

The 3D model Development Workflow from Design to Deployment

Jennifer Sieck

3D Medical Modeler/Animator
National Capital Area Medical Simulation Center,
Uniformed Services University
Bethesda, MD



The 3D model Development Workflow from Design to Deployment

Why do you need good models?
...because the eye doesn't lie.

Believability – if the user doesn't believe that the models are real, then the training exercise is will not be successful.

Accuracy – if clinicians are "doubtful" of a model's accuracy during the procedure, then it will be a constant distraction.

A little bit of effort goes a long way!

Believability



Resembles a Manikin



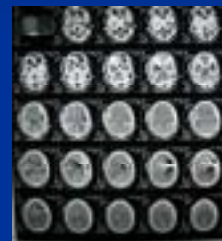
Resembles a Man

Lean on your clinicians! Get References!

Accuracy



Visible Human data



MRI data

3D Model Creation for Anatomy:

Software



3DS Max



Maya

Very Different Results:

3DS Max

- Better SDK for programmers
- Easier to Learn
- 100+ 3rd Party Plug-ins



Maya

- Writing exporters is a hassle
- Much steeper learning curve
- Very few 3rd Party Plug-ins



Very Different Results:

Software



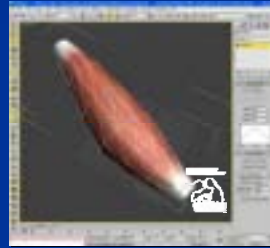
3DS Max



Maya

3D Model Creation for Anatomy:

Absolute Character Tools (ACT) Plug-in



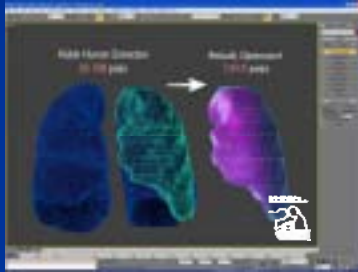
Building a CGmuscle



Full model of CGmuscles

3D Model Creation for Anatomy:

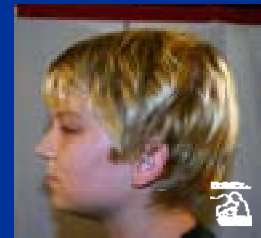
Absolute Character Tools (ACT) Plug-in



Visible Human data into a CGmuscle model

3D Model Creation for Anatomy:

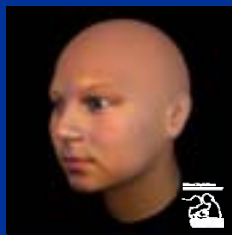
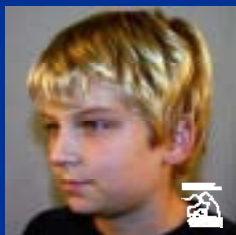
Face Gen- Generating 3D geometric faces from photographs



Only 2 photos needed

3D Model Creation for Anatomy:

Face Gen - Generating 3D geometric faces from photographs

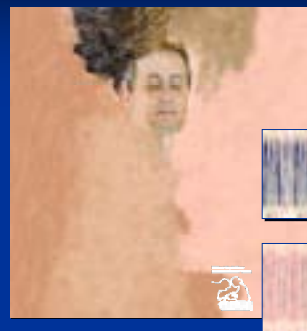


3D Mesh Reconstruction and Texture Map Creation

2D Texture Creation for Anatomy:

Photoshop

- Ease of use
- Cross platform compatibility
- Extended file formats



<http://www.adobe.com/products/photoshop/photoshop/>

Internal Anatomy Creation :

Sources:

- Store Bought, Commercial Models
- 3D Data, Visible Human

Internal Anatomy Creation :

Store Bought, Commercial Models

Pros:

- Time Savers
- Sexy and appealing
- Polygonally efficient?
- Some contain textures
- Cost efficient (usually)



Internal Anatomy Creation :

Store Bought, Commercial Models

Cons:

Who modeled it?



- Cross referencing CT or MRI?
- Legal for Simulation use?
(Read the fine print)
- Can they guarantee accuracy?

Internal Anatomy Creation :

Store Bought, Commercial Models

- Buyer beware!
- Clinicians need to "sign off" on their accuracy!

Zygote Media: www.zygote.com
TurboSquid: www.turbosquid.com

Internal Anatomy Creation :

3D - Visible Human Models

Pros:

- Public Domain
- Accurate

Cons:

- Remodeling needed
- Fallen structures



Absolute Character Tools (ACT) Plug-in

Remodeling

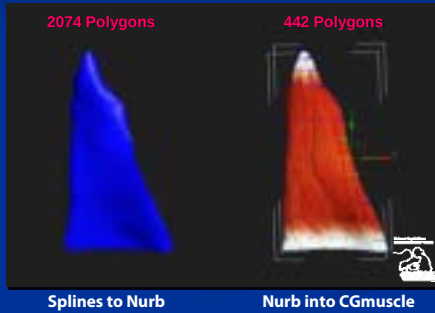


Visible Human sliced into Splines

Splines copied

Absolute Character Tools (ACT) Plug-in

Remodeling

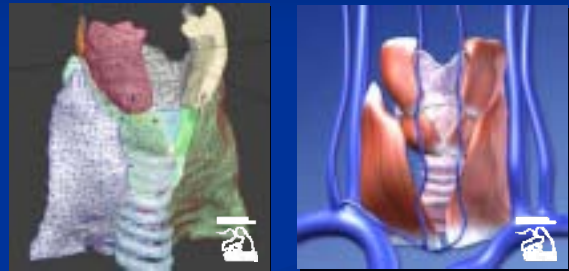


Splines to Nurb

Nurb into CGmuscle

Absolute Character Tools (ACT) Plug-in

Remodeling

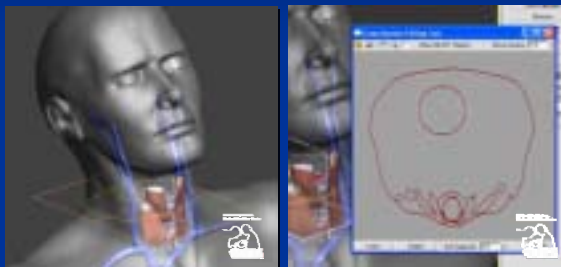


Original

Remodeled

Absolute Character Tools (ACT) Plug-in

Cross Section Editing Tool



Crossing Plane can be moved

Interactive View of Cross Section

Internal Anatomy Creation : Rendering Considerations:

Speed (in simulator) vs. Accuracy

- Only show what is necessary...
- You don't be a purist and model every internal structure.
- Only create details that will be seen.

Polygon Count

- Build it high, then reduce it down.
- Max 's Optimize and Multi-Res that allow for "dialed in" reduction.
- With CGmuscles, you can eliminate on a per fiber/cross section level to ensure complete control over your reduction
- Awesome Textures can make up for less Polygons!

Internal Anatomy Creation : Rendering Considerations:

Polygon Count: The Hi Res Texture makes this door "appear" Hi Poly



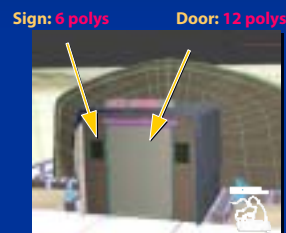
Original photo
(courtesy Mark Bowyer, MD)



Photo used as a Texture Map

Internal Anatomy Creation : Rendering Considerations:

Polygon Count: The Hi Res Texture makes this door "appear" Hi Poly



Inside 3DS Max



Close Up of Final w/texture

Internal Anatomy Creation :
Rendering Considerations:

Patch Modeling to control Polygon Counts:

Surface Steps: 0
Polygons: 1134

Surface Steps: 1
Polygons: 4418

Surface Steps: 3
Polygons: 17,396



Inside 3DS Max

Internal Anatomy Creation :
Export Considerations:

Limitations of the Renderer: Know your Limits!

Prioritize your models for their Poly counts:

- 1) **Interactive parts** (most dexterity, less artifacts created)
- 2) **Skin**
- 3) **Non-Interactive models**
- 4) **Equipment** (Level of detail will vary and high poly models usually are not necessary)

Internal Anatomy Creation :
Export Considerations:

Visual Effects: Know your Limits and Prioritize

Bleeding, cutting, suturing, etc:

- 1) Is it unattainable?
- 2) Is your time better spent on didactic training and better models?
- 3) Can you make a "work around"? (i.e. an animated opacity map for bleeding)
- 4) Leave them till the end if extra time allows.

Internal Anatomy Creation :
Export Considerations:

Lighting: Getting around this nasty Bugger!

Solutions:

- 1) Create a "Viewer" for your artist that mimics the engine's lighting.
- 2) Use the highest resolution textures that you can.
- 3) Make textures that have "pre baked" shadows in them. Lights that create shadows are too render heavy.

Internal Anatomy Creation :
Export Considerations:

Texturing Models: Colors are BORING, Textures are REAL



Color Only



Texture Mapped

Internal Anatomy Creation :
Export Considerations:

Texturing Models: Starts with "Pelting" the model

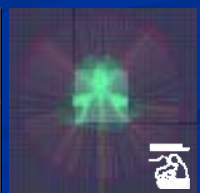
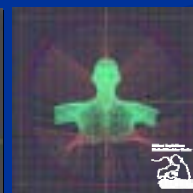
Pelting: The goal is to have open and flat polygonal coordinates

- 1) Select a "Seam" to cut the models UV Coordinates open
- 2) Expand the faces into a "square" Pelt

Seam

Stretcher ready

Pelting Flat

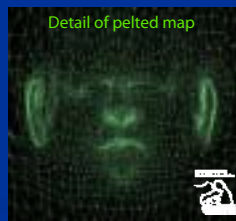
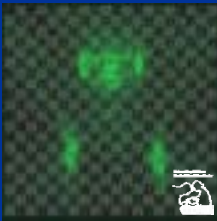


Internal Anatomy Creation :

Export Considerations:

Texturing Models: Starts with "Peltting" the model

Pelting: The goal is to have open and flat polygonal coordinates
Expand the faces into a "square" Pelt



Internal Anatomy Creation :

Export Considerations:

Texturing Models: Colors are BORING, Textures are REAL

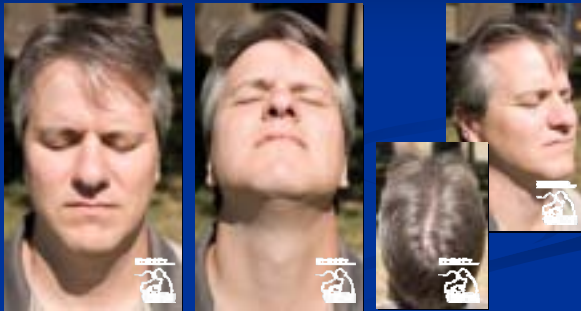


Solutions: Make it recognizable, photograph the "Real Thing".

- 1) High Resolution Photographs taken in Sunlight or with Pro-lights (better color and luminosity)
- 2) Photos taken every 15° and top (creates a "shadow less" texture map)
- 3) If you want shadows on your map, make them consistent

Internal Anatomy Creation :

High Resolution Photographs taken in Sunlight at 15° increments



Internal Anatomy Creation :

Use the sections that are perpendicular to you for a "non distorted" angle and the most "shadow less" area



Internal Anatomy Creation :

Some shadows can work for you: Take the more "shadow less" photo

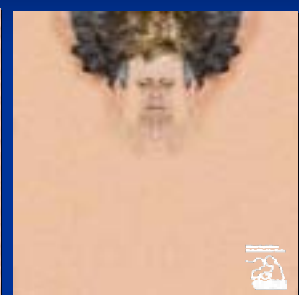


Internal Anatomy Creation :

Overlay Pelted Coordinates into Photoshop



Cutting and Pasting Photos to fit wire frame



Finished Bitmap

The 3D model Development Workflow from Design to Deployment

Case Study: *Intracranial Hematoma*

Define your Objective – Design a force feedback simulator for training general surgeons on the battlefield to perform a craniotomy to relieve intracranial pressure caused by a traumatic head injury.

Case Study: *Intracranial Hematoma*

Collaborating :

- surgeon or subject matter experts
- List the steps and locations of how the procedure is performed.
- Note unique circumstances and extra nuances that need to be paid special attention to.

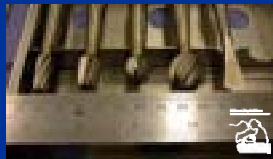


Case Study: *Intracranial Hematoma*

Define : Critical Anatomy and Equipment

Anatomy :

- Skin, flipped back,
- Periosteum
- Skull
- Dura
- Brain



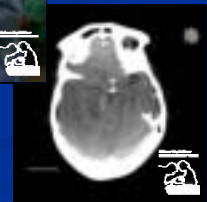
Equipment :

- Drill
- Craniotome
- Suction



Case Study: *Intracranial Hematoma*

References : Books, 3D data, Surgical Video, x-rays, 3Dradiology



Case Study: *Intracranial Hematoma*

Modeling :

- 1) Start with the skin (age, weight, sex, medical condition)
- 2) Create skin from scratch, FaceGen, or commercial models
- 3) Manipulate per surgeon's criteria (ours needed a head trauma and to be pre-opened with a deflected flap of skin)



Case Study: *Intracranial Hematoma*

Texturing :

- 1) **Trauma to the face** (used references of cuts, wounds from other people)
- 2) **Interior of skin flap needed to be bloody** (I used a photo of red meat)



Case Study: Intracranial Hematoma

Texturing :

- 1) Trauma to the face (used references of cuts, wounds from other people)
- 2) Interior of skin flap to be bloody (used red meat)



(Courtesy of Josh Rosenberg)

(Courtesy of a cow)

Case Study: Intracranial Hematoma

Texturing :

- 1) Trauma to the face (used references of cuts, wounds from other people)
- 2) Interior of skin flap to be bloody (used red meat)



Case Study: Intracranial Hematoma

Combining the Skin with Anatomy :

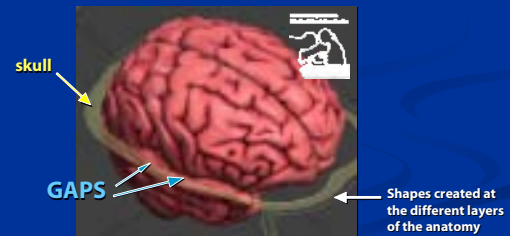
- 1) Scale major proportions that are obvious (i.e. skin to skull, brain to skull)
- 2) Allowed space for interstitial tissues (i.e. Periosteum and Dura)
- 3) Used the Cross Section Editor to inspect for gaps, then mark those spaces



Case Study: Intracranial Hematoma

Combining the Skin with Anatomy :

- 1) Shapes created with the Cross Section Editor marked the gaps.
- 2) Scaled the sections of the brain that did not lie flat against the skull's wall



Shapes created at the different layers of the anatomy

Case Study: Intracranial Hematoma

Final models in the Engine : Skin, periosteum, skull, dura, brain



We created a proprietary exporter for Max to get a true transform of the 3D data.

Courtesy of
Jamie Haggerty

The 3D model Development Workflow from Design to Deployment

...in conclusion

No need to get overwhelmed – the tools that you need to make great models and textures are out there!

Keep it simple – construct only those objects that are necessary, and then add the bells and whistles

Accuracy – work closely with your clinicians for ongoing feedback

References

[3ds Max 2009 Bible](#) by Kelly L. Murdock (Paperback - Aug 11, 2008)

[Adobe Creative Suite 4 Bible](#) by Ted Padova and Kelly L. Murdock (Paperback - Dec 31, 2008)

Creative Essence the Face (Paperback) by [Paul Fedor](#) (Author)

[3ds Max Modelling for Games: Insider's Guide to Game Character, Vehicle, and Environment Modeling](#) by Andrew Gahan

www.cgsociety.org (Mark Snoswell) (2 Million Users) Models, Forums, Software, Events

www.turbosquid.com Software, Tutorials, Models

www.cgcharacter.com/act_pro16.html Absolute Character Tools and CGmuscles

www.autodesk.com 3DS Max and Maya

www.facegen.com FaceGen Software