Department of Mathematics, Natural and Computer Science

Game Character:
Concept to Product

Danial Rashidi
June 2009

Thesis, 10 points, C level
Computer Science

Creative Programming
Supervisor/Examiner: Sharon A Lazenby
Co-examiner: Ann-Sofie Östberg
Game character: 
Concept to Product

by

Danial Rashidi

Institution for Mathematics, Nature and Computer Science  
Högskolan i Gävle  
S-801 76 Gävle, Sweden  

Email:  
nkp06dri@student.hig.se

Abstract  
A production pipeline of different game companies is explored with the idea of creating characters specifically designed for games. A character was created following the different components of a real game studio which produced a low poly count character that could be implemented into a game from a technical and aesthetic point of view. An aim of this research paper was to obtain a better understanding of how the idea of a game character is developed and also why industry professionals utilize some techniques and not others. A finished game character model was created from the design process concept stage to the final product for an online game contest.

Keywords: game character, pipeline, workflow, computer game, polygon modeling, Zbrush, digital sculpting, next-gen character.
Table of Contents

1 Introduction ............................................................................................................. 1

2 Questions .................................................................................................................. 1

3 Past or current research .......................................................................................... 2
  3.1 Research outline .................................................................................................. 2
  3.2 Concept ................................................................................................................ 3
  3.3 Mesh Analysis ...................................................................................................... 4
  3.4 Low Polygon Modeling ....................................................................................... 4
    3.4.1 3D base ........................................................................................................... 5
    3.4.2 Sculpting base ................................................................................................. 5
  3.5 Sculpting ............................................................................................................... 5
  3.6 Retopology / optimizing the model ...................................................................... 6
    3.6.1 Animation requirements .................................................................................. 7
    3.6.2 Silhouette ........................................................................................................ 7
  3.7 UV map .............................................................................................................. 8
  3.8 Texture maps ........................................................................................................ 9
    3.8.1 Diffuse ........................................................................................................... 9
    3.8.2 Normal Map .................................................................................................. 9
    3.8.3 Occlusion ........................................................................................................ 10
    3.8.4 Specular ......................................................................................................... 10
    3.8.5 Light .............................................................................................................. 10
  3.9 Current generation restrictions .......................................................................... 11
    3.9.1 Polycount ....................................................................................................... 11
    3.9.2 Texture size ................................................................................................... 11

4 Development of character ...................................................................................... 12
  4.1 Concepting my character .................................................................................... 12
  4.2 Mesh analysis ..................................................................................................... 13
  4.3 Creating the base mesh ...................................................................................... 14
  4.4 Sculpting in Zbrush ............................................................................................ 15
  4.5 Retopology ......................................................................................................... 17
  4.6 UV map .............................................................................................................. 19
  4.7 Texture maps ........................................................................................................ 20
    4.7.1 Diffuse ........................................................................................................... 20
    4.7.2 Normal .......................................................................................................... 21
    4.7.3 Specular ......................................................................................................... 22
    4.7.4 Light .............................................................................................................. 22
  4.8 Rendering ........................................................................................................... 22

5 Discussion ............................................................................................................... 23

6 Conclusion .............................................................................................................. 24

References ............................................................................................................... 26
1 Introduction

In today’s industry, there are many different methods of creating a character that is optimized for games. My goal is to evaluate different approaches and then apply these to a game character that I will develop. I have several different expectations for this research paper. First and foremost, I want to use this as an opportunity to explore different professional methods for creating characters and also the most efficient and timesaving methods in use today. I also wish to create a guide for others to use when creating characters and explain why certain methods are preferred over others.

This research will be focusing only on the production methods while inserting some theory and reasoning behind it. It will mostly concern itself with the practical side of character design. Since method evaluation is a vital part of this paper, I will also focus a great deal on the effects of different methods as well as professionals statements in regards to using these methods in actual production pipelines.

I will also combine this research project with Dominance War IV, a contest I am entering in online [10]. The contest concerns the creation of a game character. It is an international contest with seven countries and several online communities entering. There are several restrictions that would apply to current generation game character such as polygon count, texture size, rendering engines etc. I plan on explaining more about the competition in other sections.

2 Questions

The questions I plan to research concern game characters and specifically my own part in a pipeline. However, to know my own part in the production pipeline, I must first understand the pipeline as a whole. During this thesis, I plan to research how professional game companies develop games and what the production environment looks like.

My main questions that I want to obtain answers from are:

- How is a professional game character pipeline designed?
- Can I apply the pipeline to my character creation process?
3 Past or current research

Game character creation is an area that has been examined by many (first and foremost game companies such as DICE, EA Games, Ubisoft, Epic Games and many others), however more focus has been on the technical and underlying structure of character creation. Such things as game engine design and matrix calculations for optimal polygon count are topics that are often examined. However, the side of game creation that I wish to focus on in this research is the more artistic one; the side of games that allow the artists to be as free as possible while making sure they are working in the most efficient manner possible. There are some possible sources of related research in that area, such as Game Development which deals with the creation of game assets in general as well as with engine and technical configurations [1].

Since the creation of tools such as Pixologic™ Zbrush® and Autodesk Mudbox™, the focus for artists has been shifted from technical and vertex oriented creation to more fluid and sculpting style process [7]. Many have focused on the capabilities of these programs as a stand-alone utility; however I will focus on these programs as a part of the whole and their roll in the character process [8]. I will also draw information from different sources in the industry such as interviews by leading artists and statements from technical directors who control the pipelines in different projects to better understand how and why they work in the manner they prefer.

One rich source of research are contemporary artists that share their work process on the internet for emerging artists and others who want to know what it takes to create characters in a professional setting today. I will use several different artists as guidelines [2] [3] [4] [5].

3.1 Research outline

The past and current research about this subject is divided into several sections to obtain a better understanding of the underlying techniques used to create game characters. The following is the list of the main categories that will be examined.

- Concept
- Mesh Analysis
• Low Poly Modeling
• Sculpting
• Retopology / Optimizing the model
• UV-Layout
• Texture maps / Light / Occlusion / Normal

These main categories are the major steps in creating a character. Many artists go through these steps which are the minimum for creating a character today. This specific list was a composite of a few different artists’ workflows [2] [3] [4] [5].

As stated before, there are different categories of the character creation pipeline. This process depends on the different stages of game development that precedes it, but since they do not lie in the scope of this paper I will not go in to them in any depth. Suffice to say, there is a great deal of work that goes into a game idea before it reaches the character stage and the resources, both monetary and personnel, are often extensive.

As I mentioned before, I chose these particular steps because they are vital to the process. My main source will be a book explaining the process of creating a character for the popular game *Gears of War* [5]. Since *Gears of War* is a next-generation game and is viewed as a standard for which many games are measured against and also because it has received high marks for its visual effects, I thought it fitting to use its process as a reference for how a successful pipeline is achieved.

### 3.2 Concept

In the process of creating a character, no artist works alone. A game character moves through many steps and is altered by many different artists from start to finish. The most common practice is to start the creation of a character, not with 3D models and digital sculpts, but with 2D concept drawings of a character idea. I mention character idea and not character for the simple reason that characters do not emerge in the beginning of the concept stage. A lead artist explains his need to a team of concept artists and they try to translate this idea from a proposal of a character type to an actual character that would fit in the game. It is not uncommon that there are several different versions and variations of every character. Often, it is only a component that the project managers select and the rest has to be substituted for other parts that meet the requirements of the producers and project managers. In this approach, concept
artists are both the most free and controlled group of the production since they have to create many different approaches that vary greatly to the original idea. However, they must also conform their creativity to the project managers’ preconceived ideas about how it should look.

### 3.3 Mesh Analysis

The second section of the character creation pipeline is analyzing the approved concept of a creature and realizing what parts of the model as a whole will work in three dimensions and also which of those parts of the model in specific will need more attention. After looking over the concept and agreeing to something that is both realistic to create and achievable in a reasonable amount of time, the artist will then examine the character and divide it into several different parts according to the level of detail they will need. The artist will also examine different types of materials since different materials will have inherently diverse shape qualities.

Mentally separating the different parts of the model will also assist in the modeling process because working with pieces is easier to manage, both for the computer and the artist as it allows for easy substitutions and mesh manipulation. Character artist Kevin Lanning discusses this technique in D’artiste 2 [5].

“When starting a new character, taking a couple seconds to breakdown the concept is always a good idea. Whether it’s done mentally or visually is up to the artist. But it will help to simplify your character from one massive form into several smaller ones, in return making it a less daunting task to get the ball rolling. This breakdown will also help to determine what areas of the model will be organic, hard surface, as well as what can be ‘kit-bashed’ from previous models.” Kit-bashing or model bashing is a practice whereby a new scale model is created by taking pieces out of commercial kits. These pieces may be added to a custom project or to another kit.

### 3.4 Low Polygon Modeling

The next step that follows mesh analysis is the mesh construction where the modeling of the creature is started by creating a low polygon version. This version is the basis for future work but is by no means any definitive version of the low polygon mesh since it is always subject to change during this process. There are several different
techniques of creating a low base mesh. Since Zbrush® and Mudbox™ were introduced many artists prefer to move quickly from the technical aspects of creating a character’s base mesh and dive right into sculpting the mesh. However, for this to be able to be accomplished, a base mesh is needed. There are two main methods of creating this base mesh: 3D base and Sculpting base.

3.4.1 3D base
This method is the more traditional. An artist creates a basic mesh in an external 3D software such as Autodesk® Maya® or Autodesk® 3D Studio Max® and then exports this character into high polygon sculpting tools, such as Zbrush® or Mudbox™. The model is then altered in many different styles and the base mesh does not necessarily need to be an approximation of the concept art but rather a "blob" that fits the general anatomical needs for the character. In other words, it needs only to be a simple shape that has the right number of limbs and features. However, the proportions and placements of different parts can be and is often preferred to be off due to its significantly timesaving quality. If only a basic shape is needed to sculpt, it is often easier to do so with pressure sensitive tools and more traditional artistic inputs rather than the standard interface of a mouse and keyboard that most 3D software’s utilize. This base mesh is then imported into a sculpting package where it is subject to changes to alter it according to the concept art.

3.4.2 Sculpting base
The second method is to employ the tools in these sculpting packages and create a base inside of them. In Zbrush®, this is very easily created with the use of Z-spheres. The artist only concerns himself with drawing spheres on a canvas where the joints are needed. These spheres are then converted into a 3D mesh which is then conformed to the same standards as an imported mesh from an external 3D package. There is currently no such feature in Mudbox™ where a base mesh needs to be imported and worked on.

3.5 Sculpting
This step is perhaps where most character artists spend most of their time. The sculpting process is one of the most challenging and enjoyable parts in the pipeline. While it is not advance in a technical sense for there are a limited number of tools and
methods involved in the sculpting, it is more challenging from an artistic standpoint. Anyone can use clay and sculpt something that looks similar to a face but it takes time and dedication to make that face realistic. And, it is even more challenging for game character artists to make a face look realistic while constantly battling the fixed number of triangles allotted to the character. This does not mean that it is easy from a technical point since knowing the different tools at the artists’ disposal will allow for a time efficient project, but rather that the challenge in this part is in the artistic capabilities of the user.

Many artists also choose to make use of a Wacom tablet. It is a pressure sensitive drawing tablet which allows the user to “draw” on it, however instead of anything appearing on the tablet itself the motions are transferred into the computer and then translated into pencil strokes. The advantages of using the tablet are many; the two main features that appeal to artists are the freedom that lends itself so easily to pencil strokes and the pressure sensitivity that is crucial when sculpting [8]. Since artistic ability is something that is required for professional game artists, the use of traditional tools that allow for strokes and curves that the mouse does not allow, are a necessity. A Wacom tablet is a powerful instrument in creating satisfying and realistic creatures. The pressure sensitivity is just as important as the ability to make broad strokes. The mouse is purely in a digital world with an on and off mode for clicking. The pen however allows for the artists to use different pressures to create difficult strokes that would not be possible to create with a mouse.

### 3.6 Retopology / optimizing the model

When the character is sculpted, the more technical aspects of character creation come into play. In many cases, the original mesh does not have the necessary edge loops for animators to use. They also do not have the right silhouettes, since the modelers have to stay within the allowed number of triangles. They must work with the low polygon version of the character to make sure that where the illusion of detail can not be covered up with texture maps there is no hard edges that shows the drop in detail to the player. I will examine these two important subjects more in depth in the following section.
3.6.1 Animation requirements

Since the character has to be animated and placed inside the game, it is not complete when the modeling is completed. Animators will then take the model and apply different animations and blend shapes. They need a model that has been fitted for animation. This means that there is a specific requirement for edge loops and borders. Different parts of the model are needed to do different things, such as the bending of arms or legs, or the opening and closing of the mouth. With this in mind, it is the modelers job to not only create the characters shape that it is supposed to have but also to make sure that the divisions in the model are placed in the correct manner to deform naturally when the character is animated. When working on a low polygon character, it is especially imperative to make sure that the edges are placed correctly since any ill-placed edges will create a deformation that is very noticeable to the end-user because of the small number of triangles.

3.6.2 Silhouette

The second key item to address is the silhouette of the character. Again since the artist is only given a fixed number of triangles to work with, it is important to place these wisely. A technique to disguise a low polygon character as a high polygon character is to use different texture maps, such as diffuse and normal maps. These maps allow the game to fool the user into thinking that the number of polygons is much higher than they actually are. One place that textures can not assist is the silhouette of the character. The artist needs to look at the silhouette and make sure that there are not any unnatural long flat areas that are typical of low poly characters [5].

Kevin Lanning stated:

“The use of proper edge loops for mesh deformation goes alongside creating a smooth silhouette. Both are key factors to keep in mind when trying to achieve the high-poly look for an in-game model. Nothing gives away that the model is low-poly more than having sharp polys protruding off the silhouette of an in game model. The goal with the use of normal maps is to achieve the visual impression that the in game model is much more than simply a low-poly mesh. By paying attention to these two things, this is achieved.”
3.7 UV map

When the character shape is finalized, the artist has to move from the sculpting and forming stage to the texture stage. And the most important thing before creating textures of any variety is a well planned UV map. There are several different methods of creating a good UV map.

There are stand alone programs that deal specifically with importing an .obj model and splitting up the model into different UV groups to provide the user more control over the UV map. Using this method, the precision needed can be used, however it allows for the computer to handle the more repetitive tasks such as laying out the UV map while providing the user the control of choosing how the cuts are performed and how they are to be laid out.

Another method to create the UV maps is by using the built in pelting features within the 3D applications Autodesk™ Maya™ and Autodesk™ 3D Studio Max™. Both have the feature of laying out the UV’s after the model is completed.

An additional aspect that is invaluable in game characters is the choice to mirror the texture. Using this method, a character needs only one side textured since the other side can be mirrored. This leads to half of the UV layout to be mirrored on top of itself providing the artist double the resolution. This is preferred for many types of characters that are symmetrical (Left and right side identical) and not of great importance in the game. For the more prominent characters, this technique is not often used because of the added level of realism with asymmetrical maps. This does not mean that mirroring is never used on characters that are important in games, but perhaps not as frequently as less central characters. There is also the alternative of mirror parts of the character that do not draw much focus, however providing the face and body a unique texture space for both the left and right side of the character.

I also need to mention the importance of keeping the UV layout leveled, which means that the orientation of the maps are the same as their orientation on the character. It is easy to rotate a part of the character 90 degrees to make it fit in the texture space, however this is sometimes problematic in the texturing phase as the artist will have to draw the textures sideways or constantly rotate the canvas every time he wants to make a change on a part with different orientation.
3.8 Texture maps

The last section of the character creation process is the different texture maps that are to be applied. There are several different types of texture maps with different goals. I will outline the most important that make a key difference to the quality of the character.

3.8.1 Diffuse

The diffuse map is perhaps the most straightforward map. This texture map decides the color of the character. The texture should have no other information than pure color. It is therefore very important that the artist keeps the texture map free from any specularity or shadows that may look good on the character but will interfere with the other maps while rendering in the game.

3.8.2 Normal Map

The normal map is a relatively new feature which has only been in active use in videogames since 2003 [6]. This is a type of bump map that provides the illusion of added geometry by comparing the actual geometry and the normal map and then bouncing light off a certain part of the model differently according to the normal map even if the area does not have any variations. The normal maps do not change the actual geometry of a character. They can alter how light is bounced off the surface and it can provide the false impression of a high polygon mesh.

The normal map can be created in different methods. The most common is that the map can be generated from a high polygon character and then applied to the low polygon version of the same character. There are also programs, such as Crazubump that can make an approximation of the normal map based on the diffuse texture.

Zbrush has one has the option between projecting a high polygon mesh onto a subdivided low polygon mesh, providing the low polygon mesh a higher total polygon count and then generating the normal map from the subdivided low polygon character. Or the high polygon mesh can be placed on top of the low polygon mesh and then project the normal map on the low polygon mesh. Using any of these two methods, the artist can be sure that the normal map is generated correctly regardless of the relative UV maps of the two characters.
In Autodesk® Maya®, the process is similar to the second Zbrush method. The high polygon mesh is captured and then projected on the low polygon mesh. Thus, it creates a normal map that can be applied to the low polygon mesh with all of the detail of a high polygon mesh.

3.8.3 Occlusion

An occlusion map is used to simulate some realistic features in any object. Since the game engine only has the low polygon version of the character, it can not create accurate ambient occlusion on the character. And even if it could, it is a costly computation in terms of render time. Occlusion maps are therefore generated from high polygon characters and then multiplied with the diffuse map to provide the impression of light being realistically obscured by objects close to each other.

3.8.4 Specular

The specular map is a control map that informs the game engine of how the different parts of the character will reflect light and what color this light is going to be. In many cases, the same texture node is applied to the character as a result the game engine can not control how much, for instance, the finger nails reflect light compared to the rest of the fingers. Specular maps are therefore applied to contain the information of what sections of the character are going to be highly reflective and what sections are not. In this technique, the simulated light will interact differently with different element of the character without using several different shaders.

3.8.5 Light

Light maps are texture maps that are used when there are no complicated light changes in the scene. The light map is then multiplied with the diffuse map and a “lit” character is created. This fake lighting is only convincing when there are no contradictions between the rest of the scene lighting and the character lighting. The benefits are tremendous, light does not need to be computed for every frame when the character is in the scene and computing power can be used for other tasks.
3.9 Current generation restrictions

This section is dedicated to more current research. Current-gen refers to “current generation,” as current generation video games. The Xbox 360 was for instance a “next-gen” console before its release. It is now a “current-gen” console. To gain knowledge about what it takes to create a character one also needs to know the different restrictions for the characters. The two most important restrictions for the character artists’ are the polycount and the texture size.

3.9.1 Polycount

The polycount refers the number of polygons currently making up the mesh. This number is strived to be kept as low as possible to make sure that computations are no more than necessary. However, aesthetic expectations from the end users require this number to be ever growing as consumers become more and more used to the increasingly lifelike products from the entertainment industry and come to expect better graphics with every released title. Here is a summary from two major games and polycounts for different assets ingame:

Gears of war, Xbox 360 [5]

<table>
<thead>
<tr>
<th>Character</th>
<th>Polycount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wretch</td>
<td>10,000</td>
</tr>
<tr>
<td>Boomer</td>
<td>11,000</td>
</tr>
<tr>
<td>Marcus (Main)</td>
<td>15,000</td>
</tr>
</tbody>
</table>

Half-Life 2, PC [9]

<table>
<thead>
<tr>
<th>Character</th>
<th>Polycount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alyx (Main)</td>
<td>8,323</td>
</tr>
<tr>
<td>Soldiers</td>
<td>4,682</td>
</tr>
<tr>
<td>Police</td>
<td>3,852</td>
</tr>
<tr>
<td>Resistance</td>
<td>4,976</td>
</tr>
<tr>
<td>Zombie</td>
<td>4,290</td>
</tr>
<tr>
<td>Helicopter</td>
<td>6,415</td>
</tr>
<tr>
<td>Strider</td>
<td>6,444</td>
</tr>
</tbody>
</table>

3.9.2 Texture size

The texture size refers to the size of the texture sheet used for each individual map (1 map for diffuse, 1 for normal etc). Since there are often many assets in a single game,
there are an equal amount of textures for each unique asset, which means that the computer will have to render out many different textures and the computations increase with the texture size. Much like the polycount, there is a constant battle between computer efficiency and aesthetic beauty.

### 4 Development of character

This section is dedicated to the creation of my own character with all of the previous sections as support for completing this task. I plan to work through every component with the same diligence as a real game studio and produce a character that could be implemented in a game, from a technical and aesthetic point of view. There was a contest among several game dedicated communities where artists from around the world could join and create a game character; therefore I have seized this opportunity to create a character with realistic current-gen restrictions and regulations [10].

#### 4.1 Concepting my character

The first task was to create a concept for my character. Since I was the art director as well as the artist, I had more flexibility than the typical game artist, because I did not have the need to obtain external approval for my ideas. The contest did have some guidelines about what type of characters were allowed in the contest; however the rules were lenient on this point. I started out with a feeling rather than a character type. I wanted this to be a powerful character, exotic, beautiful yet deadly. I wrote down different keywords that were important to convey and when I had them I could then start coming up with different concepts that would fit my original thoughts. This process allows the artist to focus more on the feeling that character emits from the start rather than creating a character and then infusing it with different types of traits that would evoke similar feelings.

Once I had these keywords and a general idea of what I wanted I started to create the concept with some really quick sketches of the character. Below are some samples of the concepts (Figure 1).
4.2 Mesh analysis

The next decision was to look at these concepts and analyze what parts of the character were going to require a great deal of detail and what parts were not. For instance the legs of the female do not need a large amount of edge loops because there are not a lot of variations. The leg extends almost straight down and becomes thinner thus there is no need to place a large amount of definition there. Conversely, the staff and the head both require more edge loops because geometry needs to be there to be able to show the model from different angles. The nose for instance does not show if looking at the model straight ahead, but if the perspective is changed there needs to be a defined nose or the model will appear lacking.

In this stage, I also mentally divided the model into different parts, hiding the seams between objects. For instance, the females’ torso is a separate object and the bra and skirt covers over that seam, and the legs are both individual objects as well. These splits provide me with added control when I start sculpting because I could choose to
work with different sections at a time or the whole model if I so wish. They also allow me to conserve computer memory because Zbrush only works with “active points,” meaning that the models total number of polygons can be quite high as long as the active object is not higher than the maximum amount. For instance, the total number of polygons on the entire object can be somewhere along 20,000,000 while the active polygons (the parts you work with) are lower than the maximum of 9,000,000. Since Zbrush only works with the active amount, the total amount makes little difference.

4.3 Creating the base mesh

To create the low polygon base mesh, Autodesk® Maya® was utilized to start with the box modeling. Box modeling is a technique in 3D modeling where the model is created by modifying primitive shapes in a method to create a “rough draft” or the final model. I imported the concept drawings created earlier and used them as reference images, as well as several images of models to obtain the correct anatomical proportions for a young woman with a similar body type. This technique was used because I am more familiar with it and there was not enough time to experiment with Zspheres.

![Figure 2: Base mesh for the dragon.](image)

Above is the low polygon model of the dragon (Figure 2). Again, this is by no means the final low polygon model that I will apply the normal map and texture maps. This
is only a shaped “blob” to start sculpting with, once inside Zbrush this shape will change and several parts of the model will be moved around.

Once the low polygon meshes are complete, I exported them from Autodesk® Maya® in an .obj format so that other 3D applications can import them without any problems. Every different part was exported separately; therefore this character had different pieces for the head, torso, wings, tail and saddle. This was prepared because of the advantage of separate pieces in Zbrush concerning the polygon count. The same process was followed for the female character and when the exporting was finished, I had a folder with all of the different pieces of the two characters.

### 4.4 Sculpting in Zbrush

The next process is by far the most enjoyable in my opinion. This section is dedicated to the sculpting of the character. The mesh is imported from a 3D package and the process of working over the character with immense detailed and scrupulous skill. This is what can really separate an obvious 3D character from a realistic and lifelike image. During this phase, I made several critical design choices. I had the opportunity to quickly try out different solutions and see them in a 3D environment which provided a better understanding of the form as a whole. For instance, I experimented with letting the dragon be an amputee and to create him with a magical armor leg instead. It was a quick matter to change the base mesh and delete excess polygons and then sculpt a stump to see how it would appear (Figure 3).

![Figure 3: The dragon sculpted inside Zbrush.](image)

After testing the leg out, I went back to the original design where the dragon had two legs and continued with the sculpting. That level of freedom is what makes Zbrush
such an excellent tool for artists’ everywhere, the ability to quickly try something and just sculpt the base mesh as with traditional tools in clay.

When the dragon was completed, I started working with the female, the problems were similar yet different when it was time to model something real. In the case of the dragon, I could just invent how the limbs interconnect and how the proportions were related, however when it came to the woman there were strict rules for where the arms are placed and how far apart the eyes are. The process of creating these two characters was not that unlike for even though I had my choice of the dragons design, I still had to follow certain rules. To create something that does not exist in reality provides you freedom to choose how it is going to appear, however if it is to look convincing there are regulations about how muscles interconnect and where the bones need to be for a joint to function. The overall design was mine to create but the details were actually taken from animals with similar anatomy. The torso, for instance, was to a great extent from a cat, the hands and feet were taken from dinosaurs and the face was a compilation of different lizards. This process of “borrowing” anatomy from real animals lets me create something fictitious with the illusion of reality because of the already established authenticity of these designs.

The female was somewhat straightforward to sculpt with a large library of reference images and anatomy material. A convincing female was sculpted within Zbrush and also the clothing was sculpted with realistic folds using different alphas as brushes to get the material to crease similar to how folds naturally flow (Figure 4).
4.5 Retopology

After finishing sculpting both the female and the dragon, it was time to retopologize the characters. This is, in my opinion, a most tedious and repetitive task. This process started by using the paint feature in Zbrush and lines were painted over the high polygon characters where I wanted the edges to go. This was partly made because it is easier for me to see where the lines will go later on in the process, and also to discover any problem areas that might come up during the topology process (Figure 5). By drawing the lines by hand, I could see if I miscalculated and created faces with five or more sides. When the edge flows were worked out, Zbrush built in retopology tool was used by opening up a Z-sphere and importing the mesh onto it. Then, Edit Topology is chosen and I could start to draw the new topology over the lines I drew earlier. Because I have the lines already in place, there is virtually no undoing and back tracing over parts that will not work.
The above picture shows the high polygon dragon with the planned low polygon edges. There is little definition for areas like the throat, legs and wings but increased resolution for areas like the head and feet. Any area with high geometry detail will receive more definition to make sure that all the deformations are correct in those areas.

As mentioned before there are several different aspects that have to be considered when retopologizing the character: the silhouette, animation requirements and polygon count.

The silhouette is extremely important when it comes to a low polygon character because of the restricted number of polygons allowed. These have to be placed wisely and nothing reveals the true nature of a low polygon character more than the silhouette. In Figure 6, there is an example of the dragons’ silhouette. The throat and
legs have less definition than the head but the silhouette makes it seem like there is an even dispersion of edge loops all over the character.

Since this character was made for a competition where the only product was an image, there really were no animation requirements. I had the luxury to disregard the need to make it animation friendly and instead focus on its appearance as a whole rather than how it would look when it moved. The dragon had to be posed but any problems could be worked out by hand before the final render thus freeing me from changing the topology to make it deform better.

The polygon count was the most important thing to consider during this phase. The contest rules stated that the entire character and all accessories displayed in the scene could have a maximum of 10,000 triangles. This would mean that before starting to draw the new topology, a few assessments would have to be made depending on the different characters and how prominent they were going to be. The dragon, for instance, is much larger than the female but an equal amount of triangles were allotted for them because the dragon needed to look good from a distance but the female needed to look good when it was time for close ups. That only left 5,000 triangles for the dragon (including armor and gear), as well as only 5,000 triangles for the female (including clothing and weapon). Once I knew how much I could spend on each character, a crude approximation was started and then more definition was added until the most important areas were covered and the remaining triangles could be evenly distributed across the characters.

4.6 UV map

When the low polygon character is retopologized, the next step is to create the UV map. This is the creation of a 2D representation of the 3D character, and in this step the character is laid on a 2D sheet where the 2D textured can be applied on it (Figure 7). The program that I used to lay out the UV map is UVLayout, a program that can import an .obj file and then easily create a UV map. It loads the character and allows the user to define a symmetry line (if it is a symmetrical character) and then mirror everything across the line. The user then splits up the character into several different objects that are to be laid out on the UV map. For instance, I chose to create a separate piece for the female's head because I wanted more detail on that area and therefore more texture space.
Since this is for a game character, the more you can “fake” the better. I have mirrored the wings which are quite large in relation to the rest of the dragon and used one set of UVs to represent both of them. Using this technique, a single, larger area for both wings could be used other than two separate wing UVs. The same technique was used for the females’ legs but not for the upper body because I wanted the option of adding detail unique to one side (such as tattoos or decorations).

Figure 7: UV layout for the dragon and sorceress.

4.7 Texture maps

This is one of the largest parts of the character creation process, a well made texture can make all the difference between a good and a great character. Since texturing is not one of my strongest traits, a great deal of time was spent researching different techniques for creating convincing textures. In these different subdivision topics, the process of how the final three textures were created is described.

4.7.1 Diffuse

The diffuse texture is the one that is most apparent to players and therefore this area needed more attention. To start with, an ambient occlusion bake was created and then multiplied with a single color layer in Adobe Photoshop. In this process works, the high polygon character and the low polygon character were both loaded into a bake program, XNormal, which is a free program to use for any 3D artist. Then, an ambient occlusion map was baked from the high polygon character unto the UVs of the low polygon character. This provided a black and white picture with the darker
parts relating to the areas of the character that were close to each other and therefore naturally covered up from different light sources.

When this black and white picture was created, it was opened in Adobe Photoshop and set to multiply mode to allow all of the dark patches to come through while letting the areas of no interest (white areas) to disappear (Figure 8). When the basic set up was completed, I could then start to paint on different colors that correspond to color variations on the character. That provided a solid foundation to work on; I had the basic colors down and all of the detail from the ambient occlusion layer. The next step was to add details which were a combination of other images that was used to blend with my texture and hand painted details.

Figure 8: The diffuse texture for the dragon and sorceress.

4.7.2 Normal

The normal map is auto-generated from Zbrush; therefore little manipulation was needed to apply it to the character. There were small sections where the software made mistakes and I had to manually go in and correct it. In this case, an artifact had to be painted over that was created in the baking process which made some color distortions on the face resulting in normals going in the wrong direction.
4.7.3 Specular

The specular map is also a very straight forward map. The method used to create it was to simply take the diffuse map when it was finished and then desaturate it and manually increase or decrease the brightness in those areas where more control over the specularity was needed.

4.7.4 Light

The light map is optional. In this competition, one was used because the end result was a still image and not for an actual game. Since I had complete control of both the light positions and camera angle, I could make sure that there were no conflicts between the light map and the rest of the scene. This is more difficult to do in a game where the player controls the character movement and the shaders have to react to the different lighting situations. The method that I created the light map was to import the low polygon mesh in Autodesk Maya and then place the different lights that were needed. When the lights were placed, the built in baking options was used to bake the lighting and color information which then renders these attributes out onto a texture that could then be imported into Photoshop.

4.8 Rendering

When all the different textures were finished, the rendering would be the next step. For this competition, I was only allowed the hardware renderer in Autodesk Maya or a rendered image from a game engine. 8MonkeyLabs released their Marmoset Engine so that competitors could import their characters into it and render out images from a real time engine. However, a screen shot was rendered from inside Autodesk Mayas viewport (Figure 9).

There were several different types of images that were to be submitted for this competition: a beauty shot (where any renderer and any post effects could be added), a presentation shot (with a render from a real time engine), a construction shot (with images of the characters from different stages of production), a texture sheet (with all of the different textures used to create the image), a text image (with a short explanation about the character) and also a concept image (with all of the different concepts used to create the character). These images can all be viewed on my website at [http://www.dadonmedia.com](http://www.dadonmedia.com).
5 Discussion

After going through this process, I have gained new insight to what tremendous work goes into even the smallest character in today’s games. When I started working on this research paper, I was not familiar with the different stages that are employed in production. Now however, I am fully versed in the production pipeline. Using this contest with accurate industry restrictions, I had the opportunity to apply my knowledge to real world standards and not just an arbitrary project where there were no guidelines or tangible connection to the industry.

The reason I entered into this contest and why I chose to write my thesis about this subject was to gain the knowledge required to work in a professional milieu. I feel that this goal is reached and that I now can continue on with more practical research into more artistic fields. I feel that this is an industry that is on the rise and this knowledge will help me gain access to an entry level position.

Looking back on this project, I would have preferred doing some things differently. I would have spent more time on the concept stage and perhaps created different variations of the dragon and the sorceress. I would also have spent less time than I did working on the base mesh as I now know that the base mesh is not that vital and it is just a starting point. However, I am pleased with the sculpting portion of this project as I tried out different tools and different methods for sculpting. I would also have liked to put more detail in the diffuse texture, however all of these are minor issues and overall I am happy with this project and the different tools I now can use.
The contest is not complete as of the completion of this research paper, therefore there is no way of knowing the results of my character and where it placed in the contest. There is also no information available concerning the final date for judging.

6 Conclusion

This research paper was designed to allow me to investigate and understand the production pipeline of the game character companies and I believe that I have gained new insight as to what it means to create characters specifically designed for games. The two questions I set out to answer were the following:

- How is a professional game character pipeline designed?
- Can I apply the pipeline to my character creation process?

The first question relates to the first section of my thesis, past or current research where I investigated how game characters were designed today. I have reached that goal and now know the design process from the concept stage to the final product. I can summarize the different parts into five major events in the pipeline:

- Concept
- 3D-base
- Sculpt
- Texturing
- Rendering

The concept stage is similar to my own project but many times more complicated. In a professional environment, the number of concepts created for a single character can range from 10 – 100 different variations and alterations.

The 3D-base stage is ideally as short as possible where the foundation for the sculpting is created. Many companies keep vast libraries of different base meshes to make this stage as short as possible. There is also something called “kit-bashing” where different characters are taken apart and the pieces of several different characters are used as base meshes for new characters [5].
The sculpting stage is where the more senior character artists sculpt the design of the base meshes to make them look like the concept art. While the technical difficulties are few, the artistic difficulties become more apparent and traditional skills such as painting, sculpting and drawing become more important.

The larger companies have designated texture artists that receive the finished model from the modelers and then spend all of their time creating the different textures to make a good looking character. In smaller companies, the task of texturing is dealt out to the modeler as well and that is the reason it is included in this thesis.

The last key section of the pipeline is the rendering. This can have several different meaning depending on the development environment. For the contest, it required only a fixed pose render where everything was setup for that shot. In games however, the rendering is handled by the game engine and the character modelers job is to make sure that the character can be imported into the game engine by following project standards (such as polycount, texture size, naming conventions, file type exports etc).

The second question relates to my own knowledge and if I could apply the pipeline to my own character creation process. The answer to this question is yes. During this project, I have learned different professional methods of solving different problems and I have applied these methods to my own project. Granted, my own project was much smaller than an actual game character production with less people involved. However, the different techniques used are the same and the different software programs are used in the same manner both in a professional and novice environment.

There are other fields involved in the game character pipeline, such as animation and game engine optimization. But these fields are not pertaining to this thesis and I leave them as suggestions for future research by others because they are equally important but deal with more technical problems rather than artistic.

I also gained some insights as to why artists use some methods and not others and it comes down to personal taste. Many of the tools used in the industry are sufficiently advanced to let the user complete many different stages. Then the user has a choice and can choose the software he or she is most comfortable with.
References


   Ballistic Publishing, Mylor, Australia.


[7] Pixologic : Interview : Epic Games -


