

## The 3D model Development Workflow from Design to Deployment

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## 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.

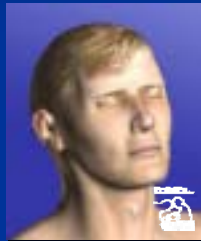
**Accuracy** – if clinicians are "doubtful" of a model's accuracy during the procedure, then it will be a constant distraction.

*A little bit of effort goes a long way!*

### Believability



Resembles a Manikin



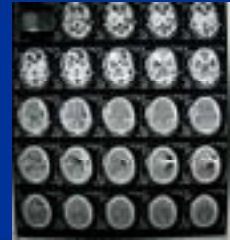
Resembles a Man

*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+ 3<sup>rd</sup> Party Plug-ins



### Maya

- Writing exporters is a hassle
- Much steeper learning curve
- Very few 3<sup>rd</sup> 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:*

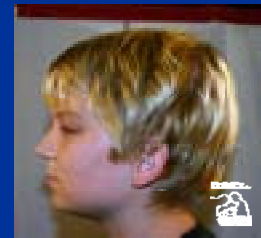
**Absolute Character Tools (ACT) Plug-in**



Visible Human data into a CGmuscle model

*3D Model Creation for Anatomy:*

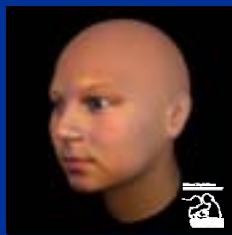
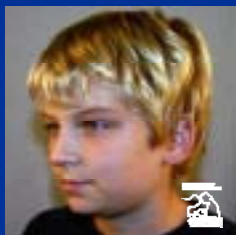
**Face Gen- Generating 3D geometric faces from photographs**



Only 2 photos needed

*3D Model Creation for Anatomy:*

**Face Gen - Generating 3D geometric faces from photographs**

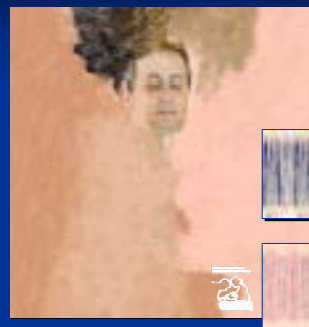


3D Mesh Reconstruction and Texture Map Creation

*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](http://www.zygote.com)  
TurboSquid: [www.turbosquid.com](http://www.turbosquid.com)

### Internal Anatomy Creation :

#### 3D - Visible Human Models

#### Pros:

- Public Domain
- Accurate

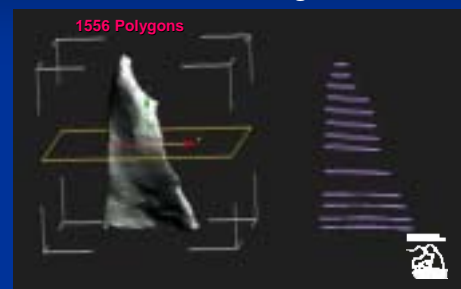
#### Cons:

- Remodeling needed
- Fallen structures



#### Absolute Character Tools (ACT) Plug-in

#### Remodeling

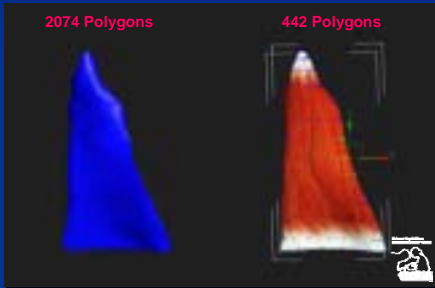


Visible Human sliced into Splines

Splines copied

## Absolute Character Tools (ACT) Plug-in

### Remodeling

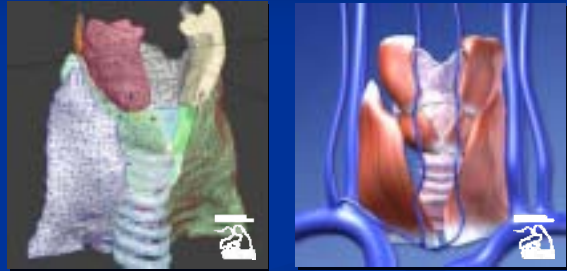


Splines to Nurb

Nurb into CGmuscle

## Absolute Character Tools (ACT) Plug-in

### Remodeling

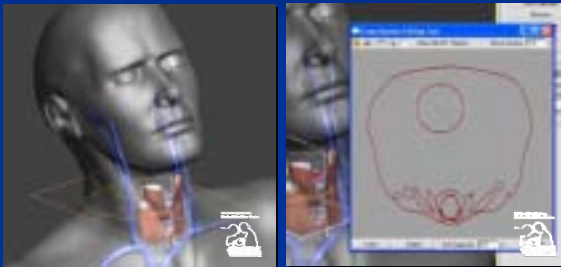


Original

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

Sign: 6 polys      Door: 12 polys



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**

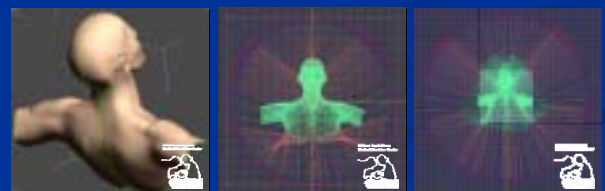
**Pelting:** The goal is to have open and flat polygonal coordinates

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

Seam

Stretcher ready

Pelting Flat

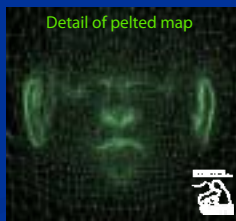


*Internal Anatomy Creation :*

*Export Considerations:*

**Texturing Models: Starts with "Peltting" the model**

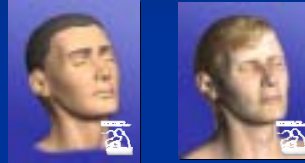
**Pelting:** The goal is to have open and flat polygonal coordinates  
Expand the faces into a "square" Pelt



*Internal Anatomy Creation :*

*Export Considerations:*

**Texturing Models: Colors are BORING, Textures are REAL**

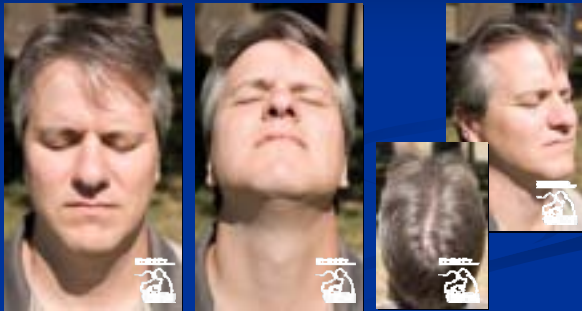


**Solutions: Make it recognizable, photograph the "Real Thing".**

- 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



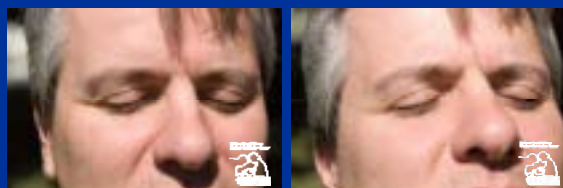
*Internal Anatomy Creation :*

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



Good

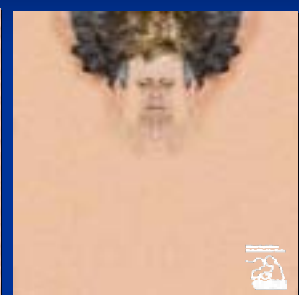
Better!

*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



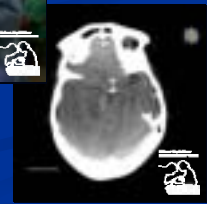
##### Equipment :

- Drill
- Craniatome
- 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)

