stars, was also programmed in machine language, and porting from the Apple II to the Commodore 64 posed no real difficulties (Figure 5), the graphics techniques essentially followed the same techniques as Reach for the Stars. Graphical elements for this game included aircraft carriers, individual planes flying around, involving a "tremendous amount of data moving around every second" . Over half the processing power available to the game was consumed by the game play prior to the consideration of graphics. The developers deliberately used simplified graphic structures so that the game could fit into the available platforms and enable smooth game play (Keating, 2014a).

Some games developers at the time took a different approach, enabling more advanced graphics and complex game play, but there was a trade-off. Keating recalls playing one American game that once the first level was completed, the game paused with a screen that stated that the next level was available "in an hour". Keating took the approach that more than a 30 second wait made players frustrated and annoyed, and ensured that within that time some computer feedback would occur (Keating, 2014a).

Carriers at War consisted of a 84x72 hex grid which mapped to the real-world size of 20 nautical miles per grid (Figure 4). It was arranged so that the displays and location procedures were simplified by using a mega-hex arrangement, comprised of nine small hexes. There were four maps included: Battle Map A was the North Pacific Ocean, used for the Pearl Harbour scenario and the Midway scenario. Battle Map B showed the South Pacific Ocean and the Coral Sea, from New Ireland to Brisbane, Noumea to Lae, and was used for the Coral Sea, Eastern Solomans and Santa Cruz scenarios. Battle Map C showed the Western Pacific and was used for the Philippine Sea scenario. The final map was blank, left for people who wanted to design their own maps (Brand & Garnham, 1984).

The game allowed 63 aircraft types and 63 ship classes. 127 aircraft squadrons could exist in the game, along with 48 task groups, including 32 aircraft carriers and up to 214 other ships. The operations in the game were performed using an hierarchical network of menus - there were 28 available for the normal running of the game. The command structure was complex, but game play was assisted by automating the placement of supporting fighters to any bomber squadron on the maps (ibid).

Figure 6 Carriers at War screenshot of menu displays (Strategic Studies Group, 1984).

Carriers at War "sold even better than Reach for the Stars" (Keating, 2014b). The company was expanding. John Gleason, an American marketing expert and Eric Baker, a games designer, joined the company. Baker was the first of many hired to assist the games designers in the complex task of creating historically accurate strategy games. In 1985. Europe Ablaze was released, and in the same year, Carriers at War won the Charles Roberts Award for Best Adventure Game for the Home Computer 1984-1985 at the 11th Annual Origins Convention held in Baltimore in July 1985 (Emrich, 2014; Trout, 1985).

Europe Ablaze was the last game that Keating did artwork for and from then on focussed on programming and game design. This game also marked a turning point in computing technologies - the Apple II was losing its market power, and the PC was starting to dominate the market. Although further games were developed for the Apple II, Europe Ablaze marked the turning point in the domination by the IBM personal computer (Keating 2014a).

In 1986 Gregor Whiley joined SSG as a producer, "after convincing Roger and Ian that they needed some help". His first game with SSG was Battlefront, which was developed on the same platforms, using similar techniques in generating the graphics as SSG's first three games (Whiley, 2014). At around the same time Nick Stathopoulos was hired as SSG's first Art Director.

> "I don't recall anything that we couldn't ultimately do because of these limitations, but Roger hand to expend considerable time and effort in squeezing

everything into memory, and the games only ran smoothly because of his skill and ingenuity." (Whiley, 2014)

Battlefront was memorable because it was a game that was made in fourteen weeks, when the company was stalled on The Road to Appotmattox. The artwork is visibly rushed, as the fourteen weeks included programming, game design, manual and packaging. (Keating, 2014a).

The Road to Appotmattox was a large scale strategy simulation of the entire American Civil War. This ambitious game was never completed (Keating 2014a).

"For the 8 bit games, the graphics were created directly in the game's editor. Units and terrain were created as hex sized icons and assembled for display by the game program" (Whiley, 2014).

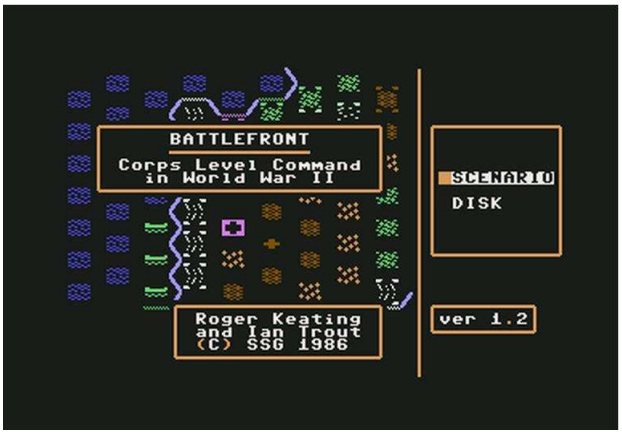

Figure 7 Battlefront saw no great developments in on-screen graphics, but saw improvements in game mechanics (SSG 1986).

For Battlefront Roger created a routine which was able to find its way from point x to point y on a hex grid, "no matter how cluttered it is with impassable hexes or hex-sides." In calculating the distance, the routine took "into account the movement point cost of the terrain as well as any additional costs incurred by the presence of enemy units or hexes (Trout, 1986 p.3). It had a sophisticated way of streaming data into the machine so that the actual amount of memory being able to be used was higher. Only the part of the game that was being used at the time was in the machine. The AI remained on the disk. Keating wrote a disk operating system that allowed for phenomenally rapid disk access. This allowed for the AI to load when needed and quickly reload the games screen (Keating 2014a).

"Serious war games more or less demanded a top down view that showed units on a map. The fact that conveying game info was, in a war game, much more important than aesthetics, combined with the graphical limitations of the 8-bit platforms meant that SSG didn't need an artist for its Apple II/C64 games. Ian and Roger between them were sufficient to create the graphics that the games needed" (Whiley, 2014).

Figure 8 Later versions of Battlefront contained more sophisticated graphics than the original.

There were a total of eight Battlefront games produced by SSG, from the original which was published in 1986 to subsequent games that were published up until 1992 (Figure 8). Platforms developed from the original Apple II/Commodore 64 to the PC and the Apple MacIntosh machines. It was the Battlefront series which saw the transition from primitive pixel art graphics generated by Keating, through to the use of artists and more sophisticated paint programs that best made use of the 16 colours available.

3 The 1990s Deluxe Paint and Photoshop

Deluxe paint (Dpaint) was the first graphics program used by SSG, and all of its artists had to be able to use it (Keating 2014a). Dpaint was short for "Deluxe Paint". It was a bitmap graphics editor written by Dan Silva for Electronics Arts. It was released in 1985 for the Commodore Amiga 1000, and was ported to DOS and became the standard bitmap graphics editor in the 1990s (Wikipedia, 2014c). It had indexed colours initially, no layers and although it had the ability to create gradients, it could not automatically do so - they were painted by the artist, using different shades of colour.

The next release of Reach for the Stars (1988) was at a time when 16-bit consoles and computers were available (Figure 9). The game was available on the Apple IIGS, Commodore 64/128 and PC DOS (Hall of Light, 2014). Although 16-bit processors also supported higher bit-depth graphics, there was a lack of standardisation in the allocation of bits to the cards. "Unfortunately, some cards used 5 bits for each of the RGB values (5-5-5 format) and some allocated an extra bit to the green value (5-6-5)

format. This was a great leap forward for the artists as the minimum of 32,768 available colours finally erased (almost all) the limitations of earlier graphics cards. On the downside, both formats needed to be supported and rather than juggle with the formats inside the program, it was decided that all game graphics would be created in one format and then converted to the other format with both versions included as game resources. Even with some snazzy Photoshop scripting, it was a painful and tedious task to do this." (Whiley, 2014).

Figure 9 The 1988 release of Reach for the Stars using high quality graphics.

Warlords (Fawkner, 1990) was memorable for SSG. It was originally created by Steve Fawkner and marked a radical departure from the hard-core war gaming that was their speciality. Fawkner sent the company the fantasy game on-spec, with a view to getting it published. The company had never been given a game previously, "to say we were amateurs at this was an understatement". The mechanics of the game was rewritten to use SSG's military mechanics - "but everything on top of that was Steve Fawkner's" (Keating, 2014a). It was released for DOS Amiga and Mac OS and was distributed on a 5.25 inch diskette and 3.25 inch diskette (Wikipedia 2014d).

Warlords was created in a 4-bit (16 colour) environment. It was a turn-based fantasy role-playing game which for the first time had a special class of player - the Hero. Heroes in game were treated differently than other players, the higher their strength, the harder they were to kill. Each additional army that was attached to a hero increased that hero's chances of survival (Trout, 1991 p. 18). It had eight different sides (or clans), the Sirians, Storm Giants, Grey Dwarves, Orcs, Elvallie, Horse Lords, Selentines, and Lord Bane. Each clan could be either a human or a computer player.

Warlords was named by Computer Gaming World as co-winner of game of the year in 1991. (Wikipedia 2014e). The computer art for Warlords was by Graeme Whittle, with the box art by Nick Stathopoulos (Fawkner, 1990). The game was a great success, and a number of sequels followed:

Warlords II (1993)
Warlords II Deluxe (1995)
Warlords III Reign of Heroes (1997)
Warlords III Darklords Rising (1998)
Warlords IV Heroes of Etheria (2003)

It also provided the universe of Fawkners' Warlords Battlecry series of real-time strategy games.

Figure 10 Warlords screenshots (Fawkner, 1990).

SSG had by 1990 switched their development environment from Apple to PC computers. In 1993 they released the Carriers at War Construction Kit which enabled players to become games designers, allowing them to design their own maps to recreate the great sea/aircraft carrier battles in history (Keating, 2014a). The construction kit was used with the 1991 release of Carriers at War II which used bitmapped graphics created in Dpaint. Ian Trout was the project lead for this version of Carriers at War, although he said at the time "I have no artistic talent whatsoever, merely some little ability to copy in a 'monkey see, monkey do' fashion". The pixel art was created by Steve Ford and put together by Ford and Trout. Together they assembled over 200 ships, of which 150 appeared in the game (Trout, 1993 p. 21, Keating, 2014a).

Deluxe Paint II was the version that Trout used for the graphics, which saved .lbm files, which was the native bitmapped file format. For the construction kit, SSG developed a Ship Paintboard, which was a template that contained gun turrets, funnels, torpedo tubes, etc. which could be used to create the game artwork. The process of creating the ships was pixel painting, a process made simpler through using the pre-made elements, and by using reference images provided as part of the construction kit. This process could also create animations. Once the artwork was completed in Dpaint, the construction kit integrated the graphics for use in-game (op cit, pp. 22-26).

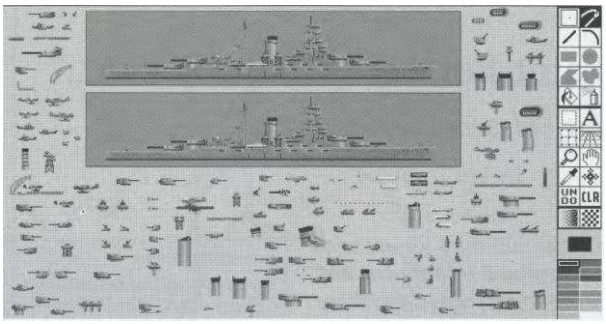

Figure 11Carriers at War Construction Kit inside of Deluxe Paint II (Trout, 1993 p. 22).

"The early 16-bit games were pretty straightforward. Most of the hard work was connected with the map creation process. Maps were made up from tiles, and a lot of effort was made to disguise this fact, to avoid ugly artefacts and to allow the artists more scope for customising and varying the appearance of the maps" (Whiley, 2014). It is worth noting here that 16-bit games were capable of displaying between 512 and 32,768 colours, "16-bit" is not referring to colour depth, but to the size of the memory addresses or other data units which were at most 16 bits (2 octets) wide (Wikipedia 2014f).

One of the problems in the 1990s was the lack of memory, often the limitation in graphics displayed in-game was imposed by the design team in order for the game to run. There was also the problem of a lack of standardization of graphics cards, developers would make a game, a new graphics card would be released, and the game would no longer work To address this concern, Microsoft created Direct X, which minimized these problems (Keating, 2014a).

In 1995 Alister Lockhart joined SSG, initially to paint trading card art for a card game that was being developed. The in-game graphics he subsequently created comprised of 8-bit colours (16.8 million in total), not because the computers at the time were not capable of higher graphic quality, but the games mechanics were designed for lower quality graphics. The games created at the time could have run on an IBM PC 486, but the specifications of the development machines were much higher. It took some time for the graphics capabilities of the games to be able to support the higher quality 16-bit graphics. (Lockhart, 2014).

The artwork was still pixel art created in Dpaint. Lockhart learned Photoshop while still creating his graphics in the older program. Switching to Photoshop was a steep learning curve for Lockhart, but ultimately proved to be a faster and more efficient program (ibid).

Warlords Battlecry (1999) was SSG's first attempt at a real-time strategy game, and the company made the dramatic step of moving from 2D to 3D graphics. Even though the game was 2D, everything within it, except for the background textures was a rendered 3D shape (Keating, 2014a).

4 The Millennium and 3D Modelling

I joined Strategic Studies Group in 1999 as one of their 3D artists. The other full-time 3D artists were Grant Arthur and Janeen Fawkner who both worked with Steve Fawkner (Creative Director, Musician and Programmer) in Melbourne. I worked out of Sydney with Art Director Alister Lockhart.

The computers used at the time were the IBM Pentium III, capable of using 24 bit images and higher resolution graphics. The screen size at the time was 1024 x 768, although SSG's games could run on computers with smaller resolutions.

I was hired to create the in-game 3D character art for Warlords Battlecry (1999), a role which also saw me take the concept art created by Alister Lockart and translate it into 3D models, render it out and send it to Melbourne to be integrated in the game. I was also responsible for hiring and managing a stable of freelance 3D artists. The graphics technology we were using was 3D Studio Max 3.1 with the Character Studio plug-in for character rigging. Adobe Photoshop 5.0 was used for texturing the characters, interface artwork, box art, character illustration and concept artwork. Metacreations Painter was also used for box art (which later became Corel Painter).

For our in-game character art, a 3D mesh was created - often if a character was similar to previously made characters, the starting point was an already existing mesh. The clothes were made, usually using a technique called box modelling, or edge modelling, a bottom-up technique where a box shape was modified and faces or edges were extruded to make the desired shape. Patch modelling was also used for more flowing clothes (Figure 12).

Once the modelling was completed, the model was coloured, a process called "shading" or "texturing" using images painted in Photoshop, or by using materials generated in 3DS Max. It was not necessary to create a single-skin model (i.e. one complete object), as the final output did not need to be integrated into a 3D gaming engine, as is often the case today, so each object on the body could be separate. This made the texturing reasonably easy, although texture seams had to be carefully hidden. The process used was similar to "reference mapping" where each part of the character was detached, textured separately, then re-attached. The front, side, top and back of the head was textured as separate objects, then re-attached and the vertices welded together for seamless textures. In true reference mapping the textures are integrated into a single texture map, but this was not necessary for sprite-based games.

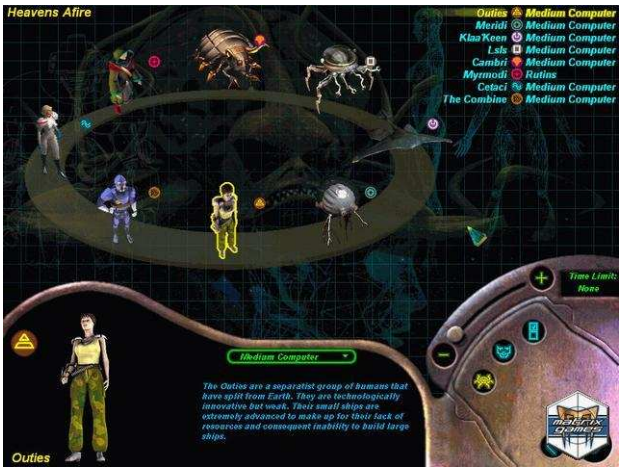

Figure 12 The Outie from Reach from the Stars II: from base mesh through to final render (Strategic Studies Group 2000).

Once modelled and textured, the characters, in the case of the Warlords games, were rigged for animation. This is the process of placing bones within the character so they could be moved and animated. The mesh was bound to the skeleton to enable it to be moved. The Character Studio plug-in was used to achieve this, which created a skeleton called a Biped, which was attached to the mesh with a modifier called Physique.

Biped had built-in inverse kinematics. In 3D animation there are two main systems of animation - forward kinematics and inverse kinematics. Forward kinematics works with a series of rotations. For example, if you want to place a character's hand on its head you need to rotate the upper arm, the forearm and finally the hand to achieve this. Using a rigging system like Biped, which uses inverse kinematics, the hand can be placed on the head directly, saving time in the animation process. Inverse kinematics also allows for walking, where the feet are pinned to the ground while the hips and centre of mass of the character move forward.

The advantage in using systems such as Biped is that the animation can be created using an automatic walk cycle, although this is quite a character-less animation and often needs major modifications to give the characters life. As SSG's characters walked on the spot, it was often quicker to hand animate the walk cycles, so that the nuances that make a character believable and to create a continuous loop animation. One of the generals in Warlords Battlecry, for example, was created to have the slight limp of a battle-weary warrior.

The animations were rendered out as a series of FLC files, each character had 8 different directions. Each animation had a separate shadow file that was rendered against a magenta plane, usually placed under the feet of the characters. To create the 8 directions the lights and the camera had to be kept static, while the character rotated, so that the shadows were kept consistent.

Another innovation in the games of this era was the use of particle effects. Sometimes used for attack cycles, these were usually created with a glow to depict spell casting. The particle emitter in these cases were linked to the character's hands and the glow created in video post effects. Other particle systems used in the games included blood spurts, smoke and other forms of magic. The particle systems were also rendered out against a magenta background for in-game integration.

Game integration was aided by a little programme that Steve Fawkner created which took the animated renders of the FLC animation file that was outputted from 3DS Max and made a sprite sheet, which was then used in the game. This utility also enabled us to combine the shadow renders into the main sprites. The result was a magenta sheet with multiple frames of the animation and shadows on it (Figure 13) (Keating, 2014a). Bink video was used to integrate the cut scenes with the game.

Figure 13 Part of a sprite sheet for Warlords 4 (Infinite Interactive 2003).

We had a strict pixel size limit for the characters - we were not to exceed 32x32 pixels, and 25 frames, although for some of the larger monsters this was ignored so that we could render them larger and allow them to walk slower. Most of the walk cycles were around 16 frames. Creating a credible walk/fight/death cycle was therefore sometimes a challenge.

Rendering out the characters was done at a strict 45 degree angle against the magenta background. Side colour was created in cyan - so we had to ensure the colours magenta and cyan were not used in any of the artwork. This was not problematical, as these pure colours do not naturally occur often. When rendering we also had to ensure that the images did not contain perspective (which means the character gets smaller the further away from you he or she walks). There was a setting in the cameras of 3D Studio Max that turns on orthographic projection, thus turning off perspective. The characters also had to walk on-the-spot to allow the pathfinding mechanics of the game to place them on the correct position and moving at the correct pace on the screen.

The edges of the renders had to be aliased, ultimately saved as BMP format in 8-bit colour. Usually when you render a character or scene in a 3D package, the edge pixels are usually blended with the background. This results in a smooth integration of the foreground with the background - a process called anti-aliasing. Early computer games used pixel art - which have aliased edges (no blending). This allowed the background colour of the sprite image to be ignored by the programme and "keyed" over the game's background, a process similar to chroma-keying in television.

As we were not yet using alpha channels to key out the background, any blending of the edges of our characters

with the magenta background would mean we would get a magenta "halo" around our characters, an undesired result. The edges of the renders had to be clean, which was achieved by modifying the settings in the render panel of 3D Studio Max, by turning off the anti-aliasing. This meant that the edges of the renders were a little bit unsightly, but internally the geometry did blend. The result was a clean outline, but also nice looking internal geometry.

These days game developers are able to use the PNG format which can save to a 24 bit format. This has "thousands of colours" and an additional channel of information - the alpha channel, which allows the background colour of renders to be ignored, and be rendered as transparent. This enables integration of anti-aliased graphics in games, assuming that developers are happy with the additional overhead in the processing and memory requirements o the higher bit-depth graphics.

The 3D art assets were also used for other in-game elements such as icons, ID shots and interface elements (Lockhart, 2014).

Figure 14 Warlords BattleCry II screenshot (SSG, 2002).

The limitations placed on the game were not so much the technology - fully 3D games were possible at the time. The issue was more the amount of work that was required to be done and the limited amount of people available to do it. Working in 3DS Max takes a lot of time and a number of freelance artists were hired. Unfortunately not all could work at a professional level, and that work had to be rejected (Lockhart, 2014).

Warlords Battlecry II was memorable because we had already made Battlecry I and had achieved a "level of polish on the graphics that was really nice and we had so much material from the first game that we were able to re-use, it had an enormous amount of scope in it. It was a beautiful looking game and a really good one as well". (Lockhart, 2014).

I worked on Warlords Battlecry, Warlords Battlecry II and Reach for the Stars II. I had begun work on Warlords IV and concept art for Dungeon, when I left SSG in January 2001 to move to the UK (Figure 15). Dungeon was never completed, but was to be SSG's first fully 3D fantasy game. Shortly after I left, the company divided into two: SSG returned to its roots in strategy war gaming, using primarily 2D graphics, releasing games such as Korsun Pocket, Battles In Italy, Battles in Normandy and Kharkov: Disaster on the Donets. The Melbourne branch of the company became Infinite Interactive in 2003, under the leadership of Steve Fawkner, who maintained his interest in fantasy games. They subsequently published Warlords Battlecry III and Warlords IV, before moving into casual gaming for smart phones and tablets, with titles such as Puzzle Quest, which were primarily 2D games generated in Photoshop.

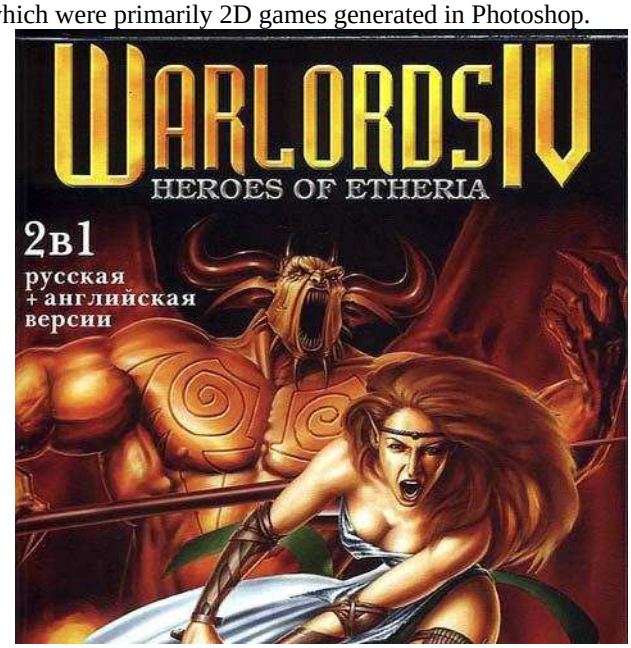

Figure 15 Box art for the Russian version of Warlords IV with portrait of the author on the box art(Infinite Interactive, 2003).

Much of the distribution of SSG games has moved online, with Matrix games now being their main distributer and publisher.

Co-founder, CEO and games designer Ian Trout passed away in 2011, after a battle with cancer. SSG has not published a game since.

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