
Final Year Study Project:

“Carry out research and evaluation in the field of 3d Character Modelling and Animation, in order to create and animate my own character.”

Matthew Juffs

021818354

The University of Lincoln
Department of Computing

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‘CMC173 Independent Study’*

15,578 words

Accompanying CD:

*See ‘Accompanying CD Directory Structure’ Document in
the Appendix section*

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Appendix (In order as they appear)

- Level One Assignment (2D Animation)
- Level Three Assignment (3D Animation)
- Independent Study Proposal
- Gantt Chart
- Process Models (x 5)
- 'Crash Tester' Storyboard (7 pages)
- Questionnaire
- Accompanying CD Directory Structure

Glossary (Terminology)

This section provides definitions for many words used throughout the study. Some words have specific meanings relating to the study, and the creative side of the computing industry. *Several definitions have been adapted from dictionary.com.*

Rendering – “*The conversion of a high-level object-based description into a graphical image for display.*” Rendering is the process used to turn an animation within 3D Studio Max (or similar) into a video.

Editing – This study contains two instances of editing; firstly the editing of the animations within Adobe Premiere, which integrated sound into the files; secondly, the editing of the study, refining the chapters and layout.

Modelling – Modelling is the process of turning initial ideas into a 3D model. Various techniques are used within 3D Studio Max to form a model, and refine it, until it resembles a character.

Animating – This process involves moving the character model into various positions along a timeline. This creates movement over time, which forms an animation.

Study – The Independent study made up of 6 chapters, along with a study project.

Study Project – The practical side of the study, which involved implementing the various designs.

Model Sheet – A technique used within the animating industry, which shows various poses, facial expressions and colours (for example) of a character. A modeller and animator will use it as a reference.

Character Sheet – The outcome of the study project; it builds upon the idea of a model sheet to provide an interface for a user to interact with a 3D character.

Process Model – A diagram that shows various processes used to complete a task, or series of tasks. The study has several process models describing the whole of the implementation stage of the project.

Polygon – “*A closed plane figure bounded by straight sides.*” Software such as 3D Studio Max, can build up 3D models using polygons. The models within the study project all use polygons in their structure.

Polygon Count – A feature within 3D Studio Max (and other similar software) to count the amount of polygons within a model or scene. A high polygon count usually means a high detailed model, and a low polygon count usually means a low detailed model. The higher the polygon count, the longer it will take to render the animation.

Texturing – The process where 2D images are mapped onto 3D objects, to provide colour and texture.

Lighting – The process where virtual lights are added to a 3D scene, to cast light on the objects.

Bones – To provide a virtual skeleton, bones are used within a 3D character model. They are attached to limbs of the model to aid in movement. They are not visible in the renders though.

Controllers – Used to control the bones within a 3D character, they make manipulation of the bones a lot easier.

Scenes – There are two definitions of scenes within this study. Firstly a 3D Studio Max file (where modelling and animation takes place) is called a Scene. Secondly the Short Animation is split into scenes, which indicate a change in movement or location.

Shots – Similar to scenes, shots indicate a change of camera within the Short Animation.

Storyboard – Produced during the design stages of the study project, the Storyboard outlined what the Short Animation will look like.

Scene Plan – This document details each of the Scenes and Shots within the Short Animation. It was written after the Storyboard.

Set – A collection of objects that are positioned within an area forms the set. The set used within the Short Animation contained G401; 3 other robots; a car etc.

Title Sequence – This usually appears at the beginning of a video, showing who made it, along with the title of the video. A Title Sequence was used within the Short Animation, along with a Credit Sequence at the end.

Short Animation – The short story animation produced in the study project, which is present in the final Character Sheet. It puts the character, G401, into context.

Individual Animations – The 17 animations that display emotion, movement and voice of G401.

Emotion – “*A mental state that arises spontaneously rather than through conscious effort and is often accompanied by physiological changes.*” Emotion is one of the 3 types of Individual Animations.

Movement – “*The act or an instance of moving; a change in place or position.*” Another of the 3 types of Individual Animations.

Voice – “*The sound produced by the vocal organs of a vertebrate, especially a human.*” The last of the 3 types of Individual Animations.

Buttons – The devices used within the Character Sheet to provide navigation through the different sections. They react to mouse movement and mouse clicks.

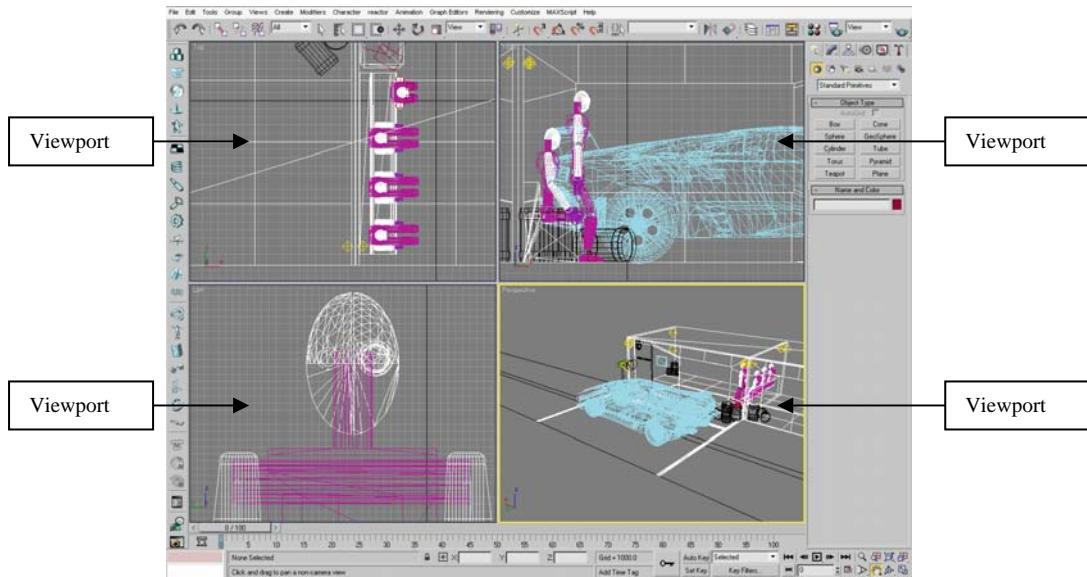
Text Boxes – Again, used within the Character Sheet, these boxes contain text which provides additional information to the user.

Publish – Specific to Macromedia Flash, publish is similar to rendering, where the raw data contained in the flash file is published to a chosen format. The final Character Sheet was published to both .swf and .exe formats.

Codec – Compression/Decompression a device that was used within the study project to compress the animations. This reduces the file size, but also affects the quality. The Cinepak codec was used for the final animations.

Pixilation – Where the pixels used to build up an image (still or moving) are obvious to the viewer. This usually occurs if an image is highly compressed. The quality of the image is affected.

Viewports – This refers to the 4 panels within the 3D Studio Max interface that are used to produce models within:



Chapter 1: Introduction

Study title: *Carry out research and evaluation in the field of 3d Character Modelling and Animation, in order to create and animate my own character.*

The purpose of this study is to research and evaluate character modelling and animation, within the creative side of the Computing Industry; including games, and films. From the research, techniques and rules will be followed when creating an original character and animating it. Research, along with the final animation(s) will be evaluated to draw up conclusions.

1.1 Context:

This study will help to develop current modelling and animation skills, improving upon them and at the same time, learning new techniques. 2D/3D Modelling and Animation is a huge interest of this study's author, and he hopes that this study will also form part of a portfolio. This study fits in with the degree – BSc (Hons) Games Computing (Software Development)'s current academic work, as 2D and 3D Modelling and Animation is a major part of the Games Industry and is taught throughout the 3 year course in various units. The skills and techniques learnt within this study and the degree can also be used in other areas of work, such as special effects for movies; Short Animation sequences for advertisement and the media; and entire films created using 2D/3D animation.

Character animation itself, plays an important part within the creative side of the Computing Industry and the Film Industry. Almost every game produced today, contains some form of character animation. Films such as Disney/Pixar's Toy Story also use character animation techniques extensively.

1.2 Objectives:

Several key objectives have been created which will be followed throughout this study and evaluated towards the end. The first objective is to research suitable tools, methods and techniques for use within the study project. This will include 3D character modelling techniques, along with animation techniques; inspirational

research for development of the character; and suitable software tools to be used throughout the study – for developing the animated character. Once the research has taken place, the next objective is to use this in the development of the 3D character. The character will be modelled, animated, and from these both a Short Animation along with several Individual Animations will be produced. The next objective will require the animations to be edited using an appropriate software package, to integrate sound (music, sound effects and voice) into them. This will produce a Short Animation putting the 3D character into context (a short story) along with Individual Animations showing various attributes of the character. The fourth objective involves developing the character further – so that the Individual Animations and Short Animation is in a presentable format. At this stage the exact format is unclear, but will follow a similar technique discussed in Level One of the degree within the unit “2D Animation” [1]. The unit required the students to design and develop a ‘model sheet’ which allowed the users to interact with a 2-dimensional game character – speech and movement were demonstrated within the model sheet. This foundation will help with further development of the project’s 3D character.

1.3 Methodology:

1.3.1 Basic:

The basic stage involves researching several areas relevant to the study and its development of a 3D animated character. Software tools will first be researched to decide upon an appropriate development platform. Then modelling and animation techniques will be researched, at the basic stage of the study, but also throughout the further stages where necessary – to aid development.

1.3.2 Intermediate:

The intermediate stage involves the development of the 3D animated character. Development will firstly require initial sketches and models of the character to be produced. From these a ‘look’ can be decided upon for the character, which will then allow modelling of the character to take place. Once modelled, the character will be animated for both the Short Animation and the Individual Animations. These animations will then need to be rendered into a suitable format for further development.

1.3.3 Advanced:

The advanced stage of the study requires the character animations to be developed into a presentable format. This will take into account the model sheet [1] idea mentioned earlier, to create an interface allowing the user to interact with the character. The animations created in the intermediate stages of the study will be edited using an appropriate tool, to incorporate sound and a structure for the Short Animation. From these, the Character Sheet can be developed and then evaluated along with the rest of the study.

Alongside the practical aspect of this study, the report itself will be developed – detailing all of the stages involved during the study project along with evaluations and conclusions. It will also highlight various sources used during the research stages of the study, and any techniques followed. Access to several software packages will be needed throughout the duration of the study. Specific packages are not known at this stage – hence the need for tool research, but it is known that a 3D animation software package, along with a compatible video editing package will be required – for both editing of the animations and further development. The character shall be animated in various poses and actions, aiming to create realistic and believable movement. Exact techniques to be used are not known at this stage, hence the need for character modelling and animation research.

1.4 Deliverables:

This study will produce a 3D character, modelled and animated in a 3D animation software package. This character will then be developed into both a Short Animation (which will show the character in context, similar to a short-story) along with several Individual Animations (displaying movement, emotion and voice). From this, further development will take place to create an interactive user interface, which will allow presentation of the developed character. A successful solution should be able to clearly demonstrate the interactive character's movement, emotion and voice to an audience well. The study will also document each stage of the study project within its chapters. Once the practical aspect of the study is complete, evaluation can take place and conclusions can be made.

1.5 Following Chapters:

Chapter 2: Research

This chapter will show the research carried out during the study. It will look at various software tools available for the development of the character, and compare them to each other. From the comparisons conclusions can be made to decide which software will be the best choice. Then research into the various formats available for the character will take place, and again conclusions will be produced to determine the appropriate formats for the character development.

Chapter 3: Design

This chapter will document the design stage of the study, which firstly involve planning the implementation and further stage of the project. Then the character will be designed using various sources and research gathered, for inspiration. Further development of the character will also be planned during this stage of the study.

Chapter 4: Implementation

This chapter will show the implementation stage of the study – taking the designs along with the research to practically develop a 3D animated character. It will also discuss the further development of the character that will take place.

Chapter 5: Evaluation

This chapter will document the evaluation stage of the study. Not only will the final outcome of the study project be evaluated, but each stage within the study will be too. The original objectives will be compared to the final study to aid evaluation.

Chapter 6: Conclusions

This final chapter will document any conclusions made during the study. The evaluation stage of the study will have highlighted problems or successes which will aid in the conclusions. The overall study, along with the practical development, time management and the processes involved will all be concluded within this chapter.

Chapter 2: Research

2.1 Software:

The study's intermediate and advanced objectives require a 3D character to be modelled and then animated. The character will then be further developed into an interactive Character Sheet. Modelling, animating and then producing an interactive Character Sheet will all involve several software packages.

2.1.1 Modelling, Animating and Rendering:

The character will be 3-dimensional and animated in both a Short Animation and Individual Animations. This will require a 3D animation software package, along with additional software packages for developing the Character Sheet, and editing of the animations.

Research [2], [3] has shown 4 industry leading 3D animation software packages:



Lightwave 3D (Newtek) [4]

"LightWave offers a combination of the most complete professional toolset in the industry at the most affordable price, making the best choice for any 3D job anywhere."

Lightwave appears to be the industry leader for media – many adverts that incorporate live-action footage with computer animation are developed using Lightwave. Examples include: HP; Toyota; Suzuki; Nissan and Levi's.



3D Studio Max (Discreet) [5]

"3ds max is the world's most widely used professional 3D modeling, animation and rendering solution, offering the ultimate in professional 3D tools required for creating eye-catching visual effects, cutting edge games, and distinct design visualizations."

3D Studio Max is arguably the most popular animation package for the Computer Games Industry. Examples include: Need For Speed Underground 2; Prince of Persia 2; Fable; Halo 2 and Max Payne 2.

Maya (Alias|Wavefront) [6]

"The world's most powerful 3D animation and visual effects software and the ultimate version of Maya®."

Maya is a very popular choice for the Movie industry, when a 3D animation software package is required. Examples include: Pixar's The Incredibles, Finding Nemo, Ice Age; Spiderman 2 and Lord of the Rings.

SoftImage|XSI (SoftImage) [7]

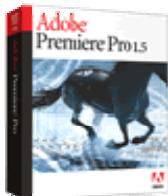
"Through the power of integration, SOFTIMAGE/XSI gives you the most efficient workflow in the industry. XSI takes the guesswork out of creating 3-D content with in-context viewing and non-destructive non-linear control. The profound integration of all functions and toolsets in XSI means your clients can experience an unmatched level of iterative control without losing valuable production cycles. XSI also takes full advantage of the Avid family of products to offer a combination of unparalleled compositing, video and effects tools all in one box. Get it right the first time: SOFTIMAGE/XSI."

SoftImage|XSI is another powerful 3D animation software package, developed by the company who pioneered many animation techniques. Examples include: Half-Life 2 (and its modifications); Terminator 2 and The Matrix: Reloaded.

2.1.2 Editing:

Once the character has been modelled and animated, further development will be involved. For the Short Animation, an editing software package will be necessary to edit the renders into a complete animation and incorporate sound too. The Individual Animations used in the Character Sheet will also need to be edited in a similar fashion.

Research identified 3 suitable digital video editing software packages:



Premiere Pro (Adobe) [8]

"Adobe Premiere Pro 1.5 software revolutionizes nonlinear video editing. Powerful real-time video and audio editing tools give you precise control over virtually every aspect of your production. Adobe Premiere Pro 1.5 takes video production to an entirely new level."



Xpress Pro (Avid) [9]

"Loaded with features and functionality, Avid Xpress Pro software lets users edit DV, mix resolutions in the timeline, and save space using the new 15:1s offline resolution. Editors can access 24 video and 24 audio tracks with unlimited layers, apply 2D and 3D OpenGL-based effects, edit true 23.976 media, trim and edit using JKL keys, and customize their workspaces. Built-in software "experts" such as AutoCorrect and NaturalMatch color correction, DV Scene Extraction, AutoSave, and ExpertRender let both new and experienced users focus on the creative process, not the technology."

Windows Movie Maker (Microsoft) [10]

"Windows Movie Maker 2.1 makes home movies amazingly fun. With Movie Maker 2.1, you can create, edit, and share your home movies right on your computer. Build your movie with a few simple drag-and-drops. Delete bad shots and include only the best scenes. Then share your movie via the Web, e-mail, or CD."

Windows Movie Maker is included with (and limited to) Microsoft Windows XP. It is basic in function compared to the other two choices, but allows for simple linear video editing.

2.1.3 Character Sheet:

The exact format for the Character Sheet will be discussed later in this chapter. However, an additional software package will be needed to develop the Character Sheet. It needs to incorporate rendered video from the animation package, which has been edited using the editing package, to produce an interactive Character Sheet:



Studio MX 2004 (Macromedia) [11]

"Macromedia Studio MX 2004 provides professional functionality for every aspect of web development and includes the newest versions of Dreamweaver, Flash, Fireworks and FreeHand. Seamless integration and a common user interface across all tools streamline web development and application workflow, enhancing productivity and ease-of-use."

Studio MX 2004 contains several software applications, developed by Macromedia, including:

Flash MX Professional 2004 [11]

"Macromedia Flash MX allows designers and developers to integrate video, text, audio, and graphics into immersive, rich experiences that deliver superior results for interactive marketing and presentations, e-learning, and application user interfaces. Flash is the world's most pervasive software platform, used by over one million professionals and reaching more than 97% of Internet-enabled desktops worldwide, as well as a wide range of devices."

Dreamweaver MX 2004 [11]

"Dreamweaver MX 2004 is the professional choice for building web sites and applications. It provides a powerful combination of visual layout tools, application development features, and code editing support. Dreamweaver enables web designers and developers to easily create and manage any website."

Studio MX 2004 is ideal for developing the interactive Character Sheet, as it supports many formats and is widely used. Both online and offline applications can be developed too, allowing for several possibilities.

2.1.4 Cost Estimation:

The cost of each software package has been researched to help draw conclusions. Each cost estimate has been sourced from AcademicSuperstore.com [3] and converted [12] from US \$ to UK £ using the current conversion rate of \$1 to £0.52. The prices

are for academic discounted versions of the software (essentially the same as the commercial versions, but with student licenses).

Software	Developer	Version	US \$	UK £
Lightwave	Newtek	8 Animator's Kit	399.95	208.04
3D Studio Max	Discreet	7	599.95	312.07
Maya Unlimited	Alias	6.5 Student	369.95	192.43
SoftImage XSI	SoftImage XSI	4.0 Adv. Student	249.95	130.01
Premiere	Adobe	Pro 1.5	199.95	104.01
Premiere	Adobe	Elements	69.95	36.38
Studio	Pinnacle	9 Media Suite	109.95	57.19
Xpress	Avid	Pro 4.3 Student	295.95	153.94
Movie Maker	Microsoft	2.3 (XP)	-	-
Studio	Macromedia	MX 2004	178.95	93.08

The price comparison table above shows significant differences between each software package. SoftImage|XSI's 3D animation package proves to be the cheapest choice, whereas Discreet's animation package is expensive. The editing software packages researched also show a price difference – Avid's Xpress Pro package proves to be the most expensive, with Microsoft's being the most cost effective as it is free.

2.1.5 System Requirements:

As software tends to be platform specific, the system requirements need to be taken into account when comparing software packages. Animated Films such as Pixar's 'The Incredibles' [13] take many months to plan, model, animate, render and then edit the film into what is released to the public at the cinema. Rendering is possibly the most resourceful process during development of 3D animation – some frames can take hours, even days to render. Thus, 3D animation in all forms proves to be 'resource hungry' demanding powerful computers to dedicate processing power to the software.

The system requirements for all the software packages researched [3] - [11] are shown below. The graphics processing unit (GPU) has been grouped into 3 categories; low refers to dedicated OpenGL/DirectX cards; mid refers to 64mb+ cards and high refers to workstation graphics cards (usually utilising the Quadro chipset). All system

requirements shown are the minimum requirements – those that are needed for the software to run. Obviously, the higher specification of the machine, the better the software will perform – quicker rendering times, advanced features available etc.

Software	Developer	Version	OS	CPU	RAM	GPU
Lightwave	Newtek	8 Animator's Kit	2k/XP	600mhz+	512mb	Mid
3D Studio Max	Discreet	7	2k/XP	500mhz+	512mb	Mid
Maya Unlimited	Alias	6.5 Student	2k/XP	600mhz+	512mb	Low
SoftImage XSI	SoftImage XSI	4.0 Adv. Student	2k/XP	600mhz+	256mb	Mid
Premiere	Adobe	Pro 1.5	XP	800mhz+	256mb	Low
Premiere	Adobe	Elements	XP	800mhz+	256mb	Low
Studio	Pinnacle	9 Media Suite	98/Me/2k/XP	800mhz+	256mb	Mid
Xpress	Avid	Pro 4.3 Student	XP	1.6ghz+	1gb	High
Movie Maker	Microsoft	2.3 (XP)	XP	600mhz+	128mb	Low
Studio	Macromedia	MX 2004	98/2k/XP	600mhz+	256mb	Low

The computers available during the development of this project have at least a 2.6 GHz CPU; 512mb RAM; a dedicated 64mb GPU and Windows XP. This already eliminates Avid's Xpress Pro 4.3 software package from the available choices.

2.1.6 Conclusions:

Essentially, each software package allows the user to develop the same as the next, though there are subtle differences between them. At this stage, Microsoft's Movie Maker can be eliminated as a choice – this is due to the fact that it doesn't support many file formats, and is very linear in terms of editing.

Looking at the available choices for a 3D animation software package, SoftImage XSI's package seems the most appropriate, as it is the cheapest available and its system requirements are met/exceeded by the available development computers. Adobe's Premiere Elements seems to be the best choice for an editing software package – it's the least demanding and cheapest available.

However, the University of Lincoln's computing department has 100's of computer workstations available for access during the development of this project; many of which come with several suitable software packages already installed. 3D Studio Max

5 (Discreet) is available for use at the University, along with Premiere 6 (Adobe) and Flash 5 (Macromedia). This heavily influences the software choice for the development of the project.

The degree BSc (Hons) Games Computing (Software Development) utilises Discreet's 3D Studio Max, Adobe's Premiere and Macromedia's Flash in its course material and teachings, which means familiarity with the software and support from lecturers. For this reason and the availability of the software packages, 3D Studio Max (Discreet) will be used for modelling, animation and rendering; Premiere (Adobe) will be used for editing; and Flash (Macromedia) will be used for developing the Character Sheet.

2.2 Format:

With the software packages chosen, the format(s) for the animation(s) need to be considered. Once comparisons have been made, conclusions can be drawn – showing the best choice for the format(s).

2.2.1 Final Project Media:

Once the Character Sheet development has finished, it will be presented in a certain format. There are two obvious options available at this stage:

CD/DVD media

Web-based

CD's are usually 700 MB in size; DVD's however can hold around 4.7 GB of data. If the final project was web-based, in theory it would be limited by the web-space available. However, the bigger the project, the longer it will take to download to the viewer's computer. This needs to be taken into account when choosing further formats for the project.

Access to both a CD writer (700 MB) and DVD writer (4.7 GB) is available during development, along with some Web-space (1 GB). With this in mind, developing the project to end up on a 700 MB CD seems appropriate. This allows for a reasonable size, but also ensures compatibility – most (if not all) computers have a CD-ROM

drive installed, whereas many don't have access to the internet, and even fewer include a DVD-ROM drive.

2.2.2 Animations:

3D Studio Max 5 has been chosen for the animation software package. Max supports many file formats for both input (importing) and output (rendering), both still image and animated formats. Flash 5 again supports many input (importing) and output (publishing) formats - still image; animation; interactive animation. Early testing showed that .avi video format would be the most compatible format for the animation video, as 3D Studio Max 5, Flash 5 and Premiere 6 all support it. With the video format chosen, a comparison was made between .avi codecs:

Codec	Developed by	File size	Quality	Compatibility
DivX	The DivX Team	843kb	3	4
Cinepak	Compression Technologies	5.01mb	5	5
MS MPEG4 v3	Microsoft	1.03mb	4	5
RAW	-	680mb+	5	1

A codec compresses normal video into a smaller, compressed file which can be read using an appropriate media player along with the codec relevant to the file. 3 codecs were chosen for comparison – The DivX Team's DivX codec [14]; Compression Technologies' Cinepak codec [15]; Microsoft's MPEG4 v3 codec [10] along with RAW which is the video rendered as raw data (no compression).

The above table shows the results from the comparison of the 4 files tested. The 'Quality' of the video was rated between 1 and 5 – 1 being appalling (pixilation, hard to distinguish etc.), 5 being almost perfect (no visual loss of quality). The 'Compatibility' of the video was rated again, between 1 and 5 – 1 being very incompatible, 5 being very compatible (based on Windows computers).

A short 16 second portion of the Short Animation video was chosen for comparison. It is 768 x 576 pixels in dimension @ 25fps (frames per second). This video was rendered in 3D Studio Max to an .avi file using the codecs. Render time was around 30-40 minutes (2 GHZ CPU, 512mb RAM, 64mb GPU) for each of the 4 tests.

The RAW format proved to be of the highest quality, but had two major drawbacks – the file size was over 680mb which in turn had an affect on the compatibility – the media player could access the file, but playback was very stuttered due to the RAM limitations of the test machine. This would not only require several DVD's to transport the final project for playback, but would also require a high performance machine to play the video at full speed.

The DivX codec is proving to be very popular – with most (if not all) media players supporting the codec, along with several hardware DivX players emerging on the market. This ensures compatibility with the codec, but many computers would still require installation of the codec prior to video playback. Compared to the other codecs used during the comparison, the DivX codec appeared to be bad in quality – though the small file size would make up for this.

Microsoft's MPEG4 v3 codec is very compatible with Windows based computers. The file size was the second smallest in the comparison and the quality of the video was high – but not the best.

Compression Technologies' cinepak codec was of a very high quality – with no visual loss of quality. It also proves to be one of the most compatible codecs, as it has been around for over 10 years. The file size was the second biggest, but considering the media used to store the final project will be 700 MB in size, this isn't a worry.

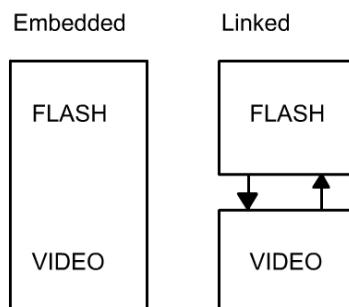
2.2.3 Character Sheet:

The Character Sheet to be developed during this study will hopefully be stored on a CD (700 MB) – if however it proves to be bigger than 700 MB in size, then a DVD will be used. The possibility of distributing it over the internet too, is also available.

The format of the Character Sheet needs to be decided in order to continue development. Macromedia's Flash 5 has been chosen for development of the Character Sheet, along .avi video from Discreet's 3D Studio Max 5 and a short-animation edited in Adobe's Premiere 6.

Flash 5 allows the user to develop interactive animations, which can then be published in several formats. The first format available is Macromedia's Flash format (.swf), which is widely used on the internet and proves to be small in file size as it allows for compression. The second format available is .html with the .swf file embedded within it. This would allow for a html/flash interface for the Character Sheet, but using another software package such as Macromedia's Dreamweaver would probably be better suited to writing a html/flash interface. The third format available is Windows Projector (.exe) – which would provide the most compatibility and also allows for compression. A Macintosh Projector is also available and could be included if the Character Sheet was to be used on a Mac too. Finally, the Character Sheet could be published as a Quicktime Movie (.mov) – though this would remove the interactive features of the Character Sheet completely.

For compatibility issues, a Windows Projector (.exe) file format will be used for the Character Sheet. Though there's one further choice to make concerning the format for the Character Sheet. Flash either allows the user to embed video files within the Flash file (.exe in this case), or allow the video files to be separate from the Flash file, but call them within. The following diagram should explain this better:



Embedding the video (.avi) stores it within the Windows Projector file (.exe), converting the original video file (.avi) into frames within the Flash animation. Linking the video (.avi) to the Windows Projector file (.exe) means that the video is stored externally to the Flash animation and is called when required. Both options have their advantages and disadvantages:

Type	Advantages	Disadvantages	Suited to
Embedded	Compatibility	Non re-usable	Single file
		Poor quality	CD/DVD
		Sound	
Linked	Highest Quality	Less compatible	Directory of files
	Sound	More files	Web/CD/DVD

Embedding the video files within the Flash file proves to be the most compatible method, as it negates the need for codec installation on the Character Sheet playback machine. But this also means a reduction in video quality. The sound also needs to be integrated into the Flash animation, which adds development time. Embedding is best suited to a single file distribution of the Character Sheet, on either CD or DVD media.

Linking the video files to the Flash file proves to be the better choice – as it ensures that the video files remain at the same quality as when rendered. It also means that the sound will be integrated into the video files, which wouldn't require any additional modifications (development time). Linking the video files would be less compatible than embedding them, but codec choice should take this into consideration. Also, linking the video files would allow modularity within the Character Sheet – the individual videos could be re-rendered, re-edited or replaced completely without needing to alter the Flash file at all. This re-usability would allow further development of the Character Sheet, including re-use by other animators – who could use the main interface alongside their own character renders.

2.2.4 Conclusions:

Possible choices for the software, along with file formats, codecs, media format and Character Sheet format were researched. Comparing the choices to each other showed several obvious choices. The University of Lincoln's computing department already allows access to 3D Studio Max 5 (Discreet); Flash 5 (Macromedia) and Premiere 6 (Adobe). The course (BSc (Hons) Games Computing (Software Development)) teaches the students various techniques, utilises and provides material concerning Max, Flash and Premiere too. This has influenced the choice of software significantly – as it reduces the cost of the study project by a vast amount.

With this in mind, a suitable media was chosen for the final Character Sheet project – CD (700 MB) would prove to be the most compatible format, as most computers come equipped with a CD-ROM drive. This puts a constraint on the study project outcome – as it cannot exceed 700 MB in total size.

The software choice also influences the file formats for the project – as Max and Flash (along with Premiere) support a wide range of differing formats. From the research carried out, rendering the animation videos in .avi using the Cinepak codec would give the best quality, for a reasonable file size. The Character Sheet itself will be published using the Windows Projector file format (.exe) and will link to the edited animations that will be stored externally within the Character Sheet directory.

The Individual Animations will be developed in Max and rendered. The rendered animations will be edited within Premiere, and outputted as the same format. These edited animations will be linked to within the Flash Character Sheet interface. These choices will allow for high quality individual animation videos, which will contain sound. These animations will be accessed via an interactive Flash interface – retaining the original quality of the videos. The Flash interface will link to the video files, allowing for re-usability along with modularity.

Chapter 3: Design

3.1 Process Models: [30]

With the basic plan in mind, the study has been split up into several sections, and documented using the method of process models. This involved analysing the study plan's objectives and methods, to create a list of tasks. These will form the various stages of the implementation of the study. Each of the 5 process models [30] are detailed below and on the following pages.

3.1.1 Project:

The first process model shows the study project as a whole – with the further 4 process models forming part of this model. The 10 stages in this process model feed into each other with the final output being the finished project, along with the models, animations and Character Sheet.

Introduction – the first stage of the project, this stage produces the first draft of Chapter 1 for the study. This expands on the Study Plan [16] created at the outset of the study.

Research – the second stage requires research to be carried out, which will produce the first draft of Chapter 2. The research will be used both for inspiration and as an aid during the design and implementation stages of the study.

Design – the third stage of the study forms the first draft of this chapter – Chapter 3: Design. This takes elements of the first and second stages to aid in the design of the project.

Modelling – the fourth stage is described in more detail in the Modelling process model. Its output (Finished Model) feeds into the next stage, as it is required for the next stage to take place.

Animating – the fifth stage involves two sub-stages, for the Short Animation and Individual Animations. The relevant process models describe this stage in detail.

Character Sheet – the sixth stage of the study is, again, described in more detail in the relevant process model.

Implementation Write-up – the seventh stage involves the previous implementation stages to be documented. This will create the first draft of Chapter 4 (Implementation).

Testing/Evaluation – the eighth stage of the study requires testing of the implementation section in order to evaluate it. The Character Sheet, along with the stages required developing it and also the project as a whole, will be evaluated.

Conclusions – the ninth stage of the study will take the evaluation, from which conclusions will be created. This will form the first draft of Chapter 6 (Conclusions).

Final Editing – the tenth and final stage of the study will involve editing each of the chapter drafts (possibly several times) along with making any changes to the implementation project part of the study. Once this stage is complete, the study should be finished.

3.1.2 Modelling:

The fourth stage of the Project process model (Modelling) has been split into a process model of its own, as it involves several sub-processes. Modelling involves turning the initial ideas for the character into a 3-dimensional character, using 3D Studio Max entirely. The final character model can then be used in the next stage of the project – animating.

Initial Sketches – In order to create a character, research needs to be carried out to provide inspiration. From this inspiration, ideas can be made in the form of sketches. These will help throughout the development of the character.

Character Proportions – Research into human proportions will be carried out, to ensure that the character complies with them. This will produce a basic character design, which adheres to human proportions.

Low Polygon Modelling – Using the initial sketches and character proportions, a basic 3-dimensional model will be created using 3D Studio Max. This will be low polygon to begin with, to enable easy modification of the character, if any changes need to be made.

Detailed Modelling – With the basic character modelled, more detailed modelling can take place. This will create a detailed character, possibly with a much higher polygon count, than the basic character.

Texturing – The detailed character modelled will be textured using 3D Studio Max. Several textures will be created for the character, possibly using digital images in the process.

Lighting – The textured character will be lit (again using 3D Studio Max), using several lights of various types and settings. This will create a lit character which will act as a first draft.

Model Refining – The lit character will need refining as lighting may show errors or highlight changes that need to be made. Further high-detailed modelling may need to take place, and alterations may need to be made to the textures and lights used.

Bones – In preparation for the animating stage of the project, the character model needs to have bones. The bones are linked to the character's limbs to enable individual limbs to be moved on the character. The bones aren't visible in the final animations, but are a vital part of 3-dimensional character animation.

Controllers – Along with the bones, controllers are needed to animate the character. They allow limbs to react with each other, and also allow control of the bones during animating.

Once the character has been modelled; textured; lit; refined; and bones along with controllers have been added, the final character is complete and ready for animation. Further modelling may need to take place to put the character in context, though will be discussed in the relevant animating stages.

3.1.3 Short Animation:

This stage of the Project process model has again been expanded into its own process model. It involves the development of the Short Animation, which will show the character in context, similar to a short-story. The first stage requires the input of the ‘Finished Character Model’, from the Modelling stage.

Concept + Storyboard – This involves the planning of the Short Animation, which takes the form of a Storyboard. This will be used throughout development of the Short Animation, and may be refined or added to if necessary.

Scene Breakdown – Using the Storyboard, the animation will be split up into scenes and shots. Shots will indicate different camera positions, and scenes will indicate a change of location. This stage will produce a Scene Plan, which will be adhered to throughout the following stages.

Set Modelling – The set to be used in the Short Animation will be modelled, with the character in place. Additional models will be imported too, and the character will be resized accordingly.

Set Texturing – The set will be textured to complement the character.

Set Lighting – The textured set will be lit.

Model Refining – In a similar fashion to the refining stage that took place in the Modelling process, the set will be refined if necessary. Texturing and lighting may have highlighted any changes that need to be made. This stage will produce the final Master Set, ready for animating.

Scene Composition – This stage involves taking the Master Set and creating each individual scene from it. The individual scenes will be almost identical to the master, though will have cameras added in, and several models removed, depending on the Storyboard. The Scene Plan will be followed exactly when creating the individual scenes.

Animating – Each of the individual scenes will be animated separately within 3D Studio Max. The character; additional models along with the cameras within the scene will be animated.

Rendering – This stage involves taking each of the individual scenes and rendering them to the chosen video format. Due to the nature of 3D Studio Max and 3D animation, this stage could take several hours, even days if mistakes are made. This will be taken into account throughout the study.

Editing – The final stage of the Short Animation process model, will use Adobe Premiere to edit the individual scenes and shots into one animation, incorporating sound along with a title sequence and end-credit sequence.

Once each stage is complete, the Short Animation should be finished. It will hopefully put the character in context, within a short-story style animation. This will be incorporated into the Character Sheet during further development.

3.1.4 Individual Animations:

Using the ‘Finished Character Model’, along with the Short Animation as a guide, Individual Animations will be developed for use within the Character Sheet. These will display emotion, movement and voice of the character.

Animations Plan – This stage will take place later on in this chapter, and will involve planning the emotion, movement and voice animations for use within the Character Sheet. This will produce an Animations Plan, which will be followed throughout the following stages.

Animations Breakdown – Following the Animations Plan, each of the Individual Animation ‘sets’ will be setup, ready for animating. This will use the Master Set from the Short Animation as a basis, and will include camera placement and refining of the sets.

Animating – With the Individual Animation sets complete, the animating can take place. It will involve animating the character using the bones and controllers to convey each of the emotion, voice and movement animations. Again, the Animations Plan will be adhered to throughout animating.

Rendering – As mentioned previously, rendering is CPU intensive and can take several hours (or even days) to complete. At the end of this stage, the rendered Individual Animations should be complete.

Editing – Each of the Individual Animations will be edited using Adobe Premiere, to incorporate sound, and ensure that the files are of the correct format, ready for use within the Character Sheet.

The Individual Animations process model documents each of the stages that will take place, with the end result being several animations which display emotion, movement and voice.

3.1.5 Character Sheet:

This final process model documents each of the stages that will make up the development of the Character Sheet, which is part of the further development stages of the study. The Character Sheet section towards the end of this chapter, will explain it in more detail.

Research Format – This stage has already been documented in Chapter 2. It involved comparing various suitable formats to decide upon a format for both the animations and the Character Sheet. With this in mind, the following stages of the Character Sheet development can take place.

Research Software – Again, this stage has already been documented in Chapter 2. It was required to choose several appropriate software packages to be used throughout the study project's development.

Prototyping – With the chosen software and format in mind, the prototyping for the Character Sheet can begin. Using the Character Sheet design plan (towards the end of this chapter), a prototype can be created. This will incorporate some, or all of the features, along with the animations. The focus for this stage will be on function, not visual appearance. Several prototypes may be created, building on the success of the previous.

Layout – Taking the prototypes, the Character Sheet layout will be improved, so that it is visually appealing. Buttons, video windows and text boxes will all be incorporated.

Add Content – Content such as the text descriptions, and all of the Individual Animations along with the Short Animation will be incorporated into the Character Sheet, once the function and layout have been developed.

Tweaking – The Character Sheet will be tested to ensure that it functions as intended. Any errors will be removed, and any final changes will be made.

Testing + Evaluation – This stage will form part of Chapter 5 of this study. It will involve testing and evaluating the Character Sheet. A testing strategy shall be made, and followed, to ensure that the Character Sheet meets the original objectives for the study.

3.2 Robots (Inspiration):

The 3-dimensional character to be developed during this study will take the form of a robot, based upon human proportions. For inspiration, research looking at several human-like robots has been carried out. The sources are of both fictional and factual robots, and resemble the human form in many ways.

3.2.1 Honda [17]:

Honda is known mainly for its production of cars, though the company is a lot more than just a car manufacturer. They innovate, research and develop in many fields of technology, including robotics. Honda has been developing robots since 1986, and its

current robot ASIMO (2000) formed part of the inspiration for this study's 3-dimensional character. ASIMO stands for Advanced Step in Innovative Mobility, and resembles a human, with two legs and two arms, along with a head that recognises movement and sound. Honda believes that ASIMO will function in an actual human living environment within the near future. This idea is further enhanced by the next source, I-Robot.



Since the start of this study, a newer version of ASIMO has been revealed to the public, named 'The Research Model'. It is very similar to ASIMO, but features quicker movement speeds; thumb movement and has improved statistics (weight, operating time etc.). This model wasn't used for inspiration during the development of the 3-dimensional character, as it was unveiled in December 2004.

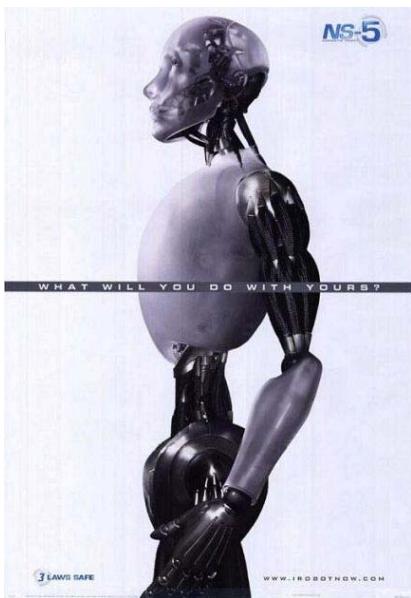
Honda's website proved very useful during the character development, as it contains many short video clips of ASIMO in action – movement, communication etc. These video

clips were used both during the design of the character, and the animation stages – to ensure that the character still retained robot-like movement, even though it took a human form. Several key aesthetic features of ASIMO were used in the development of this study's character – the segmented fingers; joint shapes; compact chest; limited features on the head; along with the colouring of ASIMO. These features will be noticeable in the finished 3-dimensional character.

3.2.2 I, Robot [18]:

"In the year 2035 a techno-phobic cop investigates a crime that may have been perpetrated by a robot, which leads to a larger threat to humanity."

Released summer 2004 in the UK, the film ‘I, Robot’ also proved to be a huge source of inspiration for the development of the 3-dimensional character in this study’s project. It is based in the future, on the theory that robots will become everyday servants to the human race. The storyline doesn’t concern the study, but the robots themselves do, as not only is their aesthetic design useful in the development of the character, but the robots in the film were also made using 3D animation software packages. Though to achieve the same look (both detail and textures) would take many months of development along with many months of rendering.



The robots in ‘I, Robot’ (named NS-5) have a human appearance and proportions. They live and work alongside humans in their environment. They can communicate; interact with objects and move, all in a similar fashion to human beings. Several key features from the robots were used during the development of the character, including – the human proportions; exposed joints and wiring; compact chest; clean, shiny look. The movement of the robots in the film is very fluid, often with over-exaggerated action, showing the robots superior strength to humans. This aspect wasn’t used during the animation stages of the development of the character, as it seemed un-believable. Instead, the slower, precise movement of Honda’s ASIMO was examined during development.

3.2.3 CGNetworks [19]:

CGNetworks and its community, CGTalk, is possibly the leading creative computer graphics and visual effects website. It showcases many pieces of art from games and films, to Short Animations from enthusiasts.



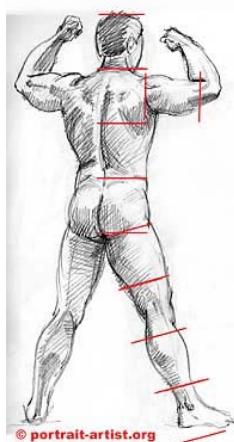
The author of this study has regularly browsed the CGNetwork site along with the CGTalk community site, for

inspiration during this study. The sites feature 2-dimensional and 3-dimensional images, showing various works of digital art. Of particular interest were the 3D characters, including many robots of various shapes and form. Not only is the site useful for inspiration during the development of the character, but techniques and methods for 3D animation are also talked about within the CGTalk community, which would also prove useful when modelling and animating the character.

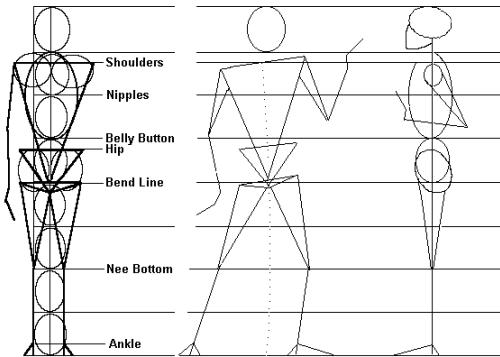
3.3 Character Development:

With a general idea for the character formed, human proportions needed to be researched and then followed, to ensure that the character is human-like in appearance. Then a Storyboard was scripted for the Short Animation, and a scene-breakdown created for use in the modelling and animation development stages. Alongside the Short Animation, the Individual Animations were developed for use within the Character Sheet.

3.3.1 Human Proportions [20]:

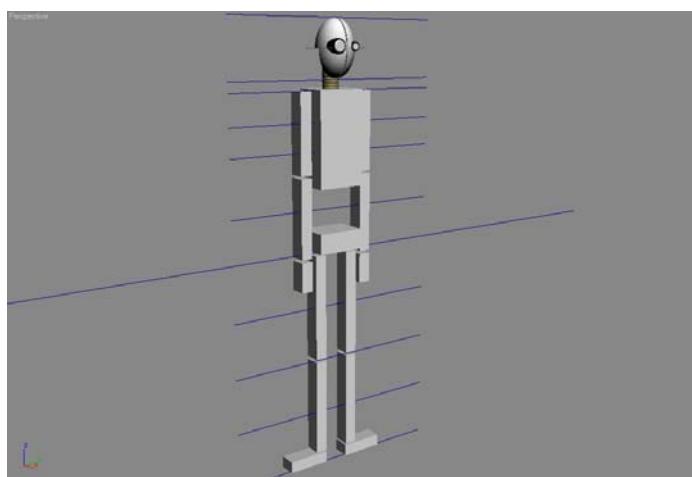


There are many ways to make a representation of a human proportionate to the human form. Some are a lot more technical than others, though one method stands out, and has been used for centuries. The human body is roughly proportionate to 8 human heads stacked up on top of each other. In reality, some people are equivalent to 7½ heads or even 6½ heads, but external research has shown that figures look distorted unless they follow the 8 head rule. Take the image to the left, for example. The artist mentioned that the figure is 7¾ heads in height (from the top of his head to the base of his foot), though any shorter and he would look out of proportion. The figure looks 'stocky' as it is, and most artists encourage people to use the 8 head rule, even if the human being drawn isn't in fact 8 heads in height. With this in mind, the robot was developed so that he was proportionate to 8 of his heads stacked up.



The image to the left was used as a guide-line within the animation software 3D Studio Max, to ensure that the basic model of the character was proportionate to the human body. This is important, as during the short-animation, the character will be interacting with objects (such as a car)

that humans would be too; and so human-like qualities, such as size, would be important. The image has split a diagram of the human figure up into 8 heads. The first head being the figure's head; the second is between chin and nipple height; the third touches the height of the belly button; the fourth is the bend line, at the human waist; the fifth is roughly halfway down the thigh, or just up from the knee; the sixth is just below the knee; with the seventh being mid-calf and the eighth is at the base of the feet. As you can see from the render to the left, the 8-head rule was followed during basic modelling of the character. The robots head was first modelled, and then guide-lines were put in-place. These were followed when carrying out basic modelling on the rest of the character's body parts. The end result being a basic model of the character that is in proportion to the human body:



3.3.2 Movement, Emotion and Voice:

The Character Sheet to be developed towards the end of the project will include various animations. These will be used to demonstrate certain aspects of the character, in a similar way to how Honda showcased various features of their ASIMO robot.

There are three key areas in animation that can be conveyed to the viewer, using various techniques. Firstly, movement – the main form of animation, as it is very visible and critical to providing motion within the animation. Secondly – emotion, which is useful to provide a lifelike look to the characters within an animation. Thirdly – voice, which includes both the sound used and lip-sync to the sound.

It has been decided to include 17 Individual Animations within the Character Sheet, along with the Short Animation. 7 of these Animations will be movement; 7 will be emotion; and 3 will be voice.

3.3.3 Character Context:

The actual use for the developed character and the Character Sheet itself has not been discussed fully within this study so far. As the course that the study's author is undertaking is BSc (Hons) Games Computing (Software Development), it makes sense to develop the character in a games context. The character could, in theory, be used in the next Playstation 2 hit 'Robot Rampage' (entirely fictitious). The Character Sheet would provide a means of conveying the character idea to a prospective user. The following could potentially be a use for the Character Sheet:

A small freelance 3d artist has a great idea for a games character. He develops the character and ends up with several key animations. These could be put into the Character Sheet framework, providing an interface for the user to interact with the character. The artist then takes the Character Sheet to several developers (or publishers) to show them his idea. This allows the developer to interact with the character, and get a 'feel' for how he would look within their game – the movement, his emotion and voice.

This gives the character a context (within a game) and the Character Sheet a use (albeit theoretical at this stage), which will be followed throughout the development of the project. The course code for the author's degree is G401 – and often when sketching designs for the robot character, the name G401 was assigned to him. For the purpose of giving the character a context, both within the short-animation and the

Character Sheet, the name G401 will be used to refer to the 3-dimensional robot character.

3.3.4 Movement, Emotion and Voice Continued:

With this context in mind, the following seven movements would be relevant and keeping with the style of a games character:

- Walking
- Running
- Crouching
- Jumping
- Climbing over an obstacle
- Kicking an object
- Picking up an object

These movements feature in many games where the player controls a character. For example – within ‘Tomb Raider’ [21], players control ‘Lara Croft’, from a third-person perspective. She is able to walk, or run around the various levels within the game; often needing to crouch under obstacles, or climb over them. These movements would also show the character interacting with objects.

To convey emotion to the viewer (of the animations), various animation techniques will need to be used. Not solely 3-dimensional techniques, but 2-dimensional techniques from cartoons, and other 2d animations will be followed. The following seven emotions will be animated for use within the Character Sheet:

- Happy
- Sad
- Angry
- Tired
- Laughing
- Crying
- Shocked

These are familiar and less-obscure emotions that should be relatively easy to convey with the 3-dimensional animated robot character. Finally, the following 3 voice animations will be produced for the Character Sheet:

- “Hello”
- “My name is G401”
- “How may I be of service?”

The first is a greeting, the second being a statement, or introducing itself, and the third is a question. These should demonstrate lip-sync with the robot, and relevant animation techniques will be followed when developing the Individual Animations.

3.3.5 Short Animation:

The Short Animation will put the robot character, G401, into a context. This short-animation is based upon the unit 3D Animation [22], taught during the 1st semester of the 3rd year on the Games Computing degree course. The unit’s assignment asked for a character to be animated in a short-story, which displayed 2 or more emotions. With this in mind, the Storyboard for the Short Animation was created, using the character G401. The original Storyboard [23] has been included as an appendix at the back of this study.

3.3.6 Scene Break-down:

The idea of scenes has been used in theatre, film and animation for thousands of years. The relevance of scenes within 3-dimensional animation is obvious – it allows the animation to be more manageable and often indicates a change in location or movement. Using the Storyboard, the Short Animation was split up into a total of 4 scenes, each containing several shots. Shots indicate a change in camera – not movement of the camera, but switching to another camera within the scene. And scene indicates a change in location, or movement from one part of the set to another. The following ‘Scene Break-down’ will be used throughout development of the Short Animation:

Scene 1, Shot 1: Title Screen

“Crash Tester”

Starring G401

Matthew Juffs 021818354

Scene 1, Shot 2: Waiting room

Camera moves from left to right
 G401 and 4 other robots sitting down
 Clean, white look to both Robots and the waiting room
 Window shows testing arena outside

Scene 1, Shot 3: Close up of G401

Shows G401 *scared*, as he waits
 Hands move up to cover his face
 His head shakes slowly from side to side
 Sweat pouring from his face?
 Other robots in the shot appear inanimate

Scene 1, Shot 4: Waiting room + speaker

Camera reveals a loudspeaker on the wall
 Announcement causes speaker to vibrate

Scene 1, Shot 5: G401 walking

G401 gets up, and walks to the waiting room door
 Camera side-on to G401, full body shot

Scene 1, Shot 6: G401 slams door

Camera cuts to show G401 walking out of the door
 Door slams shut behind him
 Picture falls off of wall next to the door (fades to black)

Scene 2, Shot 1: Test arena

Fades into wide shot, showing the whole of the test arena
 Camera begins to circle around the test car + G401
 Stops showing the lower half of the car + door

Scene 2, Shot 2: G401 prepares

Car door slams
 Rapid cuts to different aspects of the car + test arena:
 Dashboard, wheels, wing mirrors, car lights etc.

Scene 2, Shot 3: Behind G401's head (in the car)

Shows countdown timer (3 lights)
 End of the test track unclear, seems to go on forever
 Lights countdown (5 second interval)

Scene 3, Shot 1: Side-view of car + G401

Car accelerates off of screen, camera catches up
 G401 appears *happy* as the car accelerates
 Motion blur + camera wobble, to emphasise speed

Scene 3, Shot 2: Test car bonnet

Camera cuts to bonnet, showing it wobbling loose
 Bonnet detaches from the car

Scene 3, Shot 3: Side-view of car

Bonnet flies over the car roof
 Air-bag triggered off, G401's head comes loose and flies off screen

Scene 4, Shot 1: Car crashes

Camera cuts to brick wall at the end of the track
 Car collides with the wall, causing a huge explosion

Either animate the car exploding, or sudden fade to white screen

Scene 4, Shot 2: G401's head rolls onto screen

Fades into shot, showing test arena's floor

G401's head slowly rolls onto screen

G401 is *happy*

Scene 4, Shot 3: Credits roll

"Crash Tester"

Starring G401

Matthew Juffs 021818354

Soundtrack:

Thanks to:

This will enable easier management of the production process when creating the Short Animation, as the animation will be split into 'modules' allowing the author to concentrate on specific sections at a time, and not needing to worry about affecting the other sections of the animation. It will also make the rendering process a lot easier and more efficient, as shots can be re-rendered if mistakes are present, or changes need to be made. Also, the editing process should be more efficient, and it would allow a certain degree of flexibility when it comes to putting together the animation using Adobe Premiere.

3.4 Character Sheet:

The Individual Animations, along with the Short Animation have been designed and are ready to be developed using 3D Studio Max. The Character Sheet will use both of these animations as content, which will allow the user to interact with the character, G401.

3.4.1 Assignment (Level 1) [1]:

The idea for the Character Sheet came from an assignment within the 2D Animation unit in the first year, of the Games Computing degree:

"You are required to produce an interactive "model sheet" for a game character. The character can be original or adapted from a recognised character. Traditional model sheets are produced by character designers to show the animator the characters key motion and emotional attributes."



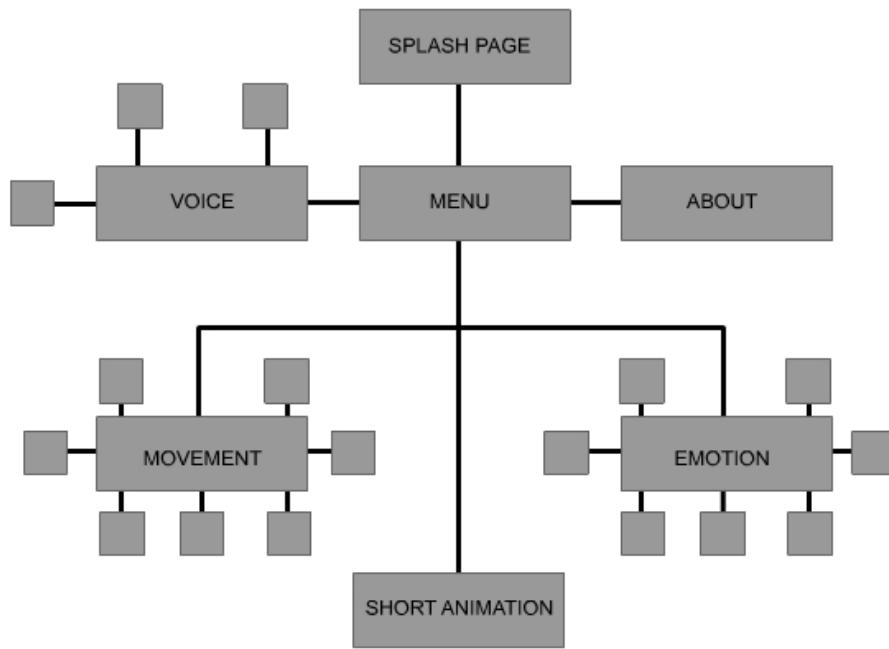
The above quote from the assignment describes the task, which involved developing a model sheet which could potentially be used by character designers. Research showed that model sheets have been

used in animation from a very early age. As animations were often created by more than one artist, a model sheet was used by the character designer, to convey the character's poses; movement; emotion; facial features; size etc. to the artists. The image above is an example model sheet, from 'Big Blue Fox' [24].

Whereas the assignment referred to it as a 'model sheet' this study refers to it as a 'Character Sheet'; essentially the same idea, a medium that provides information about a character. This study names the model sheet a Character Sheet, as it is adding another set of features to it. The Character Sheet will be 3-dimensional and interactive, to allow the users to see the character in motion. The assignment used Macromedia Flash to develop the 2D model sheet, and this study will use the software package to develop the 3D Character Sheet.

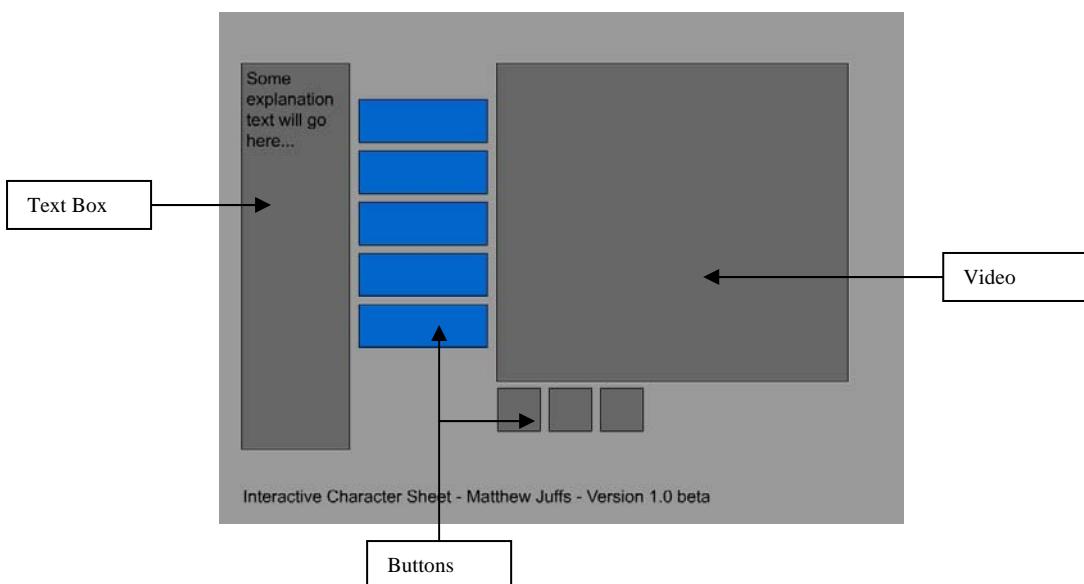
3.4.2 Function:

Before designing the aesthetic layout of the Character Sheet, the underlying function needs to be looked at. The study has already stated that the Character Sheet will integrate both the Short Animation and 17 Individual Animations (movement, emotion and voice), allowing the user to interact with the character by viewing chosen animations. For example, if the user wanted to see how G401 would move, then they would select one of the movement animations. The following diagram shows the initial design for the Character Sheet's function:



3.4.3 Layout:

With the function in mind, the layout for the Character Sheet can be designed, ensuring that the user will have access to all of the functions, in a simple yet effective way. Buttons will be used to navigate between menus within the Character Sheet, and to view the various animations integrated within it. Text boxes will also be used throughout the Character Sheet, containing text that will explain the various sections, or contain a short biography of the character. The following diagram shows the initial design for the Character Sheet layout:



Chapter 4: Implementation

This chapter will look at the project implementation part of this study, which involved the development of the character. It follows the process models shown previously (in Chapter 3), focusing on 4 stages in particular – Modelling, the Short Animation, the Individual Animations and the Character Sheet. Whereas Chapter 3 looked at the design of these stages of the development cycle, this chapter will document what actually took place during each stage. Please refer to the process models in Chapter 3.

4.1 Modelling:

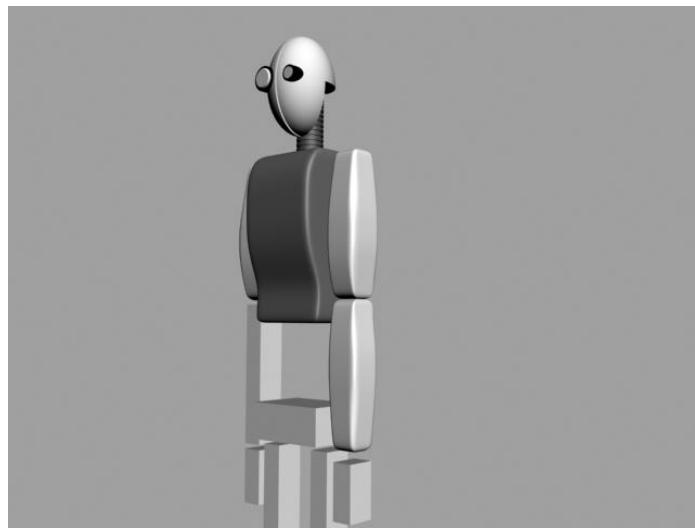
The first stage of the project focused on the development of the character, from initial sketches to the final model ready for animating. Each of the stages planned out in the design chapter, were carried out during the project implementation, without any changes.

Initial Sketches – From the inspirational research carried out, initial sketches were made. These helped form several ideas, which were considered for the robot character. Specific features, such as the design of the head were developed, until a final design was decided upon. These initial sketches formed a basis for the character, and were used throughout the modelling stages.

Character Proportions – With the basic idea for the character formed, research needed to take place, looking at character proportions. The robot character, G401, is a crash-test robot, who regularly tests various vehicles. With this in mind, character proportions needed to be taken into account when modelling, as G401 is replacing humans in the testing of vehicles, so needs to be proportionate to them.

Low Polygon Modelling – With the basic design of G401, in the form of sketches, a basic low polygon model was created within 3D Studio Max. Firstly the head was modelled, taking inspiration from research and the sketches. Then the limbs of G401 were modelled, and then everything was tweaked, so that the proportions corresponded with those of the human body.

Detailed Modelling – With the basic model formed, each individual body part was concentrated on, to add detail to G401. This detailed modelling greatly increased the polygon count of the model (from around 600 to well over 100,000 polygons), which proved to be a problem when it came to rendering, along with navigating around the model within the viewports. To overcome this, further modelling was carried out on each of the limbs that made up the robot. This involved using various optimisation techniques, which reduced the amount of polygons used to make up an object, without affecting its appearance too much. The image below shows the detailed modelling taking place:



Texturing – Once G401 was modelled, several textures were applied to the model. The inspiration for the colouring came from Honda's ASIMO [17], which is shiny white, making the robot look clean and clinical in appearance. Most of the textures were created within 3D Studio Max, using the material editor; though some textures (mainly those used within the sets) were sourced from the internet (free texture sites).

Lighting – The textured robot model was lit using several lights of various settings, within 3D Studio Max. This was the first stage that the robot looked complete.

Model Refining – The lighting stage highlighted several areas that needed refining. This stage also involved reducing the polygon count of the model further, using various 3D Studio Max specific techniques.

Bones – By this stage, the model was ready for animating. To simplify the animation stages, bones were added to the model. This involved firstly creating a skeleton within the character model, then linking the appropriate limbs to the bones.

Controllers – It is possible to animate by moving the bones by themselves, but the model contained many bones. To simplify movement of the model, 4 controllers were put in place. Two controlled G401’s arms, with the other two controlling his legs. This stage proved vital, as it made the animation stages a lot quicker, allowing time to be concentrated on the animation itself, not on selecting which bones to move.

By this stage, G401 was complete. The model had gone through several stages of refinement, to reduce the polygon count and to refine various details. Texturing and lighting gave the model a more realistic ‘feel’. And including bones, along with controllers aided the following stages.

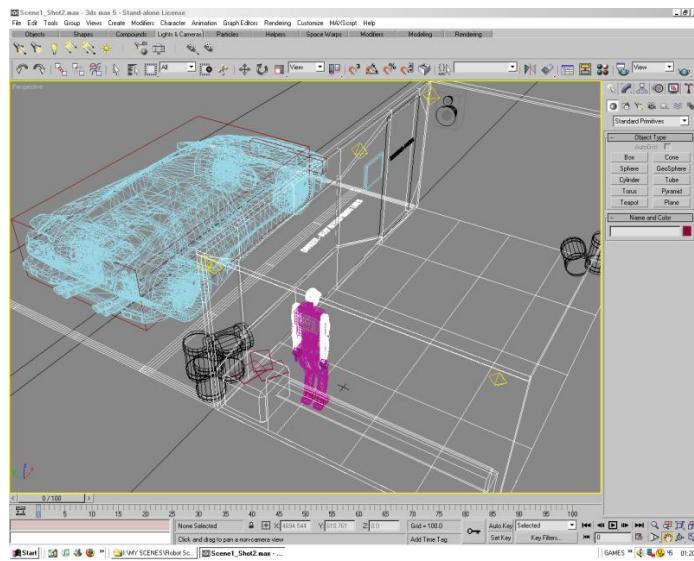
4.2 Short Animation:

The second stage of implementation, involved developing the Short Animation. This has been included within the Character Sheet, to put G401 into context. It not only allowed various animation techniques to be explored, but also highlighted several changes that could be made to G401 in future.

Concept + Storyboard – The first stage of developing the Short Animation, involved creating a concept along with a Storyboard [23], which was adhered to throughout development of the Short Animation. The concept of G401 as a crash-testing robot was chosen, as it allowed human-like qualities to be integrated into G401.

Scene Breakdown – The Storyboard [23] was refined, and additional scenes were added into it. It was then broken up into scenes and shots. Scenes indicate a change in setting or major camera angle change, and the shots indicate different cameras within the scene. In the original Storyboard, 7 shots were created. After refining, additional shots were added into the animation, bringing the total to 16. The scene breakdown has been included within Chapter 3.

Set Modelling – The set that was used within the animation was modelled within 3D Studio Max. G401 was imported into the set, and scaled, so that he was proportionate to the other objects within the set. The set followed the concept closely – a crash test arena, which contained a long test road; a waiting room; a vehicle [25]; along with various pieces of furniture and a timing light system. The image below shows the set being modelled within 3D Studio Max:



Set Texturing – Once modelled, the set was textured to compliment G401. A clean, simple look was given to the waiting room along with the track. Some of G401's textures were used, along with additional ones sourced from free texture websites and the author's digital photograph collection.

Set Lighting – Once textured, the set was lit in a similar way to how G401 had been lit previously. Several lights were placed within the waiting room, to cast shadows onto the set. Additional lights were placed along the track and within the timing lights.

Model Refining – Similar to the stage that took place during modelling, the set was refined as necessary. The polygon count was further reduced, as 4 instances of G401 were used within the set, which quadrupled the polygon count. The car model used on the set was also refined, as it wasn't complete. A chassis; along with wheels; engine bay and cockpit were modelled for the car.

Scene Composition – By this stage, the set was ready for animating. A master copy was saved, and duplicated for each of the shots within the animation. This made the animating process a lot easier and more efficient, as it allowed work to be carried out on individual shots, which wouldn't affect the rest of the animation.

Animating – Each of the individual shots were animated, one at a time. The bones along with controllers enabled easy manipulation of G401 within the scene. During the early stages of animating, several problems were encountered which required refining of the set models. For example, the car's wheels wouldn't animate as required, so had to be completely re-modelled.

Rendering – Splitting the shots up into separate files proved to be very useful when rendering. Each shot was animated, and then rendered. Once rendered, further refining and re-rendering would take place if required; otherwise the next shot was animated and rendered. This process was repeated until the whole animation was rendered. Rendering took place within 3D Studio Max, and proved to be very time consuming. Each shot took between 20-30 minutes to render, with some requiring re-rendering. A separate computer, specifically for rendering, would have made the process a lot quicker, but wasn't possible during development of the study project. Every rendered animation contained within the study project was rendered at a resolution of 720 x 578, at 25fps (frames per second). This was chosen, as a previous assignment [22] chose this PAL format for its renders. The Short Animation was rendered using the DivX codec discussed in Chapter 2, though later converted to the preferred Cinepak codec. Each of the Individual Animations (discussed later in this chapter) was rendered using the Cinepak codec.

Editing – After rendering, the animations were loaded into a media player in order. This enabled a ‘rough’ viewing of the individual shots, to see if they fitted together well enough. This would also highlight any changes that needed to be made, but luckily each shot seemed to feed into the next perfectly. Each of the rendered shots was then imported into Adobe Premiere for editing. The shots were put in order (according to the Scene Breakdown) and a soundtrack was added to it. The animation

was then published to the DivX codec format (though later re-published to the Cinepak codec for the Character Sheet).

At this stage, the Short Animation was complete, ready for integration within the Character Sheet.

4.3 Individual Animations:

The set from the Short Animation was used for developing the Individual Animations. These are used within the Character Sheet, to display emotion, movement and voice of G401.

Animations Plan – The first stage required planning the animations to be used within the Character Sheet. This has been discussed in Chapter 3, and involved designing 17 different animations – 7 displaying G401’s emotion; 7 displaying the movement of G401 and 3 displaying the voice of G401.

Animations Breakdown – This stage involved taking the master set used within the Short Animation, and refining it for use within the Individual Animations. Unnecessary models such as the car; additional robots; the test track and timing lights were removed to reduce the complexity of the scene. A camera was placed within the set, and then duplicates of the Individual Animations master were created, 17 in all, one for each animation.

Animating – Each of the sets were taken one by one and animated to display the relevant emotion, movement or voice. Techniques used and learnt within development of the Short Animation, were built upon when animating.

Rendering – Once animated, each set was rendered to the chosen .avi file format, using the Cinepak codec. Once rendered, each animation was studied by several people to decide if any major changes needed to be made, which would require refining and re-rendering.

Editing – This stage wasn't required during implementation of the study project, even though the design mentions it. It was originally thought that each animation would be further edited using Adobe Premiere to integrate sound.

4.4 Character Sheet:

The final stage of the study project, involved developing the Character Sheet. This program integrates each of the Individual Animations, along with the Short Animation into a user interface, allowing the user to interact with the character, G401.

Research Format – Documented within Chapter 2, this stage involved researching a suitable format for the Character Sheet. It was decided that the Character Sheet needed to be interactive, and compatible with a wide range of computers. Either a webpage format or a flash animation would have been suitable, as both would allow the integration of several pieces of animation. Flash was chosen, as it compacts all of the videos together with the interface, into one manageable file. This can either be in .swf format (requiring a flash player to already be installed on the computer) or in an .exe format, which integrates a flash player into the file, so that it isn't required separately.

Research Software – This stage (again, already documented within Chapter 2), involved choosing appropriate software packages for use within the development of the study project. Macromedia's Flash was chosen for developing the Character Sheet, as the software was available for use at the University, and also the author is very familiar with the software package.

Prototyping – Once all of the animations were finished, the prototype for the Character Sheet was made. This focused on functionality firstly, and went through several stages. The compatibility of the animations with Flash was tested, along with the format. The option of breaking each animation up into sequences of images (using Adobe Premiere) was looked at, though it proved to be too much for Macromedia Flash, and often caused the program to freeze. In the end, it was decided that the animations would be imported in the .avi Cinepak codec format.

Layout – Once the prototypes had been created, work on the actual Character Sheet began. The layout was altered, so that the overall size of the Character Sheet was 1024 x 768, to allow for the 720 x 578 animations to be displayed fully.

Add Content – The Individual Animations were integrated into the Character Sheet, along with the Short Animation. Then text was added for the ‘About’ section to provide the user with a brief summary of what the Character Sheet is about. Text was also added for each of the animation sections, to provide the user with additional information.

Tweaking – The Character Sheet went through 12 versions of ‘tweaking’. This involved integrating an animation at a time, and testing the Character Sheet to ensure that the animation displayed appropriately.

Testing + Evaluation – This final stage will form part of Chapter 5. It will involve evaluating the Character Sheet along with other aspects of the study, to ensure that it meets the requirements set during the planning and design stages of the study.

Programming – This was not mentioned in the process models, as at that stage the exact format was unknown. To provide navigation between sections of the Character Sheet, and to play the animations, additional code had to be included. Macromedia Flash uses its own programming language, known as ‘action script’. It is relatively simple, but powerful as it allows the developer to manipulate the Flash animation in many ways. In the Character Sheet, action script code was used for each of the buttons, to enable interaction for the user. Also, many frames contained code to control the animations themselves, and navigation between frames.

The implementation part of this study involved the development of a 3D character, which was modelled, animated and rendered within 3D Studio Max. A Short Animation putting the character (G401) into context was created, along with 17 Individual Animations, which showed various movements, emotions and voice animations of G401. To integrate all of these animations into a user interface, a Character Sheet was developed. This took the idea of a ‘model sheet’, which provides

animators with key information about a character, and expanded on it. The final Character Sheet provides the user an interaction with the character, displaying all of the animations along with additional text information.

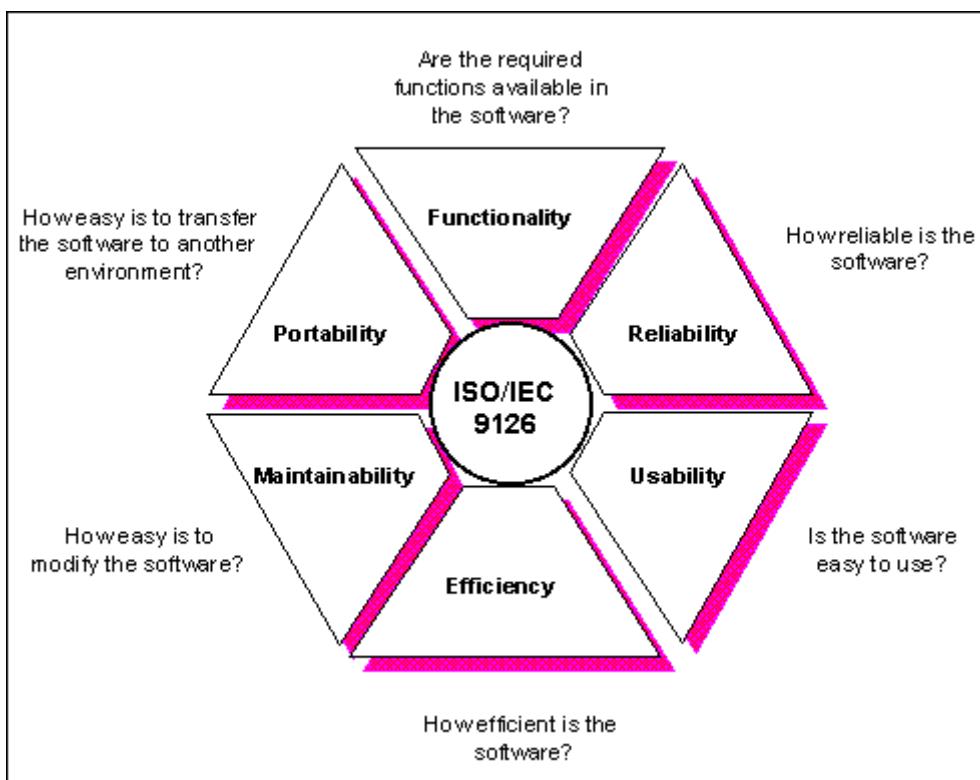
Chapter 5: Evaluation

This chapter will document the evaluation process of this study. The Character Sheet (end product) will be evaluated using the ISO 9126 standard. Then the end result will be evaluated against Chapter 1. Lastly, the time management of this study will be evaluated. This will enable conclusions to be written for Chapter 6.

5.1 ISO 9126 [26]:

“A standard that defines specific terms for evaluating software quality, under these 6 categories: functionality, reliability, usability, efficiency, maintainability, and portability.”

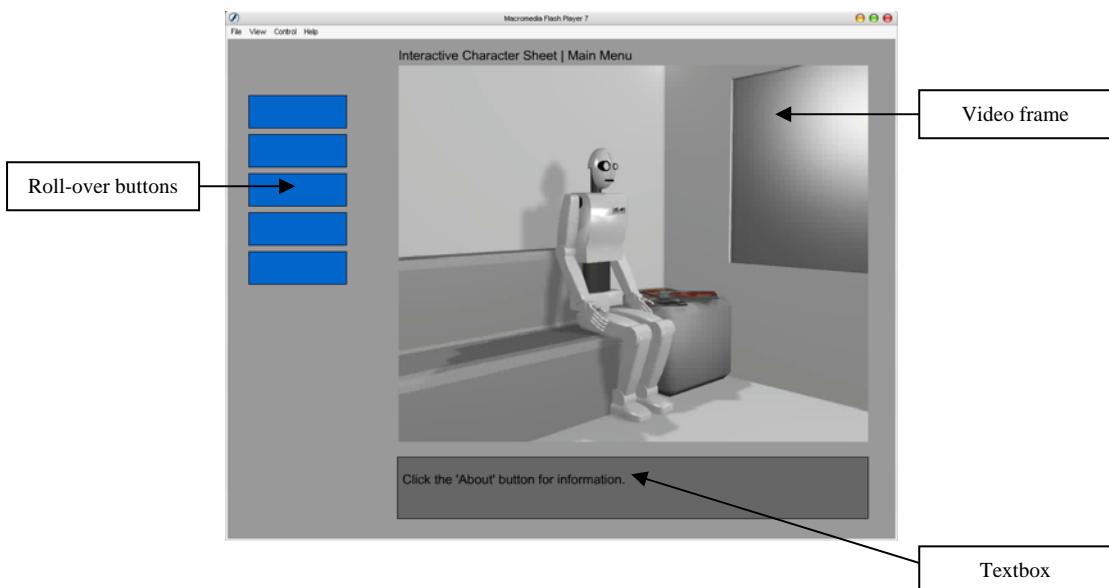
The study project involved developing a 3D animated character, along with several animations, which were integrated into a user interface – the Character Sheet. To evaluate the project, the ISO 9126 standard will be followed loosely. It is used by many software developers, to evaluate their software. The final Character Sheet is, in essence, a piece of software; so the ISO 9126 standard should be appropriate. The following diagram displays the 6 areas of evaluation:



The ISO 9126 standard has gone through several revisions, and so there are multiple versions available. To simplify the evaluation process, the above diagram will be followed – it is based upon the 1991 version of the standard.

5.2 Character Sheet:

The final version of the Character Sheet (provided on the accompanying CD [27]) has been evaluated as follows. The image below shows the layout of the final version of the Character Sheet:



5.2.1 Functionality:

“Are the required functions available in the software?”

The Character Sheet was required to be interactive, so that the user could effectively ‘control’ G401 (the robot character). This control is available in the form of buttons within the Character Sheet, that when pressed (by the user) either an animation is played, or the Character Sheet navigates to a different section. During development of the Character Sheet, each and every button was checked for functionality – to ensure that they worked as required. For example, the ‘About’ button takes the user to the ‘About’ section of the Character Sheet, which displays additional information to the user. The Individual Animation buttons, such as ‘Kicking’ all play the relevant animations within the video window of the Character Sheet. As all of the buttons work as desired, the required functions are available in the software.

5.2.2 Reliability:

“How reliable is the software?”

To ensure that the Character Sheet is reliable, it was executed a number of times, and ‘stress-tested’ to check for any software malfunctions. This was achieved by quickly selecting multiple animations at a time, to try and confuse or ‘slow-down’ the software. Only once did any errors occur – vertical white lines appeared on the Character Sheet itself. It is believed that this is a malfunction within the Flash Player itself, and not the Character Sheet – possibly a limitation of the development software. The Character Sheet did not close at all when not required; i.e. it did not ‘crash’ during execution.

5.2.3 Usability:

“Is the software easy to use?”

This area will be further explored using a questionnaire later in this chapter. The author of this study believes that the Character Sheet is very easy to use, with an ‘About’ page providing information to the user about the Character Sheet, and additional hints placed within the textbox of the Character Sheet on several sections. The buttons allow easy navigation to each section; to play the animations and also back to the ‘Main Menu’ of the Character Sheet. To ensure that the Character Sheet is usable to a variety of users, a questionnaire will take place.

5.2.4 Efficiency:

“How efficient is the software?”

To test the efficiency of the software, the Character Sheet was executed on the author’s home PC (Athlon 2000xp; 512mb RAM) a number of times and the processor and memory usage were recorded. The following table shows the average results of the efficiency test, based on a range of tests:

	CPU usage	RAM usage
Idle	0%	23.504k
Normal	61%	25.024k
Load	84%	28,076k

The first thing to note is that the Character Sheet is 14.1 MB in file size; whereas the animations separately are 62.1 MB in size. Flash integrated each of the animations into the Character Sheet, but at the same time re-compressed them, to reduce the file size. Macromedia's Flash is designed to do this, as Flash content is primarily delivered over the Internet, where file size is an issue. In terms of size, the Character Sheet is very efficient, and would easily fit on the proposed CD media format (see Chapter 2).

Looking at the efficiency test table, the Character Sheet utilises a lot of processing power during playback of the animations – several factors may cause this. Flash itself does not require too much processing power, though playback of 3D animations does. Though, seeing as the Character Sheet was originally designed for use within a workstation environment (a character designer showing the Character Sheet to an animator), then the processing power is not too much of an issue. The memory usage is not too demanding, compared to other applications. Microsoft Word [10] was used to word process this study – it uses around 38 MB of memory compared to the Character Sheet's 28 MB (on load).

5.2.5 Maintainability:

"How easy is it to modify the software?"

The main use for the Character Sheet is to allow interaction between an animator, and a character. It does this by integrating several animations, depicting movement, emotion and voice of the character, into one easy-to-use interface. It was also designed to be re-usable, so that the framework could be re-used by a character designer, to allow interaction with their own character. The Character Sheet allows for this re-usability, but only to a degree. Firstly, Macromedia Flash would be required, to re-use the Character Sheet, along with knowledge of the software package. It was originally hoped that the Character Sheet would allow for modularity – where each of the animations remained as separate files, allowing them to be replaced with different characters without affecting the Character Sheet itself. Unfortunately, due to the nature of Macromedia Flash, each of the animations were imported into the program, and integrated into the Character Sheet file. This has its advantages and disadvantages – only the one file is required to view the Character Sheet. This single file is also

considerably smaller compared to the separate animations. Though, on the downside, the quality of the animations has suffered, due to the re-compression. Visible ‘pixilation’ has occurred on each of the animations within the Character Sheet. Overall, the Character Sheet is maintainable to a degree, if further documentation is provided, detailing how to modify it.

5.2.6 Portability:

“How easy is it to transfer the software to another environment?”

As mentioned previously, the Character Sheet has been compacted into one file. This has affected the overall quality of the product, but has helped make it more portable than previously designed. During Chapter 2, a suitable file format and codec was chosen, to ensure that the Character Sheet would display on as many computers as possible. The Cinepak codec was chosen, it is old in computing terms (dating back to 1995), which means that it is widely supported, compared to most of the newer codec’s.

Flash re-compressed each of the animations during the publishing process of the Character Sheet development. This has eliminated the need for additional codec’s, or compatibility with the Cinepak codec, as the Character Sheet file contains an integrated Flash Player. The final Character Sheet is in an .exe format, which contains each of the animations (compressed) along with a Flash Player. This makes it extremely portable, and it should execute on many platforms.

5.3 Questionnaire:

To provide a wider range of opinions when evaluating the Character Sheet, a questionnaire was created. The opinion of the author is present throughout this study, but a questionnaire will help to add to this.

5.3.1 Questions:

Each of the questions was given a choice of 5 answers – marks out of 5:

1 – Very Poor/Definitely Not; 2 – Poor/Probably Not; 3 – Average; 4 – Good/Probably; 5 – Excellent/Definitely

The Questionnaire has been included as an appendix [28], please refer to it during the following section. The questionnaire also asked which platform the Character Sheet was evaluated on – this will enable evaluation of the portability of the Character Sheet.

5.3.2 Results:

The following table shows the results from the questionnaire. The first column indicates the question number and the first row indicates the mark out of 5. The numbers within the table show the frequency of the results:

Question/Mark	1	2	3	4	5
1		1		6	1
2			6	2	
3		1		2	5
4	2	2	3		1
5	1			6	1
6				4	4
7		1	1	2	4
8	2	2	2	2	
9				3	5
10			2	6	
11	1	4	1	1	1
12			1	4	3
13		2		6	
14		2		5	1
15				4	4
16			3	5	

5.3.3 Feedback:

Along with the 16 questions, several evaluators put additional comments on their questionnaires. The following bullet points show the various comments made:

- The buttons should be bevelled (along with a drop shadow when depressed)
- A ‘Play’ button should be included on the ‘Short Animation’ section
- The button labels should be visible from the outset (not hidden)
- Another feature could be the integration with the development software itself

The last point is particularly useful, as integrating the Character Sheet with 3D Studio Max (for example) would allow the character animators to import the various

animations directly into their work. This should be considered if the Character Sheet concept is to be further developed.

5.3.4 Portability:

Using the additional information provided by each of the evaluators on the questionnaire, the portability of the Character Sheet can be further evaluated. The Character Sheet was stored on CD format, and executed on several different platforms during evaluation. It was tested working on Windows 2000, XP home, XP professional and Server 2003. The lowest CPU speed of the test computers was 1.4GHZ, with the highest being 3.0GHZ. The RAM of the test computers varied from 256MB right up to 2GB. The GPU varied from onboard Intel graphics, right up to the latest NVIDIA GForce 6800 Ultra. No crashes or malfunctions of the Character Sheet were experienced during evaluation. From this, the Character Sheet proves to be very portable, executing flawlessly on many different setups. This is mainly due to the final Character Sheet integrating a flash player within the .exe file, removing the need for codecs.

5.3.5 Conclusion:

The Character Sheet was evaluated by 8 individuals. Each evaluator answered each of the 16 questions after using the Character Sheet for a short period of time. Each evaluation took around 5 minutes. The author was present for each evaluation, but didn't influence the results, just provided help if needed.

Looking at the results table, there is a mix of results for each of the questions. The 'bold' highlighted results indicate results which the majority of evaluators agreed upon. Focusing on these, several points can be made to conclude on the questionnaire:

- The Splash Page is needed on the Character Sheet
- The Quality of the Character Sheet could be improved (due to pixilation)
- The Buttons are very easy to use
- Though the hidden words on the button should be removed, so that they are visible from the outset
- The Textboxes are informative
- The About section is very informative

- The majority believe the animations were animated well
- G401 is modelled well
- G401 would suit a game character more than a film character
- The Short Animation puts G401 into context
- The layout could be improved (referring to the hidden button wording)
- The colouring could be improved
- Sound is definitely needed on the Character Sheet
- The Character Sheet could be used by a character designer/animator

5.4 Relating to Chapter 1:

This section will compare the study, along with the practical project, to Chapter 1, which outlined the study.

5.4.1 Context:

Research showed that animation is a huge part of the creative computing industries. This study helped develop the author's modelling and animation skills, building on previous knowledge to overcome the problem. This study will form part of a portfolio, but it should also inform its readers. The study project combined many varied techniques, from modelling; animation and software development to produce a unique Character Sheet. The Character Sheet combines creative animation techniques, with technical software methods to provide an interaction with a 3D character.

5.4.2 Objectives and Methodology:

The objectives outlined in Chapter 1 included – research suitable tools, methods and techniques; develop a 3D character; create a Short Animation; create Individual Animations; develop a format for presenting the animations. All of these objectives were carried out successfully, and a Character Sheet was developed to provide a format for presenting the animations, which allowed interaction with the character. One objective was not fully carried out though – the advanced objectives included editing each of the animations to incorporate sound. This would provide a voice for G401, along with background music and sound effects within the animations. Due to time constraints, the need for sound was left out, instead focusing on the functionality of the Character Sheet, ensuring it worked correctly.

5.4.3 Deliverables:

This section of Chapter 1 stated “*a successful solution should be able to clearly demonstrate the interactive character’s movement, emotion and voice to an audience well.*” The Character Sheet fulfils this, as it provides an interface for a user to interact with the character, displaying movement, emotion and voice.

5.4.4 Conclusion:

Chapter 1 outlined the whole study, detailing what would take place and why. It provided a basic methodology for the study, which was used within the process models (Chapter 3). Comparing it to the outcome of the study shows similarities, with very few differences. Sound was left out of the final Character Sheet, though the Short Animation did include it during development. This probably affected the content of the Character Sheet, but many of the test computers didn’t have sound capabilities. The objectives were expanded upon, and adhered to closely throughout the study project.

5.5 Time Management:

As mentioned, time constraints affected some of the study project objectives. This was due to not fully managing the time available to the study. The Short Animation was edited to include sound, though the Individual Animations were left un-edited. The Character Sheet format will allow for sound, either to be integrated into the animations, or to be imported into the Character Sheet itself.

Focusing on the Gantt chart [29] that was produced during the planning stages, it was followed closely during the study project and write-up. The aim of the author was to finish the actual project implementation part (models, animations and Character Sheet), along with the first draft of each chapter by Easter 2005. This was achieved, which allowed plenty of time to refine the study. Better time management during the implementation stages of the project study, would have allowed for inclusion of sound within the Character Sheet, though overall the time management was good.

Chapter 6: Conclusions

This chapter will document the conclusions for this study. Firstly the negative aspects of the study will be discussed, followed by the positive aspects. Finally, the study as a whole will be concluded in the ‘overall’ section.

6.1 Negative Aspects:

The evaluation of the study highlighted several negative aspects that affected the overall quality.

6.1.1 Polygon Count:

During the early stages of modelling the 3D character, the polygon count was ignored within 3D Studio Max. Instead, the available time was concentrated on adding detail to the model. The consequence of this was obvious when it came to animating the robot character – as the ‘viewports’ within 3D Studio Max were very slow to manoeuvre within and rendering took far longer than expected.

This problem was resolved eventually, after several processes of refining the model, using various techniques. Though this took up valuable development time allocated to the study project. If the polygon count had been noted throughout each stage of modelling, then this problem would have been eliminated.

6.1.2 Pixilation:

Pixilation often occurs when a digital image or video is compressed. The pixels used to construct the image are visible, which degrades the overall quality. The final Character Sheet (see accompanying CD [27]) contains pixilation on each of the animations. This appears because Flash re-compressed the animations as they were integrated into the Character Sheet – not because of the choice of codec (Cinepak)!

The pixilation within the Character Sheet could have been avoided if an alternative format was used for the Character Sheet, which avoided re-compression; though this was not possible at the Character Sheet development stage of the study.

6.1.3 Sound:

The Short Animation (prior to Character Sheet integration) includes a soundtrack, but each of the Individual Animations, along with the final Character Sheet do not contain any sound. This was one of the requirements of the Character Sheet, and the lack of sound affects the overall quality of the Character Sheet. Sound was not included in the final Character Sheet, mainly due to time restraints, which led to the development time being concentrated on the functional aspects of the Character Sheet. Better time management would have allowed for development time to be devoted to integrating sound, which would have added another ‘dimension’ to the Character Sheet.

6.1.4 G401 Character Model:

The author personally feels that the 3D character model of G401 could have been further improved. The model functions as required, but the head does not allow for much emotion to be conveyed within the animations. Possibly adding more human features, such as eyebrows, and eyes that could blink; would have further enhanced the emotion aspect of the Character Sheet. This could be taken into account if the study was to be developed further.

6.1.5 Questionnaire Negatives:

The Questionnaire results highlighted several negative aspects of the Character Sheet. The evaluators believed that several improvements could be made, including removing the hidden wording on the buttons. This proved to be annoying for many of the evaluators, as they found it more time-consuming to navigate around the Character Sheet. The evaluators also felt that sound is needed within the Character Sheet, especially for the ‘voice’ animations. Several of the test machines did not have sound capabilities however.

6.2 Positive Aspects:

6.2.1 Integration:

The Character Sheet integrates each of the Individual Animations, along with the Short Animation, into one file. This was not originally planned during the design stages of the study project, but was due to the choice of software (Macromedia Flash). Flash integrates an .avi video file into the Character Sheet, as it is imported. This led

to just the one 14 MB Character Sheet file (csheet.exe), instead of a Flash file along with each of the separate animations as originally planned. This integration proved to be an advantage, as it makes the Character Sheet very portable and a lot smaller than expected.

6.2.2 Requirements:

As mentioned in the evaluation of this study (Chapter 5), the Character Sheet meets all of the requirements laid out in Chapter 1. It allows a user to interact with the 3D animated character using an easy-to-use interface. The interaction is provided in the form of various animations which display emotion, movement and voice characteristics of G401. The title of the study was fulfilled:

“To carry out research and evaluation in the field of 3d Character Modelling and Animation, in order to create and animate my own character.”

Suitable formats, along with software packages were researched prior to development. Character modelling and animation techniques were researched throughout the study project to aid with development, along with inspirational research. Each stage of research was evaluated, along with the final study project outcome.

6.2.3 Time Management:

The Gantt chart [29] produced during the planning stages of this study, has been included as an appendix. It remains unchained from the original version, as the study followed it closely. The first draft of this study, along with the finished practical aspect of the study project, were completed by Easter 2005 as originally planned. For this reason, the time management was very good throughout the study.

6.2.4 Questionnaire Positives:

The Questionnaire results also highlighted several positive aspects of the Character Sheet. Many of the evaluators believed that the actual animations and G401 (the character) were modelled and animated well. They also felt that the ‘Splash Page’, ‘Textboxes’ and ‘About’ section were very informative and necessary. They could also see the potential use of the Character Sheet for a character designer/animator.

6.3 Overall:

To conclude the study as a whole, the final Character Sheet met all of the original requirements from the planning stages of the study. There are several negative aspects, which have affected the overall quality of the study project; but there are also positive aspects. If the study was to be developed further, or built upon, then the evaluation and conclusions should be taken into account, along with the results from the questionnaire, to improve on what this study and its accompanying project have achieved. A few changes were made to the study during development of the project, but overall this study adheres to the original plans made at the outset.

References:

- [1] Level One “2D Animation” Assignment (see Appendix section)
- [2] <http://www.3drender.com/ref/software.htm> - Jeremy Birn reviews high-end 3D animation and rendering software
- [3] <http://www.academicsuperstore.com/> - Used for pricing the software packages researched, along with additional information
- [4] <http://www.newtek.com/> - Lightwave 3D official website
- [5] <http://www.discreet.com/> - Discreet 3D Studio Max official website
- [6] <http://www.alias.com/> - Alias Maya official website
- [7] <http://www.softimage.com/> - Softimage XSI official website
- [8] <http://www.adobe.com/> - Adobe Premiere official website
- [9] <http://www.avid.com/> - Avid Xpress official website
- [10] <http://www.microsoft.com/> - Microsoft’s official website
- [11] <http://www.macromedia.com/> - Macromedia official website
- [12] <http://www.reuters.co.uk/currencies.jhtml> - Used for converting currency
- [13] <http://www.pixar.com/> - ‘The Incredibles’ creator
- [14] <http://www.divx.com/> - DivX codec official website
- [15] <http://www.cinepak.com/> - Cinepak codec official website
- [16] Independent Study Plan/Proposal (see Appendix section)
- [17] <http://world.honda.com/ASIMO/> - ASIMO official website
- [18] <http://www.imdb.com/title/tt0343818/> - Internet Movie Database ‘I, Robot’
<http://www.irobotmovie.com/> - ‘I, Robot’ official website
- [19] <http://www.cgnetworks.com/> - CG networks, used for inspiration
- [20] <http://www.mauigateway.com/~donjusko/96.htm> - Human Proportions
<http://www.portrait-artist.org/misc/proportion.html> - Human Proportions
- [21] <http://www.tombraider.com/> - Tomb Raider official website
- [22] Level Three “3D Animation” Assignment (see Appendix section)
- [23] ‘Crash Tester’ Storyboard (see Appendix section)
- [24] <http://www.bluefoxfiles.com/cont-bff-charinfo.html> - Model Sheet research
- [25] <http://www.3dcafe.com/> - Used for sourcing the ‘Diable’ vehicle in the ‘Crash Tester’ Short Animation
- [26] http://www.usabilityfirst.com/glossary/term_1214.txt - ISO 9126 definition
<http://www.cse.dcu.ie/essiscope/sm2/9126ref.html> - ISO 9126

- <http://www.iso.org/> - ISO 9126 official website
- [27] Accompanying CD (see Appendix section)
 - [28] Questionnaire (see Appendix section)
 - [29] Gantt Chart (see Appendix section)
 - [30] Process Models x 5 (see Appendix section)

Bibliography:

Websites:

- http://www.ece.uiuc.edu/pubs/ref_guides/ieee.html - IEEE Style referencing
- <https://renderman.pixar.com/> - Pixar's rendering software
- <http://www.mentalimages.com/> - Mental Ray (render software) official website
- <http://www.pinnaclesys.com/> - Pinnacle Studio official website

Books:

- “*Macromedia Flash 5 Practical Guide*” Straight to the point – ENI Publishing
- “*3ds max 6 Bible*” Kelly L. Murdock – Wiley Publishing
- “*Game Architecture and Design*” Andrew Rollings and Dave Morris – Coriolis
- “*3ds max 4 MAGIC*” Sean Bonney – New Riders
- “*GAME ART*” Dave Morris and Leo Hartas – Collins
- “*The Hutchinson Dictionary of Computing and the Internet 4th Edition*” – Helicon
- “*Character Animation in 3D*” Steve Roberts – Focal Press
- “*Software Engineering 7th Edition*” Ian Sommerville – Addison Wesley

Journals:

- “*Develop*” Intent Media – Several Issues up to February 2005
- “*MCV*” Intent Media – Several Issues up to September 2004



Learning Outcomes:

- 105 - Describe and show the fundamental aspects of an animation cycle
- 361 - Select and apply appropriate keyframing techniques to produce a 2D animated sequence
- 372 - Select appropriate interactive action techniques to control an animated character

Introduction: Produce an interactive “model sheet”

Tasks:

You are required to produce an interactive “model sheet” for a game character. The character can be original or adapted from a recognised character. Traditional model sheets are produced by character designers to show the animator the characters key motion and emotional attributes.

You are required to produce your interactive model sheet using Macromedia Flash 5 and supporting software / hardware. An interactive model sheet will allow the user to observe the key animation cycles, body language and voice of the character. Macromedia Flash 5 Actionscripting will be used to display these characteristics to the user.

Depending on your approach to this assignment you may elect to “draw” your characters or use live-action “puppets”. To economise on the volume of animated material you should use animation cycles as much as possible.

The final product should be presented on CD in the form of a Flash Projector file. This should be supported with a written report that details your approach to the assignment.

Component A3 – Interactive Flash Projector file and report

Deadline – please read the SLE student notices for confirmation of the assessment hand-in.

MTP093 3D Animation (Games Computing)

This document describes the first-sit coursework assessment requirements for academic year 2004/05.

The Assessment

There is one assessment for this unit but there are a number of assessment points. All of these dates are the week beginning and will depend on the day and time of your seminar session.

18th October 2004(wk4) Presentation of story board ideas to your seminar group

29th November 2004 (wk10) Presentation of final animation for critical revue

10th January 2005 (wk13) Submit final animation

This assessment process allows time to revise and revisit your work throughout the unit.

The Problem

3D Character Animation

You are required to produce a 1-2 minute character animation narrative that incorporates at least two of the following emotions – happy, sad, angry, scared. This is a very open brief that allows a variety of responses and interpretations but it should include the following:

- An original, manually rigged animated character (living or inanimate object)
- Effective use of camera placement and movement
- Effective use of lighting and texturing
- A simple title sequence (displaying animation title)
- A simple end-credit sequence (displaying your name and enrolment number)

The lectures and seminars for this unit will discuss and analyse solutions to this assessment and will provide you with the technical and creative support to this problem.

Submission

Please submit a CD or DVD with your completed animation. This should be rendered at full size PAL, 720x578 at 25 frames per second. The animation should also be encoded with MPEG4.

You should also submit a written rationale that explains your production process and the original storyboard concept.

Independent Study Proposal

Proposed Title/Subject Area

Carry out research and evaluation in the field of 3d Character Modelling and Animation, in order to create and animate my own character.

The purpose of the study is to research and evaluate character modelling and animation, within the creative side of the computing industry; including games, and films. From the research, techniques and rules will be followed when creating a character of my own, and animating it. Research, along with the final animation(s) will be analysed to draw up conclusions.

This study will help to both develop my current modelling and animation skills, and will help form part of a portfolio.

Aims

Basic:

Carry out research for inspiration.

Research various animation techniques.

Draw up conclusions for research.

Intermediate:

Develop a 3d Character.

Advanced:

Animate the character.

Render/Edit animation(s).

Further Development.

Produce report.

The character shall be animated in various poses and actions, aiming to create realistic and believable movement. Exact techniques to be used are not known at this stage, hence the need for research. The character animation research will be analysed, to decide upon the techniques to be used.

Objectives

Research 3d character modelling techniques.

Research 3d character (and universally used) animation techniques.

Develop a 3d modelled character using 3d Studio Max.

Animate the character following techniques decided upon.

Draw up conclusions on both research and final animation(s).

Literature Review

Internet sources

<http://www.cgnetworks.com/>

Said to be “the premiere website for computer graphic arts.” This site contains a vast amount of examples of CG used both in films and games. Along with huge galleries, the site reviews and criticises works and also looks at the technical side of modelling and animation. Although not character specific, many pieces of work shown are of various characters in film and games. The site also hosts a huge forum, useful for carrying out additional research, with access to many people’s opinions.

<http://www.curiouslabs.com/>

Curious Labs Inc. is the company behind “Poser” a popular character modelling and animation program. The site is rather limited, but does contain several case studies relevant to character modelling and animation. These could prove useful when carrying out research, as the modelling and animation techniques could be carried over to other pieces of software.

<http://www.discreet.com/support/>

Discreet are the developers of 3d Studio Max, and this site contains software specific information. As I intend (at this stage) to use 3d Studio Max for developing my animated character, the site could prove useful. It hosts a forum too, and from initial browsing, the forum contains a lot of information on character modelling and animation – using Max.

<http://www.3dcafe.com/>

Although this site requires membership to access its full potential, it does contain a free section, which hosts many useful resources. Tutorials are present, not only for 3d Studio Max, but many other modelling and animation software, which would prove useful for researching and comparing techniques. The 3d Studio Max tutorials cover 4 pages alone, ranging from explosions to character animation.

<http://www.gamasutra.com/>

A huge resource, covering everything and anything in the gaming industry. Although the site is not 3d modelling and animation specific, it does contain various resources that would prove to be useful in my research. Resources ranging from the art in a particular game, to showcases of an artist’s work.

Films

Recently there have been many films released containing cg special effects and characters. Films such as the Matrix series, and Lord of the Rings series would prove useful when carrying out research. The DVDs often contain documentaries on how the characters were modelled and animated for the film. Although these sources may not go into too much technical detail, they will be useful in providing inspiration, and highlighting key techniques used.

Develop

Available both online (<http://www.developmag.com/>) and a monthly magazine, this source often contains information relevant to 3d character modelling and animation. I already am a subscriber, so both past issues and future issues will be useful for research. Develop focuses on the gaming industry, in particular games programmers, artists, musicians and producers.

“Game Art” – Dave Morris and Leo Hartas (Collins)

This book looks at the graphic art in games, from the very first games right up to and beyond today’s games. It contains examples of both 2d and 3d environments, architecture and characters throughout the history of computer gaming. The book doesn’t go into too much technical detail, but is a valuable source of inspiration.

“3ds max 4 magic” – (New Riders)

Although this book is specific to 3ds max 4, all of the information and content is applicable to later versions of the software. The book is split into projects, each looking at a different aspect of the software. Project 7 in particular would prove useful to the study, as it looks at character modelling and animation.

“Character Animation in 3D” – Steve Roberts (Focal Press)

Recommended to me by my 3d Animation lecturer, this book focuses on 3d Character animation as a whole, not specific to any one application. If I decided to use an alternative software package (other than 3ds Max), then this would allow for it. This would help to develop my skills in 3d Character animation in general. Allowing me to apply them to many applications.

Miscellaneous Books

A quick search on amazon.co.uk shows many books relating to character modelling and animation. Amazon is useful as it not only contains a review of the book by the company itself, but also reviews written by customers who have purchased the books.

Of the many books available, ones which are most relevant to the study shall be sourced for additional research into 3d character modelling and animation.

Methodology

Basic:

Research

- Carry out research firstly for inspiration.
- Research character animation techniques.
- Analyse animation research.
- Draw up conclusions from research.

Intermediate:

Modelling

- Produce initial sketches/models of the character.
- Decide upon a final look for the character.
- Model the character using 3d Studio Max.

Advanced:

Animation

- Apply chosen animation techniques to character model.
- Render animation(s).
- Edit renders into final animation.
- Further Development:

Character Sheet.

Character Library.

- Produce report showing:
 - Research on character modelling.
 - Initial character sketches.
 - Research on character animation.
 - Conclusions of research.
 - Conclusions of final animation(s).

The character will be modelled and animated using 3ds Max along with Character Studio (if necessary). Additional software may be needed further into the study, but at this stage cannot be predicted; software such as video editing, image editing etc.

To further expand on the project, a character sheet, along with character library could be developed, allowing interaction with the character.

Resources

Access to the Internet, for carrying out online research.

Friends and family for analysis of final animations.

Various books for research on 3d character modelling and animation.

Films for documentaries and analysis of animation techniques.

Ideally a motion capture studio – could be used as one of the animation techniques.

3d Studio Max – preferably version 5 or later.

Word processing software for the report.

Additional software – not known at this stage – depending on requirements.

Software would be a major cost factor for the study, though the University has versions of 3d Studio Max (amongst others) available for modelling and animating the character.

Proposed form of assessment

At the end of this study, I propose to submit a 6000 word report containing:

Research on character animation.

Research on character modelling.

Initial character sketches.

Animation techniques used.

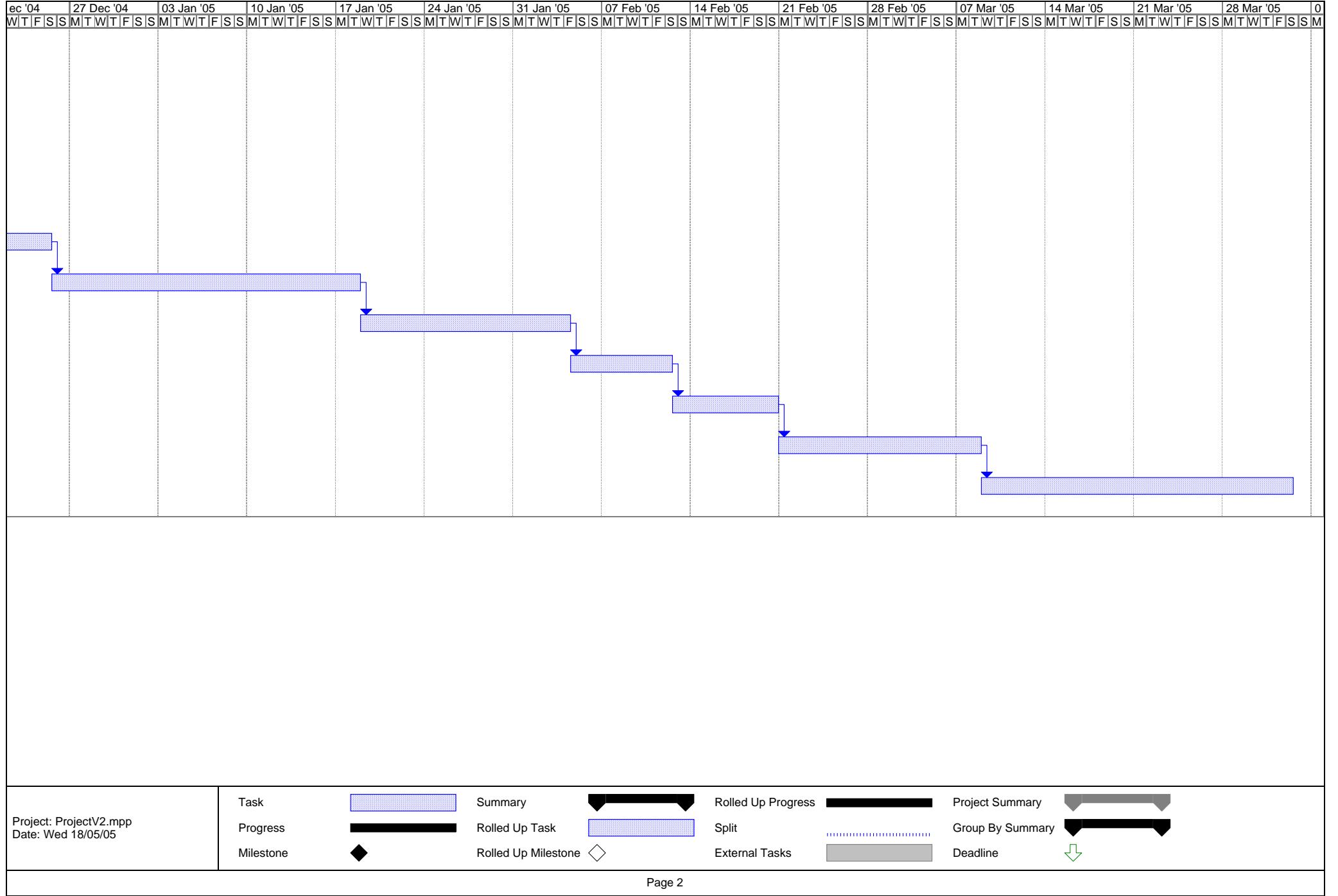
Questionnaire results.

Analysis and conclusions of final animations.

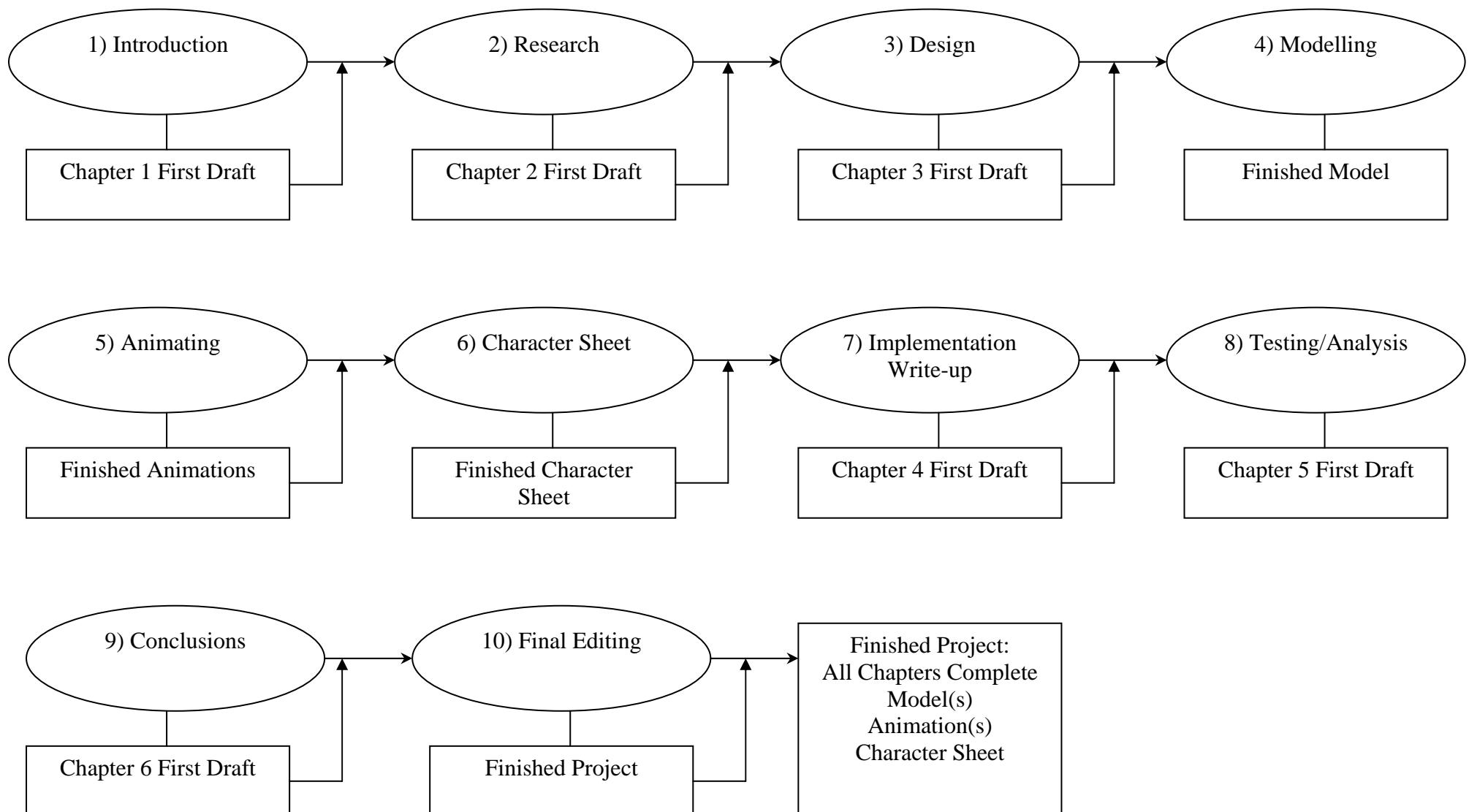
I shall also submit 2 (or more) character animations that I will have produced using 3d Studio Max. These will be in the form of a .max file, for opening in 3d Studio Max itself, along with 2 (or more) videos using a relevant format.

ID		Task Name	Duration	Start	Finish	ct '04	25 Oct '04	01 Nov '04	08 Nov '04	15 Nov '04	22 Nov '04	29 Nov '04	06 Dec '04	13 Dec '04	20
1		Inspiration Research	7 days	Thu 21/10/04	Fri 29/10/04										
2		Character Animation Research	14 days	Fri 29/10/04	Sun 14/11/04										
3		Analyse Animation Research	7 days	Mon 15/11/04	Mon 22/11/04										
4		Conclude Research	7 days	Tue 23/11/04	Tue 30/11/04										
5		Initial Models/Sketches	14 days	Wed 01/12/04	Fri 17/12/04										
6		Decide upon final look	7 days	Fri 17/12/04	Sat 25/12/04										
7		Model Character	21 days	Sat 25/12/04	Tue 18/01/05										
8		Apply Animation To Model	14 days	Wed 19/01/05	Fri 04/02/05										
9		Render Animation(s)	7 days	Fri 04/02/05	Sat 12/02/05										
10		Edit Render(s)	7 days	Sat 12/02/05	Sun 20/02/05										
11		Further Development	14 days	Mon 21/02/05	Tue 08/03/05										
12		Finish Report write-up	21 days	Wed 09/03/05	Sat 02/04/05										

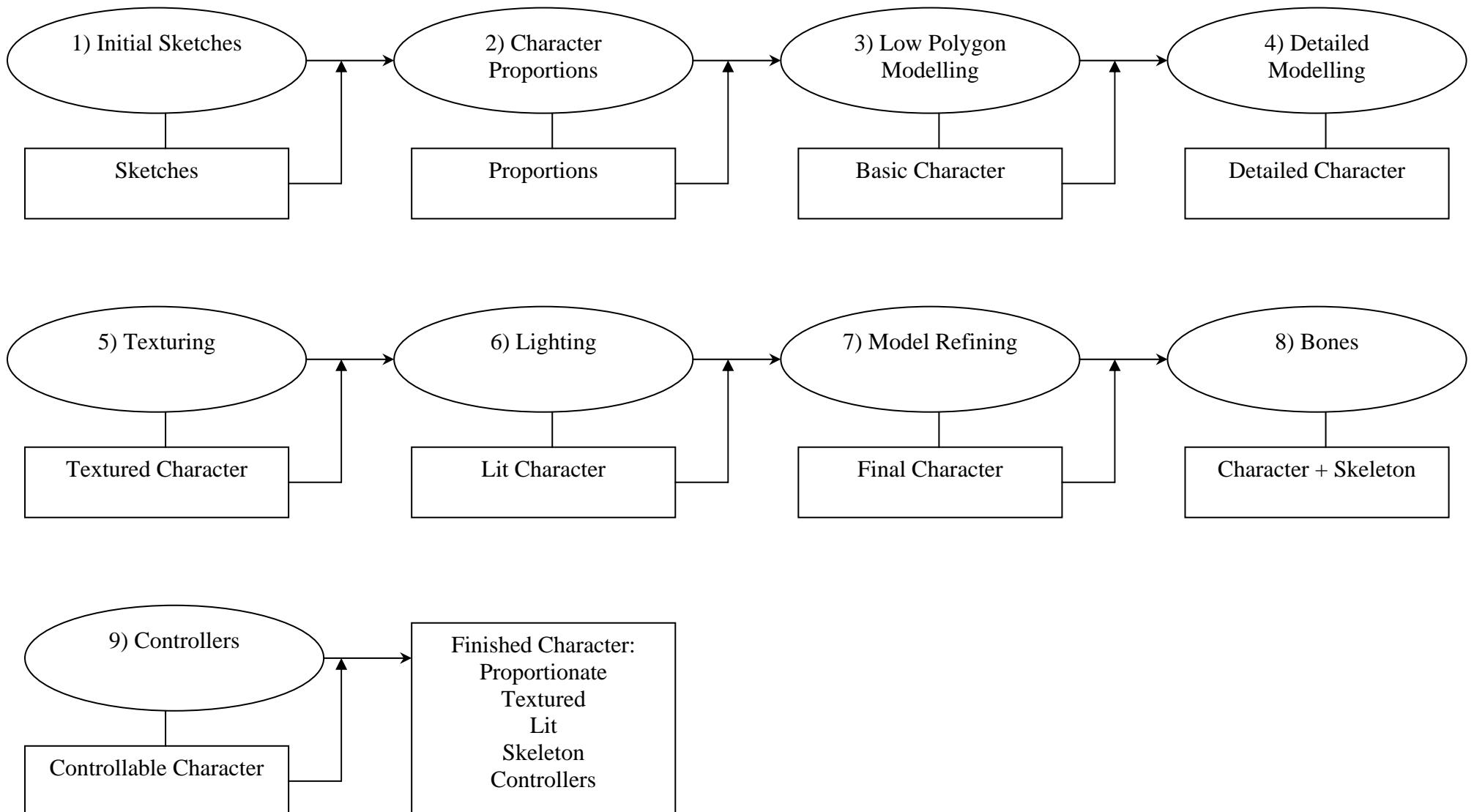
Project: ProjectV2.mpp Date: Wed 18/05/05	Task		Summary		Rolled Up Progress		Project Summary	
Progress			Rolled Up Task		Split		Group By Summary	
Milestone			Rolled Up Milestone		External Tasks		Deadline	



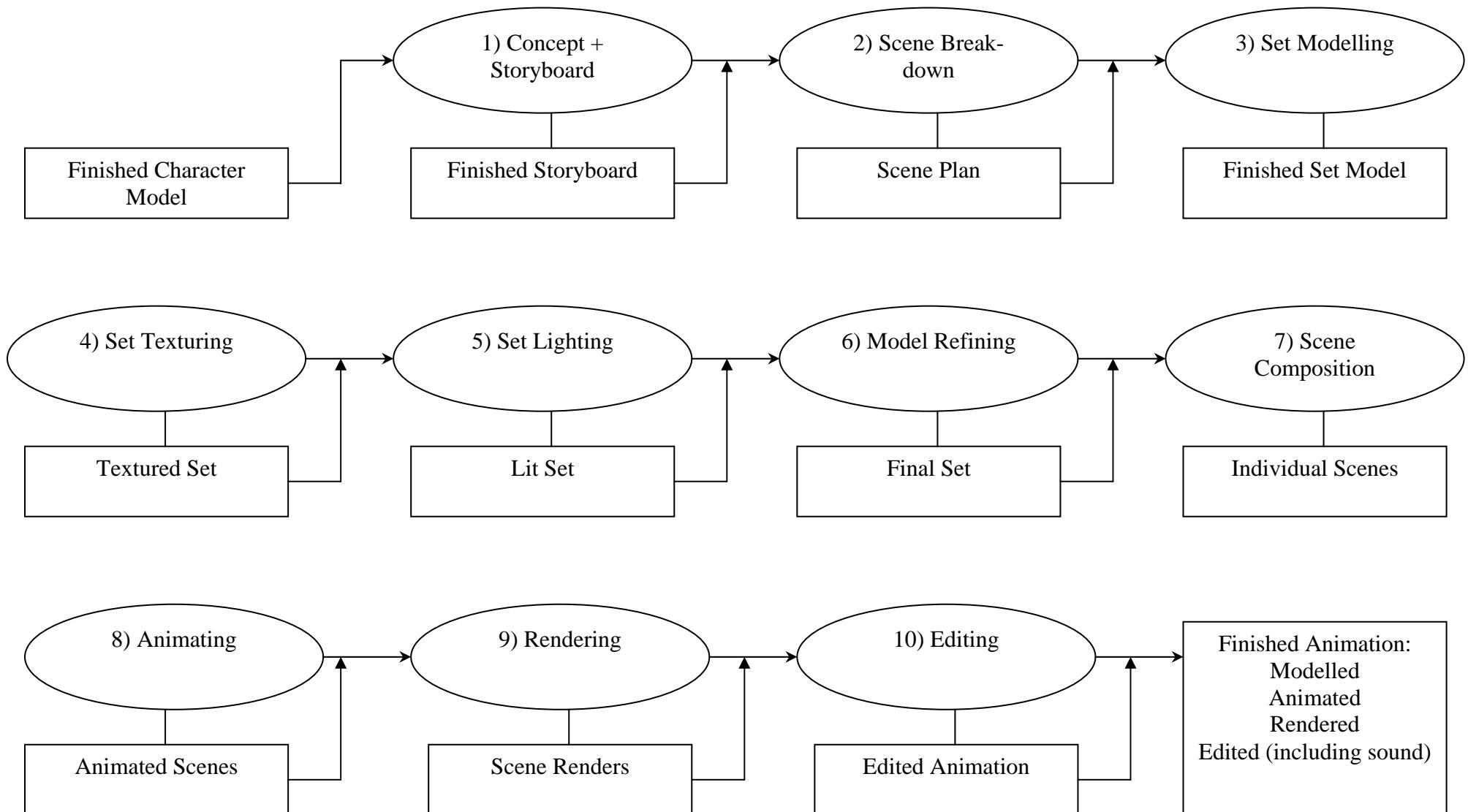
Process Model 01 – Project



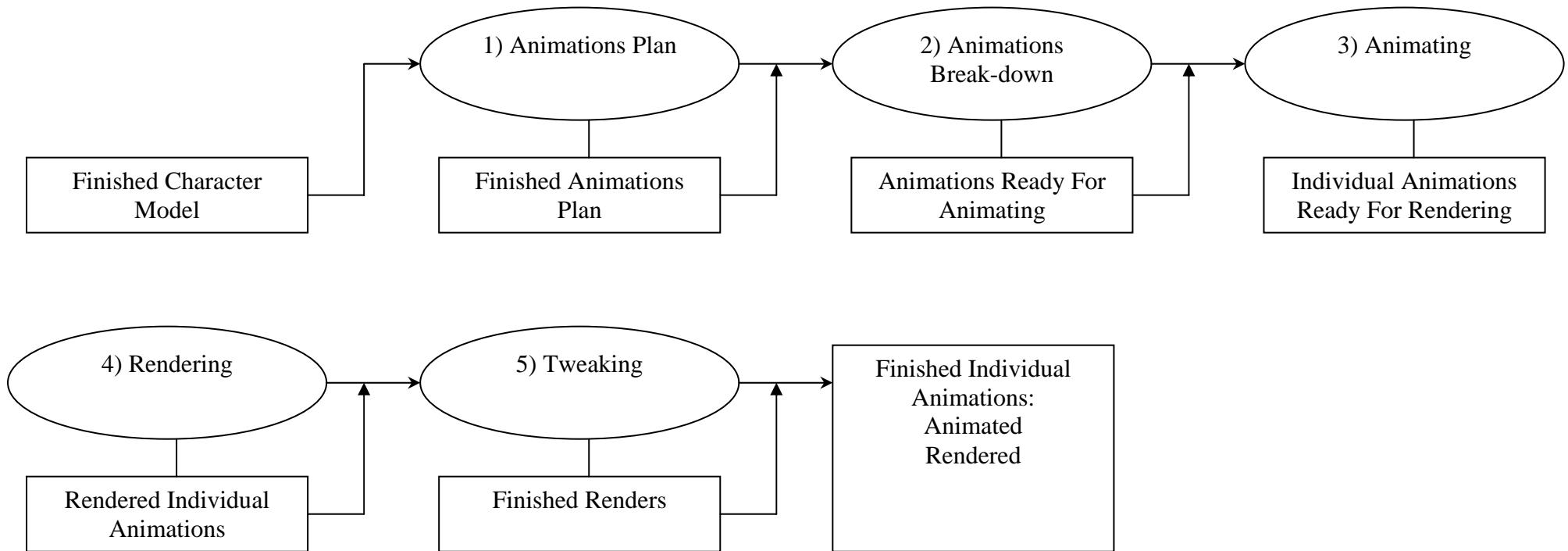
Process Model 02 – Modelling



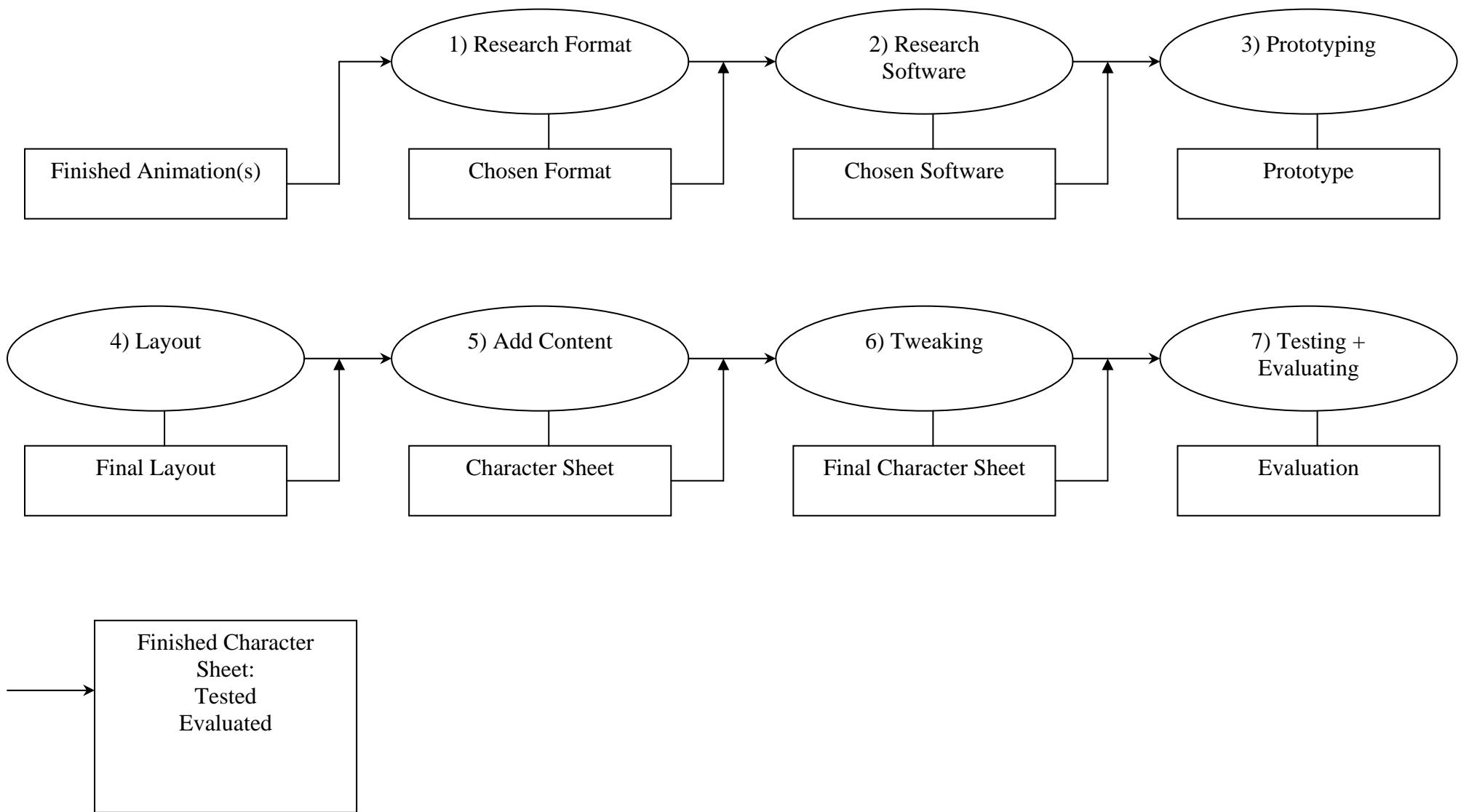
Process Model 03 – Short Animation



Process Model 04 – Individual Animations



Process Model 05 – Character Sheet



Project Title: CRASH TESTER

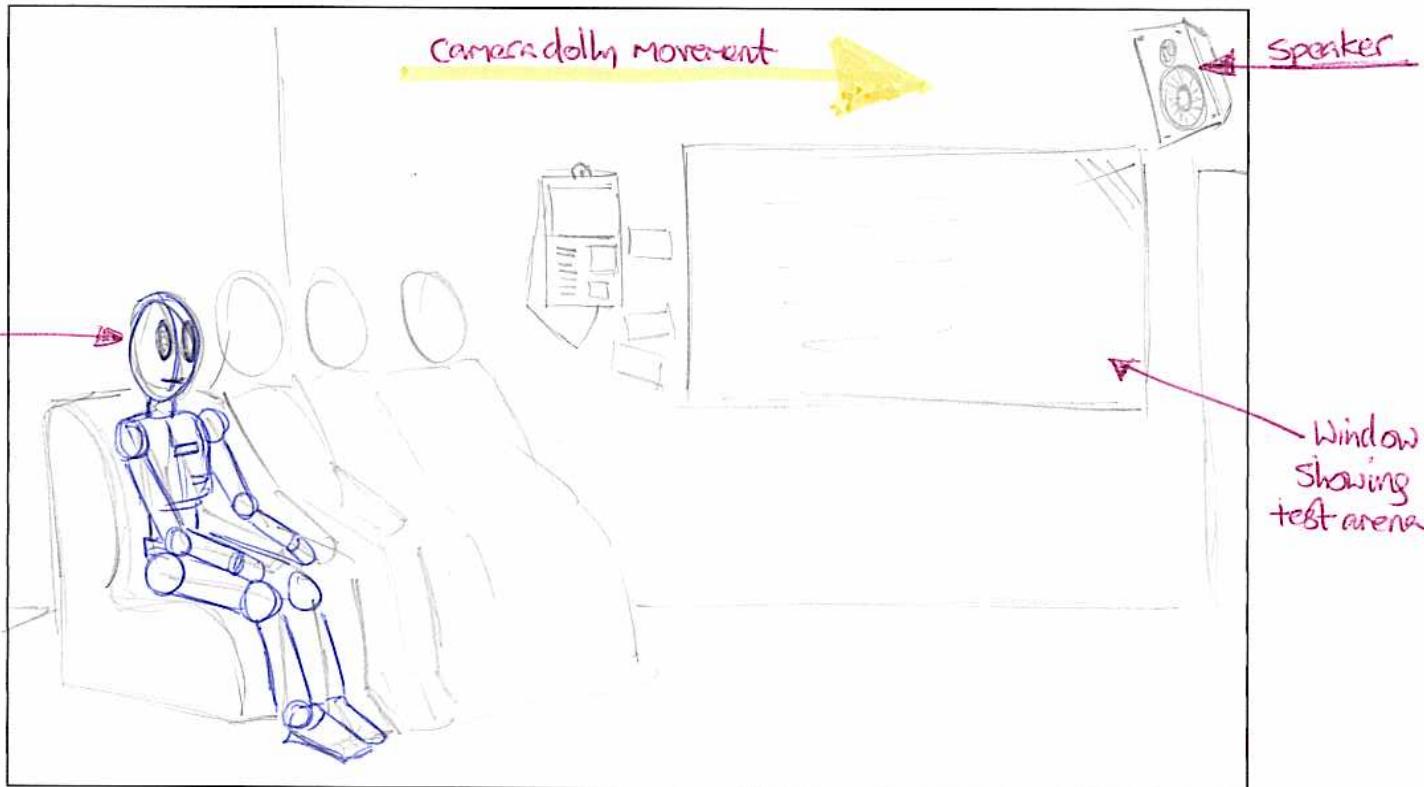
Author: D21818354 M.JUFFS

Date: 20 /10 /04

Scene: 1 ONE

Shot#: 1 ONE

Duration: 0 m 15 s



Description:

- Title screen cuts to 1st scene
- Camera dolly to right, from left
- Shows waiting room full of test robots
- Window possibly shows crash testing taking place
- Robots look plain/in-animate
- Clean, white look to waiting room
- Battered/rusty look to waiting robots

Project Title: CRASH TESTER

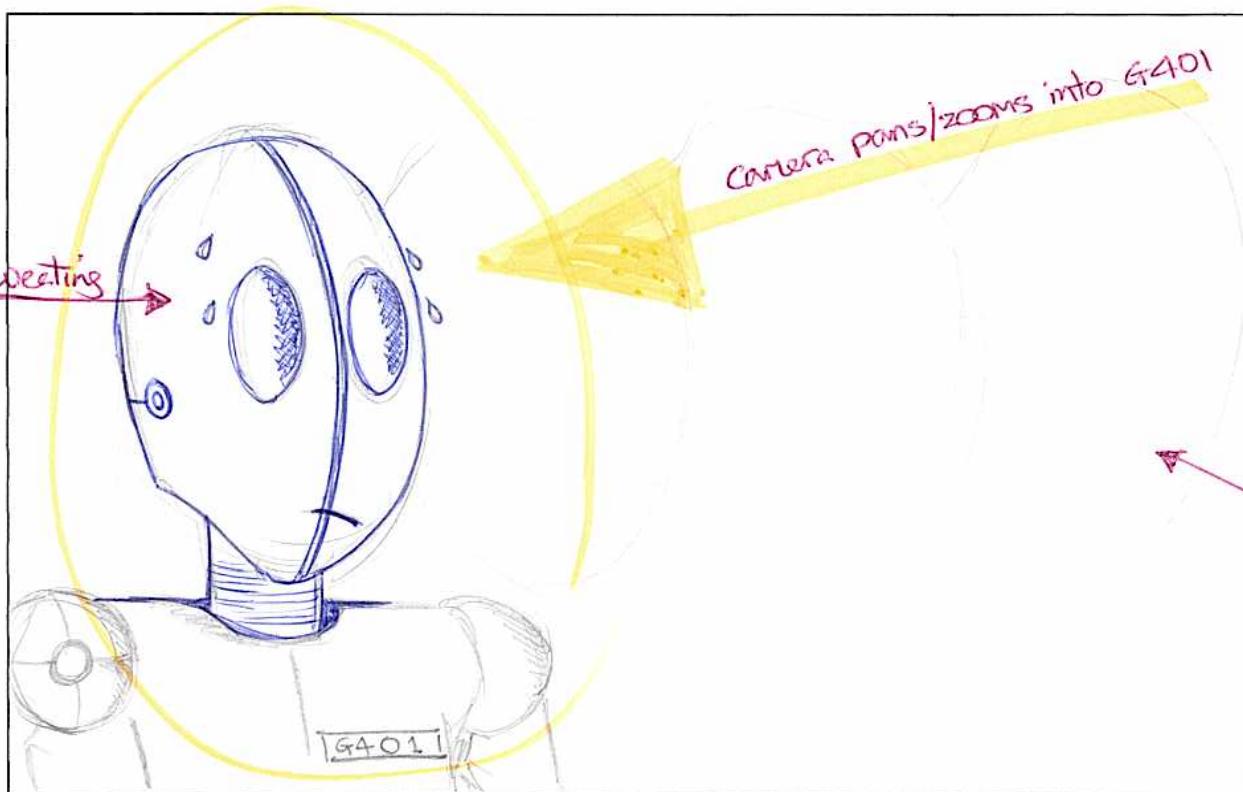
Author: 021818354 M.JUFFS

Date: 20 / 10 / 04

Scene: 1 ONE

Shot#: 2 TWO

Duration: 0 m 5 s



Description:

- After showing whole of waiting room, the camera pan/zooms in
- Shows 'G401' main character, with emotion
- G401 is SCARED - portrayed by facial expression
- Sweat and shaking movement emphasise mood
- Other Robots waiting still have blank emotion
- Possibly focus camera on G401

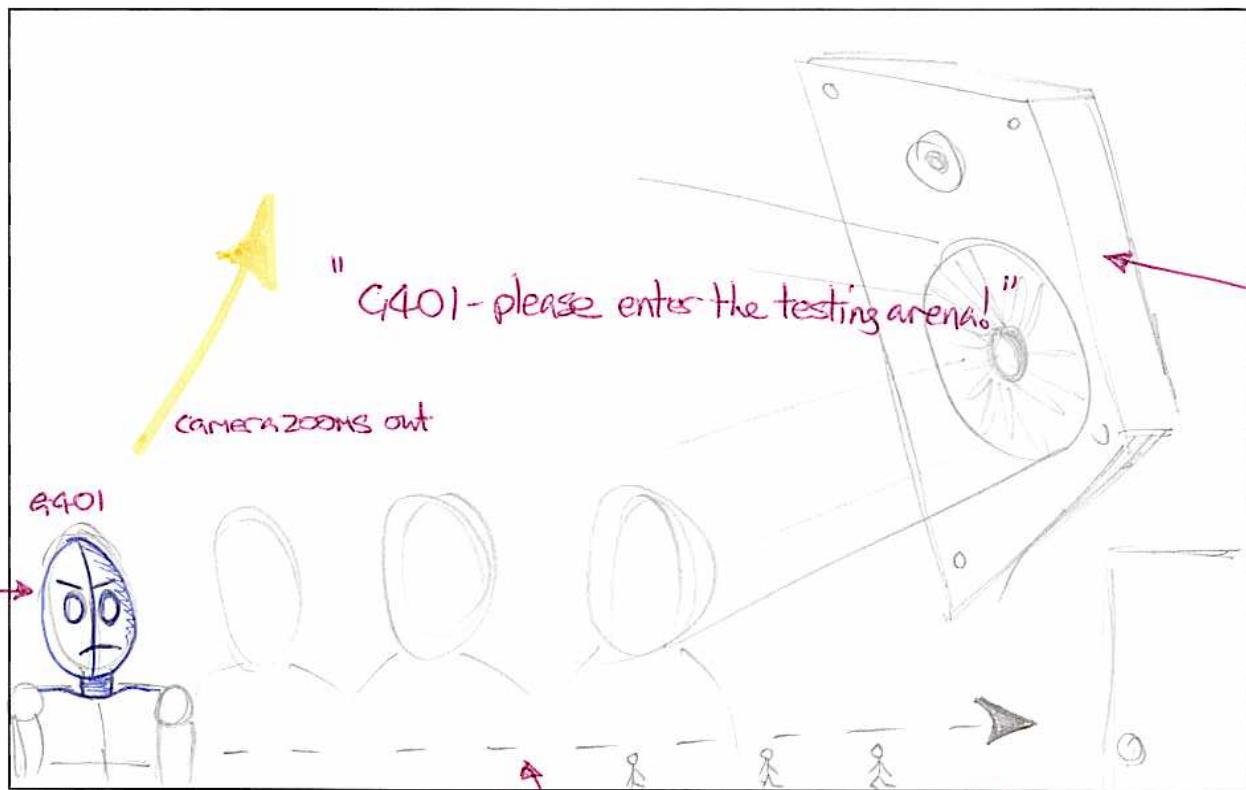
Project Title: CRASH TESTER

Author: 021818354 M.JUFFS

Date: 20 / 10 / 04

Scene: 1 ONE

Shot#: 3 THREE Duration: 0 m 15 s



Description:

- Camera slowly zooms out to show whole of meeting room again
- Loudspeaker shorts announcement
- G401 becomes ANGRY as he realises he is due for testing
- Camera moves from head/shoulders, to full body shot
- G401 stands and slowly walks out of the room
- Possibly slamming the door upon exiting the room
- Other robots still in-animate / staring into space

Project Title: CRASH TESTER

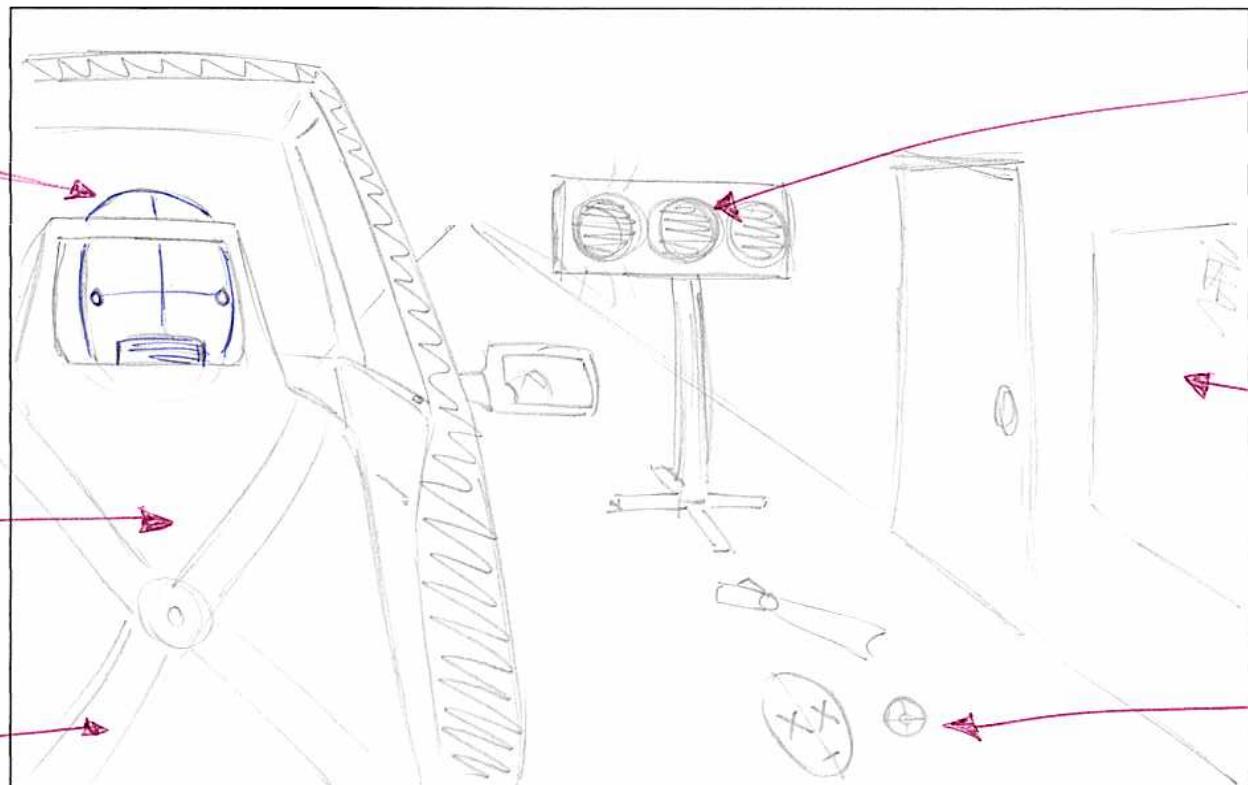
Author: 021818354 M.JUFFS

Date: 20 / 10 / 04

Scene: 2 TWO

Shot#: 1 ONE

Duration: 0 m 25 s

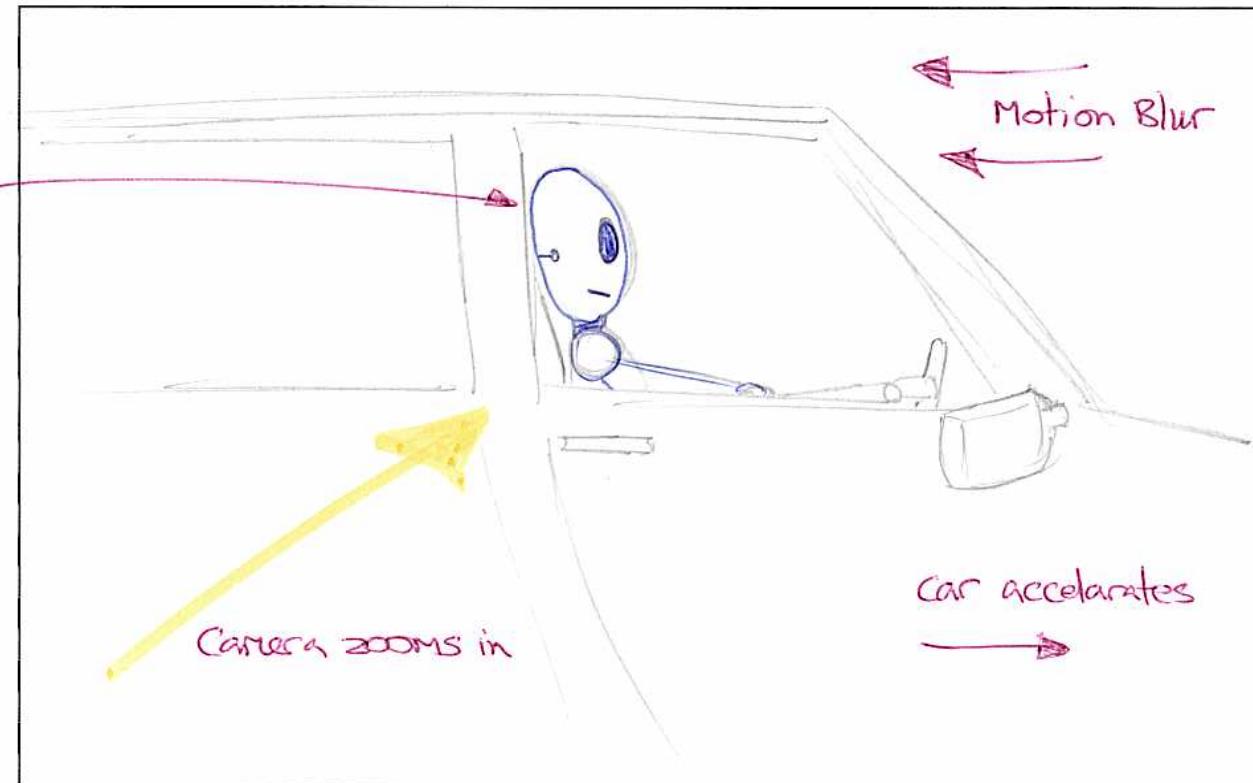


Description:

- Fades in to wide shot, showing G401 + timer
- Viewer only sees the back of his head, through cut-away car
- Broken/old robot parts lying on the track
- Timer counts down/changes colour (Red/Amber/Green)
- 5 second pause between each colour change
- End of track is too far away to make out
- Camera circles car then zooms to side/internal view

Project Title: CRASH TESTER
Author: 021818354 M.JUFFS Date: 20 / 10 / 09

Scene: 2 TWO Shot#: 2 TWO Duration: 0 m 15 s



Description:

- Camera cuts to wide-shot side on/profile view of car
- Car accelerates off screen, then camera catches up with G401
- Camera zooms in, to focus on G401 through the window
- G401 smiles - he's HAPPY - for now!
- Motion blur emphasises speed/acceleration

Project Title: CRASH TESTER

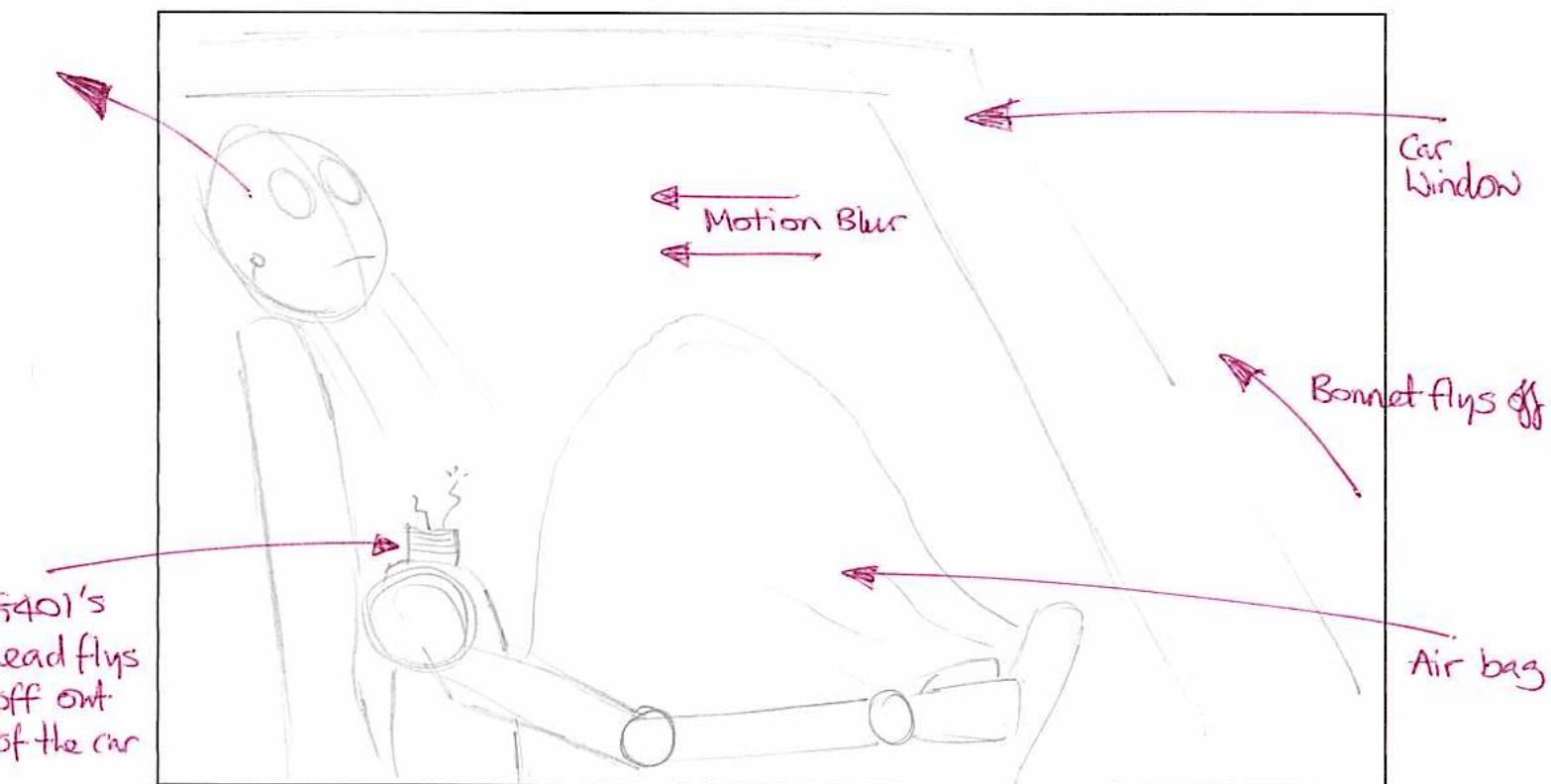
Author: 021818354 M. JUFFS

Date: 20 / 10 / 04

Scene: 2 TWO

Shot#: 3 THREE

Duration: 0 m 25 s



Description:

- Suddenly the car hits a bump
- The car's bonnet breaks off and flies off screen
- This triggers the airbag, which expands quickly
- The airbag knocks G401's head clean off
- The car eventually hits the wall
- Both G401 and the car react to the crash
- Camera fades out

Project Title: CRASH TESTER

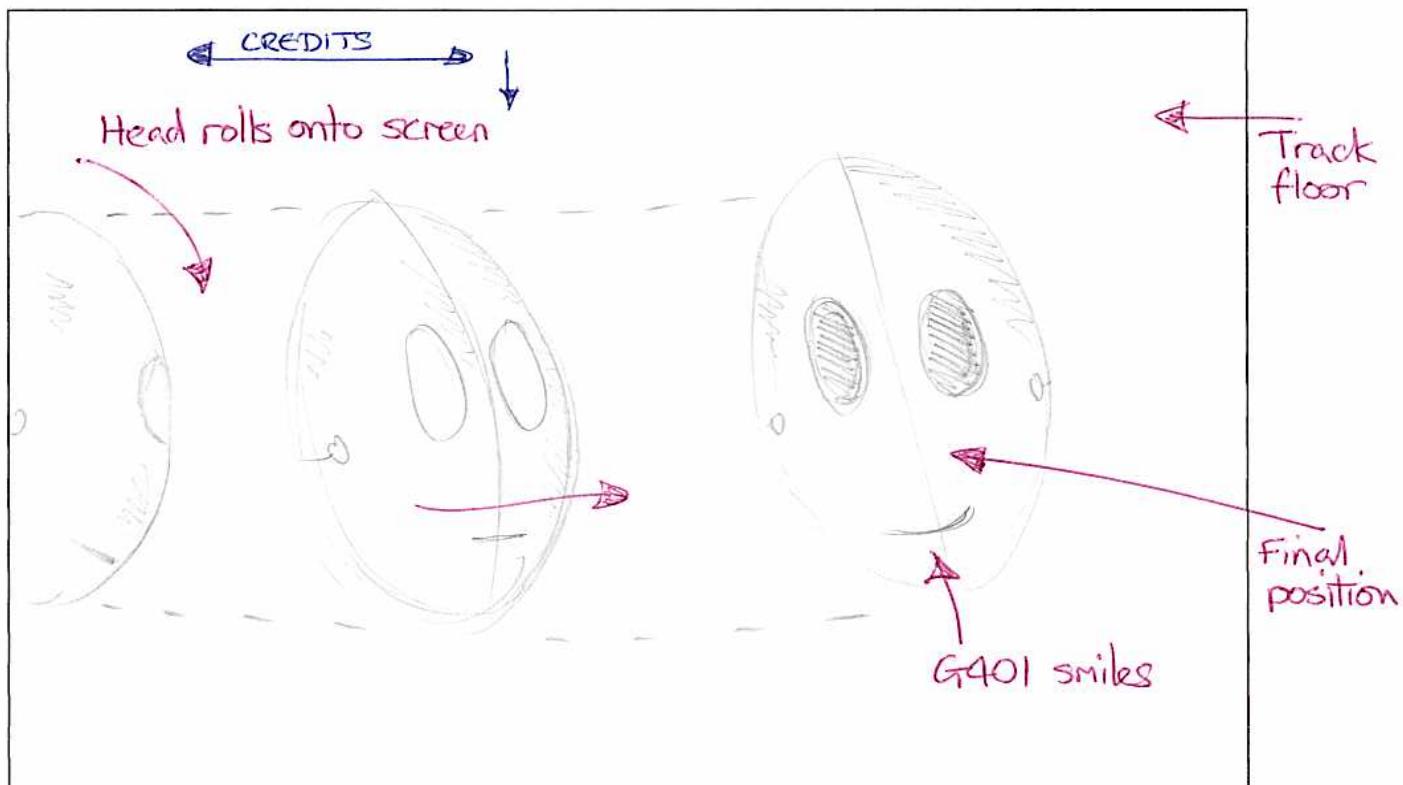
Author: 021818354 M.JUFFS

Date: 20 / 10 / 04

Scene: 3 THREE

Shot#: 1 ONE

Duration: 0 m 10 s



Description:

- Camera fades in, focusing on the floor of the test track
- Pause for 5 seconds
- G401's head rolls onto screen
- As it comes to a stop, G401 smiles - HAPPY!
- Credits scroll down the space to the left of his head

— Total time: 1m 50s approx + credits —

Character Sheet Evaluation Questionnaire

If you don't wish to answer a question, leave it blank.

Each of the questions has a choice of 5 answers – marks out of 5:

1 – Very Poor/Definitely Not

2 – Poor/Probably Not

3 – Average

4 – Good/Probably

5 – Excellent/Definitely

1) Splash Page – designed to provide author information to the user, is it

necessary?

2) Quality – looking at each of the animations, how would you rate the actual

quality?

3) Buttons – are they easy to use?

4) Buttons – is the hidden wording a good idea?

5) Textboxes – are they informative?

6) About – is it informative?

7) Animations – are they well animated (in the context of a robot character)?

8) Animations – are there too many?

9) G401 – is he modelled well?

10) G401 – could you see him as being a computer game character?

11) G401 – could you see him as being a film character?

12) Short Animation – does it put G401 into context?

13) Layout – could the overall layout of the Character Sheet be improved?

14) Colouring – could the colouring of the Character Sheet be improved?

15) Sound – is sound needed within the Character Sheet?

16) Potential use – if you were a character designer/animatior, could you see
yourself using a similar interface, for allowing interaction with your character?

Finally – which platform was the Character Sheet tested on?

Operating system; CPU; RAM:

Accompanying CD Directory Structure:

\csheet.exe - **execute this file to view the character sheet** (note: this is not an installer)

\csheet.swf - this is the flash version of the above (only use if a flash player is installed on the computer)

\ReadMe.txt - this document, in digital form.

\csheet - contains files relating to the development of the character sheet, including the animations (rendered from max) along with the flash file.

\csheet\emotion - contains the emotion animations (.avi).

\csheet\movement - contains the movement animations (.avi).

\csheet\voice - contains the voice animations (.avi).

\csheet\021818354...avi - the short animation (DivX required to view).

\csheet\csheet.fla - the flash file used during development.

\csheet\default.avi - the default animation.

\installers - contains a DivX codec installer (shouldn't be required), along with a Flash 7 installer (may be required for viewing of the character sheet).

\max - contains the MASTER max (version 5) file, along with the textures needed.