A research investigation into asset creation and production pipelines for Unreal Engine 3

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Research Dissertation

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April 2009

Word Count: Approx 18000

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ABSTRACT

In the games industry today, studios and developers strive to increase productivity within their development team. However, due to the highly competitive nature of the games industry, up to date information about current techniques and pipelines is closely guarded as a company secret under NDA's which many employees have to sign in order to work on a project.

This is not only a hindrance to the industry's growth as a whole but also makes a study of the processes and decision making involved in asset creation within modern studio pipelines a whole lot more difficult.

Fortunately some studios and freelance artists are willing to offer information about what has been adopted in the industry as good practice when generating content for the current and next generation of games.

The goals of this research dissertation are to take what professionals regard as good practice and use it for analysis via the creation of content using the pipelines employed in industry today. Suggestions on ways to improve the pipeline and techniques will be made.`

The end product of which should showcase what is possible using today's preferred techniques and pipelines along with how long it takes to create assets using this method and draw conclusions on whether there are feasible ways to improve it to either increase quality in production or speed up creation or both.

ACKNOWLEDGEMENTS

Greg Penninck – Games Design Lecturer, Staffordshire University

Cris Robson – Owner, 3D-Palace.com

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CHAPTER 1

INTRODUCTION

The computer games industry is the fastest growing entertainment industry in the United States of America, expanding at a faster rate than both the film and music industry. [1] This fact also applies to most of the developed world.

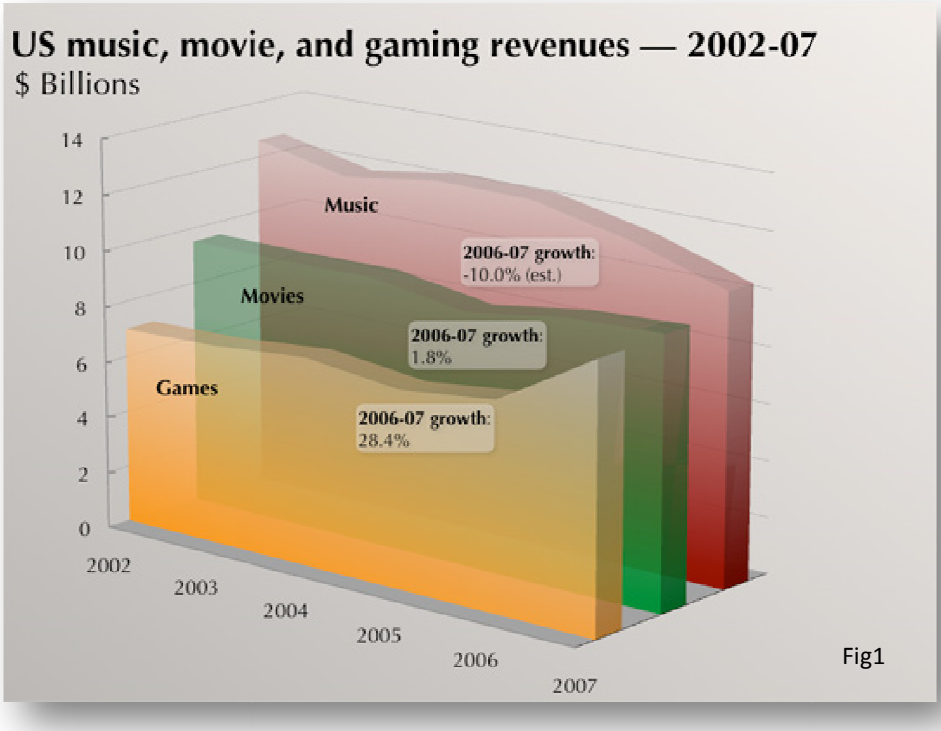


Fig1

Data source: NPD Group; ESA; MPAA; BoxOfficeMojo.com; RIAA; IFPI

This phenomenal growth rate means that the production and quality of games has to be continually improved to meet ***and*** exceed customer demand. Approximately 268 million games were sold in 2007, meaning that on average 9 games were sold every second. [1]

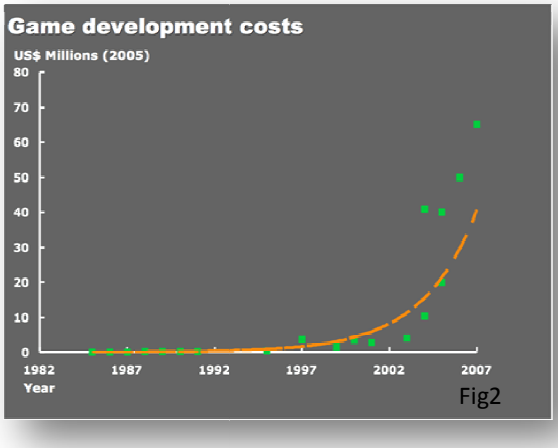


Fig2

With these facts in mind, it is important to address how these games get developed in time and to a standard that satisfies consumers. The cost of a 'AAA' title in 2005 averaged £1.7m and £3.4m. [2] This figure has increased since then and is continuing to do so in 2009.

Part of this cost is the development staff involved in creating large scale next generation game projects. The time it takes to create a next generation game is

increasing due to the complexity and amount of art involved in creating such a title. Development and in-house staff are seen as a variable cost and therefore companies are always looking for ways to get more out of their staff in a shorter period of time.

With the current economic climate as it stands, companies are struggling to compete or stay alive in this highly competitive market. Long running and well established development houses such as Ensemble Studios which were closed by Microsoft following the completion of Halo Wars in 2009 was but one of the victims. [3]

The ability to deliver a high quality finished product with the potential for great sales is one way to ensure job security within the industry, meaning investment being employed in development is increasing to attempt to achieve this. Tried and tested Middleware and Third party programs and plugins are being used now more than ever before in a bid to speed up the game development process whilst still maintaining a high level of quality within products.

HumanIK [4] which was used in the creation of Assassins Creed and the 3ds Max plugin Polycruncher [5] created by MooTools was heavily used in the creation of Unreal Tournament 3 are examples of successful commercial middleware. All of these software investments cost money to acquire, however the time they save in the development process are seen as a sound investment for the future or current projects to justify their purchase.

Today's computer generated film industry receives many awards for its innovation in 3D technology. Being able to create more realistic and convincing computer generated art has always been one of the main focuses of the CG industry. The games industry has always tried to match this in the products it releases; however there is one difference between the two industries which is making this increasingly more difficult.

In computer generated films still frames of 3D art are sequenced together and composited into a video sequence. This means that the length of time it takes to render a single frame of art isn't the most important factor. In real time applications like games the time it takes to render a single frame is one of the most important factors as the game needs to run at an acceptable fps or frames per second in order to be playable.

Because of this the CG and games industries cannot adopt a single unified art production process.

Even with great leaps forward in technology it can still take hours to render a single frame of a CG film whereas games need to be able to produce a minimum of 30fps in most cases.

Attempting to get something of similar standards to that of current CG films to render in $1/60^{th}$ of a second is an amazing feat and the games industry employs many techniques in order to achieve this.

The limitations of today's real time hardware means that steps have be taken and techniques put in place in order to achieve similar results. Optimised real time shaders, displacement and normal mapping are two of the current techniques heavily used in achieving high levels of detail and realism in real time applications and games.

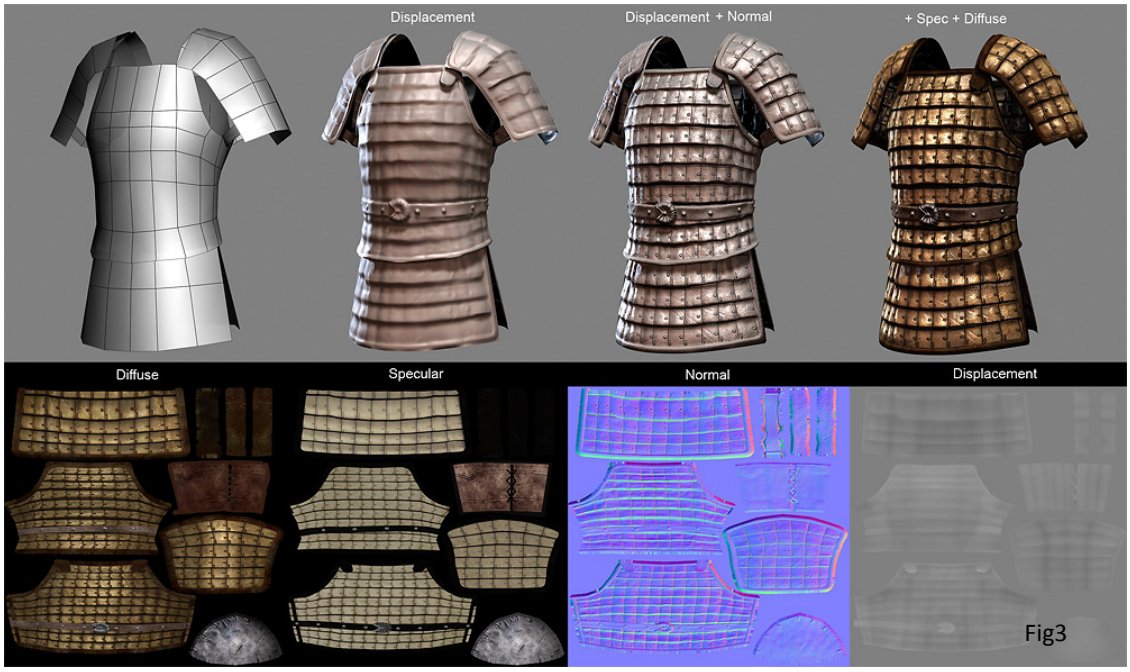


Fig3

As depicted above it is possible to go from an incredibly low polygon object to a convincing final product through a clever use of textures and mapping. As hardware develops and limitations decrease, these techniques and new ones can and will be implemented to take the realism of real time applications even further.

The Audience

This research dissertation addresses games artists involved in asset creation and studios that wish to have another point of view on the best way to lay a production pipeline for a project in the creation of different types of assets; particularly relating to studios that have licensed Unreal Engine 3 for their projects.

The Research

An extensive study drawing research information from many sources such as personal communication with industry professionals, questionnaires, internet research along with published books and personal experience.

The range of sources aims to allow an unbiased and accurate reflection of the research which was to gain an understanding and comment / improve upon current industry standard production pipelines for a variety of different in game assets.

The study has been split into many sections, which are the personal creation of 3 different types of in game asset, the research into 3 different industry pipelines used to create these assets, analysis of research data and synthesis of research sources to comment on the efficiency of today's current pipelines and to suggest improvements that could be made.

The Goals

The goals of this dissertation are to present and criticise current industry game production pipelines and suggest ways to increase the efficiency and for the dissertation to also become a resource for students preparing themselves to tackle in game asset creation for next generation production pipelines.

END NOTES

[1] Eric Bangeman. (2008). *Growth of gaming in 2007 far outpaces movies, music.* Available: http://arstechnica.com/news.ars/post/20080124-growth-of-gaming-in-2007-far-outpaces-movies-music.html. Last accessed 29 December 2008.

[2] BBC News. (2005). *Cost of making games set to soar.* Available: http://news.bbc.co.uk/1/hi/technology/4442346.stm. Last accessed 29 December 2008.

[3] GamesIndustry.biz. (2008). *Microsoft to close Ensemble Studios.* Available:http://www.gamesindustry.biz/articles/microsoft-to-close-ensemble-studios Last accessed 20 February 2009.

[4] Autodesk. (2009). *Autodesk HumanIK Middleware.* Available: http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=9491249. Last accessed 05 April 2009.

[5] Mootools. (2008). *Polygon Cruncher Overview.* Available: http://www.mootools.com/plugins/us/polygoncruncher/index.asp. Last accessed 05 April 2009.

CHAPTER 2

GAME ENGINE RESEARCH

Production pipelines vary between all game development houses, this is due to the unique nature of each game that is produced. Development houses have similar traits in their pipelines but no 2 pipelines are identical. This is due to 'in house' development tools that have been specifically created for use within that studio.

These could range from optimised compilers for maps, to custom plugins for well known game artist packages such as 3dsMax, ZBrush and Maya. For this reason research was drawn from sources that have released information on their pipelines publically. Not many studios choose to do this as the games industry is a competitive market and development houses do not wish to give their competitors a helping hand which is good business sense but cripples the industry from advancing at a faster rate than it is already doing so.

The 3 pipelines studied are Epic Games character creation workflow for Unreal Engine 3, Unknown Worlds texture creation for Natural Selection 2 engine and Art Bully Productions static mesh production workflow. The points of contact for these pipelines within the development studios are Chris Wells, a senior character artist for Epic Games, who has worked on Gears of War, Gears of War 2 and Unreal Tournament 3 over the past 4 years; [1] Matt Regan, Artist for Unknown Worlds Entertainment currently working on Natural Selection 2 [2] and Marcus Dublin, a freelance artist who is currently setting up Art Bully Productions but has produced work for Unknown Worlds. [3]

The engine being predominantly studied for the analysis of asset creation pipelines in this dissertation is Unreal Engine 3. Unreal Engine 3 has been licensed by many studios for the creation of next generation games, such as 2K games in the creation of Bioshock [4][5] and EA Montreal in the creation of Army of Two. [6]

There are many engines available for licensing in the market alongside Unreal Engine 3. The main engines licensed today excluding Unreal Engine 2/3 are CRYEngine 2/3, Source Engine and Torque Engine.

UNREAL ENGINE 3

Fig 4

Unreal Engine 3 is the latest commercial release of the award winning engine created by Epic Games. The popular Unreal Engine 2 preceded Unreal Engine 3 powering successful titles such as Americas Army. [7][8]

Unreal Engine 3 was initially accessible in RoboBlitz [9]; however this wasn't a final build and was officially released with Unreal Tournament 3 in late 2007. The typical cost to license this engine is estimated at more than $700,000[10] which reflects its enormous power it has in games creation.

There are many advantageous features of the engine for next generation games creation [11]. Some of the more notable ones include:

- Multi Threaded Rendering System – For employing the power of all available processing cores to maximise performance on any system.
- SpeedTree Support – Seamless integration of SpeedTree Middleware
- Nvidia PhysX – GPU optimised physics system
- Kismet – In editor object orientated code enhancements to maps
- Matinee – Cinematic editor
- WYSIWIG – What you see is what you get editor in which the editor shows an almost identical representation of the final compiled map whilst in editor mode.

There is a large list of useful features for developers not listed here that can be found at http://www.unrealtechnology.com.

MULTI THREADED RENDERING SYSTEM

Xbox 360, Playstation 3 and most modern CPU's have more than one processing core. This means that having a multithreaded rendering system is a great way to utilise the full processing potential in these machines to increase performance within the game. To date there aren't a great deal of games that

	Intel Core 2 Extreme QX9770	Intel Core 2 Quad Q6600	AMD Phenom X4 9950 Black	AMD Phenom X3 8650	Intel Core 2 Duo E6600
Benchmarks Scores	Results	Results	Results	Results	Results
Crysis - 1680x1050 Score in FPS Go	143.00	126.50	107.80	97.70	110.50
Supreme Commander - Forged Alliance - 1680x1050 (1680x1050) Score in FPS Go	33.85	31.17	30.77	29.37	24.38
Unreal Tournament 3 - 1680x1050 Score in FPS Go	160.40	119.10	106.70	95.20	91.90

Fig 5

support multithreading, this is because multicore is relatively new and as such the implementation and compatibility support for this technology is still in development.

As is evident from the table above, the more cores available in the system, the better performance within the game; however due to other bottlenecks in the system such as memory and graphics card, the performance is not as simple as multiplication. The Intel Core 2 Quad Q6600 is 2 Intel Core 2 Duo E6600's in a single chip, however the Q6600 does not double the frames per second in games due to the aforementioned bottlenecks in systems but it does significantly improve performance on the whole.

Multithreaded rendering is native to Unreal Engine 3 and is a huge selling point for licensees, as developers do not need to spend time implementing it and it reduces limitations on games creation. It is a forward thinking technology and is a benefit to all games about to begin development or currently in development.

SPEEDTREE INTEGRATION

SpeedTree is a middleware foliage solution developed by Interactive Data Visualization, Inc. It is now the industry's premier foliage middleware solution with partners such as Epic Games, Emergent, Simutronics and Ogre. [12]

Fig 6

NVIDIA PHYSX

Fig 7

Nvidia PhysX technology has sent waves through the industry recently by developing code for games developers that unlocks the full potential of Nvidia graphics cards. [13] This has been made possible by a code set called CUDA [14] and has got the development industry excited over the possibilities now capable through this.

ATI/AMD has updated their stream technology [15] which attempts to rival Nvidia PhysX and CUDA. Unreal Engine 3 supports Nvidia PhysX and has been proved through the Unreal Tournament 3 Tornado Tech Demo [16] in which many pieces of geometry are being affected by the tornado and all the physics is processed on the GPU without a massive loss of performance. [17]

KISMET

Kismet allows designers with little programming knowledge to dynamically change the way a level plays and interacts with the player wihtout having to edit a single line of base code. Through the use of object orientated nodes and links between these, the level designer can have almost limitless creative control over how the level performs.

Kismet is used via a window in the Unreal editor and by linking together events and nodes, the level will respond to these in the expected manner. Kismet can also be used by programmers to allow level designers to implement features into a level without level designers having to understand the base code.

An example of this is the Unreal Tournament 3 modification 'Jailbreak' where new actor classes and kismet nodes have been added by their lead programmer in order to allow level designers to implement the features into maps with a minimal of fuss.[18]

MATINEE

Matinee is the cinematic editor in Unreal Editor 3; it has been constantly updated and improved over all generations of the editor. Matinee now supports all engine features and can be played back as it would show up in game via a timeline editor. Scripted events and effects can be loaded into a matinee easily and a simple piece of code in kismet allows the triggering of matinee cut scenes.

Matinee can be used for many purposes other than cut scenes, such as level flythrough that triggers at the beginning of a map. Other uses are event driven game play elements such as the jail death in the Unreal Tournament 3 modification Jailbreak, where once all the players on a team are in Jail, kismet coupled with matinee plays a dynamic animation within the game world which is shown on all players screens via a common camera.

WYSIWYG

WYSIWIG game engine editors are where the real-time preview window of a level is identical or very similar to what the final compiled map will look like. Unreal Engine 3 and CRYEngine both support this. Whereas other engines require a compile phase before the map is playable in engine.

This is useful to level designers as not only does it give instant accurate feedback of how a level will look, it also saves massive amounts of time when testing a level compared to engines that require a computational phase before receiving an accurate representation of the final product.

WYSIWIG editors, such as Unreal Editor 3 are processor intensive and the need for a modern CPU in the development machine is essential. The reason for this is effects, animations, lighting, geometry and all the things that make up a game level can all rendered in real-time in the viewport on top of the machine having to process the rest of the editor information.

SOURCE ENGINE

The Source engine, developed by Valve Software was released for licensing in 2004. The cost of licensing the Source Engine is only discussed under NDA and is not public knowledge. Its launch title Half Life 2 was one of the most anticipated games of 2004 and has since won awards for its game play and technologies.

Source has powered some of the most popular PC titles of recent years with games such as Team Fortress 2, Portal and Left4Dead in its repertoire. [20]

Source Engine boasts many impressive and unique features which include:

- Radiosity and HDR
- Facial Animation and Lip Sync
- Eye Tracking
- Animation Blending
- Physics
- AI, Path finding and Navigation

A full list of features can be found at http://source.valvesoftware.com/index.php

RADIOSITY AND HIGH DYNAMIC RANGE

The lighting solution in Hammer which is the level editor for the Source Engine is a cut down version of a full radiosity simulation. This is a heavily processor intensive time consuming calculation in order to light a map. However it produces incredibly realistic looking lighting within a map. VRAD.exe which is the compile program for the lighting is a multithreaded application and will use all available cores on a machine in order to speed up the calculation. Hammer also supports a cordon function in order to be able to small compile sections of a map in order to view the final product and Valve recently implemented a lighting preview mode. This has been done as complaints from the development community were raised due to the lengthy computational phase required to compile a map with lighting.

ADVANCED FACIAL ANIMATION AND LIP SYNC

Advanced facial animation was a key feature in the launch of the source engine, boasting the ability to engage the player in a storyline more convincingly than ever before with characters able to realistically convey emotions. Coupled with the automatic lip syncing technology that is language independent, it proves an incredible useful tool for both single player and multiplayer experiences.

Recent examples of this can be found in Left4Dead and Team Fortress 2 where facial animation and emotions are dynamically applied to models depending on current events within the game world.

Fig 8

EYE TRACKING

Fig 9

Eye tracking is a native feature of the source engine so long as the character mesh is imported into engine in the correct manner. This allows characters to seemingly focus on the player regardless of where the player decides to move. Eye contact is an important way of engaging the player on an emotional level just as eye contact in real life does.

Using the eye tracking technology allows a developer to easily give personality to a character, and with the source engines ability to change the radial scale of the iris dynamically dependant on light situations, even extremely close up the eyes behave as they should do, giving the right reflections and bringing the character to life.

ANIMATION BLENDING

Animations in the source engine can be blended together incredibly easily to allow a whole host of possibilities from a few animations by dynamically mixing them. A walk cycle and a punch animation can be blended to make a walking punch, add another animation and the possibilities multiply. This increases the reusability of animations in game and also allows characters to react dynamically to events in the game world.

PHYSICS

Utilising Havok's physics engine, Valve implemented most of it into the Source engine, which results in one of the most convincing physics simulations in a game to date. Half Life 2 featured physics based puzzles and animations heavily to showcase this and was critically acclaimed for how it is implemented into games natively with very little work from developers.

AI, PATHFINDING AND NAVIGATION

Another acclaimed innovation in the Source engine is its advanced AI relationships and implementation; from the automatic navigation file generation to dynamic relationships creatable in engine via the input output system and events. AI in Source engine is easily created and manipulated to create realistic and interesting AI behaviour.

CRYENGINE 3

CRYEngine 2, developed by Crytek was used to create the impressively realistic titles Crysis and its sequel Crysis: Warhead. The newly announced CRYEngine 3 takes CRYEngine 2 and makes it next gen console compatible with optimisation for Xbox 360, PS3, DX9, DX10 and future console platforms. CRYEngine 2 and CRYEngine 3 both support multicore rendering. It also supports HDR and eye adaptation similar to the Source Engine along with dynamic AI and automatic navigation mesh creation.

CRYEngine 3 focuses heavily on realism and graphical effects but also supports many helpful developer features [21]; a few of these are:

- WYSIWYP
- Hot Update
- Terrain Cover and Vegetation
- Multi Core
- Real-time Day Night Cycle and Global Illumination
- Eye Adaptation and HDR
- AI and Navigation Mesh
- Level Streaming

An extensive list of features can be found at http://www.crytek.com/technology/cryengine-3/specifications/

WYSIWYP

CRYEngine 3's sandbox editor allows anything to be dropped into the world and with the click of a button be in a game window playing it. There is no pre-computation of lighting or assets as once it is placed into the world everything is applied dynamically. This improves on the Unreal WYSIWYG where lighting and AI paths sometimes need to be rebuilt once changes are applied. In CRYEngine you really are half a second and one click away from playing the game world.

HOTUPDATE

HotUpdate is a particularly useful tool for developers creating a game that is aimed for release on more than one next generation platform. It automatically adapts and optimises assets for different platforms on the fly and allows changes to be applied to all versions of a title with the click of a button. This is an incredibly useful tool in the production pipeline.

TERRAIN AND VEGETATION COVER

Similar to the purpose of SpeedTree, CRYEngine has its own tools in order to cover a terrain in lush and convincing foliage and vegetation quickly and easily. It follows real world rules in terms of plant growth and behaviour and also allows the developer manual control over placing objects but also has adequate automatic tools in place in order to create terrain quickly and efficiently. The automatic tool also adheres to technical limitations by limiting vegetation density to preserve frames per second on the intended platform.

REALTIME DAY NIGHT CYCLE AND GLOBAL ILLUMINATION

With all lighting in CRYEngine being created dynamically it allows for an incredibly realistic day and night cycle to be implemented. This can be constrained to level progression or done on a time basis meaning that implementation into MMO's is an incredibly intriguing idea of having lighting in the game world based on the actual time of day the player is playing.

Fig 10

Fig 10

Global Illumination is part of this lighting system which is an accurate way to light a game world but previously technologically impossible due to system limitations. Only recently have lighting solutions been able to move from precompiled to dynamic. With CRYEngine 3's optimisation this feature can run in real-time on the Xbox 360 and PS3 as shown in the recent GDC trailer from Crytek

LEVEL STREAMING

CRYEngine 3 builds on CRYEngine 2's ability to stream level data into memory by optimising the algorithms used to determine how clusters of data are packed for fast access and how game world objects are loaded into system memory based on dynamic scheduling properties. This allows incredibly vast and complex worlds to be used on current-gen consoles (Xbox 360 and Playstation 3) and due to the scalability of its solution, will easily work on any future gaming platforms yet to be released.

TORQUE ENGINE

The 3 previously researched engines are mainly aimed at AAA game production. AAA games are high budget and predict sales in the hundreds of thousands. Torque engine however is aimed at smaller development houses and has a license that is a fraction of what it costs to license Unreal, Source or CRYEngine. [22][23]

Torque Game Engine Advanced has different versions for different platforms meaning small indie developers can afford to license it for their project.

Some of the features Torque Game Engine Advanced supports are:

- Platform Vs Price
- WYSIWYG Mission Editor
- DirectX 8, 8.1 and 9 compatibility
- Genre Kits
- Support for all requirements of a modern game

Torque puts high quality games in reach of indie or solo publishers looking to make their mark on the industry. A full list of features can be found at http://www.garagegames.com/

PLATFORM VS PRICE

Torque employs a scaled pricing strategy depending on what the license is intended to do, this provides the most developer friendly pricing strategy of any successful game engine. Dependent upon whether you're an indie developer or commercial developer, the price will reflect the purpose of the license. This breaks down further depending on intended platform. There are different 2D and 3D versions of the engine for different platforms tailored to making the game creation process as quick and simple as possible with consideration to the engine requirements of the platform.

WYSIWYG MISSION EDITOR

In the 3D version of the Torque Game Engine Advanced, there is a simplistic yet powerful mission editor designed to implement objectives and goals into the game. There is no compile time on these which also speed up development of missions and game length.

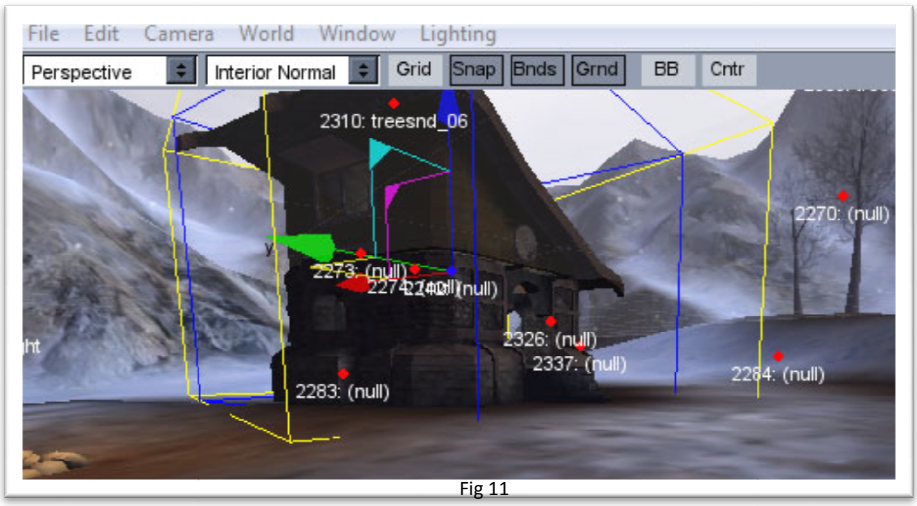


Fig 11

DIRECT X COMPATIBILITY

DirectX 10 is a new feature to games and is only used in the latest AAA titles, because of this Torque doesn't support it but this is not a complaint heard by Garage Games as no games developed on the Torque engine are aimed at becoming AAA DX10 titles. Torque Game engine supports hardware DirectX 8 and above.

GENRE KITS

Genre kits are available for selected versions of the engine meaning that a whole host of assets can come with the license specific to a genre like FPS for example. This has been designed to get indie developers some content premade to play around with to get a project moving quickly.

MODERN GAME SUPPORT

Torque game engine supports most features you see in a current day game with only advanced features of AAA game engines being ignored. This is all to do with the fact that Torque to not market themselves to large development houses attempting to create an AAA game.

	Unreal Engine 3	Source Engine	CryENGINE 2
Multi Threaded	Yes	Yes	Yes
Direct X 7 – 8.1	Yes	Yes	No
Direct X 9.0c	Yes	Yes	Yes
Direct X 10	Yes	Yes	Yes
Soft Shadows	Yes	No	Yes
Dynamic Lights	Yes	Yes	Yes
SSS	Yes	No	Yes
Volumetric Lighting	Yes	No	Yes
HDR	Yes	Yes	Yes
Motion Blur	Yes	Yes	Yes
Depth of Field	Yes	No	Yes
Bloom	Yes	Yes	Yes
Parallel Maps	Yes	No	Yes
Height Maps	Yes	No	Yes
PhysX	Yes	No	No
Havok FX	No	No	No
Code	Unreal Script	Hard Coded C++	LUA
Code Debugging Tools	Yes	No	Yes
PC	Yes	Yes	Yes
Xbox 360	Yes	Yes	Yes
PS3	*No**	Yes	No
Wii	No	No	No

Fig 12
*Information correct in November 2007

CHAPTER 3

PRODUCTION PIPELINES

Game engines come in many different shapes and sizes supporting different features and architecture; this means that asset creation varies from engine, platform and purpose. However the creation of assets retains trends over all of these and the production pipelines of 3 different studios / artists will be analysed in detail to compare the time it takes a junior game artist to recreate similar assets to a senior game artists and provide analysis on this which should result in a clear and concise way to improve design workflow.

CHARACTER PRODUCTION PIPELINE

SUMMARY

In the production of Unreal Tournament 3 by Epic Games a fairly unified production pipeline was used in the creation of character assets for the game. This was explained by senior character artist Chris Wells at an Autodesk sponsored event called 'A day with Epic Games'. [24][25] The event took place in Leicester Square, London and covered the character creation pipeline in great detail. The presentation was entitled "From Concept to Creation" and was an hour long.

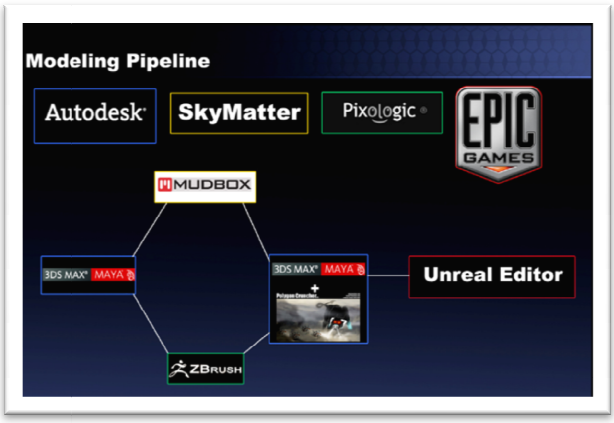


Fig 13

Above is a simplified diagram of the modelling pipeline for Epic Games Character Creation, it shows how programs are not used exclusively and different programs are used on different characters depending on art style and how the final product is achieved quicker in one program over another. However the general flow is still same regardless of route.

Model a low poly base mesh in 3ds Max or Maya which is then exported as on OBJ into either ZBrush or Mudbox for high polygon sculpting. This is then re-imported into a 3D modelling package to be 'Polycrunched'. Polygon Cruncher is a plug-in developed by Mootools for reducing the polygon count of an object without affecting its overall look. This is a powerful tool for normal mapping as it means an optimised mesh with the correct topology in relation to the high polygon mesh can be achieved incredibly quickly.

The final low polygon mesh and render to textured Diffuse, Ambient Occlusion, Specular and Normal maps are taken into unreal editor and compiled to create the final in game character.

CONCEPT DRAWINGS

The concept phase is possibly the most important phase in the creation of any in game asset in the concept phase as it precedes everything; If the concept is wrong then the final product will be completely wrong. At this stage it is important for the modellers, concept artists and creative control directors to work closely together in order to achieve what is known as a shared vision. Drawing concepts in iterations is the best way to create a shared vision quickly.

Once the final concept is approved by the creative control or art director it is then handed to the modeller who breaks it up into sections in order to better understand the best way to tackle modelling the base mesh.

In character creation, it is important to understand what the character will be made of, whether it is hard surfaces, organics or a mixture of the 2. Once the game artist has an idea of the composition of the character they can then take these drawings and use them as reference to begin modelling a base mesh.

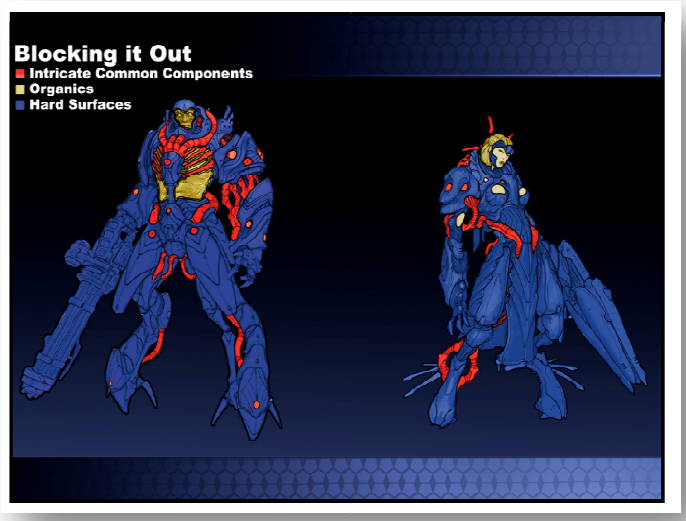


Fig 14

LOW POLYGON BASE MESH

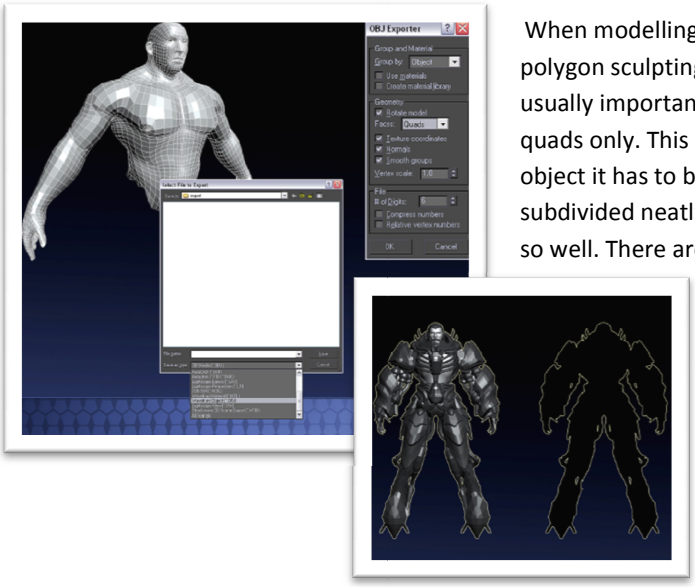


Fig 15

When modelling a base mesh for importing into a high polygon sculpting package such as ZBrush or Mudbox, it is usually important to make sure the model is comprised of quads only. This is because in order to high poly sculpt an object it has to be subdivided and whilst quads can be subdivided neatly, triangles and N-gons don't subdivide quite so well. There are options to not smooth the resulting mesh in these programs but this is generally not considered the best workflow for character creation.

Once the base mesh is created, it is considered good practice to check the model in a silhouette to analyse negative space and to make sure it has a recognisable silhouette so that it can be easily recognisable in game.

The base model is then exported as an OBJ file so that it can be imported easily into the high polygon sculpt package.

HIGH POLYGON SCULPT

Once the base mesh has been imported into a high poly sculpt package it is divided up to a reasonable polygon count for the type of mesh. This is limited by machine specification and memory but most of the time a section of character mesh will be more than 1 million polygons when in the highest subdivision level used for sculpting.

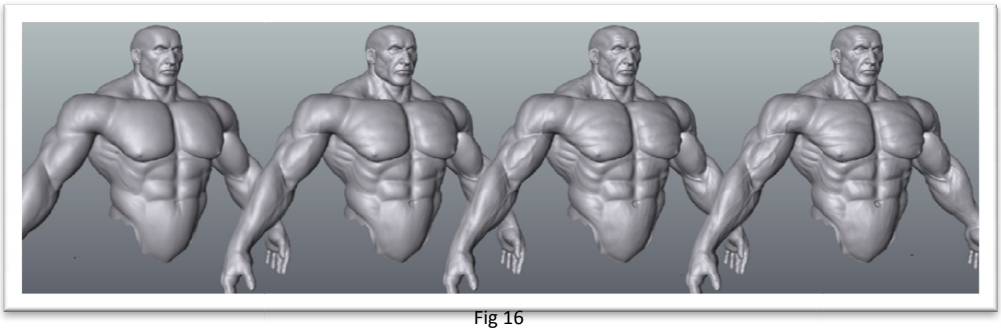


Fig 16

As with the concept images, sculpts are done in iterations before arriving at the final mesh; Detailing gets finer as the model progresses. In the above exampled the base mesh has been divided and the basic muscle groups defined. In the second iterations the furrows of muscle groups have been emphasised to give the model more definition and in the 3rd and final iteration fine detail such as protruding veins have been added.

The polygon count is extremely high on these meshes and due to the limitations of most machines, importing this many polygons into a 3d application can be slow and inefficient, so to combat this the mesh is usually split into sections and exported out as OBJ for re-import into the 3D modelling package.

POLYGON CRUNCHER

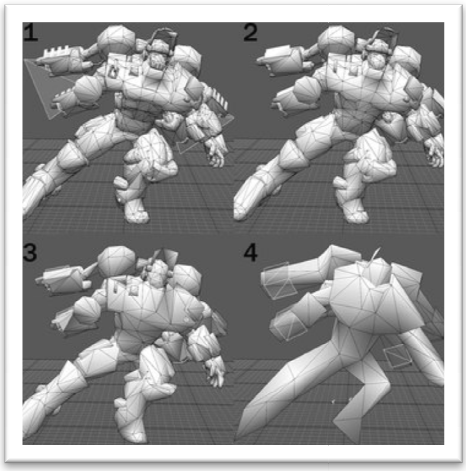


Fig 17

Polygon cruncher will take a mesh and reduce the number of polygons in it whilst attempting to retain the overall topology of the original high polygon mesh. It also has a batch optimisation feature meaning that many chunks of mesh can be placed in a directory and polygon cruncher will automatically crunch them to optimised percentages based on the settings you provide meaning the processor intensive and often time consuming process can be left to run on a machine whilst an artist continues his work on something else on another machine. The resulting files will be placed in the directory specified with relevant file names. This is incredibly useful when creating characters that often require LOD's or level of detail models.

UNWRAP

Once the optimised mesh is in the 3D package, and the artist is happy with the overall composition, the artist can either retopologise a new mash based around the polycrunched version, or use the polycrunched version. This in most cases can then be split down the middle on the x-axis and symmetrised as a consideration to maximising resolution in the UVW map.

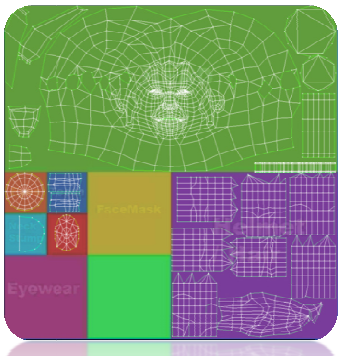


Fig 18

Unreal Engine forces game artists to use UVW space well in regards to the proportions of the mesh by allocating sections of a 2048x2048 map to specific sections of a character, sections that are focused on by the players eye such as the head are designated more UVW space compared to small intricate sections. A standard Unreal Tournament 3 character has 2 '2048 x 2048' maps applied to it.

RENDER TO TEXTURE

Once the model has been unwrapped, and optimised for maximum resolution in engine its ready for maps to be rendered out using the render to texture methodology. Using Projection modifiers on the high polygon version of the mesh compared the low polygon mesh; Diffuse, Ambient Occlusion and Normal maps can be rendered out.

Considerations to get the best out of the maps are as follows:

Diffuse Map – Set unique ray trace materials to sections of the mesh so that it is easier to see and define how the UVW translates to the model when painting textures.

Ambient Occlusion – Set the materials to an Ambient / Reflective Occlusion material

Normal Map – Reset the projection cage then use universal push and edit vertexes where required. Also up increase samples on the render setup.

TEXTURE PAINT

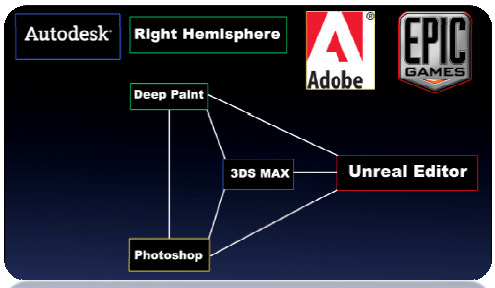


Fig 19

Once the three textures have been rendered out successfully they can then be edited in Photoshop. Generally the colour levels and details of a normal map need to be cleaned in order to bring out the details and smooth places where the normal map hasn't rendered out as well as intended. This can be done with a levels mask and layering unsharp masks on top of each other.

The ambient occlusion maps can be used as an overlay on top of the diffuse map to instantly give depth and shadowing to a diffuse map before the artist begins to paint colour and detail on top. Using Photoshop's available tools and photo manipulation the diffuse texture is usually the result of time and patience. Epic Games however sometimes use Deep Paint 3D, especially for organic texturing. Deep Paint 3D by Right Hemisphere allows sections of images to be

applied to the UVW map of a model by projecting it onto the 3D model and having the program calculate how it would translate to 2D on the UVW map.

ENGINE IMPORT

Once the model is textured the artist should be left with the following assets:

- A low polygon mesh with LOD for importing into Unreal Engine
- A high polygon mesh for kit bashing
- 6 2048 x 2048 maps (2 Diffuse, 2 Ambient Occlusion and 2 Normal Maps)
- 1 Specular if required created in Photoshop

Unlike static mesh import, characters require a bit more work before they can be imported. Firstly, the mesh needs to be in sections, and skinned to an unreal skeleton. Once this is done a plug-in called Actor X which is freely available on the Unreal Developer Network must be installed on the 3D program of choice. The mesh then needs to be exported with the correct settings as an ASE file.

Once the ASE file has been exported it needs to be imported into Unreal Engine 3, this is done through the generic browser. If exported correctly it should appear in engine as a skeletal mesh; and the textures should be imported in the same manner with the appropriate compression settings applied to them. Once all these are in engine materials need to be setup for the character, this can comprise of taking an existing character and replacing the texture samples with the new ones then applying these to the appropriate meshes in the browser.

At this stage you should have the many pieces of the character in the generic browser textured and ready to be socketed together. In the model browser opening the socket manager will allow the various joints to be applied to each piece of the character. The pivot points of the pieces should have been set before export to allow this to be done easily. Once the engine knows which meshes correspond to pieces of the body it pieces it all together into one functional character and if using a standard unreal skeleton, all the animations within Unreal Tournament 3 should translate to the character seamlessly. All that is left to do after this stage is cook the UPK file, and export the text file that needs to be added to the custom char text file within the unpublished section of my documents and the character should be available to use in Unreal Tournament 3.

STATIC MESH PRODUCTION PIPELINE

SUMMARY

Marcus Dublin is a successful freelance 3D artist currently residing in New York, USA. More information on Marcus can be found at http://www.marcusdublin.com/AboutmePage.html

Marcus Dublin's static mesh workflow is similar in ways to Epic Games' character workflow. However it has some distinct differences and these will be analysed as to why his workflow is different and what advantages it has over Chris Wells' character workflow. [26]

BASE MESH

As with the Character Creation pipeline a quad base mesh is created, and in Marcus Dublin's pipeline this is done in 3ds Max. This is due to his workflow incorporating Polyboost which is a commercial script add-on for 3ds Max which has time saving features. Once the mesh is complete and separated into suitable elements an 'STL check' is performed to make sure there are no invalid faces in the mesh. Then the XForm and pivot are rest to make sure that there are no issues when it comes to transforms and pivot rotation. It is then exported as an OBJ into ZBrush for sculpting.

ZBRUSH HIGH POLY SCULPT AND REFERENCE SHEET

Once the mesh is imported into ZBrush, a reference sheet and paint over are created to give the artist an idea of how to tackle the sculpting process, similar to the breakdown in the character workflow. The reference sheet contains photographs sourced from the web or books to give a basic idea and real world examples of how the final mesh might look.

Then the model is sculpted in iterations like the character workflow, however it is done in divide stages. A low subdivision level is used to create a rough sculpt and then progressively the subdivision level is increased as more detail is added until the final refined sculpt is achieved at a high subdivision level.

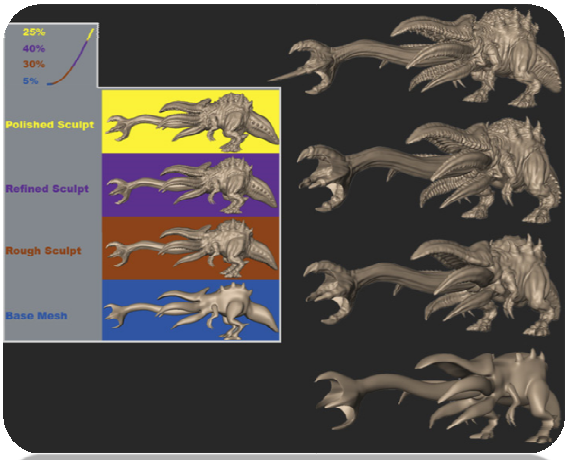


Fig 20

RETOPOLOGISE

On the retopologising stage is where Marcus' workflow differs mostly from the character workflow. Mixtures of ZBrush retopologising tools and Polyboost in 3ds Max are used to recreate an optimised low polygon mesh based on the new high polygon sculpt. This eliminates the need for polygon cruncher but unfortunately takes longer than polygon cruncher to optimise a mesh. However the mesh created from manual retopologisation is far cleaner than results that are sometimes achieved from Polycruncher meshes.

The retopologising tools within ZBrush allow a base mesh to be drawn onto the high polygon sculpt to closely match the high poly sculpt with polyboost being used in max for unique sections of a mesh that cannot easily be remade in ZBrush.

Once an optimised retopologised mesh has been created from the high polygon sculpt it is exported into 3ds Max for the next stage of the creation process.

UNWRAP

Because a static mesh is less important in terms of visual value than that of a hero character, generally only 1 '2048x2048' diffuse map is allocated to it, but this can be increased or decreased based on requirement. As with before, if symmetry is an option it is beneficial as it will maximise visual quality with no impact on game performance.

Marcus uses a 3ds Max plug-in called 'Chugnuts UV tools' to replace the standard 3ds Max UVW unwrap tools. This plug-in improves on the usability and efficiency of the standard tools by replacing the GUI with a friendlier interface. With static meshes, there is no render regions applied to the UVW maps which means automatic spacing and UVW packing can be used to make the best use of the space available within the UVW.

RENDER TO TEXTURE

Once the low polygon mesh is unwrapped to the required standard the rendering of Normal, Ambient Occlusion and Diffuse maps is possible. As with the character workflow exporting these maps is done in exactly the same manner except Marcus exports a lighting map.

He sets the scene up so that both the high polygon and low polygon mesh have a solid white material applied to them then adds a skylight to the scene and a box to simulate the floor and to stop rays being projected off into space.

He then uses light tracer advanced lighting solution and scanline renderer to export a lighting map from the model. He is then left with the all the assets from the character workflow and a lighting map for use in Photoshop.

TEXTURING

Using the reference sheet earlier created, Marcus acquires suitable texture samples that are suitable for use in the diffuse texture and using a number of Photoshop techniques and tools created a diffuse and specular map. Then in addition a bump map and bump normal map is created.

The bump normal is created either through a program called CrazyBump which analyses pixel information within an image and does its best to predict the normal's of the image. It is also capable of producing displacement, occlusion and specular maps using different algorithms. It is an incredibly quick way of getting different kind of maps straight from the colour information within a 2D image.

Another method he mentions is using the NVidia normal map plugin for Photoshop which acts as a filter and applies normal map information to an image with a real-time preview of how the normal would affect a flat surface. The reason for the creation of normal bumps and bump maps is for the use of the mesh in a CG art platform rather than games; however the exported maps can be used within the Unreal Material

Editor to create an interesting and complex shader through use of more nodes than the standard 3 texture sample basic material.

ENGINE IMPORT

Importing a static mesh into Unreal Engine 3 is incredibly simple. Export the low polygon mesh from 3ds Max as an ASE file; no need to use ActorX. Open the generic browser in Unreal Editor 3, and import the mesh with default settings, then import all the created textures with the correct settings into the engine. Create a material and name it appropriately placing the created textures and plugging them into the correct slots on the shader within the material creator.

Open the model from the generic browser into the Unreal Model Viewer; within here go to its properties and expand the LOD control until a material section appears, go back to the generic browser and select the right material then highlight the model browser again and use the green arrow which is when highlighted reads 'use current selected material' and it will apply the material to the model. Save the package to the correct directory on your hard drive and the static mesh is ready for use in the game world.

TEXTURE PRODUCTION PIPELINE

SUMMARY

Unknown Worlds Entertainment is a new developer currently publishing their first AAA title, Natural Selection 2. [27] All the textures in Natural Selection 2 have been created using the same workflow described in their development video cast #8 on YouTube. [28]

The Unknown Worlds Render to Texture method of texture creation lends techniques from other asset creation in the process of arriving at the final product. Some game textures are completely painted by hand within an image suite such as Adobe Photoshop or Corel Draw. However, using a render to texture methodology allows the artist to skip some steps in the texture painting process and also allows things to be prototyped before beginning work on the final asset.

CONCEPT

As with 99% of all game asset creation, the first step is to create a concept of some form that allows ideas to be roughly brainstormed and prototyped. A concept for the texture usually include a basic layout, a plan for tiling, a diffuse palette of recommended colours as well as notes that will allow the 3D artist to compile a model in such a way that all the key elements the texture is trying to highlight come through in the final product.

MAX BASE MODEL

Unknown Worlds use 3ds Max to create base models that will be used to render out normal and lighting information for manipulation in Photoshop before being imported into their engine for use in Natural Selection 2. For their mechanical walls a 3ds Max plug-in called Greeble is used to apply fine details such as screws, bolts and shafts. Greeble uses a library of predefined objects and has the ability to automatically or manually place these details over a mesh to give the overall texture a more interesting look and makes use of the normal map to a greater degree.

HP SCULPT

If required for a less manufactured looking texture such as an old wall, a high polygon sculpt with fine details can be created in relatively short amount of time to that of trying to model high polygon details within a 3D suite. The high polygon or the standard base mesh can then be used to render to texture within 3ds Max in order to generate different maps from the models.

RENDER TO TEXTURE

3ds Max has the ability to render many different types of maps out to files; this has the inclusion of Ambient Occlusion if the scene is set up to use Mental Ray Renderer. Once the detailed version of a mesh is in the scene, a plane can be placed behind or inside the model. Then using projection mapping the various required texture maps can be baked out into files. These usually include diffuse, normal and ambient occlusion but can also include light maps, height maps, specular maps and many more.

PHOTOSHOP

In this stage, the maps that have been rendered out of the 3D Suite will be opened inside Photoshop and edited in order to get the most from them. This will include any clean up of a normal map along with using the rendered diffuse and ambient occlusion to help kick start the texture painting process.

Unknown Worlds use the ambient occlusion map in conjunction with a base texture and then edit and paint fine details into the diffuse map before arriving at the final product. Upon completion a standard game world texture would have a diffuse, specular and normal map for use in the game engine. These when compiled into a shader give a next generation texture with diffuse for colour information, specular map for surface shine and reaction to light properties and a normal map for depth information based on a blue to red colour map.

ENGINE IMPORT

Unknown Worlds seem to be using a heavily modified version of the Source engine with custom map building tools which means that a material file is created in order to compile the shader for engine. This is a text file which instructs the game engine what to do with the separate maps and how to display them in the game world. In Unreal Engine 3, importing a world texture is as simple as importing any other textures followed by creating a material shader to have it display in game how is required by the concept and art direction.

CHAPTER 4

SOFTWARE RESEARCH

There are hundreds of design related programs and suites in the market today. All have their advantages and disadvantages and understanding which of these can improve workflow and efficiency is incredibly helpful when attempting to be cost effective in asset creation. This dissertation will analyse the software with the largest number of licensees within the games industry.

AUTODESK 3DS MAX

Autodesk 3ds Max is used widely in the creation of 3D assets for games projects and is a full suite of tools for modelling animation and rendering. The latest version of 3ds Max is 2009 and as with all new releases of the program, attempts to incorporate functionality and features called for by the industries it serves. [29]

Autodesk has recently released media on the internet showcasing some of the new tools within their upcoming 2010 release; many of which appear to be targeted at games industry professionals with improved modelling, selection and edge loop tools for achieving clean game engine friendly geometry in a shorter space of time.

Another new addition is hardware support in viewport, this allows game-like features within the design viewport of 3ds Max such as real time lighting, materials, ambient occlusion, HDRI, soft shadows with the inclusion of hardware anti-aliasing.

The 2010 version of 3ds Max will include native support for Mental Mill, a program used to create impressive and complex shaders without the need to write any shader code. Mental Mill's user interface is incredibly similar to the material creator in Unreal Engine 3 and feels familiar to an artist having used Unreal Engine 3 before.

This means that similar results between Unreal Engine 3 and 3ds Max are easily achieved; something that was previously difficult due to the shader limitations within 3ds Max.

Summary of notable workflow benefits to game artists:

- **Native Shader Technology Support**
- **Real-Time materials, lighting, AO, HDRI, shadows**
- **Fast and intuitive poly modelling tools**
- **Creativity Extension of 2009**

AUTODESK MAYA

In 2006, Autodesk acquired Alias for approximately $197 million and with this came the acquisition of the Maya design suite. [30] Maya like Max is a full suite of modelling, animation and rendering tools with particular emphasis on rigging and animation. [31]

Maya has many similar features to 3ds Max with a different GUI that feels more comfortable to some 3D artists. It is incredibly easy to set up "shelves" of custom tools in Maya simply by holding down ctrl-alt-shift and recording a macro which has an image or icon applied to it. This allows for some complex or repetitive options hidden in a menu to be easily completed by clicking an iconic representation of the function.

Maya also has a 'play-blast' function which allows Maya with the click of a few buttons to render out a rough form of the final product in a fraction of the time that it takes to do a final render. Play-blasts also support sound easily and speed up production of the final product.

Maya is renowned for its rigging and cloth simulation software; Along with this comes a new version of particle simulation in Maya 2009. nCloth and nParticles interact well due to them being part of the same solver in Maya called Nucleus. This allows for powerful interaction of complex 3D objects that can be interactively played back within the Maya viewport.

In addition to MEL Script similar to MAX Script; Maya 2009 supports Python, a powerful scripting language being used increasingly in game engines and game modifications to provide extended functionality through the calling of functions.

Summary of notable workflow benefits to game artists:

- **nParticles, nCloth and nucleus**
- **Advanced Rigging Tools**
- **Python Support**
- **Play-blast**
- **Native UV Preserve Function**

PIXOLOGIC ZBRUSH

Fig 21

ZBrush is referred to as a 2.5D program as it has the ability to model in 3D dimensions but also project work in a 2D style onto a 3D surface.[32] Its innovative approach to sculpting high polygonal objects has helped to revolutionise the games, film and special FX industry with stunning results. ZBrush was used in the creation of characters for Pirates of the Caribbean 2 and other award winning films. [33]

ZBrush allows the artist to sculpt, manipulate and retopologise 3D meshes in various subdivision levels. In relation to its use for games, it will allow a high polygon mesh to be exported for use in a 3D suite. It also has retopolgising tools for creating an accurate low polygon mesh in relation to the final sculpt.

It also has Z-Mapper, a feature originally a free add-on is now native in ZBrush 3.1 which allows normal, cavity and displacement map generation inside of ZBrush. Coupled with the retopologisation features inside ZBrush, a tangent space normal map suitable for games engines can be exported in a short amount of time.

Summary of notable workflow benefits to game artists:

- **UV Map Projection**
- **Z-Mapper**
- **Intuitive Retopologisation Tools**
- **Alpha to 3D**
- **ZSphere**

AUTODESK MUDBOX

Autodesk Mudbox is another acquisition of the Autodesk Group. Originally developed by Skymatter, Mudbox is an alternative high polygon sculpting package comparable to Zbrush, but with a completely different GUI approach.[34] It has also been used in the creation of content for award winning films such as Peter Jackson's 2005 remake of King Kong.[35]

Mudbox takes a more windows friendly approach to layout with standard features such as a file menu and options. Artists that are used to normal windows programs will feel more at home initially within the Mudbox interface than that of Zbrush. Mudbox has a similar set of features to Zbrush but executes them in a different manner.

Mudbox has very clear instructions for many of its processes such as normal and displacement map export. This makes the learning curve of Mudbox a lot less steep for junior artists developing their high polygon workflow.

Summary of notable workflow benefits to game artists:

- **Simple and intuitive Interface**
- **3ds Max like layer system**

RIGHT HEMISPHERE DEEP PAINT 3D / DEEP UV

As mentioned in the Epic Games character workflow, a program created by Right Hemisphere called DeepUV and DeepPaint3D are used to unwrap and texture models; specifically organic models. This is because it has the ability to project texture data onto the UV in 3 dimensions. [36]

DeepUV is a program that allows intuitive editing of UVW maps, and painting of UVW maps in real-time on a model. It is extremely useful for texturing and unwrapping complex objects. Epic Games use it to relax UVW's from 2 texture maps into 1 for LOD models.

It is also used to paint surfaces easily; organic objects such as human faces can be textured quickly and easily from photo reference and other sources of images and achieve impressive results quickly.

Zbrush has a feature called Z-Applink which will allow the artist to drop a 3D model into 2D space, apply textures in an external image editing package such as Photoshop then use the data to 'pickup' the model so that its once again editable in 3 dimensions but with the 2D texture data applied to the correct sections of the model.

Right Hemispheres solution takes this feature and turns it into a fully featured program with more functionality and improved efficiency. There is no need for an external image processing application within DeepPaint3D as images can be dragged into the viewport, aligned with the 3D model and projected onto the surface.

It eliminates the need to drop the model into 2D before editing, meaning that projecting textures onto the model is incredibly fast and results can be achieved in a fraction of the time.

ADOBE PHOTOSHOP

Adobe Photoshop has been the tool of choice for many 2D professionals for many years. Its extensive toolset and intuitive interface have made it the most successful photo and image editing package on the market today. [37]

Photoshop has all the tools required to professionally edit and created 2D textures for games engines. The list of useful features within this software is endless; however some that are used frequently by industry professionals are:

Levels Correction – Incredibly useful for enhancing a normal map for added exaggeration of details, used in conjunction with sharpening and masking techniques, fine details can be enhanced easily whilst subtle details can be kept in their original state.

Masking – Useful for making changes to sections of an image only without the borders of selection tools using masks can achieve subtle changes in areas of a texture where affecting the entire image is not desirable.

Layers – Incredibly intuitive way of editing images and is present in almost all photo editing programs, layers allow textures to be edited in sections then flattened to a final image for exporting to a games engine.

Alphas – Alpha channels allow parts of an image to be rendered as transparent. This is useful for games as it means complex projection of texture is possible on a plane with alpha applied to it; rather than modelling the detail in a 3D suite which has a huge impact on performance compared to the almost insignificant performance impact of using textures with alpha.

Liquefy – Liquefy is a Photoshop filter that allows an image to be changed dramatically but keeps pixel information in relation to its surrounding image. This is useful in conjunction with other tools in Photoshop such as the heal and clone brushes when attempting to change an image or eliminate seams within a texture.

Filters – These predefined adjustable functions within Photoshop can help achieve interesting effects within the suite. Filters can also be downloaded from the Internet and installed into Photoshop to increase the library of effects possible.

Image File Types and Compression – Photoshop has great support for saving an image out to almost every useful image type with full customisation options. This is useful not only for next generation games that use full depth 2048 maps with alpha, but also for handheld consoles as palettes can be optimised and images can be resized to adhere to Nintendo DS and Sony PSP limitations.

3RD PARTY PLUGINS, ADDONS AND USEFUL PROGRAMS

Polygon Cruncher

Polygon Cruncher or PolyCrunch for short is a 3D suite plug-in developed for the purpose of reducing the polygon or triangle count within a mesh without affecting the overall appearance of the mesh. This is an incredibly powerful tool when attempting to retopologise a low polygon mesh from a high poly one. [38]

Sometimes Polycruncher will achieve desirable results from a high polygon mesh that can be used within a game engine. Sometimes the resulting mesh will serve as a basis for a cleaner topology to be built around it.

In 3DS Max, the artist must select the mesh or meshes that they wish to optimise and select polygon cruncher from the utilities menu; upon selecting optimise selection a new window loads within 3DS Max and it is possible to dynamically alter the amount of polygons in the mesh on a slider. This allows the artist to remove as many faces as they wish and decide when the loss of mesh definition is too much and apply the current optimisation to the mesh.

Polycruncher is not a free add-on and costs around $129. This is a relatively small cost for such a powerful addition to games artist's workflow as it can saves many hours of retopologisation work.

The add-on can be downloaded from http://www.mootools.com/plugins/us/polygoncruncher/index.asp

Nvidia Normal Map Plugin

The Nvidia normal map plugin for Adobe Photoshop that works in the same way as a Photoshop filter. It allows options to be set in the normal map generation and also has a real-time preview window. It is free to download and is a quick and easy way to create a normal map from diffuse information within a texture. [39]

However, this is only useful for either testing purposes or surfaces that do not require a large or accurate bump. The filter can only estimate from colour information where depth occurs and attempts to simulate this as realistically as possible.

For meshes that require accurate normal's in order to display correctly in the game engine must be rendered with a different method.

The add-on can be downloaded from http://developer.nvidia.com/object/nv_texture_tools.html

Chuggnuts UV Tools

Chuggnuts UV tools were developed by an artist that was displeased with the interface and intuitiveness surrounding the standard 3DStudio Max UVW unwrapping tools. It is an easily installed script which increases the functionality of the Unwrapping tools available.[40] The GUI docks itself with the existing Max tools and has the ability to minimise out of the way should the tools not be required for the current piece of work. It also has the ability to "dump maps" out of the script meaning a UVW map can be saved out to a texture easily. This is similar to the functionality of 'Texporter', another free add-on to 3D Studio Max which has various options for exporting UVW maps from an object in various forms.

It can be acquired from http://www.chuggnut.com/Scripts/unwraptools/unwraptools.htm

PolyBoost

With the upcoming release of 3DS Max 2010, a lot of the features inherent in the commercial add-on PolyBoost have been integrated into the core Max release. However for previous versions of the software, PolyBoost is an amazing addition to the program that allows quick and easy retopologisation of a mesh amongst many other useful features. [41] These include modelling and selection tools for quick and easy creation and alteration of meshes. It also includes UVW tools such as Clonetool which will allow seams within a UVW map to be erased within the 3DSMax viewport by applying a clone brush similar to that in Photoshop, but in real-time.

A single license costs $154USD with discounts emerging if bought in 5 licenses or more at a time.

Information on this add-on can be found at http://www.polyboost.com/

CrazyBump

CrazyBump is a standalone program that is incredibly easy to use in the generation of normal and displacement maps from existing images. [42] It has a DirectX preview window of the changes being made to the loaded image. Easy to understand sliders and options allow an artist to generate useful maps from an image in a very short amount of time. CrazyBump Beta was a fully functional free program but a CrazyBump license now costs between $50 and $300 as the program has had a stable release published. The program can be bought at http://crazybump.com/buy.html

SpeedTree

This program allows the quick and easy creation of Tree meshes for use in games engines; [43] this support is built into Unreal Engine 3 should licensees of the engine wish to use it. This cohesion of a familiar middleware solution on a recognised engine only enhances the sales of both products. SpeedTree allows the game artist to quickly create a game engine friendly mesh complete with texturing and using the supplied code, drop it straight into engine within a matter of minutes, instead of hours taken to make an original custom tree mesh from concept.

More information can be found at http://www.speedtree.com/

Actor X

ActorX is a freely available add-on to 3DStudio Max, Maya and XSI which acts as an export tool for getting mesh and animation data out of 3DStudio Max in a compatible format to Unreal Engine 3. It is the simplest and almost exclusive way to get compatible data into Unreal Engine from a 3D suite. [44]

ActorX can be downloaded from the links provided on http://udn.epicgames.com/Two/ActorX.html

Updated on 2008-03-27	**Autodesk 3ds max 9 SP2**	**Autodesk Maya complete 8.5**	**Blender 3D 2.45**	**Luxology Modo 301**	**Maxon Cinema4D R 10.1**	**Newtek LightWave 9.3**	**Softimage XSI Foundation 6.2**
First market	Viz - Games	Games - Film	VIZ - Real-time	Viz - Games	Motion - Design	VFX - VIZ w/LWCAD	Animation - Game - Film
End user prices *	**5,000 €**	**2,500 €**	**FREE**	**745 €**	**800 €**	**800 €**	**450 €**
Annual subscription	**Yes**	**Yes**	**None**	**None**	**None**	**None**	**None**
Platforms							
PLE	None	Yes	NA	None	None	None	None
Trial	Yes	Yes	NA	Yes	Yes	Yes	Yes
Languages	FR EN	EN	A lot but EN is best	EN JP	CZ EN FR GE IT PL SP JP	EN JP	EN JP
Languages Switch	None	None	All include	None	All include	None	None
Industries populated	Very good	Very good	Low	Low	Good	Very good	Good
Technologies Core Aged	Old	Old	Old / Re-new	Modern	Old / Re-new	Old / Re-new	Modern
Learning path to be productive	< 2 months	< 3 months	< 3 months	< 1 month	< 1 month	< 2 months	< 2 months
Company support for single users	Low / Good	Good	Communities	Very good	Very good	Very good	Very good
Supports activities for single users	Good	Good	Communities	Very good	**Excellent**	Very good	Low
Interface	CAD style, Clean and powerful	Like a Forge, flexible and powerful, but not intuitive	Not CG standard - Fast workflow, can be more intuitive	**Excellent**	Clean and intuitive	A bit old, texts interface.	Logical texts and clean interface
Documentations	Good	**Excellent**	Good	Very good, (many videos)	Very good	**Excellent** (Shaders manual)	Very Good
DVD training	Good	Very good	Low	Good	Low	Very good	Good

TOP Import / Export needed by industries							
3DS	Very good	Very good	Good	Low	Very good	Good	Low
COLLADA	Very good	Very good	Very good	Good	None	None	Very Good
FBX	Very good	Very good	Very good	Very good	Very good	Good	Very Good
OBJ	Very good	Very good	Good	Very good	Very good	Good	Good
VRML / X3D	VRML 97	VRML 2	VRML 1 & 97	X3D	VRML 2	VRML 97	Plugin
Point Oven	Plugin	Plugin	90% working	Yes	None	Plugin	Very good
DXF	Very good	Good	Low	Yes	Good	Good	Plugin
IGES	Good	Low	None	None	Plugin	None	Good
STL	Very good	Very good	Good	None	Very good	Plugin	None
Output compositing	RPF RLA EXR	RPF RLA EXR	EXR	EXR	RPF RLA EXR	RPF RLA EXR	EXR
Rendering							
Rendering	Internal, Mental ray	Internal, Mental ray	Internal	Internal	Internal	Internal	Mental ray
Quality	**Excellent**	**Excellent**	Good	**Excellent**	Good	**Excellent**	**Excellent**
Must have render plugin	Vray	Vray	Yafray / Indigo	None	Adv.Render	None	3Delight
Quality w/plugin	**Excellent**	**Excellent**	Very good	NA	Very good	**Excellent**	**Excellent**
Textures Baker	Very good	Very good	Good	**Excellent**	Very good	**Excellent**	Very good
Top base package for industries need! (are only available in High-end Package only!)**							
Animation tools (IK, Char Rig, Bones, Controller, Blending...)	Very good	**Excellent**	Good	Low	Good	Good	**Excellent!**
UV tools (Unwrap, Pelt...)	Very good	**Excellent**	**Excellent!**	**Excellent**	**Excellent**	Good	**Excellent**
Painting	None	Very good	Low	**Excellent**	**Excellent**	None	Very good**

Modelling	**Excellent**	Very good	Good	Very good	Very good	**Excellent**	**Excellent**
Modifiers	**Excellent**	Very good	Good	Very good	Good	Good	Very good
NURBS	Low	Very good	Low	None	None (HyperNurbs)	None	Very good
Dynamics / Rigid bodies	Very good	**Excellent**	Very good	None	*Very good***	Very good	***Excellent*****
Soft bodies	Very good	Very good	Good	None	*Good***	Good	Very good
Hairs	Very good	*Very good***	Good	None	*Very good***	Good	*Very good***
Cloths	Very good	*Very good***	Good	None	*Very good***	None	Very good
Particles	**Excellent**	Very good	Good	None	Good	Very good	Very good
Fluids	None	*Very good***	Very good	None	None	Good	Good
Compositing	None	None	Yes	None	None	Yes	***Excellent*****
Nodes-Based Workflow	None	Yes	None	None	None	None	None
Nodes-Based Materials	Plug-ins	Yes	Yes	None	None	**Excellent**	**Excellent**
Nodes-Based Compositing	None	None	Yes	None	None	None	***Excellent*****
CG shader / Games	**Excellent**	**Excellent**	Yes	None	None	Yes	**Excellent**
Top unique feature	**Biped ParticlesFlow**	**PaintFX Fluids** Nucleus**	**3DRT Sculpting Video edit**	**Painting Render Sculpting**	**Body paint**	**Hypervoxel Render!**	**Anim tools Gator *Illusion*** **
Scripting	Good	**Excellent**	Very good	**Excellent**	Good	Good	**Excellent**
Scripting Dev.	Maxscript	MEL, Python	Python	Perl, Lua, Python	EXPRESSO COFFEE	LScript	VB, Python, Jscript
C/C++ Dev.	Good	Very good	Very good (open source)	None	Very good	Very good	Good
Vue 6 xStream plugin	Low	Good	None	None	Good	**Excellent**	**Excellent**
Cons	Price, no new features	Learning curve	Interface / documentations	No char Anim tools	Default render	Rig tools	Imports Exports

All you need for Film / Production Ready?							
Package	Standard	Unlimited	Standard with a lots scripts	Standard	Studio	Standard	Essential
Prices *	5,000 €	8,500 €	Free	745 €	3,200 €	800 €	2,500 €
All you need for Freelance / Designer Ready?							
Package	Standard	Complete	Standard	Standard	Bundle	Standard	Foundation
Prices *	5,000 €	2,500 €	Free	745 €	2,500 €	800 €	450 €
All you need for EDU / Student ready?							
Package	Standard	Unlimited	Standard	Standard	Bundle	Standard	Advanced
Prices *	130 €	250 €	Free	125 €	180 €	230 €	220 €
Job Opportunities							
VIZ / Design	**Excellent**	Good	Good	Good	**Excellent**	Good	Low
Film	Good	**Excellent**	Low	Low	Low	Very good	**Excellent**
VFX / Motion	Good	**Excellent**	Good	Low	Good	**Excellent**	**Excellent**
Game	**Excellent**	Very good	Low	Good	Low	Good	Very good
Web designer	Low	Low	Good	Good	**Excellent**	Good	Low
3D Real-time / VR	**Excellent**	Very good	Very good	Good	Low	Good	Low
User's communities and popularity?							
Nord America	**Excellent**	**Excellent**	Good	**Excellent**	Good	Very good	**Excellent**
Europe	Very good	**Excellent**	Very good	**Excellent**	Good	Good	Good
Asia	Very good	Good	Low	Good	Low	Very good	**Excellent**

Fig 22

CHAPTER 5

RESEARCH SYNTHESIS AND ANALYSIS

In order to have an appreciation for the workflows of all kinds of professionals, surveys were sent to a number of industry and freelance artists. A number of replies were received that ranged from senior character artists to mobile game interface designers.

This was done to gain an appreciation for workflows based around all sections of the gaming industry and to contrast and compare the pipeline and time distribution that each artist takes.

The initial research questions were sent to Marcus Dublin, whose prop pipeline has been studied; the detailed response from Marcus allowed a suitable questionnaire to be created and submitted to many artists willing to complete it.

After a few weeks of correspondence with artists this dissertation had received 12 useful replies which have been analysed in great detail in order to create an easily understandable graph representation of the data.

From Fig 5, it is apparent that all artists' workflows are very different, but there are trends within the data. The reason for the vast differences in workflow pertains to the differences in occupation. The results were averaged out in order to obtain the average workflow of artists based on the data received. (Fig 6)

In Chris Well's presentation on character design at Epic Games, he mentions that it takes roughly 15 days to create a hero character but do to the individual requirement of each asset it can often take more time than that.

Based on a studio employing on a Monday to Friday basis for 8 hours a day a definition of a studio week was created. A studio week is 40 hours per week; 15 days of asset creation equates to 2.14 studio weeks.

From the analysis of data received from the surveyed artists it takes an artist on average 127 hours to complete an asset from concept to final. This figure translates to 2.27 studio weeks based on working 8 hours a day, 5 days a week. This is incredibly close to the Epic Games estimate which validates the research to a degree.

The 12 subjects studied in the research did not give full answers to all sections relating to time distribution of their workflow and the calculations on the data reflect this with accurate averaging of each section of data.

Collated Averages					
Concept	210	Divided By 7	30		
Base Mesh	110.5	Divided By 9	12.27777778		
High Poly	343	Divided By 9	38.11111111		**Data 17/02/09**
UV	93.5	Divided By 9	10.38888889		12 Subjects
Texture	250	Divided By 9	27.77777778		
Tweaks	53.5	Divided By 6	8.916666667		
Total Time	15.93402778		Epics Estimate	15 Studio Days	
	2.27 Studio Weeks			2.14 Studio Weeks	

Fig 23

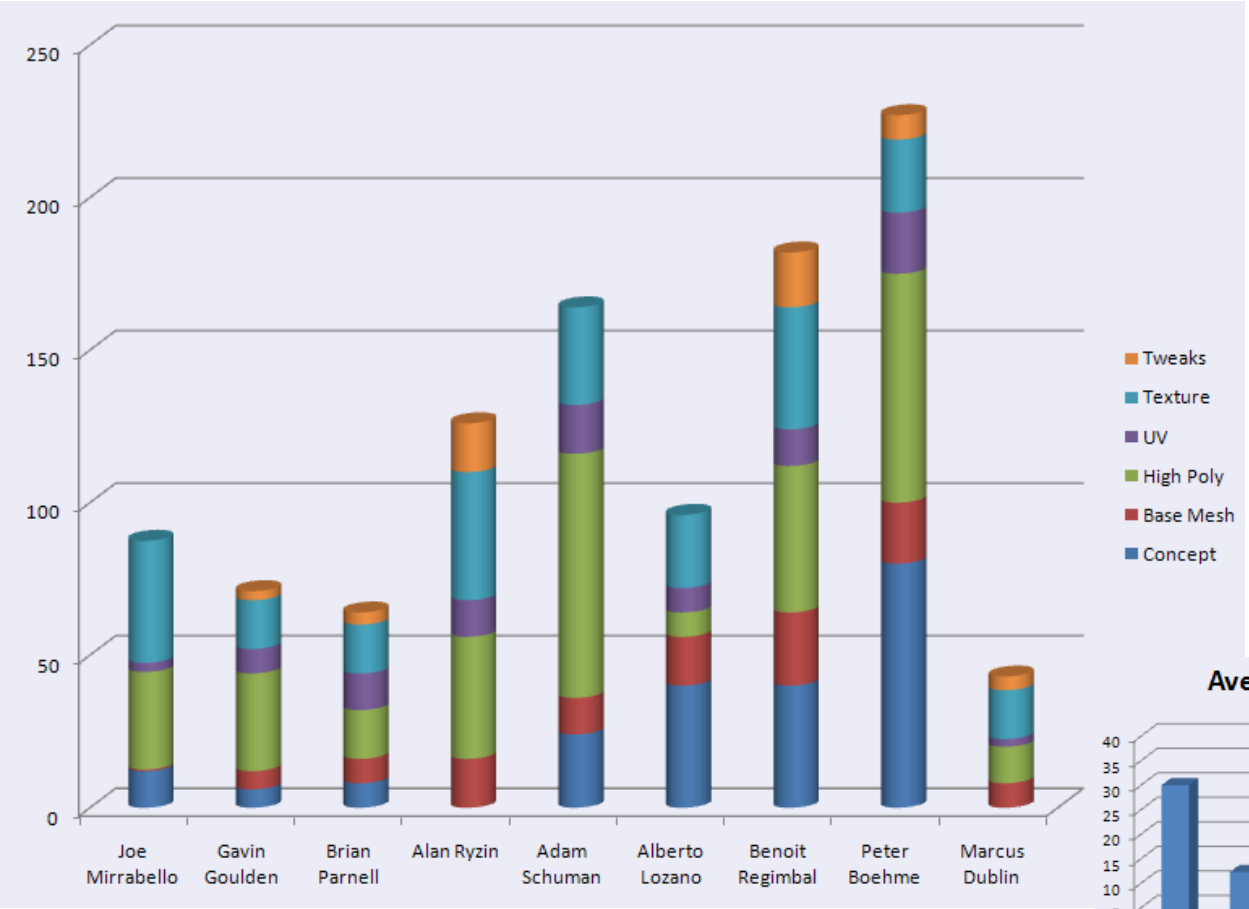

250
200
150
100
50
0
Joe Mirrabello
Gavin Goulden
Brian Parnell
Alan Ryzin
Adam Schuman
Alberto Lozano
Benoit Regimbal
Peter Boehme
Marcus Dublin
Tweaks
Texture
UV
High Poly
Base Mesh
Concept

Fig 24

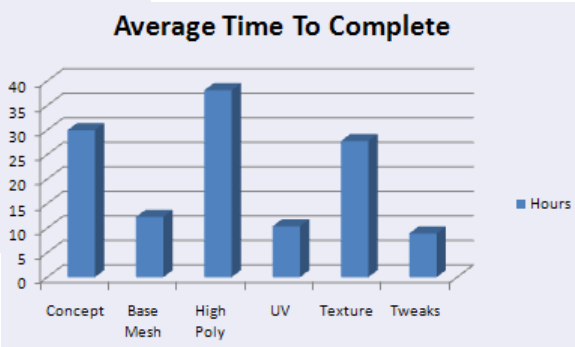

Average Time To Complete
40
35
30
25
20
15
10
5
0
Concept
Base Mesh
High Poly
UV
Texture
Tweaks
Hours

Fig 25

With research on different artists workflows and the amount of time it takes for each artist to complete a stage in the asset creation process, it was possible to predict how long it would take a junior artist to complete a similar task. As stipulated in the research, most artists agreed that it takes junior game artists a little longer to achieve results due to lack of experience and adapting to a new way of working.

Using the research, it was also learned that although game artists work in different ways, the most popular methodology of creating a next generation asset is to model a base mesh which is then serves as the basis for a high polygon sculpt within a package such as ZBrush or Mudbox. These high polygon pieces are then retopologised into an optimised low polygon mesh with relevant edge flow. After this the low polygon mesh is UVW unwrapped to apply accurate texture coordinates to it.

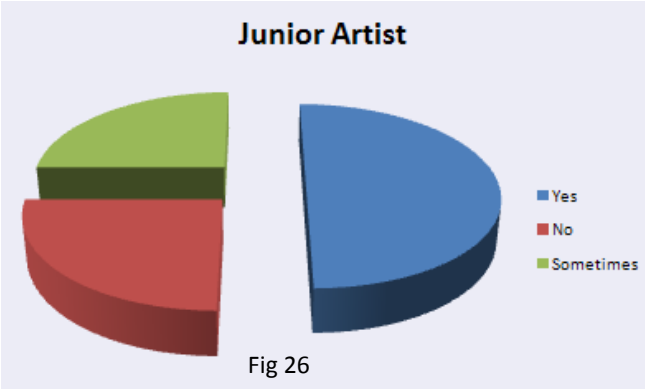


Fig 26

Once the artist has a retopologised low polygon mesh that has been unwrapped and a high polygon mesh imported from the sculpting package, maps are then 'render to texture' from the 2 models using projection mapping.

These ordinarily include Normal, Diffuse, Specular and Ambient Occlusion maps. But can include others such as height maps and lighting maps if required. The low polygon then will be imported into the game engine and the rendered maps will be applied to them to have an in engine textured asset.

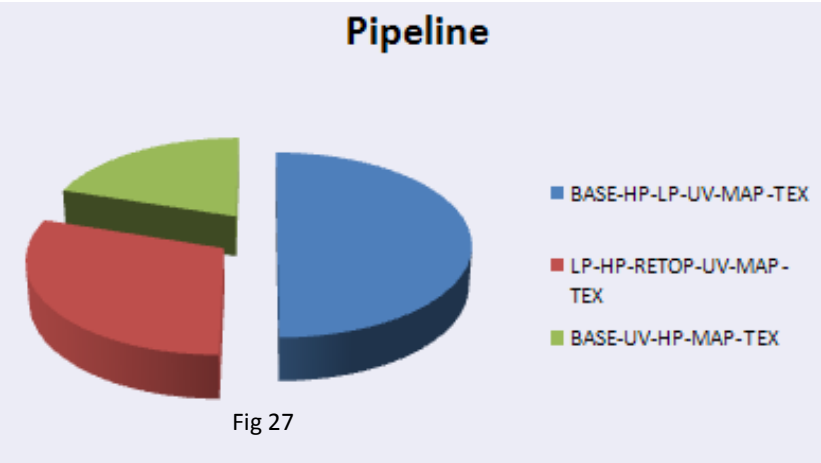


Fig 27

The rendered diffuse map from the 3D suite is used only as a guide and time will be spent manually creating the diffuse texture from hand painting to photo reference. Excluding the concept, on average the task designated the 2nd largest portion of time is texturing; 27 hours is the length of time spent texturing by the surveyed artists according to the collated averages.

High polygon sculpting is the task designated the largest amount of development time. This enforces the importance of high quality normal maps and assets in next generation games.

High polygon sculpts take in the region of 40 hours to complete, meaning an entire studio week is spent on creating the high polygon sculpt for the purpose of rendering an impressive and accurate normal map from the geometry amongst other useful exportable texture maps. However the time taken to create a high polygon sculpts will depend greatly on the type of asset being created.

As seen from Fig 5. Artist's estimates of time taken to create a high polygon sculpt for an average next generation asset varies from 8 to 80 hours. This is a 1000% variation of time taken; meaning that measuring the time taken to create high polygon sculpts within an asset is subjective and relative to the type of asset being created along with the detail requirements of that object.

Using Fig 6 as a guideline, a standard time plan can be devised for an average asset with considerations made depending on the individual requirements. In addition to the standardised time plan consideration must also be made to that of a junior game artist; allowing a percentage of time extra on each task to reflect the learning curve requirements compared to a senior game artist who has a defined workflow that they understand fully.

Through analysis of the data an algorithm for asset completion time requirement prediction can be theorised; for senior game artists and junior game artists. The following statements are a result of the research within this research dissertation.

It takes a developed game artist 127 hours on average to complete a game asset such as high detail static mesh or character.

This includes the following elements:

- Concept Art
- Base Mesh
- Optimised Low Polygon Game Engine Friendly Mesh with UVW Co-ordinates
- High Polygon Sculpt
- Diffuse Map
- Normal Map
- *Specular, Ambient Occlusion if required*

The data shows that it takes an average of 30 hours to arrive at the final concept art.
Subtracting this from the final completion time results in roughly 100 hours of work to get from 'Base Mesh' to 'Final Asset'.

Using a learning curve consideration modifier of 15% on time required to complete an asset this brings the final time to create a 'AAA' standard next gen game asset to 115 hours for a junior artist.

This equates to 2 studio weeks for junior game artist to create a final asset from the time they receive a final concept; it leaves an experienced game artist 1.7 studio weeks to complete the same amount of work.

- 100 hours will be the target for the creation of a character asset
- 40 hours will be the target for the creation of a static mesh
- 40 hours will be the target for the creation of a world texture

CHAPTER 6

PORTFOLIO CREATION

In the previous chapter research driven targets have been set for the creation of assets for use in Unreal Engine 3. Accurate measurements of the time taken to complete each section of the design process will be taken in order to provide data comparison and analysis with the final outcome.

In addition to the targets, a project gantt chart was created in order to regulate project progression within a time period. Deadlines are an important factor of game artist's jobs and failure to meet reasonable deadlines could result in an artist losing their job.

The project gantt is not a reflection of the time allowed to complete the game assets, but a reflection of the time management throughout a period of 6 months; the 3 assets production will be times accurately, however they have not been created in an industry environment where the sole focus of the artist is on the asset creation.

The challenge is to create 3 assets whilst adhering to the industry pipelines. The assets for creation are an anime style robot character for Unreal Tournament 3, a tree static mesh with advanced shaders and a tile able world texture.

Task Name	Duration	Start	Finish
Begin Prop Modelling	19 days?	Tue 28/10/08	Fri 21/11/08
Begin Character Modelling	19 days?	Tue 28/10/08	Fri 21/11/08
Begin Texture Creation	15 days	Mon 03/11/08	Fri 21/11/08
Prop Unwrap	5 days	Mon 05/01/09	Fri 09/01/09
Character Unwrap	5 days	Mon 05/01/09	Fri 09/01/09
Texture Tesselation Test	1 day	Fri 09/01/09	Fri 09/01/09
Begin Prop Diffuse Map	8 days	Mon 12/01/09	Wed 21/01/09
Begin Character Diffuse Map	8 days	Mon 12/01/09	Wed 21/01/09
Zbrush / Mudbox Prop	8 days	Wed 28/01/09	Fri 06/02/09
Zbrush / Mudbox Character	8 days	Wed 28/01/09	Fri 06/02/09
Export Normal Map - Character	1 day	Mon 09/02/09	Mon 09/02/09
Export Normal Map - Prop	1 day	Mon 09/02/09	Mon 09/02/09
Import Texture Into UE3	1 day	Tue 17/02/09	Tue 17/02/09
PolyCrunch Character	1 day	Wed 18/02/09	Wed 18/02/09
Prop Review	1 day	Tue 17/02/09	Tue 17/02/09
PolyCrunch Prop	1 day	Wed 18/02/09	Wed 18/02/09
Import Prop into UE3	1 day	Thu 19/02/09	Thu 19/02/09
Rig Character with Epic Skeletor	3 days	Fri 20/02/09	Tue 24/02/09
Import Character into UE3	1 day	Tue 24/02/09	Wed 25/02/09

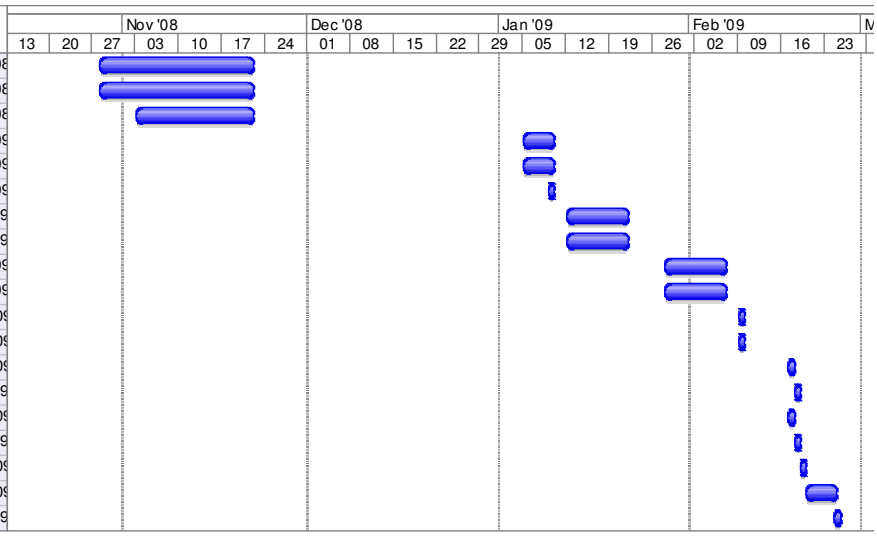


Fig 28

INDUSTRY STANDARD

Fig 29

CHARACTER

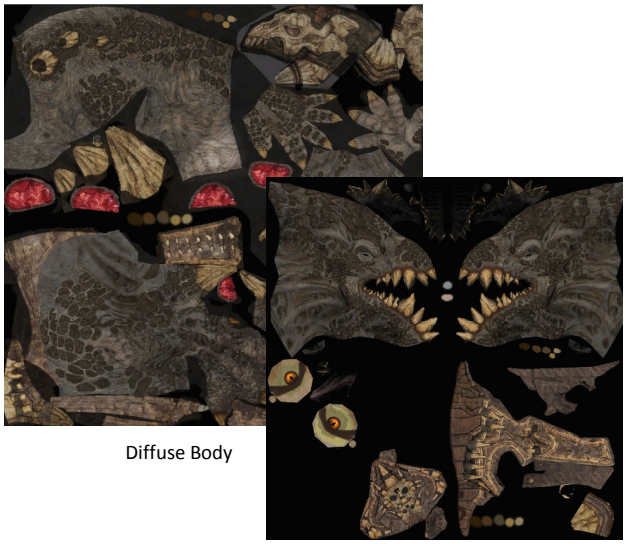
Fig 10 is a completed 'hero' character for Unreal Tournament 3. It is one of the Krall Models used in the final release of the game as a storyline NPC and a multiplayer avatar.

It consists of 10748 triangles and has an advanced shader applied to it to handle the complex requirements of the asset.

The model is fully compatible with all the required animations within the game to animate and react in the engine as expected.

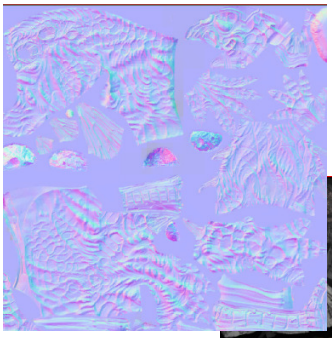
It has the correct sockets and pivot points along with the files needed to employ it as a character within the game within its own subclass of Krall Creatures.

Below are texture samples from the character; they are mixed with shader language nodes within the material editor to achieve the final texture for the finished character asset.

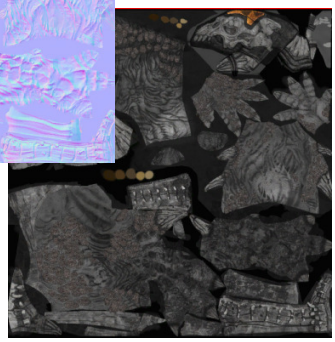


Diffuse Body

Diffuse Head



Normal Map



Specular Map

Fig 30

All images on this page are sourced from inside Unreal Engine 3 Editor

A screenshot of the material applied to the above Unreal Tournament 3 character

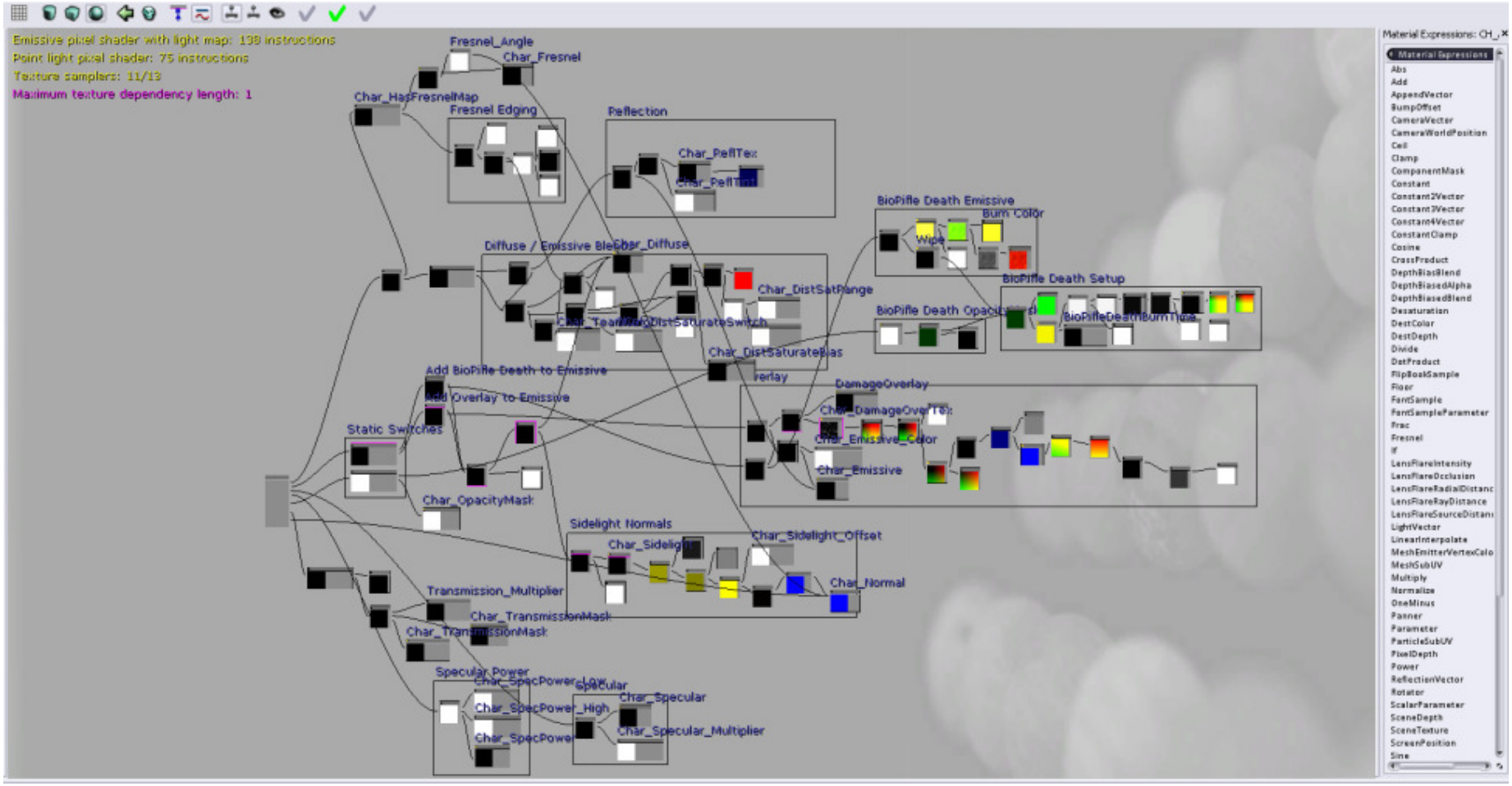


Fig 31

STATIC MESH

As previously mentioned, Unreal Engine 3 fully supports Speed Tree. It is fully integrated into the Epic Games workflow of map creation.

All trees on the map ONS-Torlan are created from SpeedTree meshes. The advantages of using SpeedTree to create foliage for environments are an incredibly quick creation pipeline with extended control of how the tree is procedurally generated and reacts within an environment.

The meshes generated by SpeedTree are also incredibly optimised for games engines, making intelligent use of alpha mapped planes for simulate leaf cover and low polygon base structure.

SpeedTree is an incredibly intuitive and easy way to create different kinds of trees, with features such as on the fly LOD and geometry optimisation.

Foliage in real life isn't perfect and the appearance of it is moulded by past events and its environment. SpeedTree caters for this with the ability to snap branches, grow geometry through an existing mesh, apply physics such as wind and shape the geometry via curl, twist, gnarl, push and pull the geometry until it is acceptable.

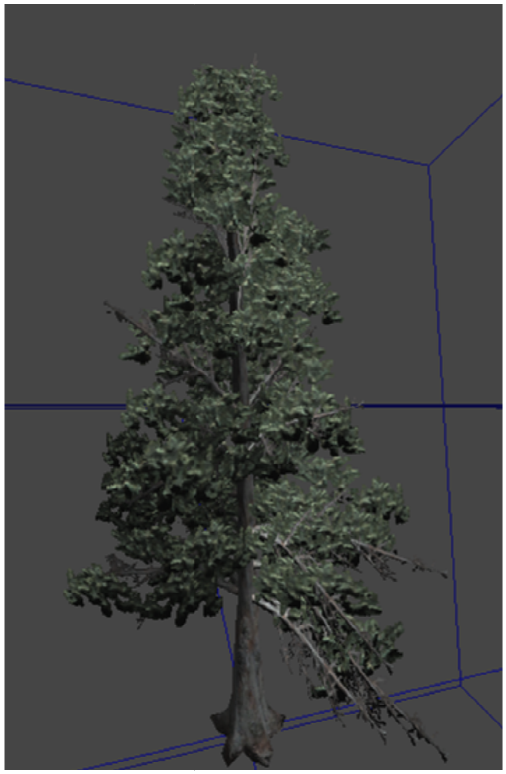


Fig 32

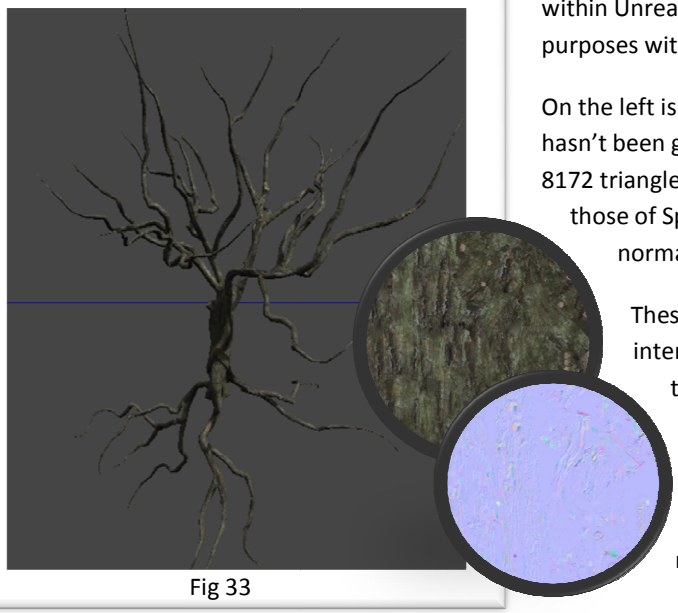


Fig 33

There are however, a few static mesh tree objects within Unreal Tournament 3, created for specific purposes within an environment or map.

On the left is an example of a static mesh tree that hasn't been generated by SpeedTree. It consists of 8172 triangles. This mesh is less optimised than those of SpeedTree and have 1024 diffuse and normal maps applied to them.

These meshes will have been created intentionally for a specific purpose, due to the exact right look not being achievable within SpeedTree.

The diffuse texture is photo referenced and a relatively simple material shader is applied to it.

All images on this page are sourced from inside Unreal Engine 3 Editor

WORLD TEXTURE

A world texture for a game can be created in a number of ways; before games engines had the ability to support normal maps many textures would simply be hand painted onto a UV layout.

Fig 34

In games for the next generation platforms and engines, normal maps are usually a requirement. The method of creating these normal maps can come from different techniques and solutions.

The previous method of hand painting textures is still relevant with software such as CrazyBump and Nvidia Normal Map plug-in allowing normal map generation from diffuse information. However, consumers today demand more and more realism within their real-time entertainment.

In order to achieve incredibly accurate realism from normal maps, a high polygon version of the mesh is created in order to replicate reality as close as possible from which the normal map is generated.

Within Unreal Engine 3 and indeed Unreal Tournament 3, the material creator has 11 different slots to plug shaders into in order to arrive at a final material. These are Diffuse, Emissive, Specular, Specular Power, Opacity, Opacity Mask, Distortion, Transmission Mask, Transmission Colour, Normal and Custom Lighting.

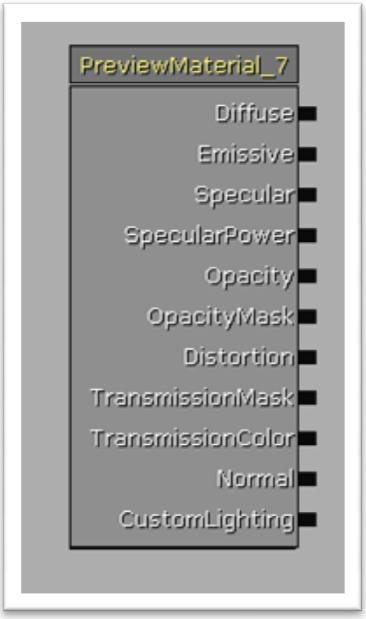


Fig 35

These are the slots that the engine supports information to be plugged into in order to affect the material. Each slot has a different purpose and effect on the material. Diffuse is used for colour information whereas Emissive is used for the glow effect apparent on many surfaces and characters. Emissive maps are an advanced way of enabling self illumination within the game engine.

As shown above, world textures are expected to tile in at least one co-ordinate direction. This is for the purpose of building BSP geometry using the texture. Some textures scale in the x and y co-ordinate direction, some in just one of these axis.

All images on this page are sourced from inside Unreal Engine 3 Editor

DISSERTATION CREATIONS

UNREAL TOURNAMENT 3 CHARACTER

Fig 36
Original Artist Permission Obtained

Forgoing the concept creation phase of the asset creation process, permission by the artist Fernando Faria was obtained to use his illustration of an anime robot as a concept for modelling.

Unlike many industry concept arts, only the perspective view was available and therefore left the interpretation of space and geometry had to be determined by the artist.

This made creating the base mesh more difficult than a standard workflow where front, back, side and perspective views are usually submitted to the game artist as accurate reference to begin modelling.

BASE MESH

Before the base mesh was created, a suitable Unreal Tournament 3 skeleton was exported from source files available on UDN. This was used as a proportion indicator and served as a mesh limitation as the body parts of the final mesh would need to be rigged to the standard skeleton in order to be compatible with the animations and functions within Unreal Tournament 3.

The original base mesh was created in 3DStudio Max in under 2 hours using basic polygon modelling techniques and primitive modelling, but due to the nature of the character being mainly hard surfaces, more work within the 3DSuite would be required later as Zbrush would only be used to add deformation to the small part of the mesh.

The only pieces of the mesh selected for sculpting were the chest armour pieces. The concept doesn't seem to require much fine detail, and because of this the decision was made to add battle scars to the chest pieces in order to demonstrate character, high polygon sculpting and where UV space cannot have symmetry applied.

ZBRUSH

Zbrush was used to add fine detail to the chest pieces and deform the main body section of the mesh which would later translate to variation in the generated normal map. The pieces were imported individually into Zbrush as OBJ's that had been exported from 3DStudio Max.

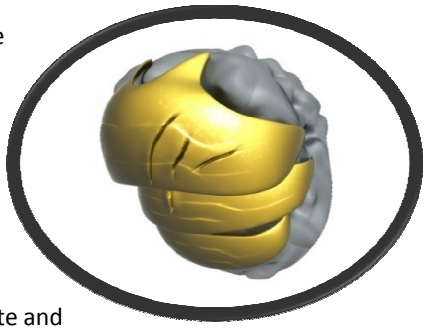


Fig 37

The standard rake tool within Zbrush was used to add a gouge battle scar to the robot. This was to give a sense of history and background to the character. Standard Zbrush sculpting tools such as nudge, inflate and

move were used to deform the body mesh into a more interesting shape than was created in 3DStudio Max. Once an acceptable result was achieved from these pieces, the high polygon versions were exported out individually so that they could be imported with consideration to machine and memory limitations within 3DStudio Max.

RETOPOLOGISATION

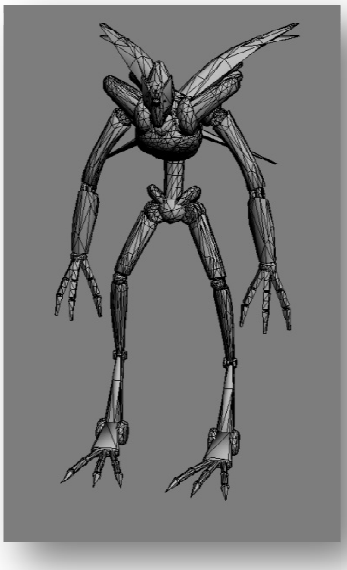


Fig 38

The retopologisation of the mesh was done in 2 stages. Firstly, the high polygon objects were polycrunched down to a suitable triangle count. After this, the geometry that had not been sculpted in Zbrush has loops removed in order to optimise the triangle count whilst retaining form. The high polygon pieces were preserved for the purpose of rendering a normal map that can interpolate the smooth curves of the high polygon pieces onto the low polygon mesh.

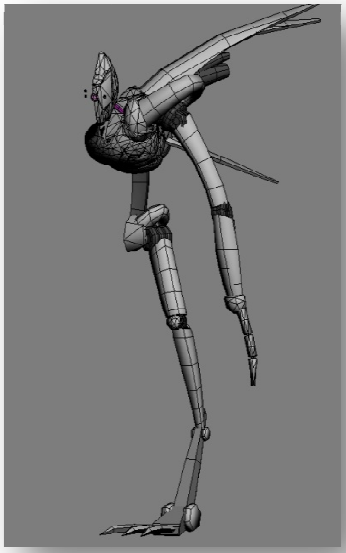


Fig 39

The centre body piece was then slice planed to add a line of symmetry and the resulting edges were optimised and realigned so that symmetry could be applied to the UVW coordinates. Unfortunately, some pieces of game meshes cannot be mirrored such as the chest pieces. For this reason they were polycrunched down to a reasonable triangle count and left as whole pieces.

UVW UNWRAP

Using a mixture of pelt mapping and DeepUV, the model was unwrapped in a standard way, applying the correct sections of geometry to the corresponding sections of the UV layout guideline. The pelt mapping was achieved by using the point to point seams function of 3DStudio Max; this involved drawing seams onto a mesh where they are desired then using the software to expand those faces into 2 dimensional space.

RENDER TO TEXTURE

In preparation for using the render to texture feature of 3DStudio Max, final checks were made to the UVW map and geometry such as resetting XForm, STL check and smoothing group association. The high polygon geometry and low polygon geometry were then aligned with each other ready to be projection mapped.

The projection modifier was applied to the low polygon geometry using the high polygon geometry as the modifier. The cage was then edited in order to allow for the best texture projection, usually this only

requires the cage to be rest and a universal push applied, but with tight geometry the cage vertices sometimes need editing in order to avoid errors.

Lastly, unique ray trace materials were applied to different types of geometry so that the diffuse map rendered out of the software was easy to understand as the different sections would have coloured seams.

2048x2048 Diffuse, Normal, and Ambient Occlusion maps were rendered out of the software, which corresponded to the UVW layout of the low polygon mesh.

At this stage the geometry of the low polygon object was mirrored. This allowed the UVW information to also be mirrored at the same time, and a game engine test was performed by applying the diffuse, normal and ambient occlusion maps to the model using a Direct X Metal Bump 9 material.

Fortunately there were no apparent errors within the resulting textures; these were then taken into Photoshop for minor alteration and texture painting.

TEXTURE PAINTING AND ALTERATION

The final texture creation for the character was done in 3 stages.

Stage 1 – Normal Map Alteration

Normal maps work by applying displacement information to a mesh via the differences in RGB scale of the normal texture map. In order to increase the effectiveness of the normal map, a levels mask was applied and the range within the levels decreased to give more emphasis on detail sections. Then via a new layer and unsharp mask, details that had become too emphasised were masked out down to the original normal map.

This allowed small details to be enhanced within the map whilst retaining the balanced output of the original normal map.

Stage 2 – Diffuse Map Painting

Diffuse map creation is achieved in many ways, however to allow an artist more indication of how the texture will apply itself to the model, using the ambient occlusion map on a multiply layer on top of the original diffuse allows the basic forms of the texture to be applied with no addition work from the artist.

The details of the mesh were then hand painted into the diffuse until arriving at the final diffuse texture.

Stage 3 – Specular Map Generation

The specular map for the character was generated using a combination of image alteration features within Photoshop. The final diffuse texture had its levels, hue, saturation, colour balance and brightness / contrast edited in layers in order to arrive at a suitable specialised specular map, applying the correct effect to the model where required.

SOCKETING AND RIGGING

Before exporting the Skeletal Low Polygon mesh out of 3DStudio Max, it is important to skin the character pieces to the correct bones of the unreal skeleton and realign pivot points to where the sockets are to be placed within Unreal Engine.

Once the low polygon mesh sections, diffuse, normal and specular map had been imported into the engine via the general browser, the socket manager needed to be called so that the engine could piece the character together. This is easily achieved so long as pivot points were set correctly in 3DStudio Max before exporting via Actor X.

This was the case therefore the sockets were given the correct parameters and the final character model was an asset within the engine. This was tested by applying an animation to the character to see if it deformed as expected.

CHARACTER SCRIPTING

In order to add a custom character to Unreal Tournament 3, a section of the customchar.ini script file had to be altered. This is essentially a text based version of the socket manager which instructs Unreal Tournament 3 how to construct the character within the game.

Once the character was tested and available from the custom character menu within the game the asset was considered complete and the package was cooked within the engine for distribution.

STATIC MESH

Concept Created by Daniel Eastlake
Full Use Granted by Artist

In order to make a comparison of the development times in the creation of foliage static meshes within a standard pipeline and the Unreal Engine 3 supported SpeedTree a custom tree mesh was created.

BASE MESH

Using the concept image on the left, a base mesh was created in 3DStudio Max, using a combination of primitive modelling and path deforms. The resulting mesh was then edited to result in the final base mesh which excluding the cylinder caps was composed of100% quads meaning that it could be neatly and accurately subdivided within the high polygon sculpting tool.

The base mesh was also split into different elements so that sections could be high polygon sculpted easily without overlap. This was compatible with the layers system within Mudbox and therefore easily imported with layer selections applied to it.

MUDBOX

Within Autodesk Mudbox, the tree was sculpted at a high subdivision level to give more detail and form to the mesh. Mudbox ships with many standard tools and texture stamps. One of the standard stamps within Autodesk Mudbox was suitable for creating subtractions and additions to the mesh to represent bark.

The mesh being created was not required to be accurate in any form meaning that the sculpting process was a quick, simple and on-the-fly process; and due to the intuitive layer system within Mudbox, different subdivision levels could be applied where appropriate and still exported back as a singular OBJ/ After the mesh had been suitably sculpted it was exported in high polygon form back into 3DStudio Max.

POLYCRUNCH

Once the high polygon OBJ export from Mudbox had been imported, Mootools Polygon Cruncher was used to drastically reduce the polygon count within the mesh whilst altering the form within the mesh as little as possible. This means that an incredibly optimised and instantly retopologised mesh was created in a few minutes.

The generated low polygon mesh then needed to be UVW unwrapped; to do this quickly pelt mapping was used. Using the “Point to Point” seams function within the 3DStudio Max UVW unwrap modifier, the ability to draw seams onto the geometry meant that they could be hidden fairly well with occluded

geometry. The faces selection was then expanded to pelt seams and then simulated to stretch the UVW's out to a small distortion level.

Once all sections of the tree were unwrapped and UVW coordinates scaled based on texture resolution required in that particular area the UV's were packed using the automatic packing tool within 3DStudio Max.

RENDER TO TEXTURE

With a retopologised low polygon mesh with UVW coordinates and a high polygon mesh all the requirements for render to texture were ready.

As with the character creation, the high polygon mesh was projected onto the low polygon mesh using the projection modifier. In the creation of the tree status mesh no manual editing of the projection cage was required. All that was performed was an automatic cage reset and a universal push until all the geometry was encompassed by the cage.

Diffuse, Ambient Occlusion and Normal maps were rendered out of the software for editing in Photoshop.

TEXTURE PAINTING

Similar to the character creation pipeline the ambient occlusion was used in conjunction with the diffuse map to give a base to begin painting. Suitable brushes were downloaded from DeviantArt and loaded into Photoshop.

After painting basic forms and grime onto the texture it was submitted for peer review which resulted in feedback which was used to add additional detail to the texture to give the mesh a unique look.

Upon finalising the diffuse texture and altering the normal map for the purpose of enhancing fine detail within the map an additional step was taken in preparation to be used as part of the material shader once imported into Unreal Engine 3.

ALPHA ALTERATION

In order to achieve the desired result in Unreal Engine 3, a custom alpha had to be made; for the purposes of optimisation and memory use reduction, rather than creating a new texture for the alpha, it was baked into the diffuse map. Unreal Engine 3 supports the use of a baked alpha map within the material editor.

A specialised alpha map that highlighted most parts of the green grime and dirt on the texture was made. This was achieved quickly using the select colour range tool and adjusting the fuzziness filter until an adequate selection could be deleted leaving the areas of the texture that weren't to be included in the effect in Unreal engine 3 could be filtered out.

MATERIAL SHADER CREATION

Within Unreal Engine 3, a basic diffuse, specular and normal material was created. In addition to this a selection of texture maps and nodes were added to apply an animated effect to a resulting texture. Using the Alpha map of the diffuse texture an emissive green glow was applied to specific parts of the texture and resulted in an interesting animated effect within the games engine. Below is a screenshot of the material shader within the editor.

WORLD TEXTURE

Fig 41

The world texture created for Unreal Engine 3 was based on an image sourced from Google images when simply searching for old wall. The texture attempted to recreate the varied form of a wall within a normal map to as higher degree as possible whilst retaining tile ability.

BASE PLANE

An old wall is a fairly organic and detailed structure, for this reason the decision to sculpt the details in ZBrush was made. Many textures in the Unknown Worlds upcoming game Natural Selection 2 are based on hard surface manufactured walls meaning that the high detail mesh can almost always be created in 3DStudio Max without the need to export out into a sculpting program.

Using the keyboard entry creation function of 3DStudio Max a plane was created to 2048 x 2048 scale. This was then exported into ZBrush as an OBJ.

ZBRUSH

Once the plane had been imported into ZBrush, it needed to be subdivided to a high polygon count in order to add detail to it. By default, when subdividing in ZBrush the result is automatically smoothed. This was not the desired result as each time the plane was subdivided the size decreased due to the corners being smoothed in towards the centre of the mesh. In order to override this function of ZBrush the SMT function was disabled. This meant that the plane could be subdivided without affecting the size or shape of the plane.

Once the original 2 triangle object had been subdivided to around 1 million polygons, a function of ZBrush called brush wrap was used to aid in the creation of tile-able geometry.

Using many custom alpha map's created in greyscale within Photoshop it was possible to stamp rough geometry into the sculpt and in conjunction with the brush wrap tool this stamp was applied many times in a cubic tile so that the sculpt had the ability to be tiled in the X and Y axis.

RENDER TO TEXTURE

Once the high polygon sculpt was finalised and exported back into 3DStudio Max, it was aligned with the originally created plane. The usual method of rendering out Diffuse, Normal and Ambient Occlusion occurred as normal but with one difference. Because the plane is a flat object, the projection cage is more of a projection window than a cage and must completely clear all geometry.

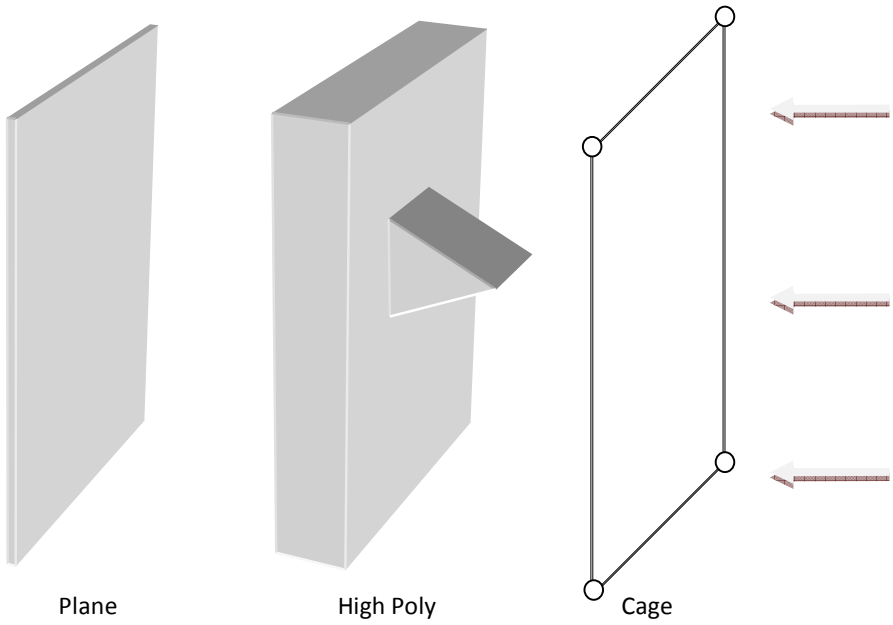


Fig 42

As can be seen by the above diagram, render to texture projects rays from the cage in the direction of the low polygon geometry to which the projection modifier is applied.

For this reason the render to texture 'sandwich' must depict the above diagram in order to prevent errors occurring when exporting maps, in particularly the normal map.

TEXTURE PAINTING

As with all the texture painting in the portfolio that accompanies this dissertation, various techniques and tools within Photoshop were used to achieve the final result using the same selection of exported maps from render to texture. However due to the nature of the asset special consideration had to be made with regards to the level of detail and tiling within the final result.

Brushes, filters and other resources were gathered from Internet sources such as DeviantArt in order to create the finalised diffuse, specular and normal maps.

MATERIAL SHADER CREATION

Using instruction from Unreal Developer Network, the ability to create a normal mapped texture with displacement was learned. This was applied to the shader used to create the material for the final world texture. It included using a bump offset node within the shader which translated displacement information from the difference between UV's and the normal map.

After the material was created, tweaks were made in the settings of the normal map in order to achieve the best result. The reason for this is using a bump offset in conjunction with the UV's of a normal map is only a way to create the illusion of displacement depth and is not an accurate solution. To eliminate the margin of error as much as possible when applying the world texture to a surface, a few settings within the normal map were tried and tested before arriving at the final product.

CHAPTER 7

TIME ANALYSIS AND TESTING

The time taken to complete each asset, at every stage was recorded in order to draw comparison to experienced artists workflows. As seen from Fig 43 below the targets set were adhered to mostly by balancing workflow against deadline. The assets overshot deadline by 6.5 hours, less than one studio day. This is an acceptable amount of time for a junior game artist to over-run by.

The deadlines were met to as higher standard as possible by using a planned workflow and understanding where workflow could be altered to save time but retain quality.

		Character	Prop	Texture
Base				
	Basic Form	1.5	2	0.5
	Tweak	0	0	0
HP				
	High Poly	10	0	0
	Tweak	5	0	2
LP				
	Optimisation	8	0	0
	Tweak	8	2	0
Polycrunch				
	Batch Process	5	1	2
	Selection	5	1	1
Sculpt				
	Sculpting	4	7	5
	Import	2	1	2
Rigging				
	Skeleton	1	0	0
	Skin	15	0	0
	Import	15	0	0
Unwrapping				
	UVW	4	2.5	1
	Tweaks	3	2	1
Texturing				
	Diffuse	3	1	3
	Normal	2	2	3
	Specular	0.5	1	1
	Alpha	0	1	0
	Painting	9	12	19
Coding				
	Ini	1	0	0
	UPK	1	0	0
	Unreal ED	6	1	0.5
		Total	**Total**	**Total**
		109	36.5	41
		Target	**Target**	**Target**
		100	40	40
		Difference		
		-9	3.5	

Fig 43

As clear from Fig 43 and Fig44 the different types of asset require very different amounts of time in different sections of the creation process.

The character asset required it to be rigged to a standard character within the 3D suite which posed problems, meaning that this section took longer than intended.

Using the research into workflows and efficiency, this setback was offset by the time saved in other stages of the asset creation process.

This means that using a defined and relevant pipeline or workflow can not only benefit studios with quicker creation process, but include the ability to leave miscellaneous creation time to overcome unforeseen problems that could otherwise impact on deadlines.

Timing each section of the asset's creation process meant it was possible to compare sections with that of the 12 specimen artists.

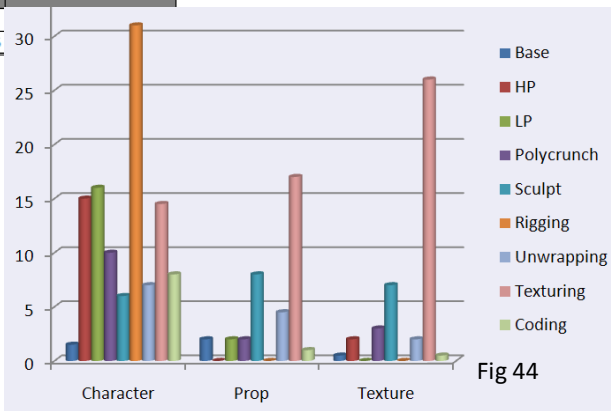


Fig 44

Using the information in Fig 43 and Fig 44 in relation to the data in Fig 46; it is possible to conclude trends and anomalies. In Fig 45, the main sections in the creation of ERU are displayed on the graph. Rigging was the section that required the greatest portion of time, an unforeseen situation. The base mesh, high polygon and UVW unwrapping have trends between the creation time.

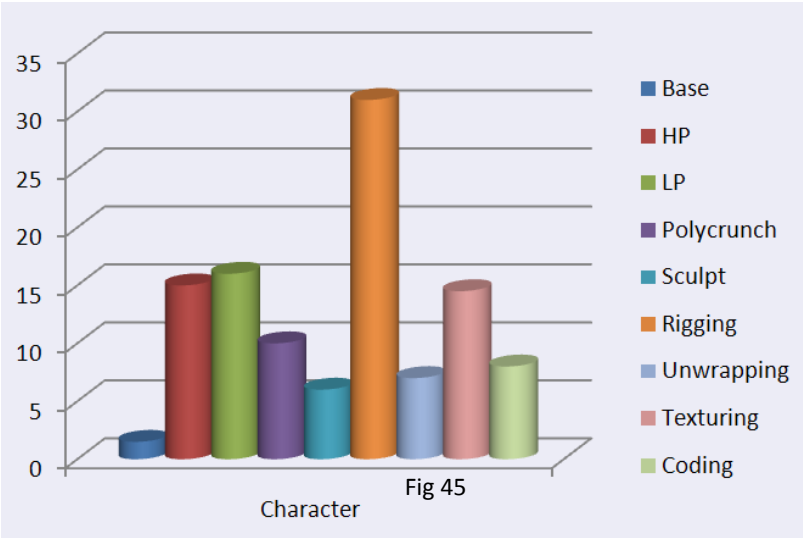


Fig 45

The Sculpt and High polygon mesh are all part of the same section within the surveyed artist's workflow and the hours spent on this section correlate when this addition is applied.

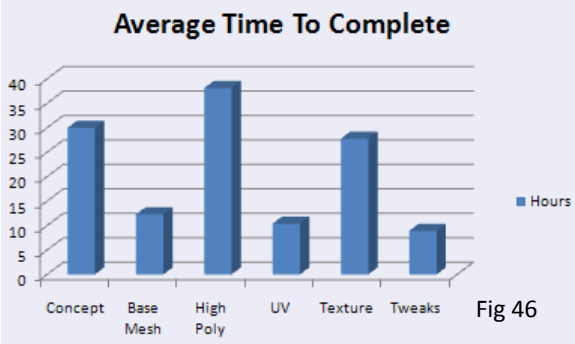


Fig 46

Using the general trends and similarity of time taken to create the character compared to other artist's estimates, the validity of the surveys is verified somewhat. The need for further investigation and a larger sample of artists would be needed to emphatically conclude anything from the data.

The graphs are however encouraging; and should further research be made into the time estimates and workflows of artists the results would be broken down into separate sections, comparing the time taken by professional artists on "art tests". Art tests are simple design challenges given to potential employees as a standardised test of their ability to create from concept.

Pipeline flow diagrams created based on the research information can be found in Figs 47 to 50. These allow an artist to plan a route through the asset creation via various software packages quickly and easily.

CHAPTER 8

REFLECTION AND REALISATIONS

Upon reflection, due to the unique requirements and styles of everything made that is created for use in a game. A unified ultimately efficient pipeline is impossible to theorise. However using a loose structure of workflow in conjunction with tools that add useful features to the workflow will allow a game artist to make better production path decisions when attempting to create an asset.

New software techniques improve workflow; common tasks within these packages can often be shortcut or hot keyed so that the task can be performed via a keyboard macro rather than having to manually navigate menus and processes in order to achieve a common task. This is an area of efficiency improvement that was not studied in this research dissertation but is relevant.

Through the data gathered, which was tested with by the portfolio it is reasonable to assume that all artists can improve their workflow. Some more than others depending on experience but due to the new and unique challenge each piece of work brings, some design decision can be improved.

In order to aid the decision making of a game artist, senior or junior; the below flowcharts have been created in order to give a basis for the production path of creating a game asset. Along with an average and predicted completion time for both junior and senior game artists.

The path a workflow takes can change all the time due to requirement; this is especially clear in the modelling workflow as what the final model is intended to be generally defines the way in which it is built. This does not only apply to how the final thing is meant to look, but also what the model is made of and how it should react in the world are all factors that have an impact on workflow choices.

Hard surface modelling has a very different construction process to creating organic forms, and when creating an armoured human, a mixture of many techniques is used to reach the final product.

This also applies to texturing, where because the wall in the portfolio is old and not a result of modern manufacturing, it was easier to sculpt the high polygon mesh, whereas to create science fiction walls and other textures that are meant to have been manufactured, it's usually easier to model the high polygon in a 3D suite, a reflection echoed by Matt Regan in recent email correspondence.

Using a base production path coupled with knowledge of how 3rd party add-ons and plug-ins can speed up sections of production should allow all game artists to make better decisions in all areas of their artistic workflow.

There are many sections of the portfolio work that could be improved aesthetically or created in a more efficient manner by using the below charts and tables.

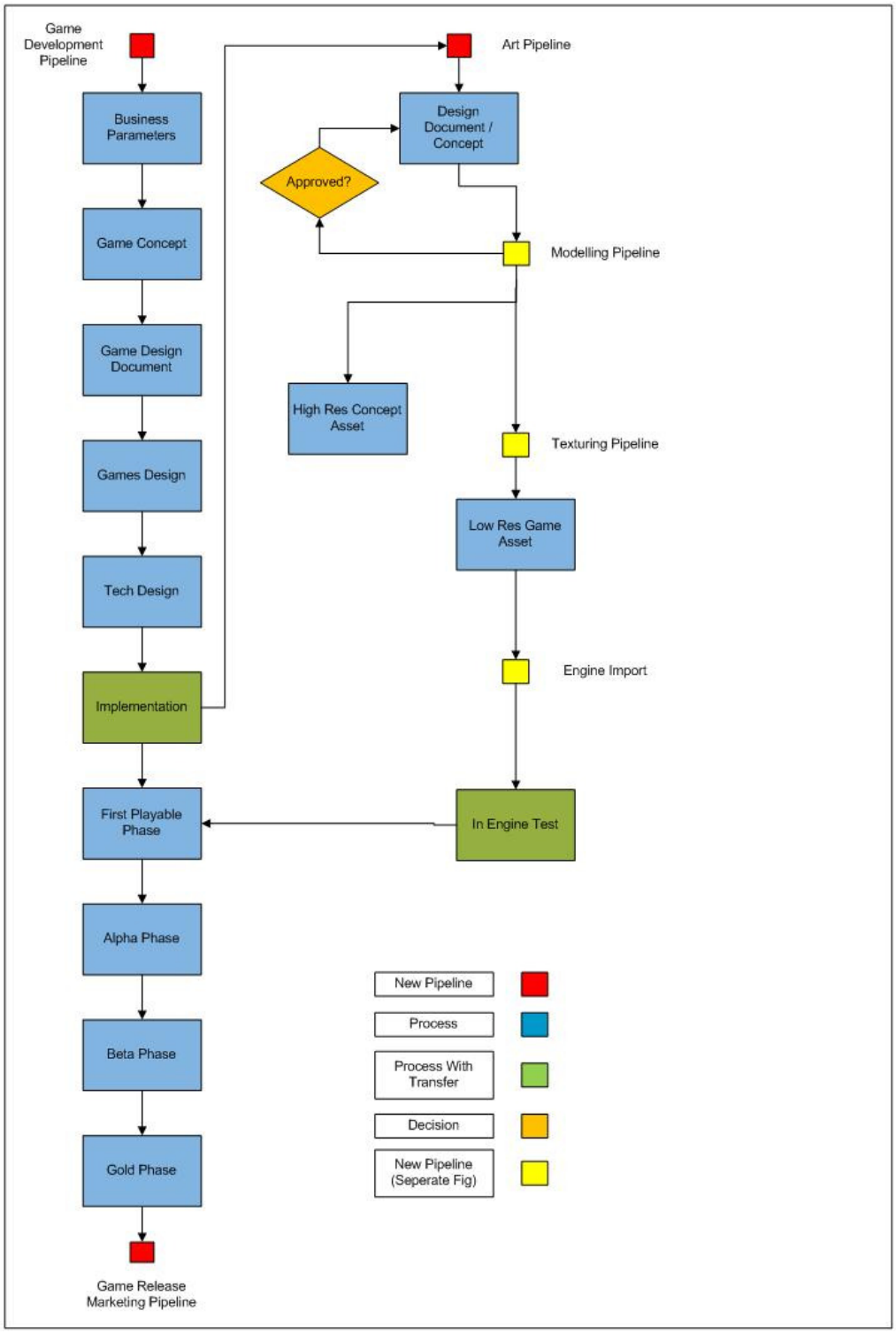

Game Development Pipeline
Business Parameters
Game Concept
Game Design Document
Games Design
Tech Design
Implementation
First Playable Phase
Alpha Phase
Beta Phase
Gold Phase
Game Release Marketing Pipeline
Art Pipeline
Design Document / Concept
Approved?
Modelling Pipeline
High Res Concept Asset
Texturing Pipeline
Low Res Game Asset
Engine Import
In Engine Test
New Pipeline
Process
Process With Transfer
Decision
New Pipeline (Seperate Fig)

Fig 47

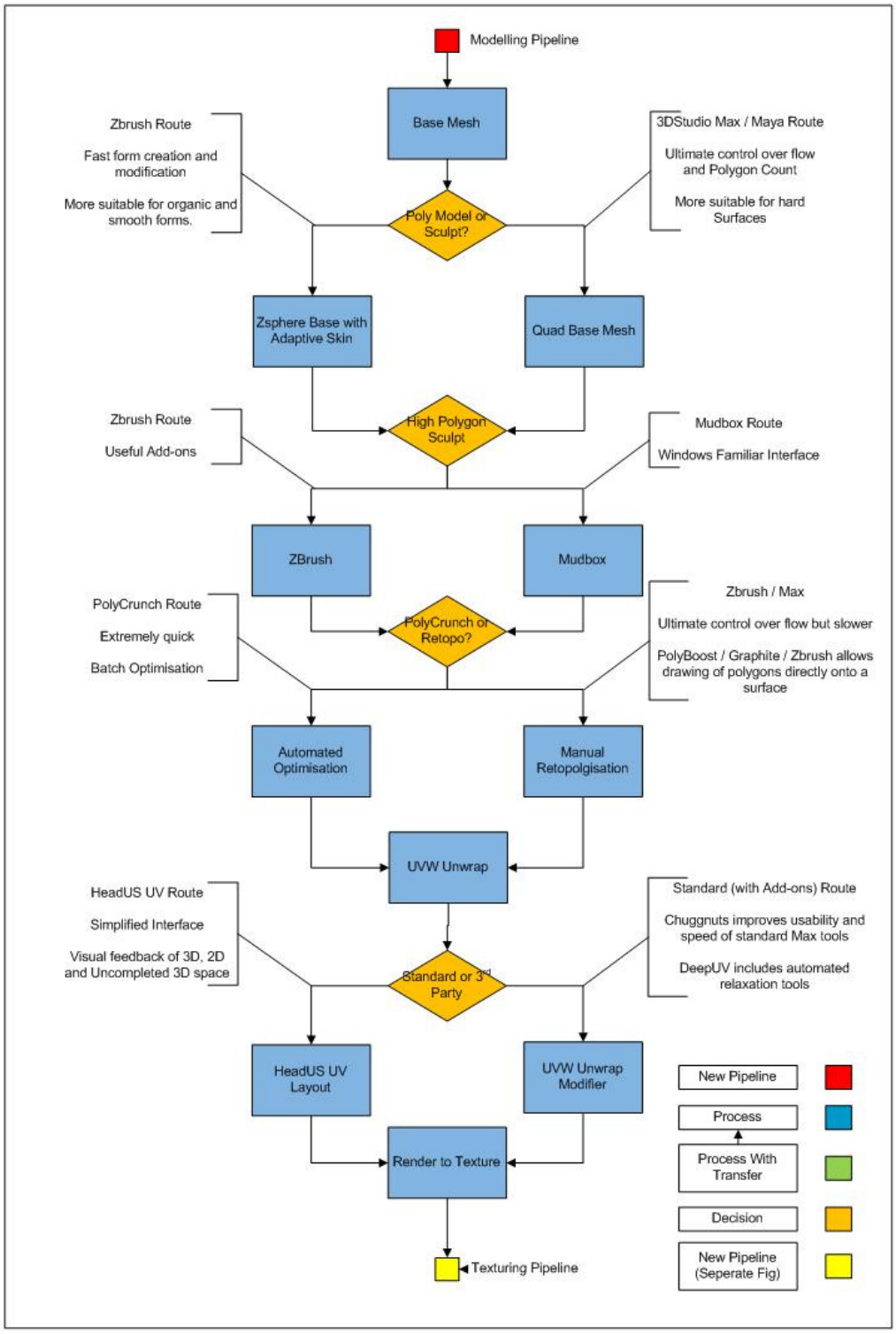

Modelling Pipeline
Base Mesh
Zbrush Route
Fast form creation and modification
More suitable for organic and smooth forms.
3DStudio Max / Maya Route
Ultimate control over flow and Polygon Count
More suitable for hard Surfaces
Poly Model or Sculpt?
Zsphere Base with Adaptive Skin
Quad Base Mesh
Zbrush Route
Useful Add-ons
High Polygon Sculpt
Mudbox Route
Windows Familiar Interface
ZBrush
Mudbox
PolyCrunch Route
Extremely quick
Batch Optimisation
PolyCrunch or Retopo?
Zbrush / Max
Ultimate control over flow but slower
PolyBoost / Graphite / Zbrush allows drawing of polygons directly onto a surface
Automated Optimisation
Manual Retopolgisation
UVW Unwrap
HeadUS UV Route
Simplified Interface
Visual feedback of 3D, 2D and Uncompleted 3D space
Standard or 3rd Party
Standard (with Add-ons) Route
Chuggnuts improves usability and speed of standard Max tools
DeepUV includes automated relaxation tools
HeadUS UV Layout
UVW Unwrap Modifier
Render to Texture
Texturing Pipeline
New Pipeline
Process
Process With Transfer
Decision
New Pipeline (Seperate Fig)

Fig 48

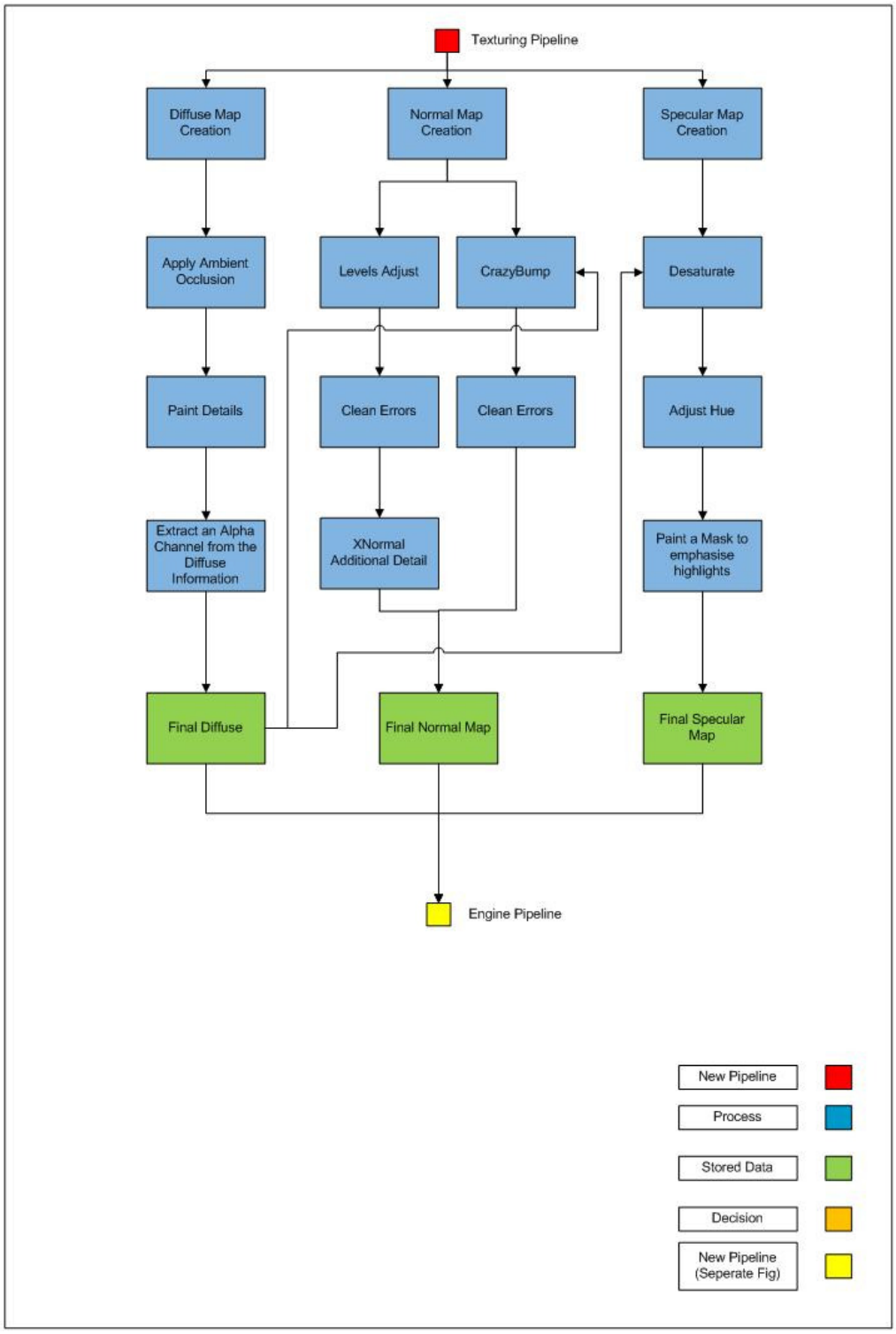

Texturing Pipeline
Diffuse Map Creation
Normal Map Creation
Specular Map Creation
Apply Ambient Occlusion
Levels Adjust
CrazyBump
Desaturate
Paint Details
Clean Errors
Clean Errors
Adjust Hue
Extract an Alpha Channel from the Diffuse Information
XNormal Additional Detail
Paint a Mask to emphasise highlights
Final Diffuse
Final Normal Map
Final Specular Map
Engine Pipeline
New Pipeline
Process
Stored Data
Decision
New Pipeline (Seperate Fig)

Fig 49

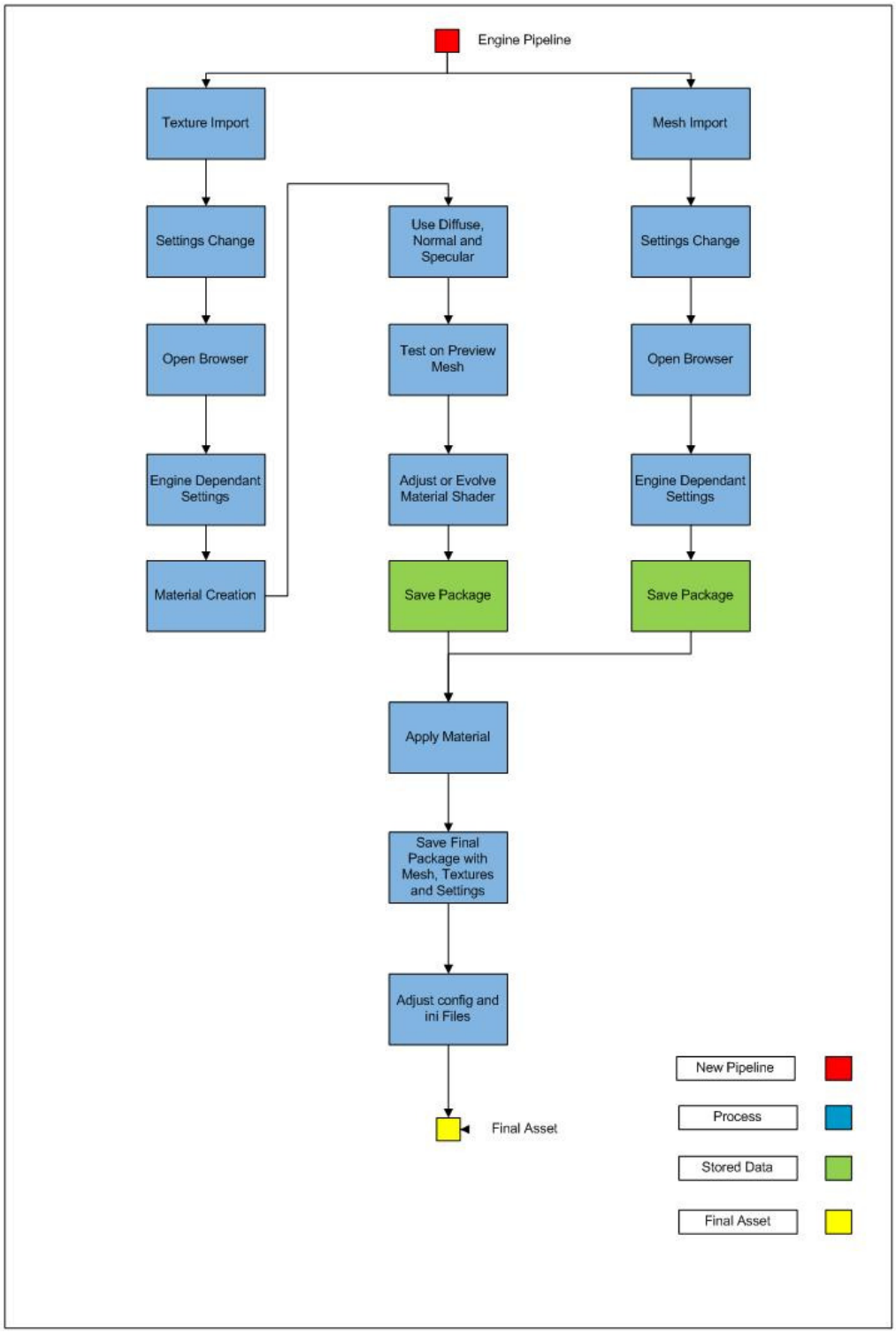

Engine Pipeline
Texture Import
Mesh Import
Settings Change
Use Diffuse, Normal and Specular
Settings Change
Open Browser
Test on Preview Mesh
Open Browser
Engine Dependant Settings
Adjust or Evolve Material Shader
Engine Dependant Settings
Material Creation
Save Package
Save Package
Apply Material
Save Final Package with Mesh, Textures and Settings
Adjust config and ini Files
Final Asset
New Pipeline
Process
Stored Data
Final Asset

Fig 50

CHAPTER 9

DELIVERABLES

UNREAL TOURNAMENT 3 CHARACTER

"ERU" THE ROBOT

This portfolio piece is a fully functional Unreal Tournament 3 character for use within the latest PC version of the game. It animates as expected and is also compatible with the Unreal Tournament 3 Titan Pack.

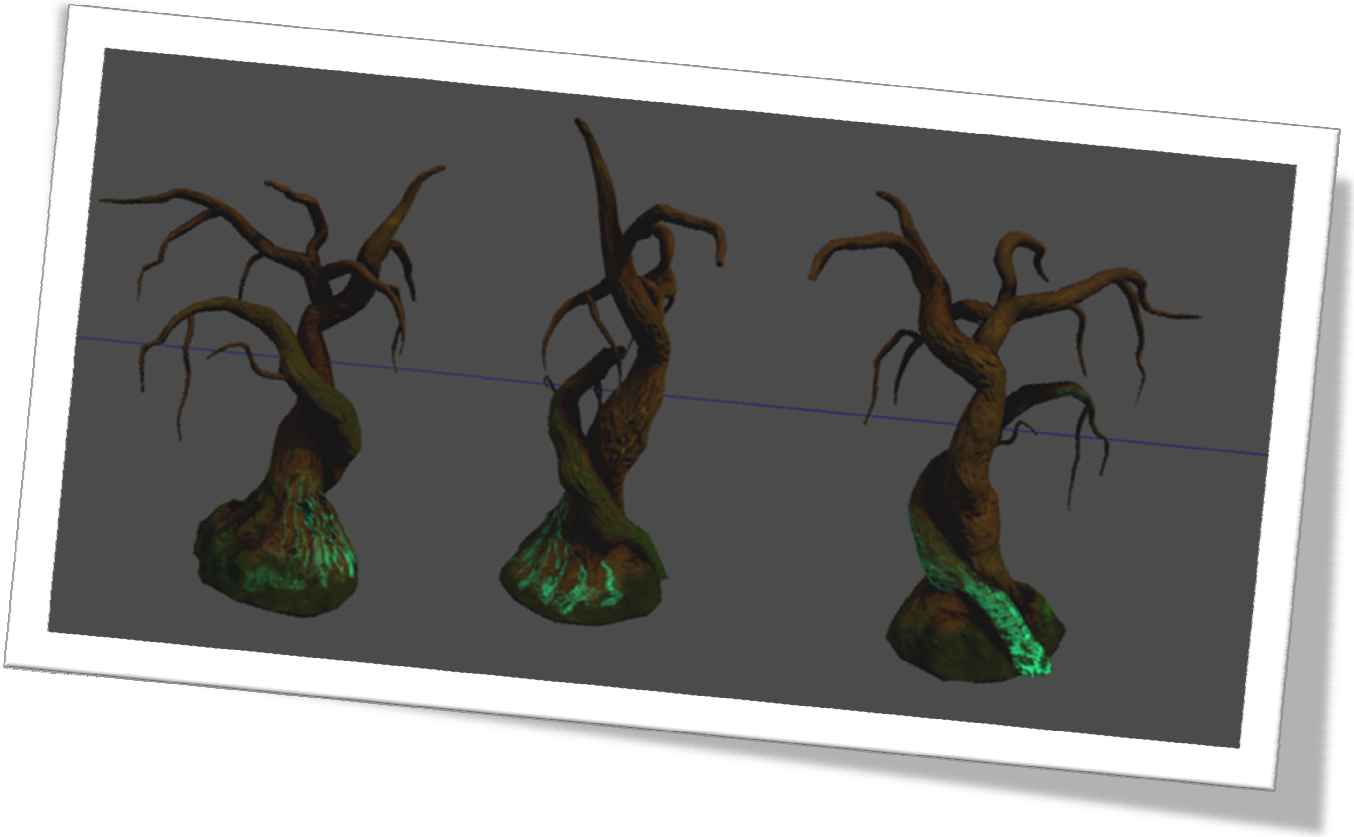
2 x 2048 diffuse textures

2 x 2048 specular textures

2 x 2048 normal map textures

1 Complete Mesh, 5 Separate Sections

STATIC MESH



EERIE TREE WITH ANIMATED EMISSIVE ALPHA

This portfolio piece is a fully functional static mesh with advanced shader. It has physics collision applied to it generated from within Unreal Engine 3. It is available within the custom package supplied with the portfolio and has the source files capable of being imported into any modern games engine.

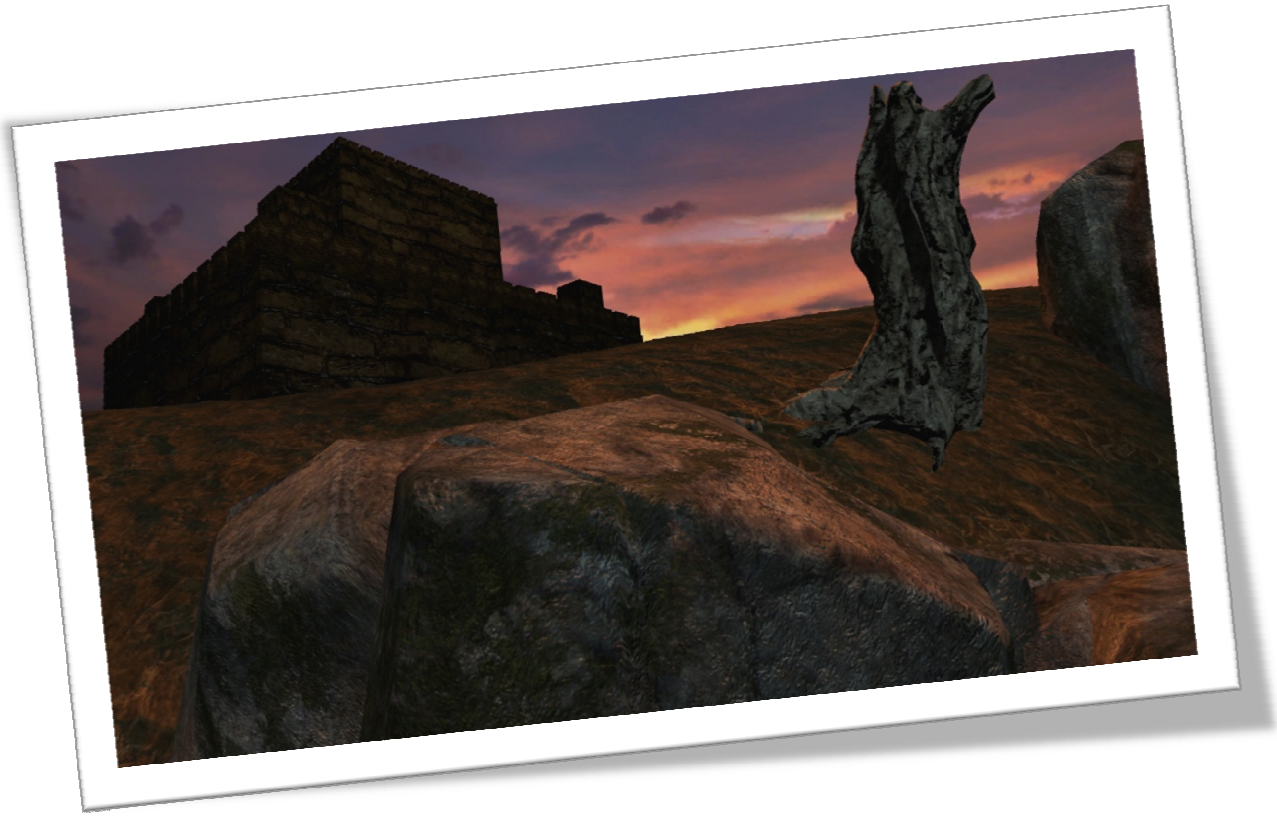
1 x 2048 diffuse textures

1 x 2048 specular textures

1 x 2048 normal map textures

1 Static Mesh

WORLD TEXTURE



WORLD TEXTURE WITH DISPLACEMENT NORMALS

This portfolio piece is a compiled material for Unreal Engine 3 supporting displacement normals and tiling in the x axis. It also has the ability to create different versions that perform differently or have a different look.

The material shader has 2 custom controls applied:

- Specular Control
- Hue Control

This means that the world texture can be manipulated in a material instance constant in order to achieve the desired result without having to change the original texture files. For example an orange glow and specular correction was applied for the above scene to simulate the sun's orange glow against the brickwork.

1 x 2048 diffuse texture

1 x 2048 specular textures

1 x 2048 normal map textures

CHAPTER 10

CONCLUSION AND RECOMMENDATIONS

In conclusion, game artists may find the information within this dissertation useful to their workflow and the planning of creating an asset; however many game artists have a defined workflow and will not see the need to use a flow chart plan in order to arrive at the final asset efficiently.

A junior game artist should benefit from the research and advice within this document and hopefully use the charts to benefit the efficiency and objectivity of their pipeline or workflow, especially when working within Unreal Engine 3 on different types of assets.

The portfolio demonstrates the ability to create content for games engines using the artist pipelines studied, along with the ability to speed up and improve quality of work by adapting workflow and pipeline.

As mentioned in many of the returned surveys, the best way to improve a pipeline or workflow is experiment with new techniques and tools which may help. Discovering these new techniques is easily done by reading artist interviews and post mortems; Along with “making of” threads where an artist will break down the creation process of their art.

Communication is essential to advancing a workflow, and with many online communities that support games and CG design, it’s relatively easy to find the tips, tricks and software that will allow game art to be created quicker and easier in the future.

The dissertation aimed to create 3 different types of assets which it achieved, however some aspects of the original plans for the assets such as levels of detail models have not been completed. This is due to the time restrictions and the desire to complete the assets within the time target. It also aimed to produce an algorithm to calculate the time a junior artist would take on an asset compared to a confident game artist.

The difference in time is a 10% allowance for junior artists, which was reflected in the targets and end product; the research allowed the final assets and algorithm to be created.

Problems such as material instancing, material parenting and rigging were overcome with research and communication with other artists. Also the original workflow was adapted throughout the creation process based on decisions from the research and other artist’s recommendations.

The final products suffered from a lack of 2D texturing skills from the artist; however the modelling process was achieved comfortably. The final assets were successfully imported into the engine, after using previously unexplored techniques such as render to texture, pelt mapping, Mudbox sculpting and others.

APPENDIX A

GLOSSARY AND SPECIALIST TERMS

CUDA - Compute Unified Device Architecture, a set of development and coding tools that allow developers to increase the performance of real-time applications in conjunction with NVidia graphics cards.

AAA – A game development project given a large budget with large expected sales

Middleware – A software solution to improve or accelerate development

FPS – Frames per Second, a measurement of how many images are displayed in the real-time application per second.

In House – The term given to staff operating within the development studio

PhysX – The name given to the popular physics processing software employed in many games today

HDR – High Dynamic Range, The ability to simulate bloom and how an eye reacts to rapid changes in lighting conditions.

DX9/DX10 – Direct X, an API standard in a great percentage of games that allows next generation rendering techniques and effects.

API – Application Programming Interface, A set of function, procedures, methods or classes that an OS provides to support requests from computer programs

OS – Operating System, the core software that a computer runs on to allow a user friendly experience

Low / High Poly – A description of the amount of triangles present in a mesh or model

OBJ – A geometry definition file format first developed by Wavefront Technologies

LOD – Level of detail, a reference to the varying number of triangles in a dynamic mesh that reduces its triangle count based on the distance from the game camera

ASE – ASCII Scene Export, an exportable format compatible with Unreal Engine 3

UPK – Unreal Package, a zip file for content for Unreal Engine. It allows many files to be stitched together in one file.

STL check – A modifier in 3DStudio max that finds errors in geometry and highlights them

Greeble – A 3rd party modifier for 3DStudio Max that allows fine a library of small details to be re-used on a mesh easily

GUI – Guided user interface, a visual interface that the end user sees

Sockets – Points within game models that are used to interact with different game assets

APPENDIX B

SURVEYS

INSTRUCTIONS

This survey is intended for GAMES INDUSTRY AND FREELANCE CHARACTER AND PROP ARTISTS

Please answer as many questions as possible. Feel free to skip any questions which are not applicable or you do not wish to answer.

Please return the survey to Kane Forrester when you are finished by attaching it in an email to Kaneth@gmail.com. Please notify Kane Forrester by email if you were unable to return the survey if possible.

If you have any questions during the survey, please contact Kane Forrester by phone or email.
(+44)7707534177 United Kingdom Phone Number
Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?
Adam Schuman. Senior Character Artist

2. Please briefly describe your responsibilities within your organisation.
I Model high and low resolution characters, unwrap, texture, material setup. Help define the look/ style of characters throughout the game. And oversee some character outsourcing.

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)
-model quick base model, setup UV's before taking base into Zbrush.
-sculpt model
-texture sculpt
-export pieces out of Z brush
-reassemble and polycrunch down the high resolution pieces to be able to rip normals out of 3DSmax
-create low resolution model (starting from my initial base)
-unwrap model
-rip normals and base textures (from the high resolution assets)
-clean up ripped normals, and diffuse texture.
-rework diffuse and create other needed textures: specular, specular power, emissive, alpha, etc.
-import character into engine, create material, and assign textures.
-tweak textures

3b. Describe the process from concept to finished model within your current art pipeline.
Concept, revisions upon concept/ repeat, finalized, handed to character artist; he creates using the steps above.

4. Do you encounter problems in transition from modelling to texturing process?

If yes, please describe the most common problems.
No

If no, what do you do to avoid problems?
Know my tools

5. How often do you collaborate with another artist to determine the modelling approach on an asset?
Whenever possible. It’s always good to get another point a view. Free crits are priceless

6. Do you find collaboration helpful in the modelling process?
If yes, why?

Yes, you should collaborate in everything you do. Learning to hear and use crit's will make you better, no matter what your career is.

If no why?

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

It’s a variable. Generally it should be officially signed off before ever hitting my desk, if not you have a week management/ checks and balances structure, and someone should be held accountable.

8. Is there collaboration between modellers and texture artists before modelling begins?
If yes, what do you discuss?
In most cases the modeller is also the texture artist. I've always textured my own work. But if so, I’m sure there is some. This that can be brought out through crazy bump, instead of having to sculpt tons of detail.

Why is it helpful?

9. Do you receive a design document before you begin modelling?
I receive a concept sheet, and generally go talk to the leads to find out the specifics of what it will be doing, so that I give the animator the character the way it needs to be. Ex: if your character needs to be in pieces for swapping mesh's so a crowd looks more randomised, than just having 2 of the same people all around.

10. How does the design document aid you with modelling?

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

If no, how are the tasks delegation resolved?

12. Have you ever strayed from the design document to design a better object? I get paid to create what has been given me to create, not to recreate someone's vision.

If yes, how did that effect the object's movement down the production pipeline?

13. How often do you remodel an object at the request of a creative director? As many times as it takes unfortunately.

14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

15a. Do you consider the UV layout of an object before modelling?
If yes, how?
no

If no, why?

it's not always relevant, sometimes it will be, but with next gen games, there are so many things that can be done; usually the UV's will get changes much later on in the process due to some random effect someone may want.

15b. Can the complexity of the UV layout of an object effect/change the modelling approach for that object?

change the modelling approach.... not necessarily. If you have a huge character with tons of asymmetrical stuff, then you might try to see where you can skimp on detail due to having too much info to try and show on a limited map resolution.

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?
they can be, depends on the object. with characters, we have pelt mapping, saves tons of time, but can still take a while to tweak.

16. Does your manager require you to model an object with the UV layout in mind? No

17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?

don't deal with them.

If Yes, why and how much longer would it take them to achieve the desired result?
18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

Concept Artwork: 1 to 7 days
Base Mesh: 1 to 2 days
High Poly Sculpt: around 2 to 3 weeks
UV Unwrap: 1 to 4 days
Texture (Inc Normal's, Specular and Glow etc):1-8 days
Asset Tweak: variable
Game Engine Import: 30 min

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

INSTRUCTIONS

This survey is intended for **GAMES INDUSTRY AND FREELANCE CHARACTER AND PROP ARTISTS**

Please answer as many questions as possible. Feel free to skip any questions which are not applicable or you do not wish to answer.

Please return the survey to Kane Forrester when you are finished by attaching it in an email to Kaneth@gmail.com. Please notify Kane Forrester by email if you were unable to return the survey if possible.

If you have any questions during the survey, please contact Kane Forrester by phone or email.
(+44)7707534177 United Kingdom Phone Number
Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?
Alan Van Ryzin - Senior Artist

2. Please briefly describe your responsibilities within your organisation.
Model and Texture Weapons, and Vehicles, also aid in helping other artists on various other tasks.

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)
High poly model, Low poly model, Low poly uv, hi to low poly bake, low poly texture, low poly rig/export to game engine

3b. Describe the process from concept to finished model within your current art pipeline.
The concept artist concepts the model, which gets approved and set off to the modeler who models the high poly and the low poly, that then gets uv'ed either by myself or by the modeler and then textured by me. Later, the model gets rigged up and exported into the game with textures.

4. Do you encounter problems in transition from modeling to texturing process?
If yes, please describe the most common problems.

Typically no, after doing this for a long time you learn to avoid problems that you often encounter, but typical problems might be from switching between Maya or 3ds max, or getting decent UV space and enough resolution so that it looks good in game, etc.

If no, what do you do to avoid problems?
Be careful in your process and learn from problems in the past.

5. How often do you collaborate with another artist to determine the modeling approach on an asset?
Every day we work closely together with each other in order to deliver the highest of quality and solve issues.

6. Do you find collaboration helpful in the modeling process?
If yes, why?
Yes, collaboration helps get every ones creative eye on the process and helps us raise the visual bar because it intensifies the process of iteration, iteration is key.

If no why?

7. How often do you remodel an object because of problems, miscommunication, or changes in art direction or final needs of the asset?
Not often, but it is a common thing, often because of design changes. Communication issues are rare as we all try to work together.

8. Is there collaboration between modelers and texture artists before modeling begins?
If yes, what do you discuss?

Yes, before beginning the texturing phase the modeler would talk to the texture artist and share their ideas and how they wanted things to look in certain areas, etc.

Why is it helpful?
It clears up issues and guesswork for the texture artist in knowing what the modeler was planning on certain areas of the model.

9. Do you receive a design document before you begin modeling?

typically no, we often just work off of concept but we do have a general design and functionality direction beforehand, especially animation direction so we know how it will move in game.

10. How does the design document aid you with modeling?
Not a lot, but in general terms, yes.

11. Does the design document aid you with determining what needs to be done in the modeling phase and what can be left to the texturing artist?
not really.

design docs are typically higher level and don't dictate art, it's usually the art director with the general vision.

If no, how are the tasks delegation resolved?

through communication between lead artist, art director, and producers.

12. Have you ever strayed from the design document to design a better object?

yes, this is often, the design document is usually just a general guidance, and we usually stray from things and allow ourselves to be creative to achieve new things and make things look different, etc.

If yes, how did that effect the object's movement down the production pipeline?

It typically doesn't affect it much, as most artists know how far to stray where it won't affect pipeline too much. I.e., we wouldn't want to make a gun bright red when we are attempting to be a realistic shooter game. Even if we did, the art director would catch it and guide the artist back in track.

13. How often do you remodel an object at the request of a creative director?
this is mostly a rare occurrence because we usually try to work closely with the directors so there isn't a lot of re-doing work.

14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

sometimes me, sometimes others, it depends on who has time to do it.

15a. Do you consider the UV layout of an object before modeling?
If yes, how?

If no, why?
modeling is usually a phase where we get the general silhouette down and shape, proportions, etc. UV's aren't usually very depending on that so we leave the uving up to a separate stage.

15b. Can the complexity of the UV layout of an object effect/change the modeling approach for that object?
yes, but only in certain scenarios.

15c. Can the layout of the UV's of an object after modeling be difficult or time consuming?

yes, but you can get pretty fast at it after doing it for a while.

16. Does your manager require you to model an object with the UV layout in mind?
in some ways yes, but its only in a way that wouldn't limit the modeling phase, most artists have general rules they follow.

17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?

yes this is rather typical.

If Yes, why and how much longer would it take them to achieve the desired result?

depends, it might add some work, it's hard to say specifically.

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

Concept Artwork:
Base Mesh: 2-3 days
High Poly Sculpt: 5-7 days
UV Unwrap: 1-2 days
Texture (Inc Normal's, Specular and Glow etc): 7-8 days
Asset Tweak: 2 days
Game Engine Import: 1-2 days

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.
keep practicing.

Please answer the following questions as completely as possible.

1. What is your name and position title?

My Name is Alberto Lozano and I'm a Freelance 3D Artist

2. Please briefly describe your responsibilities within your organisation.

3D modelling, sculpting, etc.

3a. Briefly describe the flow of content within your current art production pipeline.

(e.g. Model > UV > Texture > Lighting etc.)

Concept>Modelling>Deformation tests>Modelling>UVmapping>Sculpting>Texturing>Rigging & posing>Lighting and Rendering>Final image + Post production.

3b. Describe the process from concept to finished model within your current art pipeline.

The same as above.

4. Do you encounter problems in transition from modelling to texturing process?

No, nothing.

If yes, please describe the most common problems.

If no, what do you do to avoid problems?

I don't need to avoid problems because there aren't problems :), it's just knowing how to work and dedicate time and efforts. When you do something almost all the days... is impossible to find problems, is all very mechanic and boring.

5. How often do you collaborate with another artist to determine the modelling approach on an asset?

I have only collaborated with animators, making morphs targets. All the modelling work falls on me.

6. Do you find collaboration helpful in the modelling process?

I really don't know what to say. As I said, all the models I do are done by one person, me. It also depends... a character should never be done by 2 modellers. A huge project of architecture as example, of course, and always giving different tasks to accomplish the final product. 1 task 1 person.

If yes, why?

If no why?

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

Never for now.

8. Is there collaboration between modellers and texture artists before modelling begins?

Nothing.

If yes, what do you discuss?

Why is it helpful?

9. Do you receive a design document before you begin modelling?

I'm asked to model a concept with some views in almost all the cases.

10. How does the design document aid you with modelling?

Not much, all the drawings I receive are so abstract and not well drawn in most cases.

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

No, it doesn't. I usually do all the work from concept to final rendered model.

If no, how are the tasks delegation resolved?

12. Have you ever strayed from the design document to design a better object?

No

If yes, how did that effect the object's movement down the production pipeline?

13. How often do you remodel an object at the request of a creative director?

Never

14. Who is responsible for the UV layout of objects?

If yourself, continue with the survey. If someone else, go to question 17.

Me.

15a. Do you consider the UV layout of an object before modelling?

If yes, how?

Yes, like deformations. And how? knowing the needed seams for the UVmapping and the methods I will need.

If no, why?

15b. Can the complexity of the UV layout of an object effect/change the modelling

approach for that object?

No, it shouldn't do.

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?

Difficult for nothing, time consuming yes, and always depending of the number of pieces of the model.

16. Does your manager require you to model an object with the UV layout in mind?

No

17. Do junior designers with little experience working within an art

production pipeline have problems moving work down the art production pipeline?

Don't know, people in these cases usually hide their problems.

If Yes, why and how much longer would it take them to achieve the desired result?

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

It depends of quality and amount of polygons for the low poly model. it's almost a month of hard work, too much coffee and red bull.

Concept Artwork: 5 days or more, to have a solid idea is quite important, It determines all the work with the computer. All this means dozens and dozens of sketches and drawings.

Base Mesh: 1-2 day if it's a low poly model, 3-5 days for a complex subdivided model.

High Poly Sculpt: 1 day, it's quite fast having a solid subdivided model as base mesh.

UV Unwrap: 1 day.

Texture (Inc Normal's, Specular and Glow etc): Textures are usually 3 days.

Asset Tweak:

Game Engine Import:

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

Build your own libraries with a lot of resources, and to use the fewer tools possible for a task (software).

INSTRUCTIONS

This survey is intended for **GAMES INDUSTRY AND FREELANCE CHARACTER AND PROP ARTISTS**

Please answer as many questions as possible. Feel free to skip any questions which are not applicable or you do not wish to answer.

Please return the survey to Kane Forrester when you are finished by attaching it in an email to Kaneth@gmail.com. Please notify Kane Forrester by email if you were unable to return the survey if possible.

If you have any questions during the survey, please contact Kane Forrester by phone or email.
(+44)7707534177 United Kingdom Phone Number
Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?

Benoit Regimbal - Freelance Game Artist

2. Please briefly describe your responsibilities within your organisation.

I make bid-estimate for project, Design, Model , uvw and texture Character and Props for games
I supervise my sub-contractors

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)

For Wii, handheld and other Old School spec project its:
Info-Design-Model-uvw-texture-Fixes- rig/skin if necessary
For Next Gen
Info-Design-Base model-Sculpt-Low poly- Bake- Texture-fixes- rig/skin

3b. Describe the process from concept to finished model within your current art pipeline.

I received the information about a certain Character or props, I create the concept or design, depending of the client need in Photoshop (Once it's approved) I create the base Model, I have the client approved it again (fix if need be) . If it's for Next Gen I go on with the Sculpting Step , and I have the client Approve it before Moving on to Baking/Uvw in Max. I then paint base colours and make sure the client is satisfy with them before I start with really painting it. Once it's done and approved, I send it to my Rigger/skinner if need be. Then have a final review with clients. Then fix if need be,

4. Do you encounter problems in transition from modelling to texturing process?
If yes, please describe the most common problems.
From time to time, but with experience you can foresee these problems. You also have to make sure the client is 100% satisfy before moving on. and have all the info necessary before texturing, otherwise you might have to go back.

If no, what do you do to avoid problems?

5. How often do you collaborate with another artist to determine the modelling approach on an asset?

Just with the client to make sure the model is up to their needs. It can differ from client to client.

6. Do you find collaboration helpful in the modelling process?
If yes, why?

Only to avoid wasting time going back.

If no why?

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

It happens, but with experience you make sure Everything is 100% clear, and have the client approved each phases.

8. Is there collaboration between modellers and texture artists before modelling begins?
If yes, what do you discuss?

I make sure I'm the only one to model and texture. If not, I overseas each phases done.

Why is it helpful?

9. Do you receive a design document before you begin modelling?
I ask for all the info necessary of course.

10. How does the design document aid you with modelling?

To avoid going back to do fixes, You need all the client need. We can't read mind :)

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

Of course

If no, how are the tasks delegation resolved?

12. Have you ever strayed from the design document to design a better object?

I may have change the approach but in the end, it's not my model but the Client Model.

If yes, how did that effect the object's movement down the production pipeline?

13. How often do you remodel an object at the request of a creative director?

Less nowadays

14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

15a. Do you consider the UV layout of an object before modelling?
If yes, how?
Yes, I may need to avoid symmetry if there texture size is small.

If no, why?

15b. Can the complexity of the UV layout of an object effect/change the modelling approach for that object?

No

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?

It only take time, it's relaxing to uvw really.

16. Does your manager require you to model an object with the UV layout in mind?

17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?

Sometimes , It's our job to make sure they do deliver on time. Focus

If Yes, why and how much longer would it take them to achieve the desired result?

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

Concept Artwork:1-2hours Extra with Client approval-fixes
Base Mesh: Up to 8 hours depending on the complexity of the mesh
High Poly Sculpt: 8hour to 16hours.
UV Unwrap:1-4hours
Texture (Inc Normal's, Specular and Glow etc):8 to 24hours depending on client approval-fixes
Asset Tweak: 2-6hours. Depending if you made sure the client saw all phases
Game Engine Import:

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

It's all about what the client need.

You have to make sure you know all the information's beforehand, and make sure the client sees and approve each step. Otherwise you will waste time going back and forth.

INSTRUCTIONS

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Please answer as many questions as possible. Feel free to skip any questions which are not applicable or you do not wish to answer.

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If you have any questions during the survey, please contact Kane Forrester by phone or email.
(+44)7707534177United Kingdom Phone Number
Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?
-Brendan Keough, Concept/2D Artist at Venan Entertainment – primarily a mobile game production company.

2. Please briefly describe your responsibilities within your organisation.
- Create concept art for characters and environments, design user interface graphics, paint textures for 3D models.

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)

-After reading the description of what is needed;

Concepts: research > reference > thumbnail sketches > final pencil drawing > digital cleanup of line art and digital colours. Multiple colour variations are usually done from the same line art.
Characters need to be drawn both posed and orthographed to help both the modellers and the animation riggers.

UI Design: analysis of what inputs and displays are required > mock-ups of different thematic interface styles with multiple colour schemes > creation of working asset files and verification of the in-engine and/or on-device appearance (mobile device screens rarely match the quality of your workstation's monitor).

Texture Painting: once the modellers have a finalized mesh, layout or acquire the UV set > gather or take photos to start textures or to use as reference if a painted or cell-shaded look is needed > paint/manipulate/test/adjust UV's if necessary, rinse & repeat > test in-engine/on-device.

3b. Describe the process from concept to finished model within your current art pipeline.

-I don't often work as a modeller at my current job, but when I do my own modelling, it goes like this: concept sketches > final concepts and ortho's > working with geometric primitives > modify and combine primitives to sit my taste > finalize model > layout UV's > paint textures.

4. Do you encounter problems in transition from modelling to texturing process?
If yes, please describe the most common problems.
-UV projection and layout can be difficult, as can the texture map limitations of some platform, but they aren't real problems.

If no, what do you do to avoid problems?

5. How often do you collaborate with another artist to determine the modelling approach on an asset?
-I'm often the collaborator as I'm passing concepts and orthos to the modeller, then receiving the mesh and painting textures for it.

6. Do you find collaboration helpful in the modelling process?
If yes, why?
-Yes, it makes for a good distribution of time and skills; there aren't many people who have an equal division of 2D and 3D skill sets and time is always in short supply.

If no why?

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?
-the art asset that is 100% correct on the first try is a rare and mythical beast visible only when Venus is high in a moonless night sky.

8. Is there collaboration between modellers and texture artists before modelling begins?
If yes, what do you discuss?
-In a small or medium-sized studio there will certainly be communication and collaboration since we tend to wear multiple hats and are involved at several stages of the pipeline.
I can imagine a larger studio where there might not be collaboration/communication, but I would not prefer to work that way.

Why is it helpful?
-If all of the artists know are on the same page from the beginning they can prevent technical roadblocks and suggest strategies that will save time and/or improve game engine performance.

9. Do you receive a design document before you begin modelling?
- Yes

10. How does the design document aid you with modelling?
- Without a Game Design Document, the artists are left shooting in the dark, hoping to hit the style desired by the Art Director and meet the limitations of the game engine.

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?
-Yes, the hardware of the game platform will dictate what sorts of rendering technologies are available (specularity, bump or normal mapping), texture size limitations, polycount limitations, etc. All of these things influence the strategies available to create the best looking, best performing game.

If no, how are the tasks delegation resolved?

12. Have you ever strayed from the design document to design a better object?
- If a better solution is available, the Technical Design Document will be changed so that all of the departments can take advantage of the improvement. If the TDD calls for a limitation to the object that is undesirable, a compromise will likely be made elsewhere to meet the performance goals.

If yes, how did that effect the object's movement down the production pipeline?

13. How often do you remodel an object at the request of a creative director?
-Completely re-do's can happen, but a good creative director will have a firm idea in mind and communicate it clearly to the artists so that time and money are not wasted.

14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

- The modeller is usually responsible, but the texture artist might revise it or do an alternate or additional projection

15a. Do you consider the UV layout of an object before modelling?
If yes, how?
-depending on the platform the game will run on you might be limited to one small map per object or be able to use several large ones. If you will be using one small map, you'll get a better result with a symmetrical model.

If no, why?

15b. Can the complexity of the UV layout of an object effect/change the modelling approach for that object?
-If you have enough time to untangle them, you can UV map a porcupine's quills.

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?
-yes, but not impossible.

16. Does your manager require you to model an object with the UV layout in mind?
- It should be considered, but shouldn't be the prime decider of the object's design, the creative and technical goals should determine the properties of the object.

17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?
-Sometimes.

If Yes, why and how much longer would it take them to achieve the desired result?
- There is a learning curve to all professions; if any new artist could walk in on day one and run with the senior staff then the seniors probably aren't very good. Depending on the task, the junior artist will take 25 – 75% longer than the senior. A good senior staff will assist the juniors to help them advance their skills and accelerate their performance.

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

-My professional experience is on the 2D side, so I will concentrate on those sections:

Concept Artwork: 8-24 hours for a character design with multiple variations. The more specific the description from the Art Director, the faster it can be done. Open-ended design requests take longer.

Base Mesh:
High Poly Sculpt:
UV Unwrap:

Texture (Inc Normal's, Specular and Glow etc): 4-24 hours, depending on complexity and level of detail required (a stylized but photorealistic appearance takes longer than cell-shaded).

Asset Tweak:
Game Engine Import:

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.
For Concept work:
- Try to get the strongest, most explicit description from the AD of what they want. Nothing is more frustrating than to create something really great that fits a loose description of the character only to be told that it isn't "what they were thinking of."
- Get good reference and keep a photo file. Don't ignore history, find original sources – billions of people over many thousands or years have been creating clothes, weapons and buildings, take a look at what has come before and tweak it a little, combine cultures separated by geography and time – What would an Mayan Samurai look like? The same thing goes for creature design, more weird monsters have crawled in the mud at the bottom of the ocean than we will ever know.

INSTRUCTIONS

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Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?
Brian Parnell
Senior Character Artist

2. Please briefly describe your responsibilities within your organisation.

Modelling / texturing characters and character assets

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)

low poly model > high poly model > retopologise low poly model > UV > bake normals > texture > export to game engine > tweak textures

3b. Describe the process from concept to finished model within your current art pipeline.

See 3a. add "concept asset before low poly model"

4. Do you encounter problems in transition from modelling to texturing process?
If yes, please describe the most common problems.

Most problems occur during the normal map. As some high res detail doesn't carry over as well as it was intended. So either additional geometry needs to be added to the low poly or the high res needs to be tweaked.

If no, what do you do to avoid problems?

5. How often do you collaborate with another artist to determine the modelling approach on an asset?

ALL THE TIME. If you aren't communicating with your team you aren't in a team.

6. Do you find collaboration helpful in the modelling process?
If yes, why?

Collaboration (sharing ideas, sharing meshes etc) cuts down on tedious / repetitive tasks and speeds up the entire team.

If no why?

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

On Titan Quest I always seemed to have redirection as I was given a lot of the boss monsters or R&D type assets. I really didn't have too big a problem with it since the boss monsters were fun to make and the changes were almost always for the better. Even when the changes weren't the better it was a valuable lesson to learn.
On my latest project at Harmonix it's a bit more stressful as the team is a lot bigger so redesigns or changes can really screw up a schedule not just for me but for the tech artists, and animators.

8. Is there collaboration between modellers and texture artists before modelling begins?
If yes, what do you discuss?

N/A

Why is it helpful?

N/A

9. Do you receive a design document before you begin modelling?

Well for Harmonix typically a design document is put up by the design department months in advance on the Wiki.
At Iron Lore it was a little more seat of your pants, so a lot of the boss monster attacks and needs might change after they were put in game so modelling typically had to be able to successfully allow for a ton of different animations.

10. How does the design document aid you with modelling?

It aids by knowing what the most important elements of a character are. Take for example the design doc asks for monster. 1 that will show up in large groups and be half the size of the player character. By knowing this alone the monster should be about half the polys of the typical player sized monster and since there will be so many it's best to really conserve the polycount so you can have a ton on screen.

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

N/A

If no, how are the tasks delegation resolved?

Typically artists model AND texture assets. I prefer it that way. The days of just modelling or just texturing are coming to an end IMO.

12. Have you ever strayed from the design document to design a better object?

Of course!

If yes, how did that effect the object's movement down the production pipeline?

On Titan Quest I made a TON of stuff in my spare time and had the lead designer squeeze in a bunch of cool shit. Take forever the wolves. I wanted wolves in the game SO bad...I also wanted a hot chick in the game. SO the designer essentially made a skill tab called "nature" that had wolves and a wood nymph that would follow you around. It was probably the most popular skill tab for beginner players. Woo!

13. How often do you remodel an object at the request of a creative director?

Whenever they ask.

14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

15a. Do you consider the UV layout of an object before modelling?
If yes, how?

I try to keep in mind where I plan to segment out my UV's. It's becoming less of a thought process and more of a second nature.

If no, why?

15b. Can the complexity of the UV layout of an object effect/change the modelling approach for that object?

Yup.

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?

YES. High res mechanical stuff can take forever.

16. Does your manager require you to model an object with the UV layout in mind?

Yes...I mean it's just kind of understood that you know what you are doing. Making a crappy UV layout is no one's fault but your own. So get research and learn as many tips/tricks to it.

17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?

Designers don't do art, and should never do art. Art is for artists, design is for designers!;)

If Yes, why and how much longer would it take them to achieve the desired result?

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

This is really too difficult to just throw down numbers.
Let's say it's a bipedal monster/player character.

7,000 tris.
1024x1024 textures

Concept Artwork: This could take weeks really if your AD can't make up their mind...but typically 1-2 days should suffice
Base Mesh: 1 day
High Poly Sculpt: 1-2 day
UV Unwrap: 1/2 day
Texture (Inc Normal's, Specular and Glow etc): 1-3 day
Asset Tweak: This really depends, if it's just texture tweaks I'd say 1/2 - 1 day
Game Engine Import: If your tool set is awesome it should take less than 5 minutes

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

just add me to IM if you have questions.

MSN: brianjparnell@hotmail.com

Best of luck dude! As soon as you graduate throw out all your school work, enter some game art competitions and start applying and networking like CRAZY!!
B

1. What is your name and position title?

My name is Gavin Goulden and I am a Character Artist working in the games industry here in Vancouver, BC.

2. Please briefly describe your responsibilities within your organisation.

I am mainly responsible for creating player head models, updating or high resolution meshes, character texturing and character lighting. I also try to assist my lead character artist whenever I can by sharing techniques and testing possible new workflows.

3a. Briefly describe the flow of content within your current art production pipeline. (e.g. Model > UV > Texture > Lighting etc.)

The basic flow of our character art pipeline is:

Model > UV > Base Texture > Sculpt (Using the textures as a sort of guide)> Bake final Textures > Cleanup. Then all of our lighting is handled in game.

We do this because of the heavy amount of assets we need to create and because of the nature of the project. Personally, I usually follow a different workflow for my personal models:

Model Base mesh > Sculpt > Model low poly mesh (using a medium resolution sculpt as a guide)> UV> Bake maps > Texture..then, depending on how far it goes, either do basic rigging myself, light a simple render for my portfolio or use in game lighting.

3b. Describe the process from concept to finished model within your current art pipeline.

At work, the pipeline is pretty straight forward as a lot of it based on replicating real world things. We usually use photos and a solid description by our art director and producer to get us rolling on the model. Following the pipeline mentioned above, we work away using a lot of our reference images. Once we get final approval from the producer, we check it in game to make sure it's bug free.

4. Do you encounter problems in transition from modelling to texturing process? If no, what do you do to avoid problems?

Not...really. Though, I know a lot of people in the industry suffer from this sort of thing. My theory on why this happens is that people become TOO specialized in a certain discipline rather than embracing the discipline as a whole. This could be because of how complex asset creation is becoming, it seems like everything is multilayered and higher resolution...to compensate for this, and a lot of companies have designated specific tasks to a specific role. People take on this role and are never faced with the challenge of other aspects to the job. I've been very fortunate to work for a number of companies that doesn't have this mentality, I've also freelanced for quite some time and had the opportunity to work on lots of different things that I normally wouldn't (concept drawing, environment art, lighting, etc.) But, to answer the question, I think I don't have this problem because my background is fairly diverse and, by working for smaller companies, I've more or less had to take projects from beginning to end. In my spare time I also try to learn more about things that I don't get to tackle at my day job, such as rigging and scripting.

5. How often do you collaborate with another artist to determine the modelling approach on an asset?

I try to collaborate as much as possible. Either through bouncing ideas off of my friends, working on a team or even just posting my work on forums (which I HIGHLY encourage.) Concept art is one of my weakest areas, I'd never call myself an "idea man", and so I try to pair up with people who have / enjoy using this skill to help nail down how to approach a character. I often try to get feedback from peers on forums as well, some feedback is helpful some...not so much...but it's always good to get a second opinion.

6. Do you find collaboration helpful in the modelling process?
If yes, why?

Collaboration is a very important part of creating models. For one, video game development is a creative process that involves A LOT of different minds working towards one goal. You have to learn how to compromise and all see the same vision...otherwise, you're going to end up with a lot of problems at the end of the project. I think collaborating with artists in school really helped me prepare for a professional environment. As much as I like hiding away in my office and just working away at my own stuff, having a different voice sharing their opinion on the project can make you realize problems you never noticed before and, possibly, help you think of creative solutions that will help the end product. Being able to communicate your ideas verbally is a very important part of this industry and working as a solitary type of person ALL the time can really be a problem.

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

Rarely these days. I have been part of projects that required constant reworking because of confusion in management but at the moment I am blessed with a team that has a shared vision. I think this is uncommon, I have heard horror stories (projects lasting in the production line for over a decade...) from other people and have also had a few clients require reworks because they changed direction.

8. Is there collaboration between modellers and texture artists before modelling begins?
Generally, for me, no. I try to handle my own models and textures. I like to collaborate with other artists and gladly take pointers from team mates / peers, but I try to own the asset as much as possible and take responsibility for as many aspects as I can.

9. Do you receive a design document before you begin modelling?
We do have a design document, we are all briefed on the project and have frequent meetings discussing it. It is practically guaranteed that everyone is on the same page when they begin the project.

10. How does the design document aid you with modelling?
To be honest, not much. We have game design docs and technical design docs, but really, between the art team and software engineers we manage a budget that will look great in game but not destroy the frame rate. This budget is then followed as close as possible throughout the remainder of the project. It's hard, at the beginning of the project, from an artist's point of view, to say "All characters will have such and such" but we are all given a rough guideline to follow and increase or decrease based on the assets function (hero characters get more of a budget than background guys, for example.)

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

If no, how are the tasks delegation resolved?

No, generally I (and my team) take full ownership of an asset and don't pass it on down the line. We all have a good understanding of what can be done in the texture and what needs to be done through geometry. We also have a stronger leader who reviews our work on a regular basis and points out problem areas if there is an issue.

12. Have you ever strayed from the design document to design a better object?

Generally, no. If there is a concept, I try to follow it as much as possible. Same with photo reference. If I see a problem that will occur, for example: knowing that a huge spiked shoulder pad is going to pierce this guy's head as soon as he lifts his arm, I'll bring it up. Other than that though, I follow direction as much as possible.

What I think is more important than a design document is communication. Not just within your own team sub-team (characters, environments, and textures, whatever..) but throughout the entire team. Design documents become outdated. They're made before the project begins as a rough guideline, once these ideas are implemented and can be seen in action, the can become changed...it's constantly a work in progress. Relying on everyone to constantly review this is a huge risk, in my mind, and it's always better to constantly communicate and make sure everyone is on the same page. When a new feature is added, everyone is told face to face. When we begin using new technology, everyone is informed.

13. How often do you remodel an object at the request of a creative director?

Like in question 7...at this moment, rarely. Though, I have had bad experiences before.

14. Who is responsible for the UV layout of objects?

If yourself, continue with the survey. If someone else, go to question 17.

I am.

15a. Do you consider the UV layout of an object before modelling?

In a way, yes. An important part of UV'ing in games, I think, is benefitting from "natural seams." It's nearly impossible to have one consecutive UV island that is your entire character flattened out. I try to model clean lines at these natural seams (such as the transition between neck and torso, torso and hips, etc.) to aid in the uving process.

15b. Can the complexity of the UV layout of an object effect/change the modelling approach for that object?

Generally, I don't think so. For the most part, Uving is something you should keep in the back of your mind. Though benefiting from things like natural seams is a great thing to keep in mind, you should always do what's best for the model and how it would read to the user. Focus on things like silhouette to make your model "read" better. Seams can always be painted out in one way or another :)

There are some exceptions though, but I think these exceptions are generally common knowledge. For example, if you have a robotic piece, you'll probably UV that object first before duplicating it all over the piece (like a bolt.) The same can be applied to organic characters, why would I unwrap 2 separate hands that are identical when I can unwrap one half, mirror it over and arrange the UVs afterwards?

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?

Like anything else when developing an asset, it "can" be difficult and "can" be time consuming. Though, if the mesh is analyzed properly before unwrapping and constructed in an intelligent way, it should be a fairly smooth process that doesn't eat up too much time. Depending on the engine limitations, of course, this process can get harder...for example, some engines do not accept mirrored UVs out of the box, stacking UVs can also be a hassle in some...so with those rules in mind, certain projects could be more difficult than others, such as robotic pieces.

16. Does your manager require you to model an object with the UV layout in mind?

No. It is trusted that the artists follow their best judgement and would do so anyway.

17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?

If I understand the question correctly, I would say "Yes, junior artists generally do have problems transitioning to a professional production pipeline." and my reason for it is this. No amount of school or mod projects (as great as both of those things CAN be) can prepare a person for a professional work environment. The general principles are the same, but the demands of a studio are far greater than anything those things can teach a person. It's like learning how to swim by being tossed in the pool...you know the basic idea of swimming, you flap your arms and legs around to move, but until you're actually in the water doing it, you have no practical knowledge.

With the right guidance, a junior artist can become a very productive team member, it just takes time to gain confidence in your abilities and learn the proper process for creating things in a studio.

In my experience, juniors have been given a slightly longer timeframe to work in to account for learning time.

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

For personal projects, my time breaks down something like this:

Concept Artwork: 4 - 8 hours. Though, this changes because a lot of times I either have a good idea of what I want to do and just doodle a few things to see if it would work or collaborate with concept artists and take what they work on.

Base Mesh: 4 - 8 hours.

High Poly Sculpt: 3 - 5 days for creating a high resolution mesh.

UV Unwrap: Depending on the nature of the character this can take as little as half an hour to a day by using tools like Roadkill and Wings, it can speed up unwrapping for things like organic objects. Though, I don't think I've ever spent more than half a day unwrapping a character.

Texture (Inc Normal's, Specular and Glow etc): Roughly 2 days. Creating these different maps should all be done at the same time and not as an afterthought. While I'm creating my diffuse texture, I'm bring elements of that into my spec map so that the material reacts properly. It's also a lot easier to manage than trying to manipulate a flattened diffuse texture after the fact.

Asset Tweak: A few hours to fix problem areas.

Game Engine Import: Provided the rig is already made (say you build to Unreal's character rig) this step can be fairly quick, maybe 1 day to get it in game. If a brand new rig is needed and is part of a bigger goal (as in, this rig will be used globally) it could add a few days.

In general, I would say 2 weeks is a comfortable budget for a professional looking character...it can be done in much less though...such as a week...it all depends on context.

Professionally, it gets a bit trickier as a game is a work in progress right until it's ripped out of your hands for it to be shipped. So, we constantly improve what's there.

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

I try to have a different mentality than a lot of artists in the games / film / entertainment industry. I am, what I think would be considered, a production artist. Though I do have artistic ability and really enjoy the creative process, I see the game for what it is: entertainment. This means that my view on how I work is fairly different than some might have, I have artistic integrity but I'm not trying to express myself through my work. I really just want to make things that look bad ass and function properly in game. I'm assigned an asset and, using my skill set, create the object as best as possibly can within the budget I am given and in a timely manner.

I find that a lot of people fresh to the industry, and I was one of them, become very frustrated at how things are handled. I think they are told from the beginning or have this false impression of what the industry is and once they enter into the work force become quickly jaded that they aren't using every creative bone in their body. It takes more than having a good idea or a sketchbook full of drawings (as one school's commercial might say...), I think a great balance between being artistic, mature and technically solid is very important.

INSTRUCTIONS

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If you have any questions during the survey, please contact Kane Forrester by phone or email.
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Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?
Joe Mirabello, Environment Artist

2. Please briefly describe your responsibilities within your organisation.
I am responsible for helping create environment assets and settings. I also do a fair amount of technical work. I also have done a large amount of concept art for my current project.

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)

This depends on the assets. There are two workflows I use:

For more sculptural assets, I do the following:
Base Mesh modelling>Modelling high res(Zbrush/Mudbox/Maya/max)>normal map creation>low poly creation>UV>Texturing>Import-to-game>shader/materialcreation>placement

For lower relief assets, I can get away with making the normal map after the low poly, during the texturing stage, using Nvidia plugins, and the xnormal, and CrazyBump applications. This is a much quicker process.

Lighting is generally saved for when there are multiple assets, or a full scene, to work with.

3b. Describe the process from concept to finished model within your current art pipeline.
(Pretty much answered this above)

4. Do you encounter problems in transition from modelling to texturing process?
If yes, please describe the most common problems.

There'll always be some problems when dealing with technology, multiple applications, and multiple people. The most common problem with next/current gen workflows is standardization of technology (for example, which direction a normal map's channels should be oriented). Having a thorough understanding of the technology's goals helps to get everything "playing nice together".

If no, what do you do to avoid problems?

5. How often do you collaborate with another artist to determine the modelling approach on an asset?

Every day. You only improve from communication.

6. Do you find collaboration helpful in the modelling process?
If yes, why?

If no why?

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

Rarely. Remodelling an object from scratch is drastic, and usually feedback, problems, or direction can be addressed by tweaking of the model, texture, UVS, or shader. With prototyping you might see this more often, but by the time a project is into "full production" all the pipelines should be fairly hammered out.

8. Is there collaboration between modellers and texture artists before modelling begins?
If yes, what do you discuss?
First off, usually modellers ARE the texture artists. A few studios might maintain the division of labour—but usually this is because a modeller is simply not as skilled at texturing, not the other way around. In general texturing is the more difficult of the two, for most people.

When there is a division of labour, usually the collaboration pivots around the Art director (A.D.)/Lead Artist and the person who made the concept, with the A.D. verifying that all the steps of the process maintain that vision.

Why is it helpful?

9. Do you receive a design document before you begin modelling?

Yes.

10. How does the design document aid you with modelling?

Usually there'll be some rough descriptions, but more so it sets groundwork for a 'mood' that the art team can adopt for a piece or series of pieces.

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

If no, how are the tasks delegation resolved?

12. Have you ever strayed from the design document to design a better object?

If you have a flexible A.D., they'll let you incorporate your own touches to a piece. If you have a good A.D., they let you do that while also maintaining the doc's vision. Evolving a look is one thing, but needlessly flying in the face of a doc may have reciprocations.

If yes, how did that effect the object's movement down the production pipeline?

Sometimes, if an idea is good enough, the design doc can be rewritten to incorporate it. The gravity gun in Half Life 2 was rumoured to have come about this way. This was likely a programmer's work that changed things though, in general an artist won't change the flow of a design doc. If an object falls out of mood/style/look, then it's up to the art director or lead artists to catch it and ask for revisions.

13. How often do you remodel an object at the request of a creative director?

I've never remodelled anything from scratch. I've made countless revisions, but revisions are much easier than remodelling.

14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

15a. Do you consider the UV layout of an object before modelling?
If yes, how?

Yes. With environment art, the assets are so large that they generally cannot all have unique UV space. You must think early about how to cut and lay out the UV repetitions to guarantee maximum texel density, without having things look too repetitive. With normal mapping, this because even more a concern, as normal maps create lighting seams where otherwise there would be none. There are cases in a project where you will actually texture something FIRST, and then model afterwards, unwrapping it to fit on the texture you've already made.

If no, why?

15b. Can the complexity of the UV layout of an object effect/change the modelling

approach for that object?

Yes.

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?

It used to be. The advent of pelt mapping in 3d studio, and various uv helper standalone applications has turned UV'ing into something fairly painless.

16. Does your manager require you to model an object with the UV layout in mind?

Not usually. They trust that we know what we're doing.

17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?

Oftentimes, but usually you task them with something easier, such as standalone props or all-unique-Uvs meshes. You gradually give them more complex tasks as they mature as an artist.

If Yes, why and how much longer would it take them to achieve the desired result?

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

Concept Artwork: *depends. 10-15 hours for a bigger concept. 3-6 for smaller ones. 1-2 for sketches*
Base Mesh: *20-30 minutes, maximum*
High Poly Sculpt: *varies—it could be a day, it could be a week. Depends on the task.*
UV Unwrap: *2-4 hours, unless really complex*
Texture (Inc Normal's, Specular and Glow etc): *varies. It could be a day or two; it could be a week or two.*
Asset Tweak:
Game Engine Import: *depends on the engine. The Unreal engine is fairly painless if you know what you're doing. Some engines, however, require that you wait for a full build cycle and you essentially have to wait a day and go work on something else.*

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

INSTRUCTIONS

This survey is intended for **GAMES INDUSTRY AND FREELANCE CHARACTER AND PROP ARTISTS**

Please answer as many questions as possible. Feel free to skip any questions which are not applicable or you do not wish to answer.

Please return the survey to Kane Forrester when you are finished by attaching it in an email to Kaneth@gmail.com. Please notify Kane Forrester by email if you were unable to return the survey if possible.

If you have any questions during the survey, please contact Kane Forrester by phone or email.
(+44)7707534177 United Kingdom Phone Number
Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?

Artist

2. Please briefly describe your responsibilities within your organisation.

Create character, vehicles and props models and textures and sometimes skin weight them for testing character rigs. I also do research and development work for characters and vehicles.

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)

Base Model > High poly sculpting > low poly model > UV > bake normal map/ao map >texture

3b. Describe the process from concept to finished model within your current art pipeline.

rough concept > rough model> final concept > process 3a above.

4. Do you encounter problems in transition from modelling to texturing process?
If yes, please describe the most common problems.

No

If no, what do you do to avoid problems?

Plan UV layout before hand and create a good UV

5. How often do you collaborate with another artist to determine the modelling approach on an asset?

Not often during production, sometime during R&D work I might collaborate with fx artists or animators or etch artists for certain research work.

INSTRUCTIONS

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Please answer the following questions as completely as possible.

- 1. What is your name and position title?

Peter Boehme, Freelance Artist

- 2. Please briefly describe your responsibilities within your organisation.

I work for multiple clients in the games industry, providing concept art, high and low poly models and textures (usually not all at once).

- 3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)

This depends on the client; I'm mostly producing only high and low res geometry at present, no UV or texture work.

- 3b. Describe the process from concept to finished model within your current art pipeline.

This also depends on the client, as a modeller/texture artist I am usually provided with photo reference or concept art, and will submit work in progress renders for approval at every stage (high, low, texture).

- 4. Do you encounter problems in transition from modelling to texturing process?
If yes, please describe the most common problems.

Before I was freelance, I worked at a place where I was given horrible UV unwraps by other artists to texture. Those people were lacking games experience, specifically in texturing.

- If no, what do you do to avoid problems?

Where possible, the texture artists should do the UV layout themselves, or the modeller should have thorough experience texturing real-time models.

- 5. How often do you collaborate with another artist to determine the modelling approach on an asset?

Rarely these days; this usually happens once at the beginning of a project or assignment. As a freelancer, I've so far only been interfacing with 2 or 3 people on the clients' side.

- 6. Do you find collaboration helpful in the modelling process?
If yes, why?

Definitely. Even if it does not have an immediate impact on the pipeline, communication and constant review of processes is key to a good product.

- If no why?

- 7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

Never happened to me, apart from the usual small tweaks after client feedback.

- 8. Is there collaboration between modellers and texture artists before modelling begins?
- If yes, what do you discuss?
- Why is it helpful?

- 9. Do you receive a design document before you begin modelling?

No - this is usually only the case for concept art; the finished concept should then provide any info the modeller needs.

- 10. How does the design document aid you with modelling?

- 11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

This depends on the company. some have a fairly bureaucratic approach while others rely more on their staff's expertise and verbal communication.

- If no, how are the tasks delegation resolved?

- 12. Have you ever strayed from the design document to design a better object?
- If yes, how did that effect the object’s movement down the production pipeline?

- 13. How often do you remodel an object at the request of a creative director?

Again, this has never happened really, apart from minor tweaks in high resolution geometry.

- 14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

Usually the texture artist. Sometimes that's me; presently this is done in-house by my client.

- 15a. Do you consider the UV layout of an object before modelling?
If yes, how?

Before of while modelling, yes. This does not encompass the arrangement of individual UV chunks but rather decisions like mapping certain areas with alpha planes rather than closed geometry.

- If not, why?

- 15b. Can the complexity of the UV layout of an object effect/change the modelling approach for that

object?

Yes, especially for mobile assets or environment work where you'd plan out/budget the texture first. Characters and game play objects in current-gen projects rely less on texture repetition and therefore often use more 'organic' layouts.

- 15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?

It depends on how memory-efficient the object needs to be. Environment art often has a much tighter budget and is harder to optimize for good UV usage without advance planning.

- 16. Does your manager require you to model an object with the UV layout in mind?

- 17. Do junior designers with little experience working within an art production pipeline have problems moving work down the art production pipeline?
- If Yes, why and how much longer would it take them to achieve the desired result?

- 18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

(Average current-gen character / working days)

Concept Artwork: 10 days
Base Mesh & Sculpt (can't separate these as I tend to switch back and forth a lot and add more elements while modelling): 15 days
Low poly model & UV Unwrap: 5 days
Texture (Inc Normal's, Specular and Glow etc): 3 days
Asset Tweak & Game Engine Import: 1 day

- 19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

1. Look up or assign hotkeys for common tasks, be aware of plugins or scripts that may improve your speed.
2. Try out new tools or functions in your existing software package that you don't normally use - be open for experimenting.
3. Most importantly, talk to other artists.

INSTRUCTIONS

This survey is intended for **GAMES INDUSTRY AND FREELANCE CHARACTER AND PROP ARTISTS**

Please answer as many questions as possible. Feel free to skip any questions which are not applicable or you do not wish to answer.

Please return the survey to Kane Forrester when you are finished by attaching it in an email to Kaneth@gmail.com. Please notify Kane Forrester by email if you were unable to return the survey if possible.

If you have any questions during the survey, please contact Kane Forrester by phone or email.
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Kaneth@gmail.com

Please answer the following questions as completely as possible.

1. What is your name and position title?

Vitaliy Naymushin, Character Artist, id Software

2. Please briefly describe your responsibilities within your organisation.

I create character models for id Software's new game, Rage. High poly modelling, normal mapping, texturing, etc.

3a. Briefly describe the flow of content within your current art production pipeline.
(e.g. Model > UV > Texture > Lighting etc.)

High poly>low poly>uv>render normal maps>texture/tweak shaders

3b. Describe the process from concept to finished model within your current art pipeline.

First I start with making a high poly model, I then create a low poly model that satisfies our polygon count and animation requirements, I then render the normal maps using our in-engine render bump tool, after that I texture the models and adjust the shader parameters to make everything look as best as it can.

4. Do you encounter problems in transition from modelling to texturing process?
If yes, please describe the most common problems.

No I usually don't encounter any problems going from modelling to texturing.

If no, what do you do to avoid problems?

5. How often do you collaborate with another artist to determine the modelling approach on an asset?

Majority of collaboration happens usually either between me and the concept artist or between me and

an animator, which usually happens when there is something especially complicated animation wise or if there's something specific the concept artist wanted to see in the final model.

6. Do you find collaboration helpful in the modelling process?
If yes, why?

Yes I do, it gives me insight into other disciplines and their priorities to make the final product better.

If no why?

7. How often do you remodel an object because of problems, miscommunications, or changes in art direction or final needs of the asset?

Usually next gen assets take long enough to make that things like miscommunication or other problems can be caught in the process and addressed before the asset is complete. Changes in art direction are another matter, they do happen, it depends on a number of factors, the Art Director being one of them, but also the type of project as well as how fleshed out the design was to begin with. If everyone in the approval chain can get on board with the design early on and there is a healthy amount of communication going on throughout the process then it is much less likely an asset will have to get redone later on.

8. Is there collaboration between modellers and texture artists before modelling begins?
If yes, what do you discuss?

At ID Software all the artists do both modelling and texturing; although there is usually communication between different artists since people have different approaches.

Why is it helpful?

Getting insight into different ways of doing things is always advantageous; it makes you much more versatile as an artist.

9. Do you receive a design document before you begin modelling?

There's usually something in the design doc about most characters, it depends how crucial they are in the game, but there is usually some sort of design functionality behind most characters.

10. How does the design document aid you with modelling?

It’s very helpful since it gives you an idea of what’s important about the character and what you need to focus on when you begin to model/texture it.

11. Does the design document aid you with determining what needs to be done in the modelling phase and what can be left to the texturing artist?

No, design doc usually doesn't delve that deep.

If no, how are the tasks delegation resolved?

Majority of the technical aspects of the asset creation usually fall under my discretion.

12. Have you ever strayed from the design document to design a better object?

Most design docs usually start out very vague, so artists do have quite a bit of creative control over an asset while they are working on it. For the most part we try not to stray in a completely different direction than the design intended originally; typically we end up adding more to the character in our part of the process and really fleshing things out.

If yes, how did that effect the object's movement down the production pipeline?

At the beginning a character starts out as a vague description and maybe some functionality that it performs in the game world as well as some reference to either an existing game character or character from a movie. When the artists get a hold of that the concept artist will create a concept for it, at this point there is usually at least some communication between the modeller/texture artist and the concept artist and by the end the character is more or less designed and fleshed out.

13. How often do you remodel an object at the request of a creative director?

I believe I already answered this for question #7

14. Who is responsible for the UV layout of objects?
If yourself, continue with the survey. If someone else, go to question 17.

15a. Do you consider the UV layout of an object before modelling?
If yes, how?

Yes, I will usually try to figure out which parts of the model could be mirrored/reused and that would determine how the UVs will be laid out.

If no, why?

15b. Can the complexity of the UV layout of an object effect/change the modelling approach for that object?

Yes, depending on which parts you plan to mirror/reuse the UV layout could either save you time in the modelling process or waste time because you have to model more than you need to.

15c. Can the layout of the UV's of an object after modelling be difficult or time consuming?

No, with the tools available to us nowadays just about every object can be unwrapped very easily.

16. Does your manager require you to model an object with the UV layout in mind?

The managers usually leave things like that up to the artist's discretion.

17. Do junior designers with little experience working within an art Production pipeline have problems moving work down the art production pipeline?

This depends what you mean by designers, I know there aren't clear definitions of job titles for different disciplines, here in the US a designer is usually meant to be either a level designer or a game designer, someone who does a variety of things from writing design docs to blocking out levels, designing encounters and scripting game play sequences. I assume in the question when you say junior designer you are referring to what we here would call junior artist. And the answer would be yes, people who have never worked in the game industry usually take a little while to adjust to a production pipeline, working on your own at home or making a mod with a group of people is rarely meant to be efficient and you rarely have to deal with any kinds of deadlines.

If yes, why and how much longer would it take them to achieve the desired result?

There is no definitive answer, everyone is different, for the most part it does take new people longer to do just about everything, but most of them eventually get used to working within the pipeline get better and learn to work faster.

18. Please briefly detail the amount of time taken on an average next gen in-game asset. Ignore all sections that do not apply and feel free to add stages.

This is impossible to answer because different projects have different specifications and I don't think I am allowed to give out this kind of information for our game.

Concept Artwork:
Base Mesh:
High Poly Sculpt:
UV Unwrap:
Texture (Inc Normal's, Specular and Glow etc):
Asset Tweak:
Game Engine Import:

19. Please use the following space to share your personal experiences with improving your workflow, or any other information you believe to be helpful.

Best thing to do if you want to improve your workflow is to always be on the lookout for new techniques, reading interviews and post-mortems. Experience will also help you figure out what works and what doesn't, so you can make good decisions as to how to proceed in many situations that arise throughout the production process.

REFERENCES

[1] LinkedIn. (2009). *Chris Wells - Senior Character Artist.* Available: http://www.linkedin.com/pub/1/325/106. Last accessed 05 April 2009.

[2] Unknown Worlds Entertainment. (2009). *About.* Available: http://www.unknownworlds.com/about. Last accessed 05 April 2009.

[3] Marcus Dublin. (2009). *About Me.* Available: http://www.marcusdublin.com/AboutmePage.html. Last accessed 05 April 2009.

[4] Bioshock Online. (2006). *Bioshock FAQ.* Available: http://www.bioshock-online.com/faq/#engine. Last accessed 11 April 2009.

[5] Epic Games. (2008). *Success Stories.* Available: http://www.unrealtechnology.com/case-studies.php?ref=bioshock. Last accessed 11 April 2009.

[6] Epic Games. (2008). *Army of Two.* Available: http://www.unrealtechnology.com/case-studies.php?ref=ao2. Last accessed 11 April 2009.

[7] Epic Games. (2008). *Past Versions.* Available: http://www.unrealtechnology.com/features.php?ref=past-versions. Last accessed 11 April 2009.

[8] NDM. (2006). *Game Branches Out Into Real Combat Training .* Available: http://www.nationaldefensemagazine.org/archive/2006/February/Pages/games_brance3042.aspx. Last accessed 11 April 2009.

[9] Naked Sky Entertainment. (2007). *RoboBlitz - The Game.* Available: http://www.roboblitz.com/HTML_SITE/game/game.shtml. Last accessed 11 April 2009.

[10] DevMaster. (2009). *Unreal Engine 3 .* Available: http://www.devmaster.net/engines/engine_details.php?id=25. Last accessed 11 April 2009.

[11] Epic Games. (2008). *Current technology – Unreal Engine 3.* Available: http://www.unrealtechnology.com/features.php?ref=technology-overview. Last accessed 11 April 2009.

[12] Interactive Data Visualization. (2009). *SpeedTree Image Gallery.* Available: http://www.speedtree.com/gallery/?Page=122. Last accessed 11 April 2009.

[13] NVidia. (2009). *NVidia PhysX.* Available: http://www.nvidia.com/object/nvidia_physx.html. Last accessed 11 April 2009.

[14] NVidia. (2009). *The resource for CUDA developers.* Available: http://www.nvidia.com/object/cuda_home.html#. Last accessed 11 April 2009.

[15] Cyril Kowaliski. (2008). *AMD counters CUDA with renewed ATI Stream initiative.* Available: http://techreport.com/discussions.x/15886. Last accessed 11 April 2009.

[16] Ryan Smith. (2007). *PhysX's Big Break? Unreal Tournament 3 PhysX Performance.* Available: http://www.anandtech.com/printarticle.aspx?i=3171. Last accessed 11 April 2009.

[17] Rob Williams. (2008). *NVIDIA's PhysX: Performance and Status Report.* Available: http://techgage.com/article/nvidias_physx_performance_and_status_report/3. Last accessed 11 April 2009.

[18] Wormbo. webmaster@koehler-homepage.de. Personal Communication. 11 April 2009.

[19] DevMaster. (2009). *Source Engine Details.* Available: http://www.devmaster.net/engines/engine_details.php?id=34. Last accessed 11 April 2009.

[20] Valve. (2008). *State of the art games start here.* Available: http://source.valvesoftware.com/. Last accessed 11 April 2009.

[21] CryTek. (2009). *CryENGINE® 3 - Specifications.* Available: http://www.crytek.com/technology/cryengine-3/specifications/. Last accessed 11 April 2009.

[22] DevMaster. (2009). *Torque Game Engine.* Available: http://www.devmaster.net/engines/engine_details.php?id=3. Last accessed 11 April 2009.

[23] GarageGames. (2009). *Torque 3D.* Available: http://www.garagegames.com/products/torque-3D. Last accessed 11 April 2009.

[24] Autodesk. (2007). *Autodesk hails success of An Evening with Epic Games.* Available: http://www.autodesk.co.uk/adsk/servlet/item?siteID=452932&id=10073707. Last accessed 11 April 2009.

[25] Included on DVD – root\Research\Files\A Day With Epic Games.pptx

[26] Marcus Dublin. (2008). *Making of Paragalis.* Available: http://www.marcusdublin.com/ParagalisTutorialPage1.html. Last accessed 11 April 2009.

[27] Unknown Worlds Entertainment. (2009). *NS2 Engine.* Available: http://www.unknownworlds.com/. Last accessed 11 April 2009.

[28] Charlie Cleveland . (2008). *Unknown Worlds Videocast #7 - Texture rendering.* Available: http://www.youtube.com/watch?v=YASzeqIccGI. Last accessed 11 April 2009.

[29] Autodesk. (2009). *Autodesk 3ds Max.* Available: http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=5659302. Last accessed 11 April 2009.

[30] Autodesk. (2006). *Autodesk & Alias.* Available: http://usa.autodesk.com/adsk/servlet/index?id=5970886&siteID=123112. Last accessed 11 April 2009.

[31] Autodesk. (2009). *Autodesk Maya.* Available: http://usa.autodesk.com/adsk/servlet/index?id=7635018&siteID=123112. Last accessed 11 April 2009.

[32] Pixologic. (2009). *Zbrush Features.* Available: http://www.pixologic.com/zbrush/features/01_UI/. Last accessed 11 April 2009.

[33] ILM. (2006). *The Show: Pirates of the Caribbean 2.* Available: http://www.ilm.com/theshow/. Last accessed 11 April 2009.

[34] Autodesk. (2009). *Autodesk Mudbox.* Available: http://usa.autodesk.com/adsk/servlet/index?siteID=123112&id=10707763. Last accessed 11 April 2009.

[35] Matt Armstrong. (2007). *Autodesk to Fill Hole With Mudbox; Opens Script Door to Artist.* Available: http://www.studiodaily.com/blog/?p=186. Last accessed 11 April 2009.

[36] Right Hemisphere. (2009). *Deep Paint 3D / Deep UV.* Available: http://www.righthemisphere.com/products/dp3d/Deep3D_UV/index.html. Last accessed 11 April 2009.

[37] Christopher Null. (2007). *The 50 Best Tech Products of All Time.* Available: http://www.pcworld.com/article/130207-4/the_50_best_tech_products_of_all_time.html. Last accessed 11 April 2009.

[38] Mootools. (2007). *Polygon Cruncher Overview.* Available: http://www.mootools.com/plugins/us/polygoncruncher/index.asp#details. Last accessed 11 April 2009.

[39] NVidia. (2008). *NVIDIA Plug-ins for Adobe Photoshop.* Available: http://developer.nvidia.com/object/photoshop_dds_plugins.html. Last accessed 11 April 2009.

[40] Chuggnuts. (2008). *Unwrap Tools.* Available: http://www.chuggnut.com/Scripts/unwraptools/unwraptools.htm. Last accessed 11 April 2009.

[41] PolyBoost. (2008). *Full Feature List.* Available: http://www.polyboost.com/features_full.htm. Last accessed 11 April 2009.

[42] Ryan. (2008). *CrazyBump.* Available: http://www.crazybump.com/. Last accessed 11 April 2009.

[43] Interactive Data Visualization. (2008). *SpeedTree Product Suite.* Available: http://www.speedtree.com/apps/#overview. Last accessed 11 April 2009.

[44] Epic Games. (2009). *ActorX.* Available: http://udn.epicgames.com/Two/ActorX.html. Last accessed 11 April 2009.

ANNOTATED BIBLIOGRAPHY

Kevin Lanning (2007). *Character D'artiste 2*. Canada: Ballistic Publishing.

Includes the artist workflow for many different projects including the Epic Games workflow used to create characters for Gears of War. It includes high resolution images and a clear breakdown of the workflow.

David H.Eberly (2000). *3D Game Engine Design*. San Diego: Morgan Kaufmann Publishers.

A generic book mainly aimed at Games engine programmers, it allows the fundamentals of a game engine to be understood at a base level including the mathematical explanations and algorithms associated with many standard game engine features such as occlusion.

Kelly L Murdock (2007). *3DS Max 9 Bible*. Indianapolis: Wiley Publishing Inc.

A tutorial and guide book for 3DStudio Max, containing tutorials and workflow enhancing tips to take a novice modeller through many of the basic and intermediate modelling and animation techniques a shipped within the software

Mark Galer Phillip Andrews (2005). *Photoshop CS2 Essential Skills*. Oxford: Focal Press.

A Photoshop tool and technique filled book explaining the function and features of most aspects of Adobe Photoshop CS2. It includes many step by step tutorials explaining how to achieve results easily in Photoshop.

Tom Meade Shinsaku Arima (2007). *The Complete Reference Maya 8*. USA: McGraw Hill Companies.

A Maya reference book similar to the 3DStudio Max 9 bible; It contains tutorials and useful information to help guide the reader to a better and more defined workflow within Maya by providing a detailed understanding of the features in Maya.

Marc Olano (2002). *Real Time Shading*. Canada: A K Peters Ltd.

A book explaining the complex algorithms and mathematics behind real-time shading; this book gives the reader an appreciation for how real-time shading works and how incredibly complex shaders are at a core and coding level.

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