# Texturing & sculpting in 3d

graduation project - Jean Nygård

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Lahti University of Applied Sciences
Institute of Design
Degree Programme in Visual Communication
Multimedia Production
Graduation project
Jan-Erik “Jean“ Nygård
Fall 2008

# Lyhennelmä

Koska kolmiulotteinen grafiikka on varsinaisen laaja aihe, olen tässä projektissa halunnut keskittyä aiheen teksturointiin ja visuaaliseen veistämiseen. Käyn koko prosessin läpi, koska semmoisenaan kolmiulotteinen veistäminen ei mielestäni täytä minkään näköistä tarkoitusta, eikä varsinaista kuvamateriaalia edes ole mahdollista tuottaa ilman muita kolmiulotteisen grafiikan osa-alueita.

Tämän projektin päämääränä on ollut tutkia kolmiulotteisen grafiikan käyttöä mallintamistöissä (mikä ei sinänsä ole sidottu mihinkään tiettyyn resoluutiomalliin) sekä soveltaa teoriat käytännössä ja siten myös todistaa ne kelpoisiksi menetelmiksi. Menetelmien tutkimisen tarkoitus oli myös kytkeä Pixologicin Zbrush'ia kolmiulotteisen grafiikan tuotantoketjuun. Projektissani törmäsin moniin suorastaan teknisiin rajoituksiin ja ongelmiin, jotka olen myös ratkaissut matkan varrella.

Tämän työn päämääräiset menetelmät ovat siis teksturointia ja pinnankäsittelyä tai veistämistä Pixologic Zbrush'in avulla yhdessä Autodesk Mayan ja Adobe Photoshop'in kanssa. Mayalla kehitin kaikki uuden mallin varsinaiset alkuvaiheet ja palasin siihen muodostamaan kehittyneempää mallia käytettyäni Zbrush'in veistämiseen. Tietyllä tavalla tarvitaan aina Photoshop'ia välivaiheohjelmana projektin toteuttamiseksi.

Haluan ensimmäisenä kiittää Jussi Kemppaista opettajana todella tarkasta ja hyvästä mallinnusmenetelmästä. Sen lisäksi haluan myös kiittää David Giraud'ia ulkoisena lähteenä hänen valtavasta tiedostaan Zbrush'in tuotantomenetelmistä, jotka hän on jakanut Zbrushcentral'in foorumeilla (http://www.zbrushcentral.com).

Olin positiivisesti yllättynyt tämän työn lopputuloksista koska tuli tietooni että samankaltaiset menetelmät ovat käytössä myös isoissa tuotantoketjuissa. Tämä projekti on ratkaissut lähinnä kaikki kysymykset, jotka minulla oli koskien tätä aihetta ja mielestäni sen takia projektini tuntuu onnistuneelta.

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# Abstract

Because of the complexity of 3d graphics, I've chosen to concentrate in this project on the aspects of texturing and complex surface deformation methods. In this book I'll cover the process from the startup of a 3d model to the first rendering passes, for the sake of sculpting in itself doesn't really make up for proper visualization of the processes involved and therefore other aspects of 3d graphics are needed.

The projects goals are to research methods for creating resolution-independent modeling and also to put the methods in practice to prove the theories correct and fully applicable in a production environment. What I also wanted to solve with this project was the issues concerning incorporating Pixologics Zbrush into my previous production chain. Mostly the problems and issues around this subject have been technical in nature, and apt solutions have been either researched or implemented during the course.

The key working concepts I'm covering in this project is texturing and surface sculpting with Pixologic Zbrush in conjunction with Autodesk Maya and Adobe Photoshop. With Maya I construct the starting point for any given model, and I also return to it after the main sculpting and painting has been done with Zbrush. In some aspects Photoshop is always needed as an in-between program for any of these things to work out.

I'd like to thank firstly Jussi Kemppainen as a teacher of a very powerful modeling technique I'm using in this project and usually otherwise too. As an external source I'd also like to thank David Giraud for his huge knowledge on Zbrush in a production environment he's shared at the Zbrushcentral forums (http://www.zbrushcentral.com).

I was positively surprised by the conclusions from this project how much it correlates with production methods employed in much larger production chains. For my part, this project has solved at least my problems and questions on this subject, so therefore it's quite a success on my behalf.

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Avainsanat: mallintaminen, atk/ohjelmat, multimedia, Autodesk Maya, Pixologic Zbrush, Adobe Photoshop

# 1 Foreword

In my younger, less digitally enhanced years, I once stumbled upon the concept of miniature painting. Miniature painting and 3d graphics have actually quite a lot in common, though the concept of 3d graphics allows for all the live detailing that really can't be created by at least any easy means in a physical world. Since then the realms of gaming and visual storytelling have greatly developed into a higher level, with the most of this development having taken place in the 90's.

Among the most revolutionary progresses in the developing of 3d graphics, probably Zbrush would be the most united and versatile toolset that has been developed to make the 3d creation process something else than just "pushing polygons". Pushing polygons is still needed, but when the detail level of models is nearing photorealism, the tools will also have to develop. Just picture pushing polygons with pores in a human face or grains in wood, and still do it over and over again for each project.

Being a realtime media lover myself, I mostly consider realtime graphics to be the way 3d graphics eventually are meant to function, though the computing level of nowadays hardware can't still by far make up for this. Meanwhile, the technical solutions needed for 3d graphics need to compensate for the lack of computational power. The processes can be rather tedious to say the least. In this sense, rendering for cinematics is usually quite a lot lighter, technically, meaning the custom made code used stays at a minimal level and the inline working pretty much can be done visually. Of course it rather depends on what the outcome should be and the target qualities. Considerately, that could be said about any 3d production, there is no absolute method for building 3d and storing it for further purposes. If so, it would at the most be on a modeling or texturing level. Whenever there will be an industry-standard for storing 3d modeling or even animation data, the production costs most probably will drop quite a lot.

The probably largest change in the field since the realtime revolution in the 90's would be the concept of sculpting rather than modeling, and also using bitmaps at various levels to store high level sculpting data into renderable forms and techniques. For this project I've primarily investigated Pixologics Zbrush in combination with the formerly known as Alias, now Autodesk Maya package. Usually it's texturing, and foremost texturing methods that define the line between old 3d and the new approach. With the old approach, meaning what was considered the standard in the end of the 90's and the new approach with realtime graphics the employment of complex normal rendering methods and in cin-

ematic rendering relying on displacement mapping for complex visual looks that previously wouldn't even have been possible with the technology at hand.

One book I completely agree with a good introduction to the subject at hand would be 'Zbrush Character Creation - Advanced Digital Sculpting' which I read for this project. In this book, the whole first chapter references to either traditional art or traditional sculpting, and how these rules still apply in the digital realm (Spencer, 2008, Chapter 1). What's also a good point is that Zbrush fills out a big hole in the digital media industry. While traditional painters rather easily can move from painting on canvas to grabbing a stylus and firing away the same creations in Photoshop or Painter (personally I have absolutely no idea why everyone haven't done so yet), before Zbrush there really was no alternative for a sculptor to go digital.

A further underlining of relations between traditional media and digital media is also thoroughly described in relation to texturing and lighting in the book 'Advanced Maya Texturing and Lighting' (Lanier, 2008, Chapter 1). Many of the veterans in the field promptly stresses the importance of an understanding of traditional media values for understanding key concepts in 3d graphics, and it certainly isn't the first or second time I've heard it.

With my background as a traditional painter, I've always thought it rather frustrating that, though the output is a lot more rewarding and versatile in usage than for example a traditional painting or even miniature painting, the production chain usually have to be adjusted for the output at hand, mostly because there is no such thing as an industry-standard format yet, and while the development of 3d graphics in general is rushing ahead at the same speed it is right now, there probably won't be a standard either. Through my research for this project I think at least I've found out something that puts the productions a step closer in that direction, at least in some aspects of the 3d production chain.

My personal opinion is also that there is actually nothing that can really compare with solid experience in drawing or painting while considering things that actually help out in the initial stages of modeling and visualizing a particular idea, the whole first chapter of Spencer's book pretty much underlining this statement.

Now, on to defining the goals set for this project and the boundaries of the work included.

# 2 Goals, definitions and techniques

This projects primary goal is to explore best practice ways to include sculpting into a 3d production chain.

Obviously the result is a rather specific method employing the software solutions I've used for the different tasks. The techniques and principles are anyhow very much the same independent from whatever software is employed. With the initial primers in my earlier studies through the Institute of Design, multimedia department, the modeling issues were covered rather well, but there never really was any sizeable material on the texturing issues. So it's also a work on my behalf to provide a solid working technique for texturing without the expense of too much time for myself. I've built up different models with the idea of developing the working methods bit by bit, creating my own toolsets for specific texturing purposes in specific designs.

Concisely, the goal is not the actual 'physical' evidence of the work, though of course that's a direct product of the theories in practice by which the quality of the work can be analyzed. It also provides real cases by which it is easier to illustrate specific needs and specific design decisions – so therefore I've written both a theoretical or technical walkthrough with the best practice methods and later a practical workflow with the largest model currently included in the project. The 'adventurer' model, which is the largest, practically covers all the techniques used in the smaller models, so I won't be repeating the walkthroughs for each model.

The story behind the models in themselves are mostly irrelevant for the project in itself, but the morepart of the models are constructed for further exploration with realtime graphic coding and opensource game engines I've been exploring somewhat.

Obviously, this part of the work is not part of the this project, but it certainly has an impact on the work at hand. Though the primary target for the models is realtime rendering, the final renders I present will be rendered for print or movie production. Rather not optimizing for details, which is a process in itself when you actually have a target engine for the models with own issues and flaws which usually have quite an impact on the detail level possible also. As David Giraud stated in an interview about their workflow used in Assassin's Creed, a workflow thoroughly employing Zbrush for all aspects of the production, they produce a high resolution model firsthand, which will first go through an approval process with the AD before they start optimizing it and rigging it for the game engine in

itself (thread at http://www.zbrushcentral.com, published 2007).

While making this kind of decision for the rendering setups for this project, I still think it doesn't really have an impact on the models when deciding to output them to realtime graphics. This was also a large goal for this project, to actually get a resolution independent workflow, at least up until rigging or animation is done.

Now, a more indepth look at the software I'll be using and covering in the thesis. For all modeling and rendering issues my program of choice is Autodesk Maya (current version, 2008). I prefer Maya to the other large scale 3d packages I've tried out. With a little configuration I'll cover up in the technical section I've simply found out that Maya, although it also packs some rather nasty bugs, fits my production methods most intuitively of the different software I've tried. The most powerful part of it would be the modeling tools, at least while not considering animation.  It also has an excellent SDK for customization purposes not covered in this thesis. The most common 3d package I could think of to use instead would be 3dsmax, and having started out using that earlier on, through experience of both I've chosen Maya instead due to the modeling interface. I'll cover my usage of the modeling tools, including UV mapping and also rendering setups later on.

The main focus in the software and techniques I'm investigating and employing here is Zbrush, but Zbrush don't really work as a standalone program. Though you can generate direct output and renders from it, you can't really use the sculpting output without a proper workflow with another 3d modeling/rendering package. My goal when starting out with Zbrush was to integrate it completely in my workflow concerning 3d graphics, mostly because of the superior 3d designs and exquisite detail level that can be made with it with minimal technical input.

Of course, what is also needed in the process is a good image editing software, i.e. Adobe Photoshop, which has support for the different image formats needed, but also all the tools needed for 2d post-processing before input to the final 3d rendering chain. Many effects needed for the complete rendering texture supplement cannot directly be generated from a sculpting package such as ZBrush, and therefore a 2d image editing software is needed. Except from doing all the in-between 2d processing events, Photoshop is rather well equipped for painting alpha brushes for ZBrush, too. This is covered further in the technical section. Personally I haven't seen any single media design chain in which it would hurt to include Photoshop at some stage, or even downright impossible to finish the chain without it. Whether it's a good or bad thing is a whole different discussion.

Otherwise than that, Photoshop would be my primary choice for post-processing still image 2d also, while for animation post-processing the natural choice would be Adobe AfterEffects then. AfterEffects won't really be mentioned since I've decided to exclude the animation part of 3d graphics. The subject would span a bit too much information then.

For both print and visual storytelling production it is both natural and timesaving to use as much post-processing as needed, while it also usually heightens the quality of the end product. As examples of times before the post-processing of 3d there's a lot of game productions from the mid-90's where 3d graphics for cinematics are directly employed without any post-processing whatsoever. The visual difference and impact has clearly improved quite a lot just through proper inclusion of post-processing software in the production chains, which wasn't even thought of back then. A magnificent example of this would be one of my favourite games Legacy of Kain. Blood Omen (Silicon Knights, 1996), which was the first part in the game series and made without any post-processing at all for the in-game cinematics versus the latter follow-up Soul Reaver (Crystal Dynamics, 1999). In this time in between those two games happened a lot on the post-processing front for 3d graphics.

But back to the issue at hand, this pretty much concludes the software and techniques I will be covering in the following walkthrough of the production process. The technical walkthrough chapter will cover every step in detail, regardless of the model at hand, including also a bit more detailed descriptions about tools I use in the different software packages, while the final model chapter will cover up a real workflow case without too much explanation on the technical details.

# 3 Technical Walkthrough

Though excluding the animation part, the process up until that stage is still rather sizeable, so I will divide this process into these four primary stages:

1. Concept
2. Modeling
3. Texturing
4. Rendering

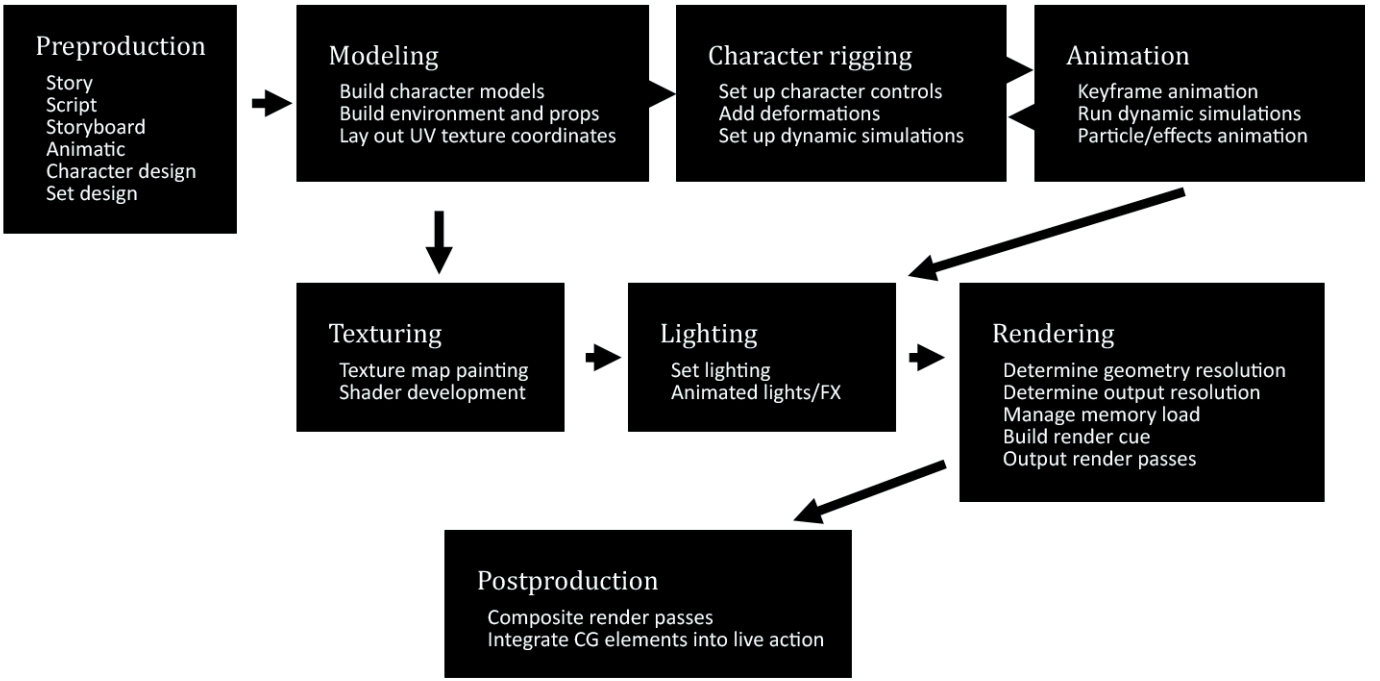
Of course, this is a simplified version of a real world workflow, because I'm merely one person working on this project as it is. A real world workflow in, for example, cinematic production would look something like the chart on the next page from 'Maya 8 - The Complete Reference' (Meade/Arima, 2007, Chapter 1).

## 3.1 Concept

2 dimensional working is still the most natural way of expressing ideas, whether that is digitally or traditionally. Mostly because, though 2d drawings and paintings can't compare with the quality of refined 3d graphics, the 2d approach is still a lot faster working method. This would probably apply on a higher level of working, in deciding what kind of techniques for what kind of works. Many experienced 3d artists usually start out with 2d concepts just to get a feel for an item. Of course, to dig up information – especially visual if there is – on the things that are to be expressed also helps out a lot in starting up new models or projects and therefore the production chain of whichever target format for 3d graphics usually incorporates the initial visualization and concept before the actual production. In fact, this method pretty much applies to any new media production chain as it saves up a lot in the production costs to always have proper concepts before starting out to do the real work.

Why it also is so important in the particular case of 3d is because it can save a lot of time in the later stages if certain design collisions or problems occur. So, initially this can be any kind of 2d image, drawing or painting. If there are only textual sources, I would always do some kind of drawing or painting to get a feel for the model at hand personally. Also, if doing the painting or drawing job personally, it's very important to just do all the creative designs at this stage, as it has a rather large impact on the layout of the model. What is crucial in that aspect is defining all the primary lines, that is, all the lines that should be represented in the absolute low polygon version of the model. To fully understand what lines are in question here there's a good example on modeling a human head in 'Maya 8 - The Complete Reference'. In this particular case, the primary polygonal lines are picked

Basic pipeline for 3d film production




up from a background photo of a human face in profile (Meade/Arima, 2007, 100). These things usually takes a bit of both eye and experience to start getting a natural flow into the working process.

For good sources on whichever subject, an image search on the web is always a good point to start. For in-depth descriptions of materials and, for more complex mechanisms, it's always good to fetch whatever texts about the subject at hand, especially if doing objects that should have a logical explanation of working. Mostly this can be performed pretty well on the web, too, but in some cases even old school book delving might be an option. For this project I used an old weapons compendium, for example. The Compendium of Weapons, Armor & Castles (Balent, 1981). This book has some very de-

tailed information about the inner workings of medieval weaponry and armor and different designs of complex mechanisms, too.

How much research done into the subject should always be put in proportion to the level of detail intended in the final production, anyhow. The more realism intended, the more important the details are. For example, in game or visual storytelling design doing guns or mechanisms related to science fiction or magic would not really need a proper way of working, but it's always neat features to the completed models if the designs are waterproof with explanations on the inner workings. Even some games have made the whole explanation process a part of the game, and rather successfully also. A good example would be a classic, Master of Orion II (Microprose, 1996), where it's a key concept of the game to research new technologies describing them with quite in-depth detail also. Of course, the graphic production wasn't that developed back in those days yet.

Whichever the case, if the deadline allows it, I suggest always making some kind of drawing, just to get a proper feel for proportions and, if painting, even the textures. In the case of textures, questions can arise in the drawing process you wouldn't have thought about even, which probably speeds up the designing process later on. Keeping a library of textures or just accessing some of them online (references in the end of this book) or even fetching photographs from stock photo libraries are all good research methods.

Personally I usually do concept painting with either Corel Painter or Adobe Photoshop. If photograph bases can be used, it greatly speeds up the painting process. Even concept painting with photograph bases that doesn't relate to the painting at hand speeds up greatly, look up speed painting for further references. The painting stage usually is done because of certain unnatural feelings, colorings or even moods that can inspire somewhat in the designing process later on. Especially for texture design the spectrum and mood of objects can vary quite dramatically just by altering the texturing. For example, stick in an Ice age cartoony character with the demons in Doom 3 and you have quite a collision.

'Photorealistic texturing for dummies' is a rather good primer on what there actually is to think about texturing by texturing artist Leigh van der Byl (online publication at his website, http://www.leighvanderbyl.com/, 2006), and also what things and methods you should absolutely avoid when texturing. The book isn't written in regard to any specific software setting, rather what applies to planning textures in 3d graphics in general, therefore I mention it right here. This book has more to do with actual post-processing of the textures though than the

Concept painting for model project, 1 hour Photoshop

actual sculpting and painting but of course it has an impact on the planning process also. At least what things to think about when considering surface properties is rather well covered.

Anyhow, some people prefer to actually paint the models in front vs. side perspective and construct models using those images as backgrounds in the 3d modeling software, my personal opinion is that this technique is kind of outdated though it was actually quite useful when the low polygon versions of models usually were rather ugly and you had to skip out on a lot of curvature or detail in the main loops for getting a model which would render and work well in realtime rendering, it doesn't really apply to the resolutions of meshes used in realtime rendering nowadays. So, my personal preference is that I usually do the sketching just to get a feel for model specific curvature and detailing and after that starts away with doing a basemesh.

Otherwise I won't cover 2d painting techniques in this walkthrough further, so we move on to creating the basemesh in a 3d application then.

## 3.2 Modeling

This step is quite familiar to me, having earlier done a lot of pure modeling and texture painting with both Painter and Photoshop. I'll now go through all the settings and tools I've configured into my work chain with Maya earlier on. I'll purely explain my own workflow here and underline why I've come up with the decisions I've made, though most recent texts I've read on the subject pretty much agree on my methods (see below). This is generally because I've worked enough with Maya to develop an own style of interacting with it. I tend to sit around in the train doing base meshing sometimes to conserve time, so this method is rather robust and working.

As stated in the introduction of the 'Maya 8 - The Complete Reference': "In fact, Maya often offers so many options that it can take days, months, or even years to discover the most efficient processes to use for completing a project" (Meade/Arima, 2007, 4). Especially if taking into consideration writing custom code to do specific tasks in Maya I may add, that's why in a complete production team usually separate people write the toolsets.

### 3.2.1 Polygons or NURBS, is that a question?

For the real basics of polygon modeling techniques and key concepts I'm also referring to, there is rather good tutorials in the 'Maya 8 - The Complete Reference' (Chapter 3 on Polygonal Modeling in Maya and Chapter 4 on Organic Modeling with Polygons). What is discussed there is pretty much problems it's rather simple to get stuck on if new to 3d modeling and still learning. On for example one particular issue that's probably the most confusing one, why is the usage of quadrants so important, there is a simple cube built from both quadrants and next to it the same cube in triangles. When both

of them are subdivided, it pretty much explains why triangles should be avoided at all times in polygonal modeling.

There's also a good hint at forget nurbs modeling totally, now really, (page 58), as it's a rather outdated technique that's been put on the shelf as the computational speeds are sufficiently high nowadays already to do more complex and detailed work with polygon modeling. As stated later in the same chapter (page 63), the only disadvantages of polygon modeling is: 1 - the data size of polygon models are larger than for nurbs models, 2 - adding detail can be difficult on high detail levels. Both of these issues are solved if you use Zbrush with Maya, the first one irrelevant because of the texturing methods compensating for low resolution at render time and the second one, well that was what Zbrush was invented for.

### 3.2.2 Configurations in Maya

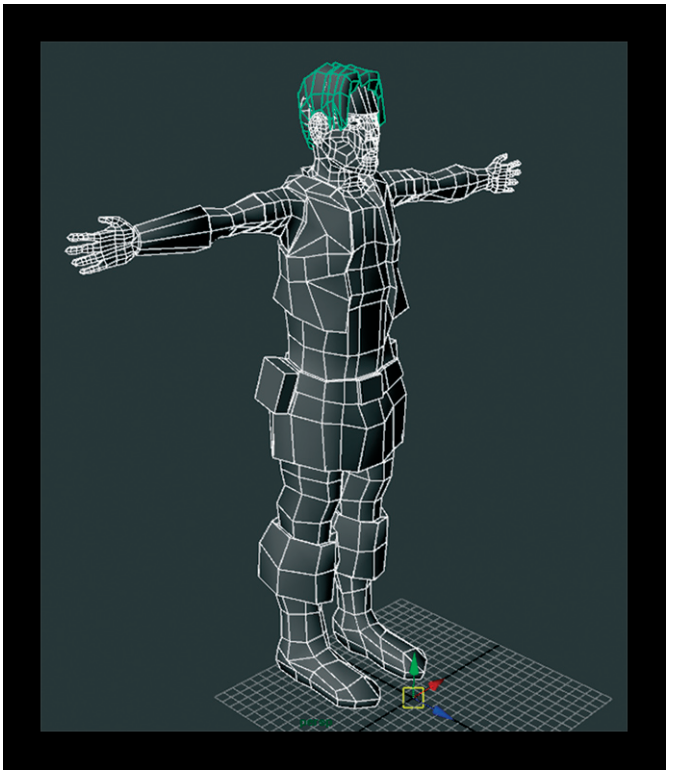
The initial set up for Maya I use, while probably not necessary in this stage yet the first thing to do is to check the most important plugins are loading. The first being .obj file import/export and the second the Maya Mental Ray interface which I usually use for all production renders. My preference is also using the 'hotbox' interface which is one of the niftier features in my opinion in the design of the Maya interface. If the hotbox interface is rather limited, configure it to show everything. Initially it is quite poor to hide all functions instead of accessing them all, later on when you have a specific style of interacting with it you can configure away what is irrelevant to your workflow. I usually make a custom setup for the keyboard, or rather just copy it from previous systems I've worked with if working on different machines. My preference is that all modeling interaction and tools are rigged to the qwerty, the standard manipulators (select, move, rotate, scale) are rigged to the asdfg row and the uv related functions are rigged to the zxcvb row. This way the left hand of the keyboard is plugged into all the tools needed for doing whichever polygon modeling task.

In further detail, here is a list of the keyboard assignments I feel most comfortable with in my Maya interaction:

Q: Cut Polygons / Cut Plane tool
W: Split Polygons tool
E: Append to Polygon tool
R: Create Polygon tool
T: Merge vertices
A: Select tool
S: Move tool
D: Rotate tool
F: Scale tool
Z: Select UV shell
X: Sew UVs tool

C: Cut UVs tool
V: Delete UVs tool

All other functions I don't really use on a regular basis, so they can always be accessed from the hotbox instead. This preference was something I thought out when starting out with 3d and have developed bit by bit - when using 3dsmax it's a fully working configuration also!



Basemesh for the adventurer from Maya

### 3.2.3 Main modeling

My modeling technique is a cross between loop modeling and box modeling. Loop modeling being a technique where you define the edge lines with polygons and fill out the spaces in between the edge lines. Box modeling would perhaps be the oldest modeling technique for visual 3d modeling. Concisely, you use extrusion methods starting out from blocks and defining more and more of the model as you go. With both techniques it is quite possible to model whichever shapes and things while always using quadrant polygons. In the UV mapping sequence I usually use a combination of Mayas auto unwrap function and manual unwrapping, combining both and sewing them up for a minimal amount of seaming.

The first stage of any model is the basemesh, the idea with the basemesh is to just flesh out the model in 3d space without minding too much about the details. Box modeling or extrusion modeling works pretty well, with the extrusion technique being a bit of a combination of box modeling and loop modeling. I usually start out doing loops, which in short are just polygon strips created from two vertexes, start, and two vertexes for the end – a quadrant. The polygon strip can then be divided into a sufficient amount of detail. With sufficient amount of detail I mean what you would need for the models animation rig to still look ok in realtime rendering, for which most probably the first level of detail, this level,

would be used. As stated earlier, this is fully covered in 'Maya 8 - The Complete Reference' in the polygon modeling section.

When doing models for a workflow including sculpting based upon UV input/output, i.e. Zbrush, it is also quite important to keep the detail level of the mesh, in pure polygon count, to be roughly the same all the time. Otherwise you get quite nasty banding issues in the rendered textures and might even have to do some reconstruction to solve the issue. This is just a word of warning, because you won't see the banding problem in the sculpting software and might have to redo the whole sculpting process. The places where I've unintendedly have introduced these kind of problems haven't really been that awkward, as I usually divide the model up in a lot of smaller parts I work individually with (see Zbrush subobjects below) and therefore can replace any specific part if the mesh has corruption in it's original data.

Anyhow, back to Maya, I usually keep a polygon count for rounded objects to go with 8 polygons, i.e. a characters arm or leg or a basic cylindrical shape. Primarily, I think you should stick to keeping simple models at this basic plane also because you always have the possibility to edit things later on if the polygon count isn't so high that the mesh, in relation to the texture coordinates, gets messed up. In the Maya books I've read for this project, this issue hasn't really been covered well by anyone, but I think this issue is pretty well solved when working with Zbrush models.

The primary tools used for this process would then be the upper row of keys and the center row of keys as defined earlier. A technique I find myself rather often using is also to append a polygon between two loops and then split up the new polygon and model the detail for the levels in between the two main loops. With the models I've worked with for this project, there hasn't really been a need to split the model into separate Maya objects even (but Zbrush subobjects for sure, see below). Mostly separate objects could be used for: hair - because then you could always skip the polygon version of the hair and use the polygon version as a container for hair simulation, eyes – because then you can easily animate them separately and they don't have a large impact on how the dynamics of the base mesh should work anyhow. If you intend to use complex modeling software dynamics, i.e. planning for cinematic render, then the case is completely another, as you can optimize the rigging process by dividing the model into different objects which relate to different dynamics and each other in rather complex ways.

As mentioned above, the worst part in modeling is trying to avoid triangles completely in the mesh. If you end

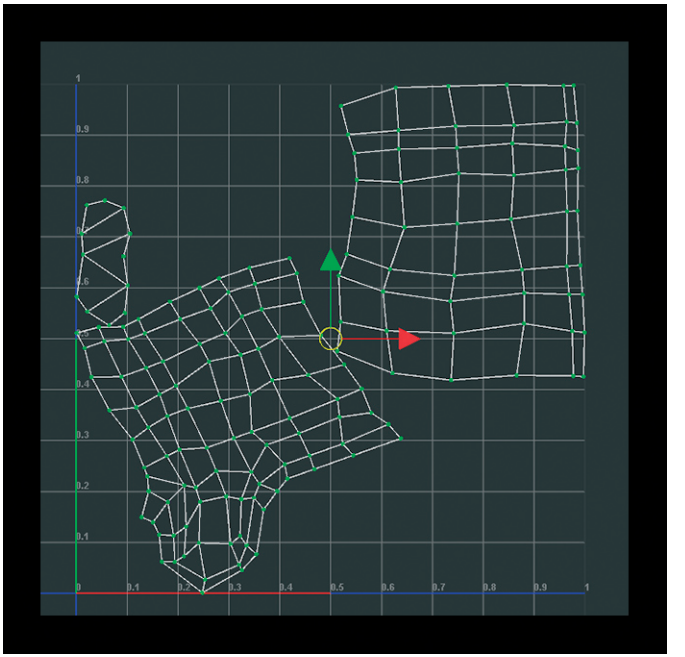
up with a triangle somewhere in the middle of the complete mesh, then something has gone very wrong somewhere earlier on, in worst cases you have to rip up the whole model again and backtrack to the point where the abnormality in the quadrant pattern was introduced. If the triangle is in a rather hidden crevice or something like that, the problem probably won't even be noticed in the final product, so correcting these kind of issues should be put in proportion to the timetable or deadline – ask yourself, is it really worth fixing it?

The modeling process in itself isn't really that more complex, and it shouldn't be at this stage either. The model should probably have quite exaggerated details for example muscles or the likes, as they tend to disappear when starting to subdivide the mesh. When the model is satisfactory in this level of detail, it's time to do the UV mapping.

### 3.2.4 UV mapping

To start doing the corrected UV mapping I recommend just killing away all the earlier mappings that Maya automatically creates by selecting everything in the UV editor and hitting the delete UV function. There is a specific function for deleting just UVs, so it's not the delete key by any means.

For the UV mapping I usually use a combination of the cylindrical mapping, planar mapping or just downright automatic mapping tool for starters. The automatic mapping does quite a good job at just unwrapping everything before starting to sew up the UVs into complete shells, and I use the automatic mapping usually with a configuration of 6 faces. Here the grouping should be done like this, for every object that has similarities in materials to each other. For example, a character can have



Example UV map, this one is for boots. Bottom, main and collar parts of the boot respectively, the parts were picked up for this screen shot only

multiple items made out of the same kind of leather or the same kind of cloth, so those elements would generally be a good idea to group together. However, two groups of the same material should not at all be sewed up together for the convenience of sculpting later, and it is an absolute error to overlap UVs inside one UV range area. Either the model won't load at all, or if it loads and you actually get it sculpted later it probably will crash Maya completely if you try to render it with overlapping UVs and displacement maps.

So, basically I pick up the areas, putting on an automatic mapping for that area after I have everything selected that should be part of it, sew it up as well as I can manage and place it just somewhere outside the main range (from 0 to 1).

Sometimes it is better to leave seams than sewing up objects too much. A good way to try out how this works is to apply a shader to the mesh with checkers assigned as color material, repeating the checkers more often than the default. The setting is quite dependent on the models size. With the checkers active, how much texture banding occurs when seams inflict too much distortion on the mesh can be seen and corrected visually. The seaming problem has gotten a bit easier with sculpting software and the likes due to texture bleeding over the edges, very much like bleeding edges in print.

The automatic mapping tool normally dumps the UVs created inside the first UV range square so it's a good idea to clear it out by moving away the previous parts before picking up the next part of the model. For the sake of keeping it simple (kiss method), the UVs should never be set to overlap if it isn't intended. Right now the relation between the parts different sizes to each other isn't that important, rather just getting them down to 2d. When all parts are put down and sewed into UVs, it's a matter of putting them in relation to each other.

Personally I use a rather complex style of editing and laying out UVs, because I don't like banding one bit, and therefore fix up seaming manually. The manual work being pretty much the same as polygonal modeling in a 2d space. In 'Maya 8 - The Complete Reference' the UV layout methods covered are pretty simplistic and usually UV layouting is pretty much a matter of patience. This is also a -very good- reason to always keep the lowest polygon level of the mesh simple. You could probably avoid a bit of banding with modeling a bit higher resolutions, but personally I don't think the compensation is worth the time it takes.

### 3.2.5 Resizing UVs

After all the groups are compiled into UV shells with seaming, by using the checker method mentioned above to visualize how the different parts relates to each other

resolution-wise, all the shells should be resized to at least visually match up each other which means they should have the same size of the squaring in the checker over the whole model. When the sizes of all the checkers are matched with each other, I then pick the layout UV tool. The map size doesn't really make a difference so long as you're not optimizing the model, i.e. putting it into code, so I normally just space it with targets depending on how big the model should be related to other objects it should interact with.

If the complete UV set is a complete character, well then it's minimum size for normal maps or displacements should be at least 2048. At some point in the history of 3d graphics somebody will probably have to solve the problem of bitmaps and resolution which the end user really don't have any clue about what's going on. For realtime renderings there are nifty optimization techniques anyhow which auto-resize textures depending on viewing distance which is called mipmaping. However, if rendering with pure normal maps for a complete human-sized model at that resolution, the result is rather awkward in closeups, it works in realtime graphics with paced animation but for quality renders it's no use.

But to cut to the problem at hand, the resolution doesn't play that much difference unless you have some really tight spaces between different shells, next is to just not allow any non-uniform scaling, nor scaling to fit – all the shells should be scaled at the same rate which previously was made up with the checkers.

When the UVs are all layed out in the first UV range, now is the time to split it up into different UV groups. Each object I like to sculpt individually for the mesh should have its UV shell moved over to a new UV range space.

### 3.2.6 UV Grouping

To do this correctly, the current UV layout must be exported to a bitmap through the UV snapshot function in the UV editor. When the file has been exported it should then be loaded to the color channel for the mesh. This way, when flipping on the show background image in the UV texture editor, the image with the UV layout will be displayed across all the available UV ranges.

The range has to be configured also, I generally use a 3x3 field, if the model is more complex than that – well probably at least my current hardware won't support it memory-wise, so then the model will have to be split up into separate smaller parts and sculpted individually. Anyhow, I configure the ranges in the UV editor by hitting in larger numbers for the U and V ranges. When this has been done, the different parts should be lined up in the different fields, each separate part will become a

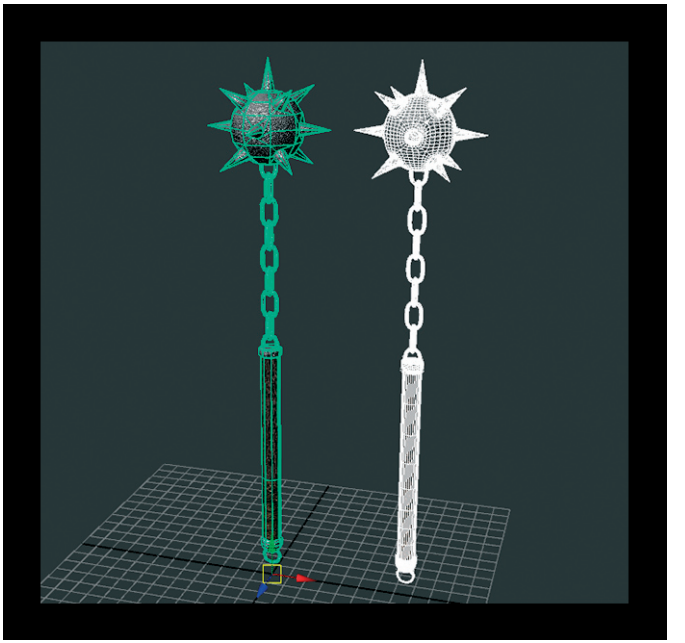
subobject in Zbrush, so this is why it's generally a good idea to keep things together which share the same kind of texturing tools or coloring info or something like that that can be done in Zbrush. When the different parts are lined up in the different fields, well then the modeling phase is as good as complete.

It is very important to place the different objects accurately on the underlying UV layout bitmap, otherwise you'll introduce seaming problems into the mesh when later applying the real bitmaps.

### 3.2.7 Subdividing in Maya

If the model is really low resolution, it should be elevated to mid resolution to keep sharp pointy edges as they are. Alternatively, the edges can just be beveled with the bevel polygon tool, too. If doing the division, I recommend using Mayas subdivision proxy method for it, and sticking in 1 or 2 subdivisions should suffice at this stage. This is because edges will disappear if subdividing the first two stages with the subdivision method in Zbrush. So after applying the subdiv proxy, preferably on a copy of the main model, I then have a main mesh subdivided and a control cage which is exactly the lowest resolution of the model.

The edges that should stay sharp after the subdivision should be picked out and using the crease tool from the proxy menu in the hot box, they should be creased enough to not make the edges disappear. Over-creasing the sharp parts tend to introduce texture banding, so a relatively low level should be used. For example a bladed weapon or sharp spikes really need this, as the crease tool works on both vertexes and edges if applying this method. Spikes should generally have their pinnacle creased to draw out the divided polygon surface towards the first levels form.



Example of subdivided mesh in Maya, low resolution to the left, high resolution to the right

The reason this method works is because the UV layouts are exactly the same on both the subdivided object and the low polygon version, therefore the texture maps have roughly the same coordinates, too.

In 'Maya 8 - The Complete Reference', there's a good section on subdividing polygon meshes, starting at page 114. Of course, it isn't really mentioned to include the UV workings before doing subdivisions, because after the subdivision the resolution of the UV mesh is too high to work manually, but it's a logical trial and error (smiley, to make this official). However, it is also mentioned that most industry standard renderers employ subdivision at render time nowadays, and that's generally the best bet at keeping the models resolution fully workable at all stages.

### 3.2.8 Exporting

So now the model can be exported, and should be exported as a Wavefront object file: .obj. The defaults for the exporter are all go because the only thing that is being transferred through the .obj interface is the vertex definitions, XYZUV. The material can also be exported, but it's redundant in regards to the sculpting process. A good idea at this stage is to also fix up a clean save of the completed lowresolution model. That is to delete the history for all the meshes, clean up everything in Mayas outliner tool with whichever grouping one prefer, and save it to a Maya binary.

## 3.3 Texturing/sculpting

Next in the chain would then be ZBrush (current version 3.1). The history of the programs development being primarily trying to fill out a previous hole in the industry when 3d graphics qualities reached the 'high-definition' standards, which really aren't realistically possible to model in a production environment with sufficient speed. That is literally when the polygon counts are too high to fathom with a human mind and editing them vertex by vertex. As is covered in Zbrush Character Creation (Spencer, 2008) I mentioned earlier, Zbrush is also used for pure sculpting, employing 3d printers to make real world replicas of the sculpted models.

In employing a modeling package with a sidekick sculpting package you get a rather clear definition between the raw technical setups for rendering methods and modeling vs. artistic input, which is also a technological advantage I've been looking for. While working directly with the rendering setups and modeling information in a typical 3d package, you usually have a model that is rather limited in detail, mostly for the convenience of working with the model, but also because of the over-

hanging lack of physical computing speed and memory needed for the finalization of the model. Therefore, it's a good invention to separate the artistic input from the rendering chain and including it as bitmaps, i.e. textures, rather than modeling everything to the tiniest detail – which is not only a lot more time consuming, but also making the model a lot harder to process further into the animation stage.

For this particular workflow the point is to include Zbrush as the primary texturing software, and from here on I'm talking about actions and functions in Zbrush and not in Maya.

For a very good primer on working with Zbrush I recommend the book Zbrush Character Creation (Spencer, 2008). Spencer is a veteran in the field and knows what he's talking about. Everything from color theories to using traditional sculpting methods in Zbrush is covered in the book. The book has a good gradual buildup of difficulty level, so therefore there's also a good walkthrough of the tools in Zbrush in the beginning.

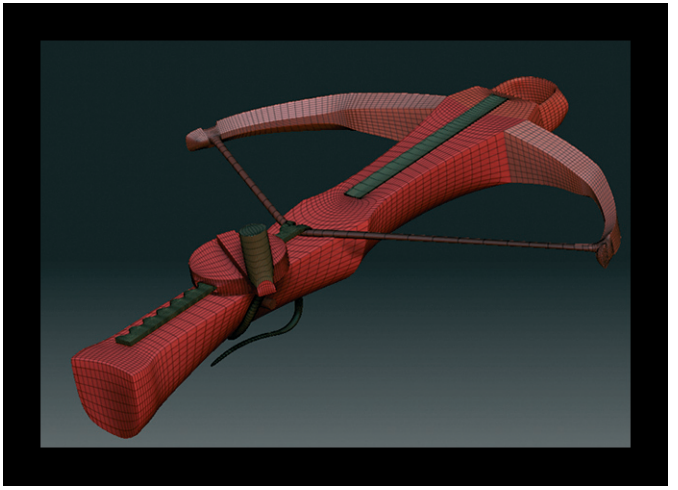
### 3.3.1 Into Zbrush

Now the initial basemesh should be finished and ready to import into Zbrush. To do this manually, I pick the import from the tool menu in Zbrush, and then dragging out the object onto the canvas. After the object has been placed the 3d edit mode should be selected in the upper right hand corner. It's good practice to make sure the object is also correctly aligned by holding in the shift key while dragging it out on stage, this is because the camera mappings line up better with the mesh if it is properly aligned at XYZ as is also defined in the .obj file when imported.

If the basemesh is still the first level of detail, designed earlier in a 3d package, it should be subdivided from the Geometry subcategory under the tool panel to the maximum possible for the hardware system. If there are UV groups present, explained earlier, the subdivision to maximum system capability should be done for each part after splitting the mesh into the different groups. With my hardware this suffices for making complex surface structures, body hair, wood grain, leather veins and details at that kind of level. Why the subdivision is done right now is mostly to avoid memory issues later on, and rather take system crashes right now when there's no actual work in play than later when the model has a lot of complex design. Per system there can be a lot of trial and error what is the exact upper limit of resolution, because, though the systems -should- be automated, it doesn't really work that way. In any given multitasking system you have different processes eating different amounts of memory at different occasions, so generally it's not a 100% sure thing per system.

### 3.3.2 Loading groups

Now to first get the model split up into the different groups earlier assigned with the UV editor in Maya I usually switch on frame mode first, which actually visualizes the groupings once they've been loaded into Zbrush. The frame mode can be found almost at the bottom of the right side toolbar in the default panel layout. I usually have the tool panel docked to the right side and otherwise use the default layout. Now to load in the groups assigned the polygroup subcategory in the tool panel should be opened and from there select the 'UV groups', the frame will get some coloring defining the different groups existing on the model. Now to split the model into the loaded groups, select the subtool category in the tool panel and select GrpSplit. Now if everything went well, the model will be divided into the created groups.



UV groups for the heavy crossbow, loaded into Zbrush via UV groups function and displayed with the frame function, the completed model can be found in the appendix

One other advantage of splitting the model into groups is also that it conserves a LOT of memory, theoretically you can now push each of the parts into the maximum allowed polygon count for the system, which is rather dependent on the amount of RAM installed. As mentioned earlier with the subdividing, therefore the subdivision should be done rather per part than for the whole mesh when using UV groups.

About the memory issue, practically, it's too bad, but it doesn't really work that way – always trying the limits of the hardware before doing fancy stuff is recommended. When I started testing out Zbrush myself I sat with a 1 Gigabyte RAM system, which actually didn't amount to quite anything. Now I'm working with a 3 Gigabyte system, and it's still not quite enough. There's really no upper limit to how much RAM would be needed as with lower RAM configurations it usually affects the level of detail quite drastically resulting in poor quality displacement or normal textures. The upper limit on my system right now is something between 15-20 million polygons total. This issue is something that can't really be resolved today without submission to either Microsofts Vista or by choosing an Apple system, which in my opinion are

neither any good solution – but that's a completely different issue.

In Zbrush Character Creation (Spencer, 2008, p. 84) there's a section on working with imported meshes and polygroups in Zbrush that pretty well covers up the same process I've described but in more specific function detail.

### 3.3.3 Standard sculpting

The standard sculpting, if the model is done from a really low resolution mesh, requires a couple of subdivisions to get the mesh up to a low-resolution-for-sculpting level. This roughly depends also on how well the polygons are distributed along the surface of the basemesh. The standard sculpting is just blocking in all the details that aren't there in the low resolution model.

If doing a pure sculpting thing, you have a lot of other things to think about also, but as long as you're using Zbrush just for texturing 3d that later will be animated, the sculpting issues doesn't really apply. For more about pure sculpting in Zbrush, there's a whole lot of information in Zbrush Character Creation I mentioned above, but that is not really what I use it for, at least, yet.

When starting out on a new model part or complete model, I usually select a level of detail just enough to accommodate for smooth sculpting with soft brushes. At this level the point is just to get a kind of general randomness into the surface, for cloth it could be soft folds or for skin it would be the general underlying muscular system or fat. It's really just to get the model into the desired shape, to look more lifelike and get it to break out of the frame from the low poly version. This stage actually does quite a heavy impact in the final renders on legibility of the surface. Generally in my models this is about at 4 or 5 subdivisions.

Now, this process should be repeated ahead while upping the resolution a level or two, adding more detail the higher the level is. Needless to say, this stage can be rather time consuming, but if the majority of the sculpting is fixed at this detail level, it sure pays off in the end.

The point is to always go into smaller details the whole time, a very good function in Zbrush for sculpting elaborate carvings into surfaces would be the usage of masks. Masking is done by holding in the Ctrl key (PC, still) while painting directly on the surface. In this way, you can incorporate all the positive benefits of alphas (discussed below) also in the masking process by accessing the masking function through the very same tool you use to sculpt and paint. You can pretty much paint up whatever shapes you want on the surface as a mask, and by smoothing the mask first a bit if it has very hard edges,

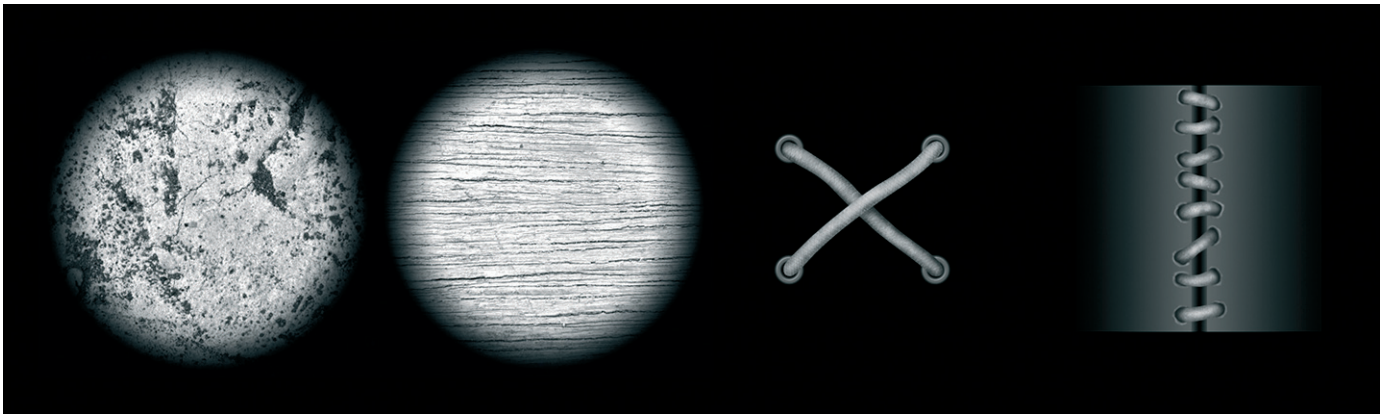
just push in the masked area with the inflate function. Inflate is part of surface deformation techniques that can be applied directly from sliders or through a specific inflate brush. These functions can be found in the tool panel or the brush settings respectively.

### 3.3.4 Using alphas

After doing a couple of tryouts myself on the sculpting part, I rather hastily drew the conclusion that with using just the primary sculpting tools, it's a rather unachievable task to produce something that would be even near photorealistic and would require a whole lot more of time than what could be acceptable for any production chain.

Luckily there is the alpha system in Zbrush addressing this issue particularly. An alpha is like any standard alpha channel image, it's a black and white picture where the grayscale values are used for evaluating something – something being primarily then dependent on whatever the application is trying to do.

In a Zbrush alpha tool black equals no surface modification while white equals full surface modification. The range or impact the brush will have on the surface can then be adjusted on the fly by modifying the Z intensity. Normal for soft brushes making large sculpting moves would be something around 25, while for extreme detailing like the surface texture in leather, or the woven cords in a cloth surface the value should be about half or lower. A good feature in Zbrush is that with the same principle as Mayas hot box, you can fire up the brush controls anywhere while sculpting by hitting the space bar.



Some of the different alphas I've designed in this project. A concrete base, a wood base, a painted roping and a rough stitching respectively.

A good thumb rule while sculpting is to work oneself in from the lowest level of detail. This should already be defined with the basemesh, and therefore won't have to be sculpted when doing sculpting in combination with modeling packages, i.e. using it for animation. As Spencer states in Zbrush Character Creation, a lot of detail can actually be made to look more complex with lower levels of detail, and this is very true. Therefore it is rather important to work up the details from a low level of detail first.

How this relates to my own models is generally by starting the sculpting somewhere at midpoint of the max resolution I have available with my current hardware and working inwards to the maximum level of detail.

In the chapter 'Zbrush for detailing' in 'Zbrush Character Creation' (Spencer, 2008, p. 111) the methods I use in regards to alphas in Zbrush is rather well covered including some heavier methods also that are really too high definition to correlate with a realtime rendering model. I made some passes earlier trying out which level of detail can be applied to a whole-body character with normal mapping methods, and the rendering results were rather poor for still images. So the explicit high definitions on a surface have to be put in proportions to the rendering methods in the production chain. Of course, there's no harm in modeling in ultra realistic surface deformation, but it's rather time consuming, but as usual it should be used with the goal of the project in mind. There's always the possibility of smoothing out the ultra high definitions before exporting if they just are causing a mess in the production rendering. This can be achieved with adjusting the affected level of detail in the smooth brush settings (Zbrush Character Creation, p. 37)

### 3.3.5 Texture alphas

After trying out to do a couple of models with plain modeling only, and using nothing else than the standard brush, the need arises for starting to compile alphas. I prefer designing alphas in Photoshop, either by taking a photo base and modify it into an alpha brush or by using vectors combined with brush painting, still Photoshop.

To create a texture alpha the first thing would be to get a photo from the 'net or anywhere, the resolution don't have to be that high, but the sharpness of the image has to be as accurate as possible. If it's a color image, the color information can be dropped out right away, the image can be a full quadrant, because there are tools in Zbrush to counter this. When the image looks ok if doing some editing on it, an auto curve should be put on it in Photoshop. Striking out the unnecessary 2d values of the image is good practice, because the alpha bitmap relates better to the alpha settings in Zbrush when this has been done. From the point when you load in the alpha into

Zbrush you can use the contrast, radial fade, midvalue and intensity or even blur up the alpha or adding noise. Therefore, to make maximum use of these tools it's a good idea to skip blank parts of the images tone curve.

Now the last level of detail should be saved for this stage, surface deformation through dragging and painting with alphas. The Standard brush has a set of stroke types and each of the different stroke types gets more important at this level of detail. Up to this level the stroke types used would be dots or freehand. Obviously, painting surface grains with a single stroke brush won't really work so for large detail objects on the surface I recommend using the Dragrect stroke mode with some rather elaborate alpha. The alpha can well be at about 512 x 512 pixels. This will do for example staining that would affect the depth of the surface like rust stains or corroded paint.

For making clusters of slight surface deformations, the Dragrect also works really well if loading an alpha that has some photo quality texture or some imitated veining painted in Photoshop. Wood grain for example would be exactly that kind of work. If applying some general texture of the object in itself as such, you should think out in which order it makes most sense to do this kind of thing. If something doesn't really work out to put on top of each other, well you can always mask away areas you wouldn't want to be affected by a surface type brush.

### 3.3.6 Detail alphas

Detail alphas is another issue than the texture alphas in that you're not specifically trying to get a texture surface, rather some small level details, for example stitching, roping, buttons or rivets of some design.

Personally I usually paint these up in Photoshop, try them out and then modify them if they don't work. It's good to keep a .psd backup of these just in case you need to modify them later.

Zbrush has a whole lot of tools I haven't had the time to try out, but it features a 2.5d system also and a lot of the brushes in question are linked to the 2.5d system which mostly is there for designing alphas on the fly or the like. So that would probably be the alternative to painting the alphas yourself, but I'm fully comfortable with creating them in Photoshop, so I haven't looked at that possibility that much. There's a section in Zbrush Character Creation on painting alphas with the 2.5d system

### 3.3.7 Sculpting with alphas

So before starting to sculpt in things with alphas, I suggest pushing the model to the highest level of detail. At points I end up saving the work and exiting to paint a new 2d alpha brush or something in Photoshop, mostly because of memory issues I won't run both the programs at the same time.

Of the actual brushes in Zbrush I'm mostly using the standard brush with alpha extensions, or the stitch brushes also with own alpha extensions. Stitching is one of the nifty brushes allowing the repeating of an alpha brush at set intervals along one stroke. With this tool you can pretty much do any kind of sewing or zippers or other things like that.

### 3.3.8 Vertex data types

In the standard brush set, you have the possibility to select on which vertex data you want the brush to operate. As mentioned earlier, what we are using from the .obj file is XYZUV, whereas XYZ are the plain 3d coordinates used for sculpting, in the Zbrush format we actually have vertex color data also, that is RGB information saved per vertex. So for the sculpting part it is either subtraction or addition to the surface, affecting the coordinates while there is also the selection of material, RGB or both. The material basically boils down to a shader model. I prefer to keep the shader model as plain as possible. For example the Basic Material selection is a good alternative with a not too overdone specular channel.

Whichever way you do it with materials, the Zbrush shader model is not compatible with anything else than the Zbrush render engine as of now, so it's a fire and forget option as the model is still going back to an animation package for filling out its purpose. The RGB information is anyhow coloring the individual vertexes dependent on whatever alpha is being used. It's quite possible to construct rather complex color textures right away with this. The UV data for the model is actually only used when exporting or rendering the final textures as output from Zbrush.

### 3.3.9 Color

I haven't really mentioned anything about how the coloring would best be done, but a good bet is to apply a general color that fits on the object in question. For low resolution characters, it would also be a great idea to activate the RGB channel while sculpting in recesses in the surface and select a quite dark color, but anyhow keep the RGB level rather soft. Painting in too dark shadows on an object in recesses just makes the color channel feel very weird in the end. Mostly this is because if you're rendering the high quality model, this should probably be done by the rendering engine and not the texture in itself. If incorporating the dark recesses in the specular channel of the texture too, which I usually do, because I derive the specular later on from the color channel in Photoshop. Again this would work rather well on a low resolution version, while it's generally not a good idea if rendering a higher resolution level.

There's a very good section in the Zbrush Character Creation book about painting. How traditional painting

techniques can be used rather successfully to achieve photorealism. Spraying and dragging alphas out are both valid techniques underlined by this chapter in the book (Zbrush Character Creation, Spencer, 2008, Chapter 5).

Anyhow, when painting in veins for, for example, leather or wood, a slightly darker color also accentuates the veining in the final rendering, so it can also be used at the stage when blocking out the surface texture with alphas.

What looks pretty good also is to actually use quite large scale textures on the color channel only, just to get some general variation into the coloring. Depending on what the object is, the alpha should be selected with some sort of judgement anyhow. With this method you can get a good overpass and sense of layering in the colors on the surface. Of course, if you're rendering with a heavier rendering engine, like for example Mentalray, it would be a better idea to use some kind of subsurface scatter method to achieve this instead.

There's a lot of trial and error in what works and what doesn't work in this process in itself, and it's rather dependent on what your target rendering method is, of course by making a complex model like this, if the UV sets and the first level of the character is good, this material can rather well be reused. When saved in the Zbrush format you actually don't have anything rendered or defined for the rendering engine yet. So you can always generate different and new sets from the same model.

### 3.3.10 Saving and exporting

Before thinking about starting the exporting process I usually save away the object as a .zbr file right about now, to at least have a full copy of the sculpting if something should go terribly wrong. Saving the 3d object in its entirety every now and then is not really a bad idea either should some horrible memory bads happen. The absolutely most annoying memory bad, would be the one doing it in the saving, effectively rendering the saved model useless. Therefore, multiple temporary files is a good idea, but can be reduced to one final as soon as the model is done - because the processed models are -very- large in filesize.

For the exporting method if I'm doing a render that allows for some level of detail in the object, it's generally a good idea to export the different objects and sew them together back in the modeling package again. This way you get a higher resolution model. The model is directly in relation to the textures that should also be generated in this process.

Still, keeping to my previous principles of not allowing the detail of the mesh get way out of hand, I usually go

by exporting the second level of the objects back to .obj files and sew them up to the final object in the modeling package. Even doing this with the first level object can be a good idea, because all the levels of detail above are recursive back down to the first level of detail in the model. With that I mean the highest level of detail theoretically affects the surface of the lowest level of detail – but in practice the level of detail on the highest level can't really have details that would affect the lowest level. Anyhow, the first level object after the sculpting process is theoretically the most 100% accurate version to use with the generated textures.

Now, to generate the textures I usually use the Multi Displacement exporter which previously was a plugin only for Zbrush, but as of v. 3 is included in the package. I've rigged my renderer to output a 16 bit normal map and a 16 bit displacement map. If I intend to use it with the second level of mesh detail, I select the second level of detail before generating the maps. This way, the exporter puts the maps in relation to the selected level. So, that's pretty much the way to get the boosted details out from the program. Switch on the vertical flip instruction for the Multi Displacement exporter, too, and the files can be used right off with Maya.

I've read on several places on the 'net that you actually should convert the color profile on the produced image files, too, but I found it unnecessary in relation to current technology (mostly from threads at http://www.zbrushcentral.com).

Another thing you'd probably want to output is the color channel, and that goes by first selecting the texture menu, creating a new texture at wanted resolution, then opening the texture subcategory under tool and selecting color Col > Tex. Keep in mind the RGB Intensity should be set at 100% and the highest detail level should be selected to get the color data from the highest resolution level of vertexes. Then it's just to open the texture panel on the left side and exporting to, for example, .psd. I like keeping my different layers of color information in .psd files in different layer sets, mostly because it generates less files and to edit in the color information you just have to open one file. Maya supports this right away if you're using the compatibility mode version of the .psd format. Of course, there is a lot of layer effects and functions that can absolutely -not- be included in the .psd, so it's a good idea to always flatten the images per layer set before even switching to Maya from Photoshop.

One annoying stage in this phase would be to composite multiple textures down to one texture generated from different subobjects in the model. As of yet, I haven't really heard of a way to composite the different subobjects

on-the-fly from Zbrush, so compositing them manually in Photoshop will have to do.

Now, as mentioned earlier, the displacements can be used right away if they don't need compositing. But what about the color channel. Now would be a good time to switch to Photoshop from Zbrush. The most minimal set to do a cinematic or even still render setup with is to produce at least a color channel and a specular channel. The color channel might be usable right away on the object, and shouldn't be tampered with too much in regards to color levels if it looked good in Zbrush. If going for very high resolution renders, it would be a good idea to fill in detail on the color channel with photos and collected textures that could apply to the material at hand. Also if there is some very high level details painted in with a general color to mark out their location on the bitmap, they could always be repainted and sharpened at this stage. This depends a lot on the memory capability of the system, but at least my 3 Gigabytes of ram don't really make up for all the detailing.

The specular channel then can easily be produced using filters, mostly the blurring, and layer effects combined with curves and color balance adjustment layers. At this stage it would be good to think about what kind of color would the surface be if I put a dead white light on it. Of course it depends a bit what kind of effects one is after with the model, since you can also throw in serious color alterations here to imitate cartoony looks. But this is at least the very minimal setup of color channels. Before saving the color channels, remember to flatten the layers specifically per layer set to get rid of all Photoshop specific effects unsupported by Maya, stick on a SRGB tag for the color profile and flip the canvas vertical. The color channel generated from Zbrush is not automatically flipped.

Generally just color variations of the same textures can be rather well produced with Hypershade in Maya also, so with that said, you can really speed up the processing a lot by using built-in methods in Hypershade, too.

Now it's back to Maya, but I usually switch back and forth in the rendering tests between Maya and Photoshop to adjust color values or the likes.

## 3.4 Rendering

Back in Maya the first thing to do is to reconstruct the whole model from the different .obj files representing all the different parts. At least if the selected rendering method is by using the second level of detail coming back from Zbrush. Otherwise, the first level of detail model can be used straight away without any modifications. The generated displacements and/or normal maps

should then be generated from the first level of detail back in Zbrush. Of course, this could also be done at higher levels of detail, but downright trying to import models at the high qualities Zbrush is handling will probably crash Maya right away (well, of course I had to try it out at some point!). Anyhow, when using displacement maps, you subdivide the geometry at render time with Mentalray, so it's not at all that relevant what level of detail the mesh is as long as it's somewhere between low to mid level so it's still fully manageable to edit and rig it.

### 3.4.1 Basic shading setup

For starters, I'm only talking about the basic shaders in Maya to not get the subject too complicated. They are in other words lambert, blinn, phong, phong e and anisotropic. The most versatile of the basic shaders would then be anisotropic, as you can do a pretty large scale of different setups with the anisotropic shader. Phong and phong e are basically the same shaders with different mathematical algorithms and fits nicely on surfaces supposed to be glossy. Blinn is generally a good choice for metallic surfaces while lambert is a shader that lacks a specific specular channel, in some cases, when doing fast setups, this can be a good thing. For example skin can be somewhat imitated with lambert, but the results are far from optimal what you can achieve with the basic shaders. Now to look at the aspect of getting in the correct surface deformation attributes for the shaders.

If the model is a complex one with many different materials, the shaders should be picked and configured accordingly, the IPR rendering mode is usually a good way in Maya to configure the shaders in the direction you want them at least. The IPR rendering mode is a "realtime" update on a fast render whenever you change something in the texture chain setups, so it can be used to put the settings for a specific shader in the right direction.

Of course, the IPR render is rather low quality, so it's usually quite a surprise what comes out in the actual render anyhow. Once the basic materials are blocked out, the surface deformers can be taken in. A tip I picked up on the Zbrushcentral forums was to just plain out use the phong shaders while determining the surface deformation levels. This is because you get a rather good contrast in the details while rendering with it. It depends a bit on what you're trying to achieve with the render, if it should be -exactly- the same model as in Zbrush, it's the way to go to determine the surface deformation firsthand.

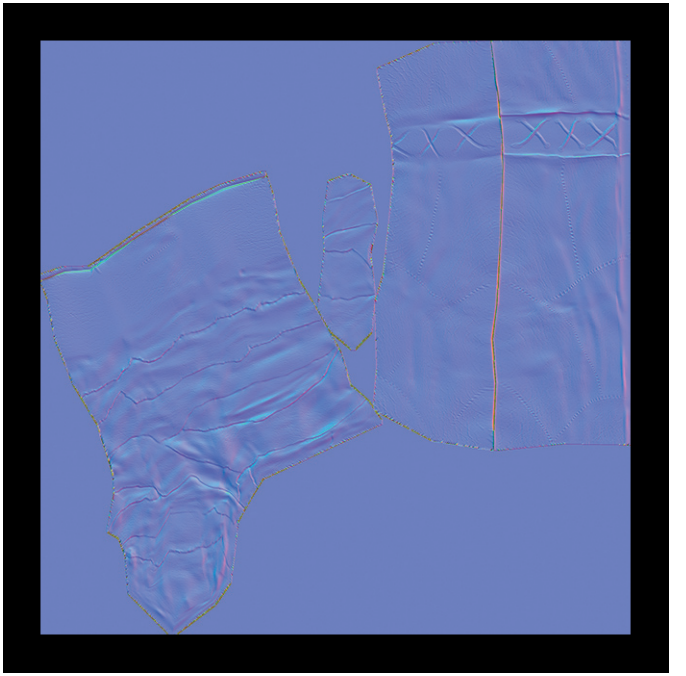
In my descriptions on shading setups here I won't cover anything further than what is for example discussed in the book 'Introducing Maya 2008' in the chapter 'Maya

texturing and shading', because this subject is really way too broad to be going into right here, and if striving for photorealistic renders, this would be the area to explore. Personally, as a mental note, I'm working on developing more complex methods in this area right now - but it's rather an outcome of the conclusions with this project than part of it.

Like earlier stated also, the primary focus for this project is about surface deformation methods and getting heavy detailing rendered. Now the normal mapping method I'm describing below would be the lightweight surface deformation method.

### 3.4.2 Normal mapping

Generated normal maps are rather the easiest way to do deforming, though normals don't really affect the surface in any way. Normal maps rather shift the way the surface takes on light by using the different color channels, RGB for the direction the surface normals are shifted in. RGB is then directly translated into the XYZ directions. This way you get a per pixel definition of how the surface appearance should be shifted in relation to the light that falls on it. This is also the only way to test out normal maps in Maya, which generally would be used for realtime rendering, but can also be used rather well for very detailed surface grains. To connect a normal map with Mayas Hypershade, select the shader that



Typical normal map, this is for the adventurer's boots, the displacement maps are so tuned, there's no point trying to print them.

should receive the normal map, if the Attribute editor is not open to the right, open it up. For the bump map channel of the shader, select the assign surface and pick file. Now load the previously exported normal map file into the channel, I usually use .tif files for this, as it is a solid lossless format with 16 bit color and also alpha support. Now if you open up the shading network for the shader in question. There should be three new nodes for the bump mapping chain. When selecting the bump map translator between the image file and the shader, in the Attribute editor change the 'Use as' attribute to

Tangent Space Normal. And that's it, if rendering now with any renderer the Normal map is attached. Some test rendering is required to get it at an adequate level, but that shouldn't be done just yet if intending to use displacement also.

### 3.4.3 Displacement mapping

Displacement mapping is different from normal mapping in the sense that it effectively deforms the surface on render time instead of just shifting the normals. For better results the displacement rendering of Mentalray should be used instead of the built-in Maya renderer. Needless to say, the object looks a lot better with real geometry than just shifting the normals, so I'd recommend using it for whatever renders not done in realtime, as this technique doesn't exist in that kind of rendering.

Anyhow, to get the displacement fixed for Maya is slightly more complicated than the normal maps. First, to get a displacement node to the shader, open up the shading network in Hypershade for that shader first, then drag out a new displacement node from the left onto the work area. Either drop the displacement node onto the shader and select displacement map or put it in the work area and connect the link from the displacement node to the shaders displacement map. When that is done, select the new displacement node, in the attribute editor, select the surface for the Displacement attribute. Select file and load the exported displacement map.

Now to finish off the displacement, there is a small issue of Zbrush exporting displacement with mid values always set to 50% gray, while Maya expects mid value to be 0% gray. This can be fixed with the Color Balance tools in the attribute editor. The best way to do this, which I found out at the Zbrushcentral forums, is to put in a formula for it, because then you can effectively adjust the level of displacement while not having to think about however the values should be shifted to accommodate for the change in the alpha gain. The idea is that when you crank up the alpha gain, you get more displacement, and when you put down the alpha gain, you get less. Now the correction for the 50% shift should be put in to the alpha offset. To trigger the formula input for whichever text field in Maya, use an equal sign. After that type in -<filename>.alphaGain/2 where <filename> should be a reference to itself, the name of the file node in the attribute editor. Now, when dragging the slider for alpha gain, the value for the alpha offset will automatically adjust to accommodate for the change. When also ticking the 'Alpha is luminance' checkbox the shading nodes are complete for the displacement.

This pretty much uses the same methods described in Zbrush Character Creation (Spencer, 2008) in the chap-

ter of rendering displacement in Maya, although the formula applied is rather different. In the method Spencer describes the scale of the object in question is also taken into account, which would be a very good idea to do if using the object for animation. If the object is scaled down, the impact of the displacement map is also scaled down which should be in direct relation to the scaling of the object actually. However, Spencer starts at a displacement level for the alpha gain at 2.2 and doesn't derive the alpha offset in regards to the alpha gain. Some general testing of the alpha impact should be done and adjusted accordingly anyhow.

The next part is to configure Mentalray to do the subdividing on render time. Of course, at this point you will have to have the Mentalray plugin loaded. Now, first select the mesh you would like to have subdivided. Then fire up the hot box, and select Window -> Rendering editors -> Mentalray -> Approximation editor. Here, while the mesh is selected use the DeriveFromMaya method and click the Create on the Displacement tessellation row, if the created approximation method doesn't show up in the attribute editor, just click edit on it. Now for a real easy setup here just type in the subdivision levels at U and V subdivisions to something which would equal the highest level of detail in the Zbrush mesh.

I've found out through trial and error that as long as you keep it at maximum that level you can avoid crashes at render time. If doing complex scenes, either the renders have to be composited afterwards, or the complexity has to be severely reduced. So next, select the same mesh again and click create on the Subdivisions row also, here you have N subdivisions which should be put to the same level also. The displacement setup is complete. To do some tryouts select Mentalray as render and render typically perspective and checking out everything works out well. Now the levels can be adjusted for both the normal and displacement techniques rather easily.

Like I stated earlier, my opinion is to keep all the very heavy surface detail rather as normals than doing it with full out displacement. Likely, you'd have to do the render as a batch render anyhow if blowing up the displacement very high to avoid memory issues.

# 4 Final model, Adventurer character

I did this model actually as an experiment for testing all the theories I've found out previously, and checking that everything works out well in a larger perspective than just with simple objects. The final model is therefore a compound of a lot of different materials which then can be used for rigging and rendering.

## 4.1 Concept

The concept for this character is rather simple. I'm a huge fan of computer role-playing games, especially the good ones, so I've picked some graphics from a very successful game in this particular period of game techniques and game designs for the initial idea of the model. That is, a generic fantasy adventurer character to serve as the main character in a computer role-playing game.

The game is former Black Isle's Baldur's Gate for which Bioware provided the game engine. Personally, I'm still a huge fan of this game engine and the creative work that was done for it. I think it has a genuine feel that I haven't really seen in the newer 3d game engines building on the same concept. The technique they used was precompiled 3d graphics rendered as 2d sprites. Obviously, the resolutions and qualities of the graphics are at… well… another level, so to speak.

Now with some minor modifications to the idea, the model can be recreated directly like that. I think for this project it was also good to not get stuck at the concept stage too long, which I probably would have done if I'd design the concept myself.

## 4.2 Modeling

I started out creating the basemesh for the model, employing the principles that can be found in the technical section. The models legs were modeled at this stage, also the groin, torso and arms. For the head and hands I usually pick up two includes I've done previously for ge-

neric human heads and hands. I read a comment earlier from David Giraud at the Zbrushcentral forums - It's not an optimal way to create the head, it should be modeled individually each time, this way, though it is very time consuming, you actually improve the design layout of the head and face. Well, this head was primarily made for this kind of character earlier on, so it's not too much of an error. If modifying the head extensively, the UV mapping has to be redone, but of course some modification should be done to at least the head to get a personal feel into it.

After this the secondary objects are made, that is, for this model the eyes and the hair. The final mesh is divided into three parts for convenience in Maya, this should be cleaned up in the animation rigging process because it is irrelevant how many objects you use in the end before putting in the dynamics on the model.

Once I've finished the base mesh, the UV mapping is done. For this particular model I've not optimized it for realtime rendering. That is each and every part of the model is exported, sculpted, painted and then imported back again to reconstruct the model with the sculpting and painting included. This is relevant at this stage, because in the final texturing rig for the character you probably won't have something that could easily be converted into a realtime model. Not without some re-rendering of the textures or just downright re-compiling them manually in Photoshop from the rendered versions. Of course, this requires the textures to be rendered at a rather decent level of detail, too. The UV maps are individual per part, so they will overlap each other if the whole mesh is exported. As mentioned earlier, the overlapping is an absolute no go thing for the sculpting, so the complete character can't really be compiled as such with Zbrush.

### 4.2.1 Problems

As I've done this model a couple of times when I've got stuck on either memory issues or downright not able to push the separate parts into the desired level of quality I ended up doing the model this way – at least it is 100% guaranteed that the different parts of the mesh can be pushed into the quality I want in my models when dividing it up in separate parts like this. In a real world project flow I wouldn't go for the technique of separating the model, but then again, in a real world project I'd probably have some budget for hardware. When doing the sculpting on the different parts, you purely have to visualize what the different parts should look like in the whole concept. When doing it with the correct method, by creating UV ranges and importing the whole model into as described in the technical walkthrough, you always can show the whole model and what all the parts will look like in the whole concept. I think it is a fully adequate work-around to the problem to separate the

model and sculpt each part individually – with the software in question, there is really no other way to do a work-around either.

## 4.3 Sculpting

As mentioned above, the parts were separated for this model, so I will write separately about the sculpting and painting processes for each part of the model.

### 4.3.1 Boots

The first part of the model would be the boots, it's a habit I have to always start from the bottom of a character, whether I paint traditionally, paint miniatures, paint digitally or even do a 3d model. The same rule applies here. The boots were earlier on planned to have a rough leathery appearance, by dividing the model up to the maximum polygon count, and testing the resolution by applying a texture alpha, I get a picture this will work.

Earlier on, at the concept stage, I just randomly searched a couple of pages about the construct of the leather boots of medieval times. Usually game characters are not that accurate, really, but as the technology continues to evolve, so will the level of detail.

I then go into somewhere around 5 or 6 subdivision levels and start doing the main deformation. The main deformation for the leather would be some minor folding along the surface, as this is not a very rigid cut of boots, so they have to be a bit slacking on the surface. I repeat this with a soft brush all over the surface, making the boots look very wrinkled – exaggeration at first hand is good, and then smoothing down the features to a subtle level. Once the smoothing is done I move on to the next level of detail.

Here, with a sharper and finer brush than earlier, I put in cuts to create an illusion of the boots consisting of a lot of wrapped leather bands over each other, and smooth out the supposedly underlying band of leather. This way the illusion looks like the overlaying leather actually just is a band over the underlying one. These cuts will of course not extend over the collar of the boots, but is merely for everything under it. The bands have to be set up rather logically to perfect the illusion.

Now, another detail that can be made at this point is folded seams around the roping for the boots. To me, it seemed like a good idea to make this kind of modification, so there it is.

After these three modifications, the surface is ready to put in the high level detail on it. This should be done at the highest level of detail, of course. The roping is actually an alpha brush I made for this purpose, so the roping

is done by merely dragging out this alpha in a line over the surface where the roping should come. This step might have to be redone a couple of times to get the sizing right. It's just a matter of undoing the action and trying again.

Once the roping is in place, I put on a primary color on the boots, select a rather desaturated brown and fill the surface with it. This is because I involve coloring information in the next step, and that's why the primary color is needed. As mentioned in the technical section, I always have the material during this process to a standard material with minimum impact on the color information, I got this tip from watching one of the Zclassroom videos.

Zbrush screendump of boot model, highest subdivision

When the primary color is in place, it's time to load up another custom alpha I made from a leather surface texture. This alpha contains a lot of leather veining and the likes, and I maxed the contrast in the alpha previously in Photoshop to get rid of unnecessary data in the grayscale range of the picture. See the technical section about creating alphas. Depending on the lighting of the alpha either subtraction or addition should be used. For this particular alpha subtraction gave better results. I applied the alpha using radial fade and a z intensity of something between 8-12. This way with the radial fade the texture seams up rather nicely on the surface blending in enough to make it look like it's not a procedural application, which it kind of isn't either as you have human input to apply it and have a single bitmap to represent it in the end. Because I'm creating crevices in the surface with this brush, I select a dark color in relation to the primary color to add to the surface along with the crevices. The RGB intensity set at about midway of the slider.

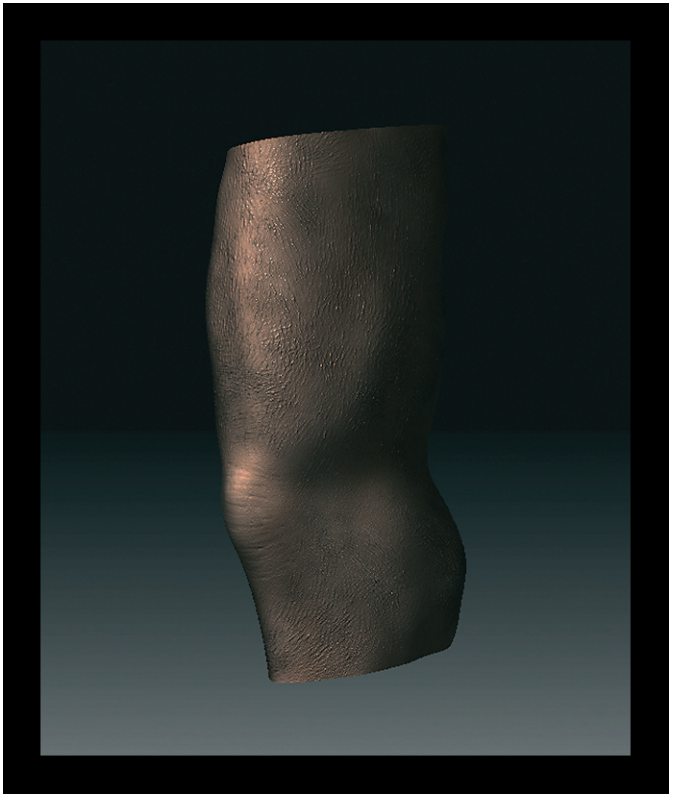
After this we have a good base for the coloring, and also all of the sculpting issues are solved. The following is to work on the color a bit, for this I load up one to several alphas with a dark splotchy granite alpha being rather nice for making variations in the material. Also using color spray with the built-in alphas generates rather good different levels in the coloring. Always remember that the color channel is -NOT- the specular channel here, because if starting to paint in specular information, i.e. about above 75% of the lightness in the color picker, then you will get an illusion of lighting in the final rendering stages. This is usually used for lowresolution, low-polygon rendering and this model isn't going that way right now. Varying the coloring a lot somewhere along the line of the primary color produces a rather natural feel to the texture in the end. Of course, this can all be done in Photoshop also, but it's a bit more tedious to paint when the textures are all flattened out.

After this stage the boots are finished, exporting first/second level of detail mesh for rendering purposes, and exporting the normal/displacement and the color data and it's done. Hardcopy of the sculpting work as a .zbr file too.

### 4.3.2 Legs

As this is a male the legs should have a bit of hair and some general muscular indentations. If designing with a complex dynamic muscular system, the muscular indentations should probably be handled by that, but since this model will not get that kind of thing, at least not for the legs, the indentations are painted in. It gives an illusion that there really are those muscles there under the surface.

Again I start out with subdividing to the maximum poly count on this system and lowering the sculpting level to



Zbrush screendump of leg model, highest subdivision

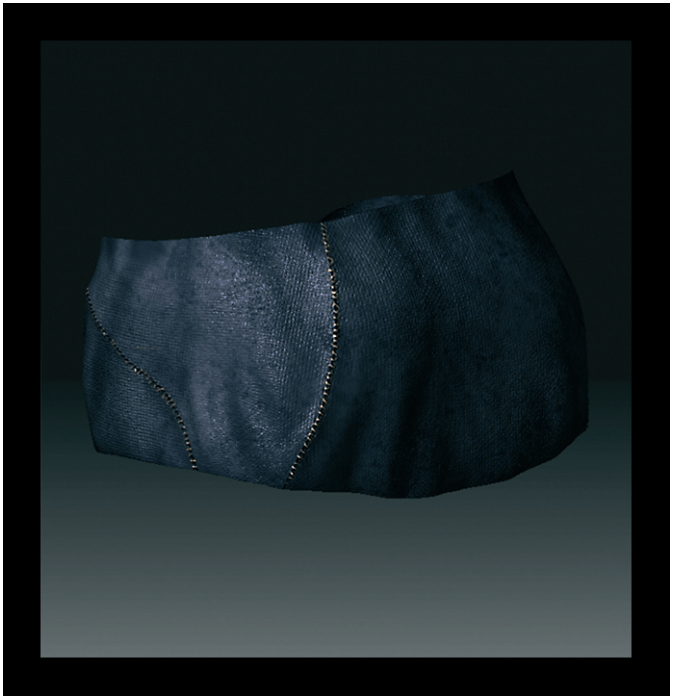
5 or 6 subdivisions. On this level the general deformation should be done, that is, the muscular indentations mentioned above. Also giving a proper form to the kneecaps at this stage is a good idea. This is all done with a large, soft brush. I exaggerate the muscles with overdoing them a bit, and then smoothing them down to a subtle level – keeping in mind all the time that this is not a superhuman model with heavy muscular indentations.

When the previous stage is done, I go directly to the high level of detail, if doing some extensive work on the mid level of detail, it could be some veining or some such, but this model doesn't have these things protruding on his legs, he's still no superhuman. Painting in veins in the color layer could be a good idea, and then it should be done in the highest level of detail.

At the highest level of detail I load up an alpha for the high definition deformation of the skin, funny enough, it's also based on a leather texture. Leather and human skin do have some structural things in common when checking the surface closely. Using the same alpha as on the boots would be an oddity, as that's way too defined for human skin. As previously described, I do a color fill with a generic flesh tone, and pick out a darker color for the cavities. The darker color should be at quite a low RGB intensity, somewhere below 30, because otherwise the definitions will get too much contrast to look good.

Once the general cavities are done, I finish the coloring of the skin with a granite alpha defining variations in the skin color. Again, it's good to switch through a lot of colors that could be part of this particular color scale for the skin and even inverting the alpha to add defined splotches could be a good idea. Repeat until satisfied.

When the skin coloring is done the final touch of the hair is done. For this I configure a spray brush with a darker color, something between dark brown and black, and add an alpha that defines some rough streaks of hair.



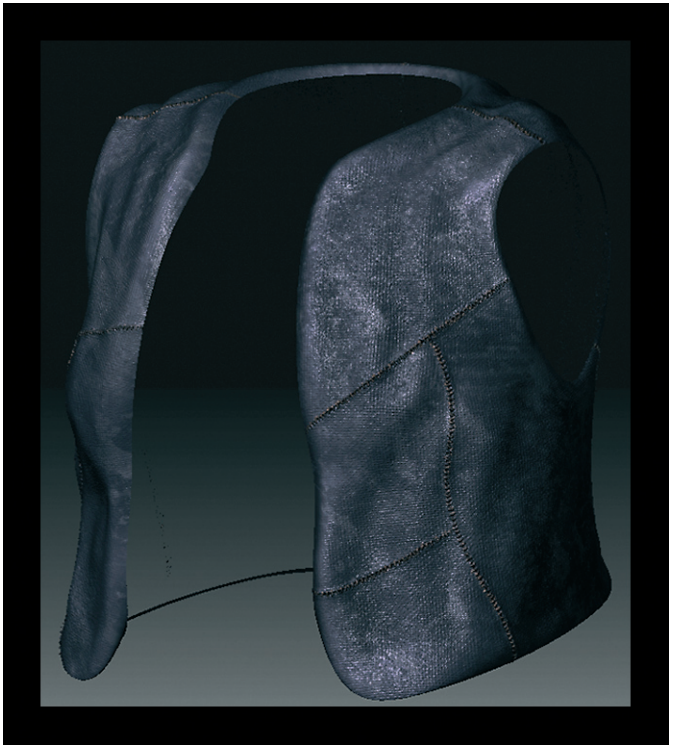
Zbrush screendump of loincloth model, highest subdivision

While spraying with this at the locations where there is most body hair on the legs, I get an illusion of body hair. The more hair, the more spray strokes.

That finishes up the leg parts. Export and save.

### 4.3.3 Loincloth and vest

As defined in the stereotypical fantasy hero running around in loincloths pestering people about quests, this one has to have one of those, too, of course. In the model itself it's also the binding point of the legs. As the adventurer isn't some multibillionaire with a high budget for buying exclusive loincloths, I planned in to do some rough seaming to make it look like it's sewn together of random parts, very much like for example patched leather pants in the real world, but with a much more crude sewing.



Zbrush vest model, highest subdivision

Again a full out subdivision to check the resolutions and then back to the 5th  or 6th level of detail.

At the lowest level of sculpted detail, I start out on this cloth material with defining the randomness in cloth folds. This is done with a large, soft brush like all the previous issues at this level of detail. First doing an exaggerated version, and then smoothing to a subtle level again. The folds will have to make up for illusions of what is underneath the cloth. That is, reproductive organs and backsides and the like. Anyhow, the folds are affected pretty much by this, so doing the folds in a manner that gives this illusion is a good idea. After the folds are completed, there isn't really anything on midlevel for this part either that can be effectively done, so I skip ahead to the high definition on the highest level.

For cloth I made an alpha that is based on a burlap sack texture. This is because the threads are utterly well defined in a photograph of a burlap sack, and therefore

suits this purpose perfectly. When painting out the texture, it is crucial to keep the direction of the weave flowing in the same direction, it can rather well be achieved when playing around with the Dragrect tool. I didn't mention the color data for this, but the same principles as earlier. I do this with a blackish-blueish color to serve as a base for the cloth. Actually for this one I don't do color information at the same time as I do the weave definition, because it would get too well defined then.

When the weave is defined I make up the seams where the cloth is sewn together, for this I've made a crude detail alpha to fit with the stitching brush in Zbrush. In the brush I've defined the edges of the different cloth patches, and protruded the stitches to overlap both the patches. This brush is also used on the boots for the collar. One negative thing with the stitching brush in this version of Zbrush is that you can't include color information to be included in as much detail as the seam itself. Therefore the seam will have to be separately painted if doing that level of detail. That is brushing in color for each stitch! Observe that I do the stitching on top of the burlap alpha. It looks all ok if the z intensity levels are adjusted for it.

The previous step of fixing the coloring for the stitches will have to be done after the primary coloring of the cloth. For that I use various granite alphas to get random splotches into the color channel and vary the color a couple of times. For fixing the stitches I use maximum three colors. Any more detail than that will start to feel ridiculous doing. If done it should be in Photoshop instead. This is an issue I don't really know how to do a work around for, how to get the color information painted in Photoshop synchronized with the normal and displacement deformation on a realistic level. But it's really such a small detail, that I won't delve into it further right now.

The vest in itself is done in pretty much the same procedure.

### 4.3.4 Belt and belt buckle

I actually sculpted them as separate objects, which works fine if taken into account. They could probably have been done with two subobjects of the belt instead. The belt also has these leather pouches for stuff the adventurer pilfers from innocent farmers.

Subdivide to max and fall back to 5th or 6th level.

Being a more complex object the belt with different patches of leather, and a rough box appearance defined for the pouches, while subdividing, the pouches will turn round. Therefore they have to be poked out into the same general shape again, but this only makes them

look more realistic in the final render, so it's not a problem. Another thing I did right at this level was to add the part of the belt that protrudes from the buckle, and adding a leather strap around the belt and that part of the belt, very much like a real belt would look. Also, on a somewhat finer level of detail, all these details have to be sharpened up, but putting in the basic deformations to make the object look like this is required at this level first. On the two pouches I made overlapping leather parts with a button on the end, as probably in a game this level of detail wouldn't be animated, but looks nice and detailed in the texturing.

Adding lighter folds in the letter should also be done here, and of course, exaggerated first and smoothed down later. When that is done the texture alpha for letter is applied, with some darkening along. Finally buttons are added at the pouches.

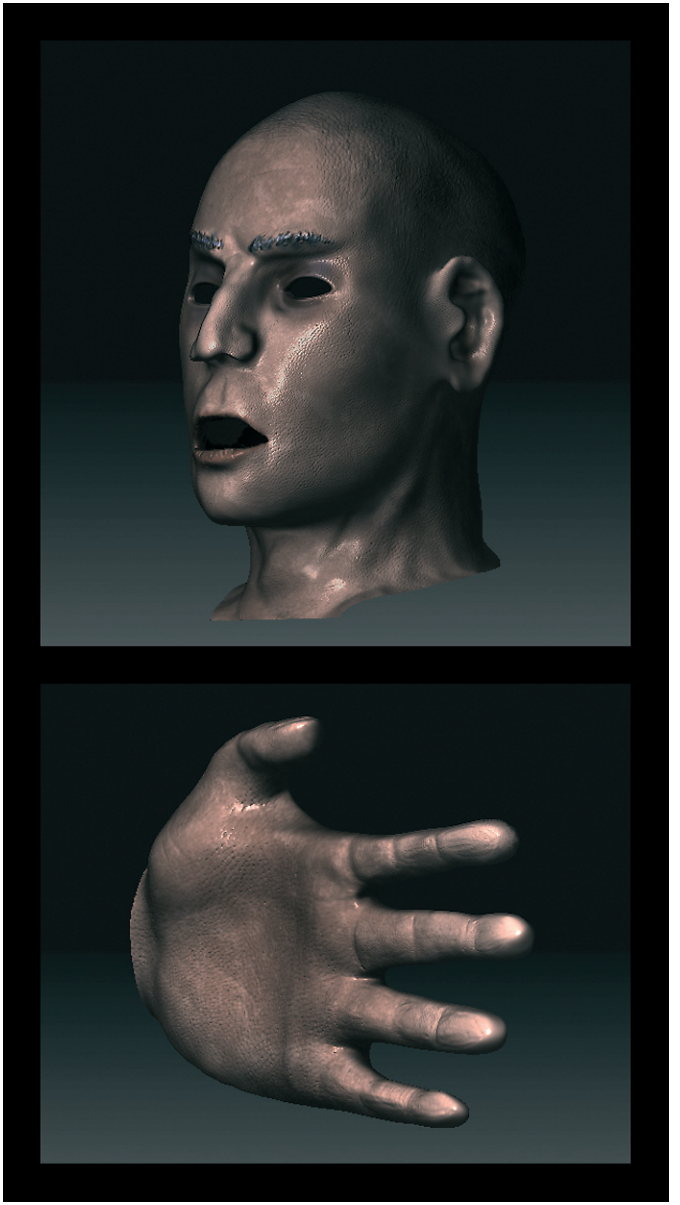
On the color channel I combine the granite alphas with spray painting with a bit lighter alphas than the custom texture ones. To finish off the detailing in the color channel I add darker points to the folds and lighter points to the protrusions. This because the detail is rather high up for the deformations, so a color channel to support it won't do any harm. The same thing counts for the holes in the belt for the buckle. The holes are painted darker and later on also darkened out from the specular channel to prevent highlighting inside the holes. That looks rather, weird, in the end, so common sense should be used in loading up the speculars, too. The speculars are done in Photoshop later on.

Zbrush belt model, highest subdivision

The belt buckle is the buckle with the leather part in it that should bulge on the belt when it's drawn through the.

### 4.3.5 Torso and arms

The torso and the arms are pretty much done the same way as the legs. I sculpted this part as a whole, also including the face.



Zbrush hand and head, part of torso model, highest subdivision

The low level (5 to 6) detail is done for protruding the ribcage a bit and getting the muscular definitions into the mesh. On the arms and the shoulders there should be pretty rough muscular definitions also, but since the lower arms for this model are covered with bracers, the veining for the arms aren't really necessary.

The face in itself is target for a lot more detail than the torso and the arms. This is also because it is needed in whatever productions are meant to be done with the model. Therefore upping the detail level a step or two and defining the face better is needed. Also sculpting the ears with all the crevices and such detail can be done right now. This is still done with a rather soft brush, in the very same way larger sculpting is done, but on a lot smaller level.

Once that is done, the same should be done with the hands, if possible, sculpt mirroring should at least be used here, this kind of detailing is way too much to do to do it twice. Copy pasting later on also works if the model allows it. In hands the general definitions should be made, as they are very time consuming to make with plain modeling, but a little less time consuming to sculpt. This detail level includes all the definitions of muscles in the fingers and hands, knuckles, and so on.

When this level is done on hands and face, the high definition can be done over the whole part. That is applying the same texture alpha, in the same way as on the legs all over the mesh. The size should be varied with good judgement, for example blotting out large skin cells in the face isn't really looking remotely good - instead pores should be produced in the face. What should also be modeled on this level is really fine tuned detailing in the face, with preferably small and sharp brush. That is line definitions around the eyes, line definitions around the mouth, general lip crevices and some line definitions in the brow. Practically you could put down a -lot- of time doing these details.

With the hands there should also be added fingernails, and the crevices around them plus some line definitions inside the hand and some for the fingerprints. At least the max level I worked with didn't allow for that much detail in these, but adding something towards it helps out.

The last thing then is the body hair on the torso and arms generally. A little also added to the back, but nothing too extensive.

Export and save.

### 4.3.6 Armbands

These are made up of cloth, so the same brush alphas are used as on the vest and loincloth. The same procedure applies here, the low level for sculpting, around the 5th or 6th, is first folded a bit to inflict the illusion of cloth, and then the burlap texture alpha is applied at the highest level. There's one seam across the whole ribbon made with the crude seam and then accordingly painted.

For the color these should be red, and as earlier, the color should be a bit desaturated to get a realistic feel. If it's shining red, it wouldn't be that realistic, though it could be used as an effect if doing something cartoony. So the color channel is done in the same way as the vest, for example, but with other colors. Otherwise than that there is only the addition of the seam color information.

Export and save.

### 4.3.7 Bracers

These are built up the same way as the collars on the boots, excluding patched seams. As they should have some kind of roping, I used the same alphas for the roping as I used on the boots, thereby also including the folded seams around it. These I placed on the inside of the wrists. So on the low level sculpting I included some

soft folding, and then pulling out all the edges on all places were that should occur.

For the color channel I used the color spray with splotches and also some Dragrect granite alpha textures, very much like the boots. Lastly the roping was painted with metal rings around the rope holes and some minor shading was added to the ropes themselves, just to get an accentuated illusion of depth in them which also supports the deformation channels.

Zbrush bracer model, highest subdivision

### 4.3.8 Hair

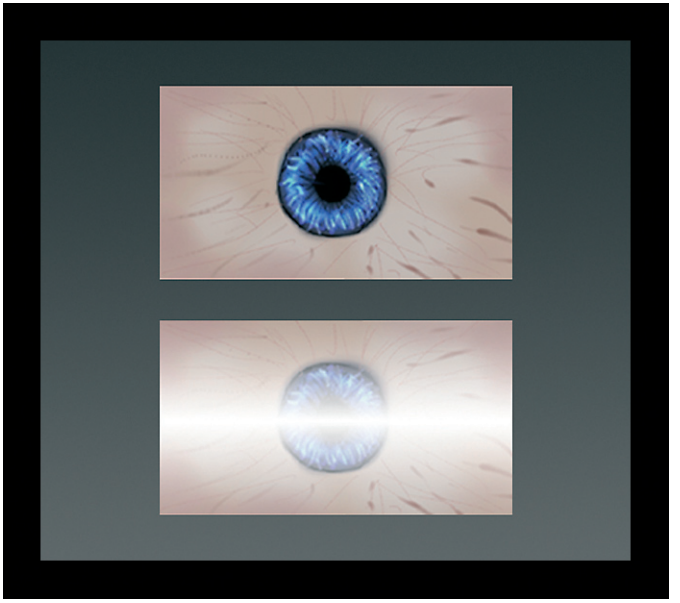
This is actually a quite an optional stage to do detailed hair, because it won't look good to use textured hair if you compare it to the results of hair simulation. Anyhow, if the character should be used in realtime rendering, painting and sculpting the hair is probably a good idea. To get polygonal hair looking good, a set of alpha channels should also be generated for it, but that is a stage later on with Photoshop. I used textured hair for my solution, simply because there's not enough time for me to test the dynamic hair rigging and making something useful out of it right now.

For painting hair I used the same alpha I used for the body hair, though this time I don't use it in combination with a spray paint brush, instead I use it with a freehand brush. This way I can make long strokes with the same hairs, faking the illusion of strands of hair. The strands should be dragged out kind of the way they would appear in the real world.

For the color channel I used the same brush as I painted the deformation channel with, though varying the color all the time between the acceptable range for it. I paint without surface modification and in generally the same direction as the deformed strands of hair. Lighter spots should be picked up here and there, mostly were light most logically will hit the hair. These things have been imitated in traditional painting a long time, so studying that somewhat helps out quite well.

### 4.3.9 Eyes

Eye painting is not necessarily the best thing to do with Zbrush, I personally used a combination of painting with Zbrush and Photoshop to get some better quality on the eye texture. First I painted the eye rather simply in Zbrush on a highly subdivided level and continued in Photoshop to get the interesting effects going on in the iris simulated. So generally what you do in Zbrush is paint in where the iris is, eventually put in some veining in the whites, the whites should be a combination of white and very light yellow, as the eyes are not spectacularly dead computer white in the end.



Eye texture, highlight and specular, underlying Zbrush color and overpainting in Photoshop

In Photoshop I use a combination of screen/dodge and multiply/burn brushes to achieve a complex iris. The specular channel is important to fix for the eyes, and can easily be done with a white gradient over the center of the eye or some such.

### 4.3.10 Post Zbrush, i.e. Photoshop

Now that all the models for the character are fixed up, I process specular channels for every texture. As earlier stated, it's the minimum work on each texture to do. In each and every file I make two layer sets, one for color and one for specular.

The color shouldn't be modified if it isn't entirely re-painted or something. So for this model I've used the color channels directly as they come out from Zbrush. The negative sides show only in real close-up renders, so this should be regulated to what the model will be used for, if doing some nasty close-ups of the model, it should be taken into consideration to repaint the textures based on the Zbrush output.

Anyhow, to create the specular channel, I firstly copy the color channel layer to the specular layer set. Depending on what kind of texture it is I either use layer color dodging, by duplicating it on top of itself or I make the modifications manually with curves and hue/saturation adjustments. Usually I combine both of them with firstly

a color dodge that I curve and hue/sat 'til I get the specular I want. Experience in traditional painting issues or even digital 2d painting can help up a lot in determining what the result should be. Picture the surface, with the kind of material it is, and how it would look if you shine a dead white light on it, that's the way I do it at least. In really extreme cases I do manual painting on the speculars also but usually it works fine with just processing.

I usually blur out the image in layers, as I have for example the two of them on top of each other. The topmost is doing color dodging and may have adjustments to it to make it brighten up the whole texture. So this layer gets a large amount of blur, this is directly relevant to the resolution how much blurring should be applied, but the specular layer shouldn't be very specific if you don't have extreme variations in materials. Therefore, I try to avoid making combo materials, because it's extra processing or painting involved, and finally it might not even look good.

So applying a large blur on the dodging layer, and a small to minimum blur on the underlying color-rigged-as-specular layer produces an effect that could be similar to specular lighting.

Now I repeat this process for every texture involved, even if doing this the other way, with subobjects in Zbrush, you have to do this processing separately for each material.

## 4.4 Rendering

The first part of the finalization and rendering of the high resolution model I actually do alongside the texturing/sculpting process. That is, sewing the parts together from the exported .obj files in Zbrush.

If the initial .obj files exported from Maya are made up from the split parts directly in relation to the model. Even though they are split from the main model, when they reside at the same locations as when they were split from the model, they will also have exactly the same coordinates when coming back from Zbrush.

So it's just a matter of fixing the seams between the different parts then to get the complete mesh with a higher resolution and also the impacts coming from the very high resolution model in Zbrush.

The only modification for the rendering I did on the modeling plane otherwise was turning the hands 90 degrees, to have the open hands facing downwards. This way the animation rig is easier to fix for the deformations that occur when rotating the hands. I guess I should have

thought about that earlier, but no big harm done as it was rather easily corrected.

### 4.4.1 Textures

To make matters less complicated, and to get relatively fast test renders for the different parts, I compiled the textures in different Maya binary files before sewing them together. This way I had the configured shading networks done already when the models came into action and in relation to the complete model. The texture assignments remain the same though sewing the mesh together, so it works rather well to use this technique when doing complicated models with lots of different texture assignments.

For the different shading networks I only picked simple shaders from the standard Maya shaders. The ones mentioned in the technical section. I mention it here, because I've included the definitions of what shaders to use for what purpose there also. The definitions can also be found in the Maya manual. Right now I've thought about fixing some heavier Mentalray shaders, because, for example, human skin is very hard to get a realistic look on with the basic shaders, because it has different levels of specular and also consists usually of a couple of layers of texture. Subsurface shaders are implemented purely for this purpose, but it isn't only the human skin either that behaves this way. This model, in this edition, does not have one anyway. I read David Girauds solution on the Zbrushforums for setting up and rendering skin with Mentalray, because the output they've done with their team at Ubisoft is rather outstanding. In an interview he also said he's spent about the 2 last years on figuring out shaders to use, so it's a rather complicated issue to say the least.

So the basic shading network includes the textures I've mentioned above: color, specular, normal and displacement maps. For the sake of convenience, I also define the Mentalray approximation level per part of the mesh when putting together the shading networks. This way, everything concerning textures is already rigged when they're included in the completed model – practically, it saves a lot of time. Partly also because of the split UVs you get from the Zbrush output for the meshes.

So now I have the model back as a T-shape with the open hands facing downwards and all the textures in place.

### 4.4.2 Rigging

In a proper cg design environment this stage is not done by the same persons who are doing the modeling and the texturing for the project, but in smaller teams it occurs that the same people help out in the other departments when needed, so it's not a bad thing to be fluent in the basics of rigging and animation at least.

I recently read a book about minimal rigging, i.e. game design rigging, called 'The Game Animator's Guide to Maya', which as the name implies also covers a lot of animation. The methods I use are all thoroughly discussed in that book and the book is still part of the Sybex series (McKinley, 2008).

I first set up a rather basic skeleton for the character, and I actually did this twice, because I thought it would suffice with a very simple one, while it didn't.

In the first skeleton I did the backbone, arms, legs, foot, head, simplified hands and toes.

In the second skeleton I fixed the positioning of the shoulders which I previously put too close to the spine of the skeleton, and secondly I added bones for all the fingers.

With the second version the binding succeeded rather well, as implied in the above mentioned book also, you should stick to smooth skinning and not rigid. The controls for smooth skinning are far more developed.

After the binding I corrected some errors that occurred at the shoulders primarily, and added simplified muscular deformations through influences for smooth skinning at the arms and shoulder.

For each arm the following setup was put in. One influence representing the breast muscles and shoulders, this one was put as a direct descendant of the uppermost backbone to animate with the shoulders. One influence represented the biceps and was therefore assigned with the upper arm. One influence represented the elbow and was therefore associated with the lower arm. The last influence I stuck in to correct the distortion for rotating the hands, which is assigned to the lower arm and follows the X rotation of the hands.

I pretty much tested out what exactly I needed to get the pose I wanted for the final render and put in only those things. I'd keep this project as an utter failure if I'd fail to complete the final rendering stage, so therefore it was a priority issue to fix the rig as far as I needed at least.

### 4.4.3 Lighting

Early on I've picked up some influences from 3d renders I saw from Steven Stahlberg back in 1997 who then used Maya and actually was the first person to produce a major virtual actor. He had this nice way of combining radical color changes and I usually fix a setup of 8-10 lights for any given render, varying in both color and intensity. I usually don't do area lights but have given it consideration when also thinking of starting to employ somewhat more Mentalray rendering effects to get high end visual output for the productions.

Well, here are some general pointers in how I do a still render of an o bject. Very much with every model I've done for this project I've used the same kind of lighting setups.

What I think is a nice effect can be produced with doing a bit of backlighting or somewhere to the sides and back of the object. With high detailed models this effect looks rather good when it produces a full contrast between really small detail and crevices if the light is just sideways touching the surface. Coloring depends a bit, but I like to keep it rather cool. For this particular render there's a real high intensity backlighting to the left, camera perspective.

I then have a not-too-high intensity solid red light to the right. We're almost talking #ff0000 red here, which gives a nice brushing on the heavily shaded parts.

From the characters front there is a light yellow light to produce some neutral warmth in the image, but also with a high falloff rate to shade the legs more.

The rest of the lighting is done with spotlighting from the left hand of the image. When combining this with the high end surface deformations, the result looks quite interesting in my opinion.

The final render from Mentalray is at the next page.

# 5 Conclusions and further goals

To start out, personally I think this project was just what I needed and also a great success. There are some minor flaws in the results here and there, but at least I've seen the problems in action, and therefore know what to look for to get a solution to them. Actually I have already picked up some of the technical solutions, but haven't got the time to include them in the final products.

My primary goal was to create a workflow with an independent output, very much like how this thing works in the real world today. I've found out that also due to this project. This is very much how game models are done today.

David Giraud was kind enough to share their workflow on the Zbrushforums they've used for the high-end graphic production they did on Ubisoft's title, Assassin's Creed. The workflow of their team included to first do renders of a high resolution model sculpted into perfection, and the renders are then going for approval. Once the high resolution renders are approved they get the green light to make the low resolution versions which are then textured accordingly, rigged, animated and ported to the game engine. Pretty much the same conclusions I drew during this project would be an optimal way of proceeding with this kind of workflow, especially when going down to low resolution with the end product.

Now that I have this part of character creation covered, I can start refining the methods for rendering, as they are still pretty rough on my behalf using only the standard shaders in Maya. Anyhow, the surface deformation methods are fully solved in my workflow and they have gradually evolved during this project.

I've also learned the weak points of the work chain in relation to hardware and how to best avoid unnecessary technical breakdowns.

I thought about coding a game engine by means of employing open source APIs to test out and build a context for the models. I think it's rather pointless to build models without a proper context or a product for which they are meant in the end. Though graphical solutions do convey a story, as I've earlier stated and what is also underlined in the massive traditional and digital history of art, I personally think something's missing as long as a 3d model don't have a context. That is a larger story, either in a movie or a game.

I find it rather disturbing also that though the graphics usually are very high quality in games today, there are a lot of flaws in the context instead. When looking

at games, the problem is absolutely not in the graphical work, it's rather a result of mass scale solutions for breaking down productions into manageable parts. While scripting for characters is usually the way it is done, the limits of the scripting toolkit limits the impact of the characters expression. So even though the graphical work can be exquisite, the character in itself doesn't convey the expression well enough to make the graphical investment worth it.

Obviously, this doesn't occur at all in fully coordinated animations – like cinematic or even in-game cinematic animation, produced with the very same engine that otherwise can have a rather hollow feeling.

There are some new innovative solutions on the horizon for this, for example, scripting character reactions would be a good place to start. Keep in mind, that this still concerns game engines primarily. The solution is in my opinion pretty much breaking out of the frame for what previous technological solutions have inflicted to be guidelines for how things should be done. With these limitations, especially when we're talking high-budget productions like games or movies, the evolving of new techniques get rather limited for the sake of avoiding total catastrophes or just to avoid taking the risks for such scenarios.

One thing I'm also going to delve further in personally right now is animation, and creating complex and lifelike rigging methods for characters. Once I'm done with that I think I'm starting to get ready to actually put together some cinematic evidence.

Concisely, my next step in perfecting my working methods is to sort out heavier shading models and also digging into complex animation. After that I pretty much can take me from one end of the 3d production chain to the finish, though not probably needed in real-world cases, it certainly allows for a greater understanding of why things are done the way they are.

After covering those aspects of 3d the techniques will have to be tried out of course, and in this kind of one-man scenario, will probably be short cinematics to begin with. I have some reluctance for joining up with the large scale industry, mostly due to my philosophies around art as a form of communication. In a large team and large production, the communication of the individual goes through many processes before completion and therefore cannot really compare with the communicational value of traditional methods where the artist designs the complete workflow and therefore dictates the message the artwork is supposed to convey also.

Dependent of how much technology we pile upon the creative process, it's primary purpose is always communication in the end. If failing this particular statement in any given artform in any given production, I consider the artwork a failure in itself. I find it in many commercial new media productions today, the values of communication are overlooked for the sake of creating products with minimal communicational values or replicated values to simply make them more appealing. Either way it is deliberate or not, i find it rather mocking to the long history and tradition of art. That would be my primary issue with the industry.

# 6 List of References

During this project, the 'net is of course the primary source for everything digital. Obviously there is no point in reading material that already is available in the head, but for more in-depth material, books I've either read or browsed through for this project, before, while and after writing this would be the following:

Derakhshani D., Introducing Maya 2008, 2007, Wiley Publishing, Sybex series

Lanier L., Advanced Maya Texturing and Lighting, 2008, Wiley Publishing, Second edition, Sybex series

Meade T. & Arima S., Maya 8 - The Complete Reference, 2007, McGraw-Hill, eBook edition

Spencer S., Zbrush Character Creation, 2008, Wiley Publishing, Sybex series

van der Byl L., Photorealistic texturing for dummies, 2006, online publication
Available as .pdf at http://www.leighvanderbyl.com

Giraud D., interview at Zbrushcentral and various threads from there, 2007-2008
http://www.zbrushcentral.com/zbc/showthread.php?t=052525

Various threads at http://www.zbrushcentral.com by different authors

Various authors, video material at http://www.pixologic.com in the Zclassroom cathegory
Available at http://www.pixologic.com/zclassroom/

# Appendix A: selected models from the project