

# **3D BODY & FACE MODELING & ANIMATION**

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# Outline

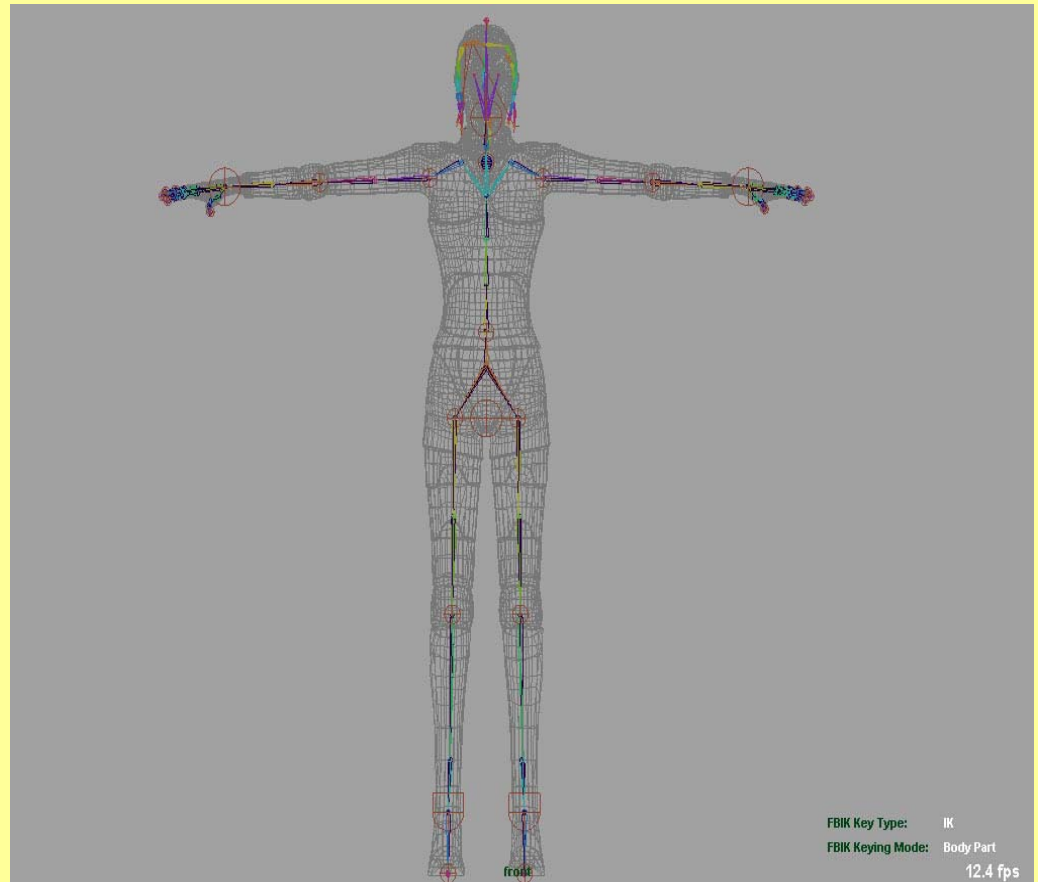
- 3D Human Modeling
- Facial Expressions
- Lip Synchronization
- Advanced Rendering
- Applications

# 3D Human Modeling

- Body modeling
  - Skeleton and skin
- Face modeling
  - Texture mapping of multiple photographs
  - Blend-shapes for facial expressions
- Hair modeling

# Body Modeling

- Skeleton fitted to the body mesh
- Hierarchical structure of 76 bones



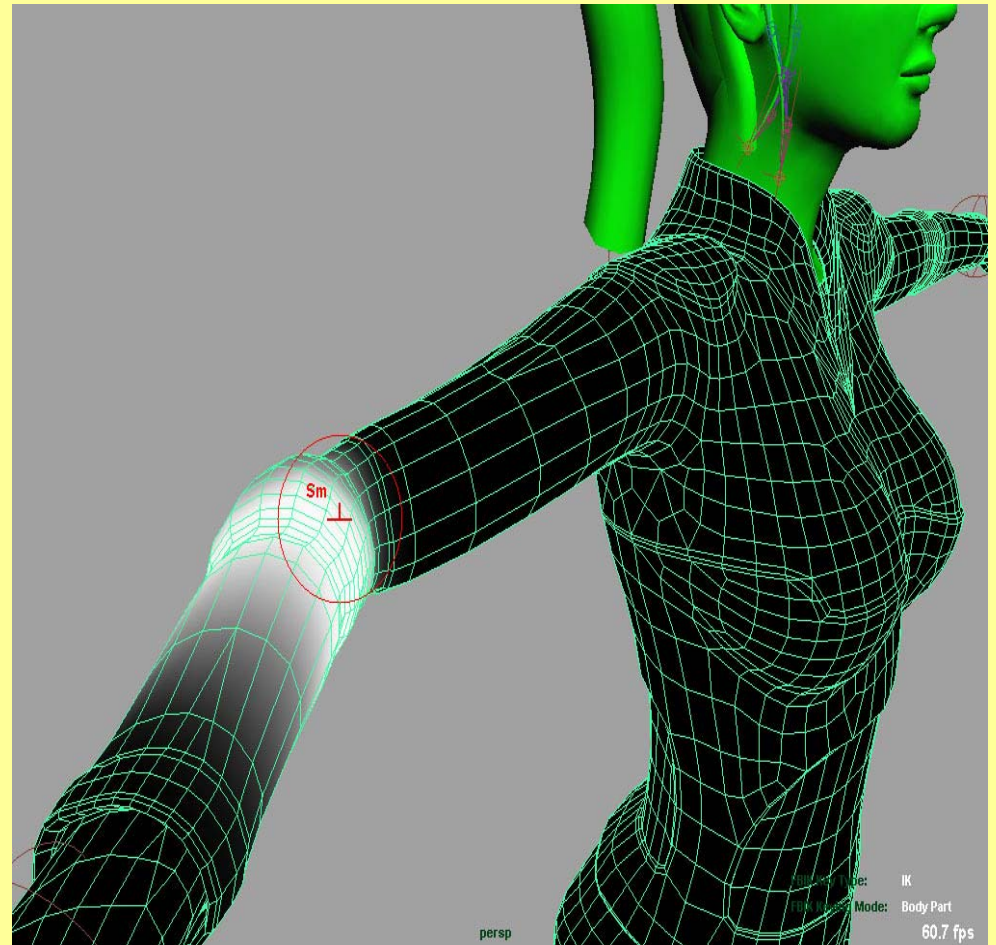
# Body Modeling

- Shaded version of the skin
- ~14500 polygons



# Body Modeling

- Matrix palette skinning
- "Paint" weights for each joint
- Four influences per vertex



# Skeletal Animation

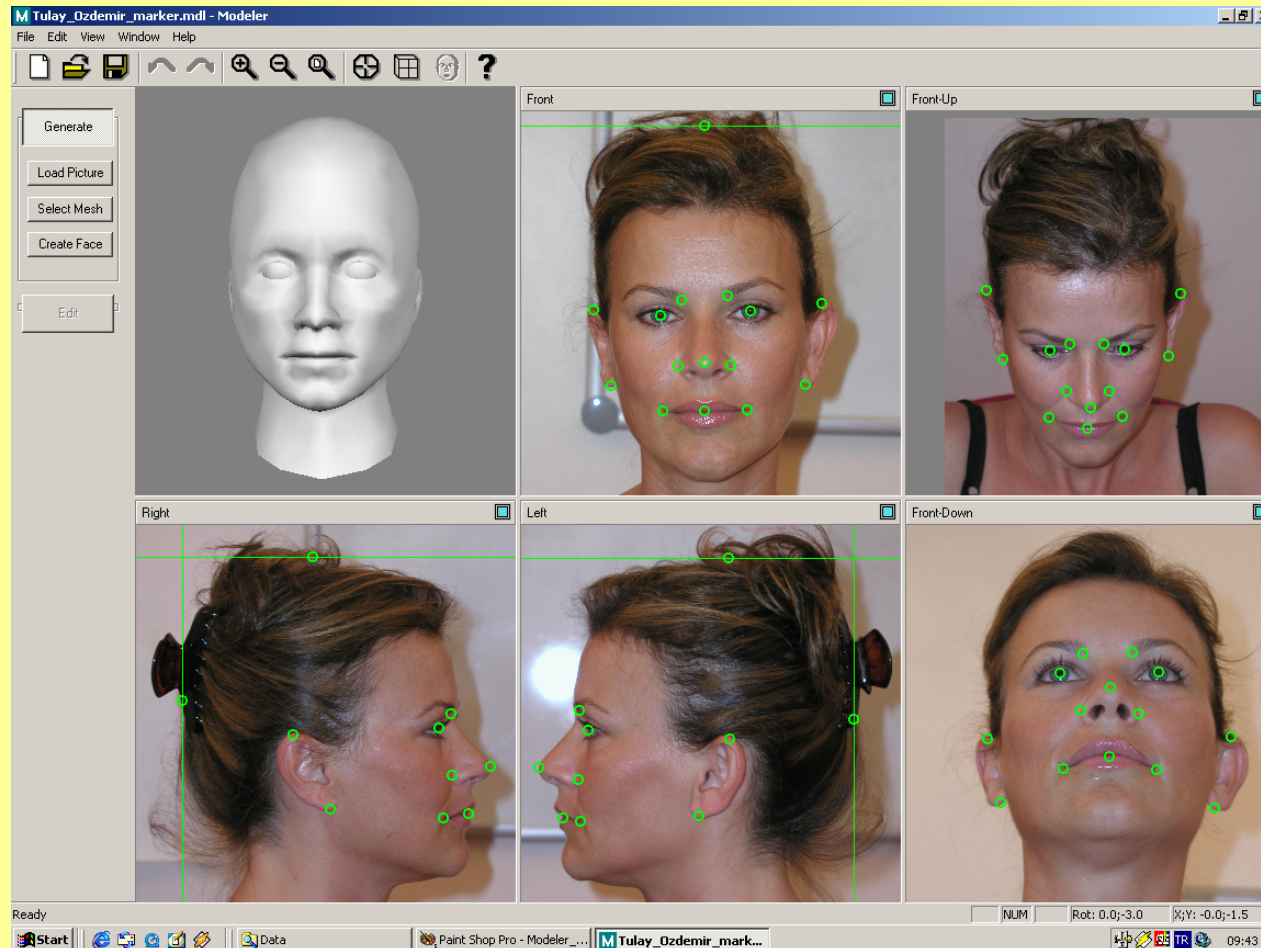


# Face Modeling

- Momentum's patented semi-automatic face modeling method
  - A few photographs taken from specific angles
  - Accurately represent the geometry and the texture of the face in every direction.
- Method is insensitive to:
  - Position, scale and illumination differences among photographs
  - Rotation inaccuracies
  - Perspective deformations due to camera lens.



# 2D Feature Points



# 3D Reconstruction

$$p_{n,x}^f = \frac{c_x^f + S_n \bullet \hat{I}^f}{\lambda^f + ES_n \bullet \hat{K}^f}$$

$$p_{n,y}^f = \frac{c_y^f + S_n \bullet \hat{J}^f}{\lambda^f + ES_n \bullet \hat{K}^f}$$

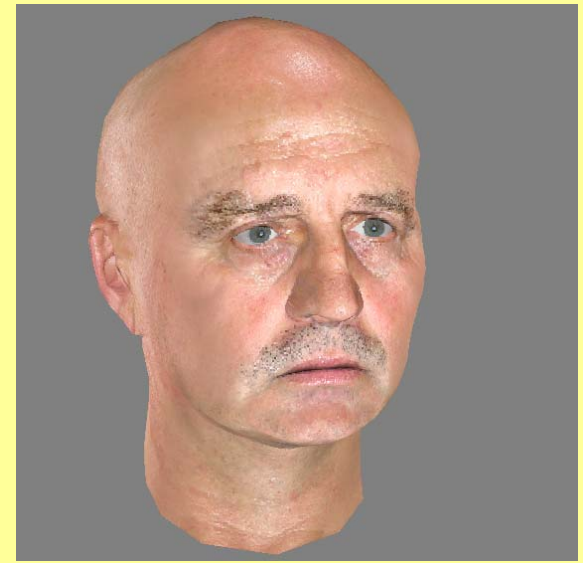
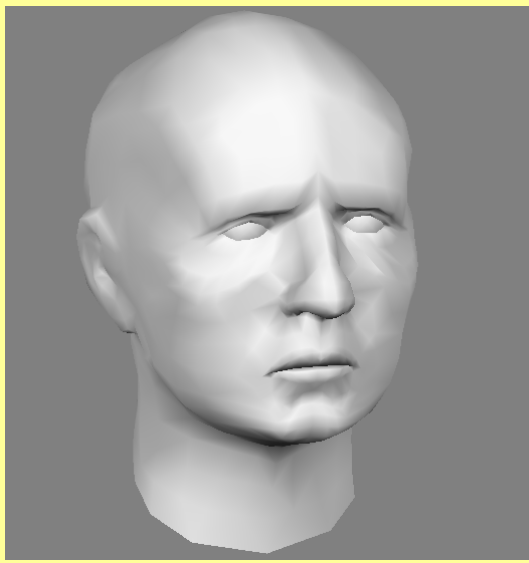
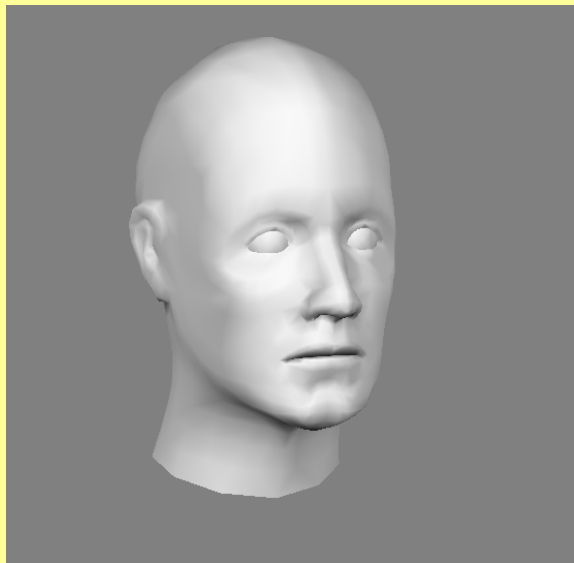
Find  $S_n$  for each point (14x3)

and  $\hat{I}^f, \hat{J}^f$   $c_x^f, c_y^f, \lambda^f$  for each view (5x6)

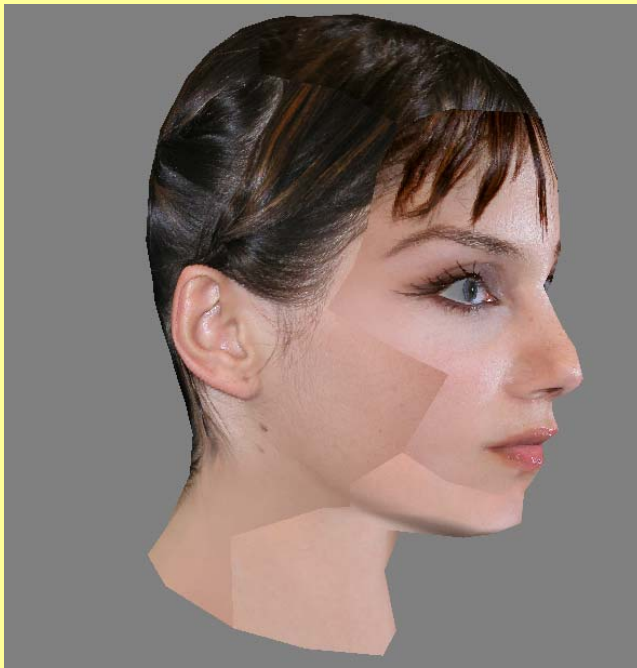
given  $p_{n,x}^f, p_{n,y}^f$  for each pt. & view (58x2)

# 3D Face Adaptation

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# Texture Blending

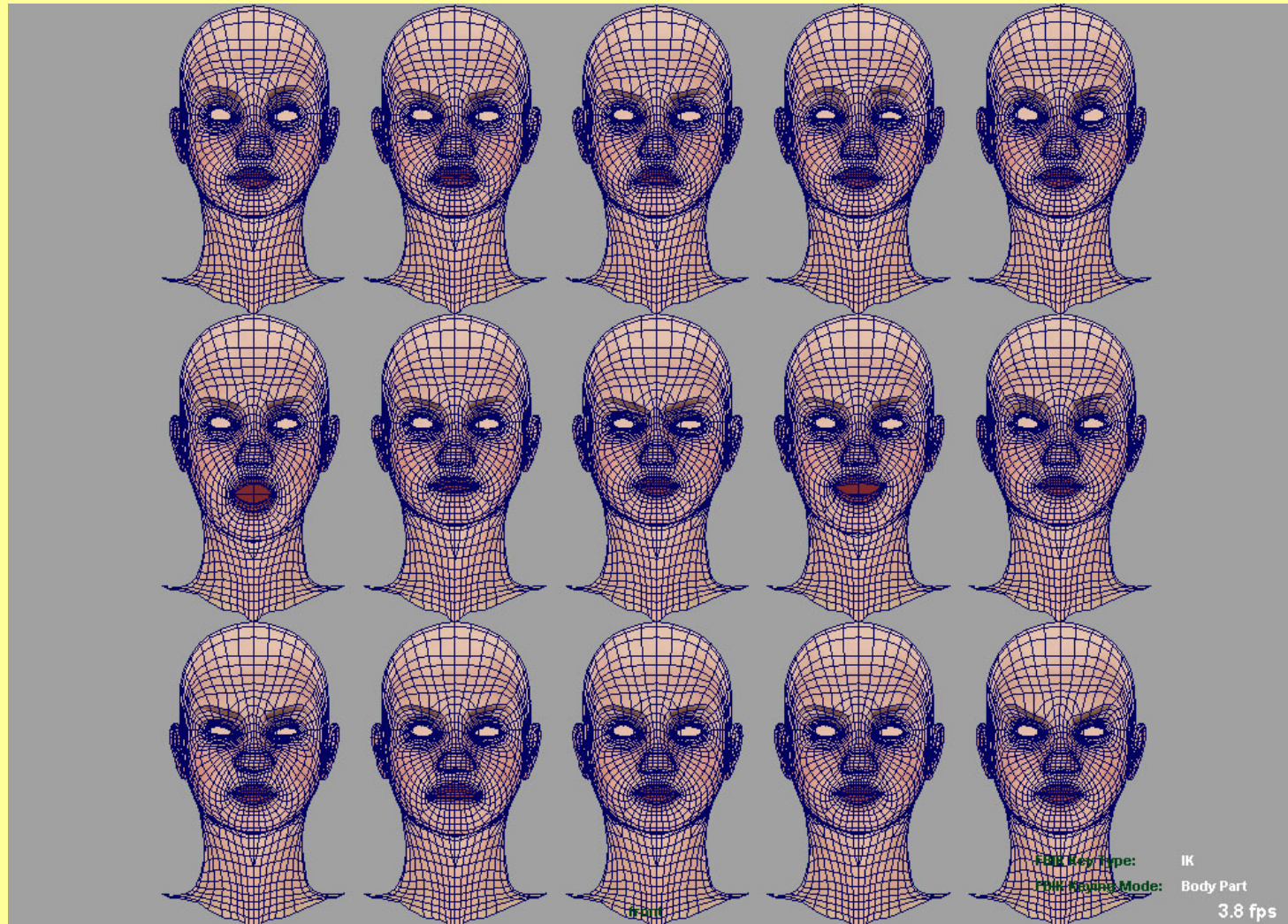


# Facial Animation

- Animation via weighted average of blend shapes
  - Expression blendshapes
    - Used to synthesize the six basic emotions
      - Happiness, Anger, Fear, Boredom, Surprise, Sadness
  - Viseme blendshapes
    - Used to synthesize sixteen visemes
      - A, F, O, P, W, ...

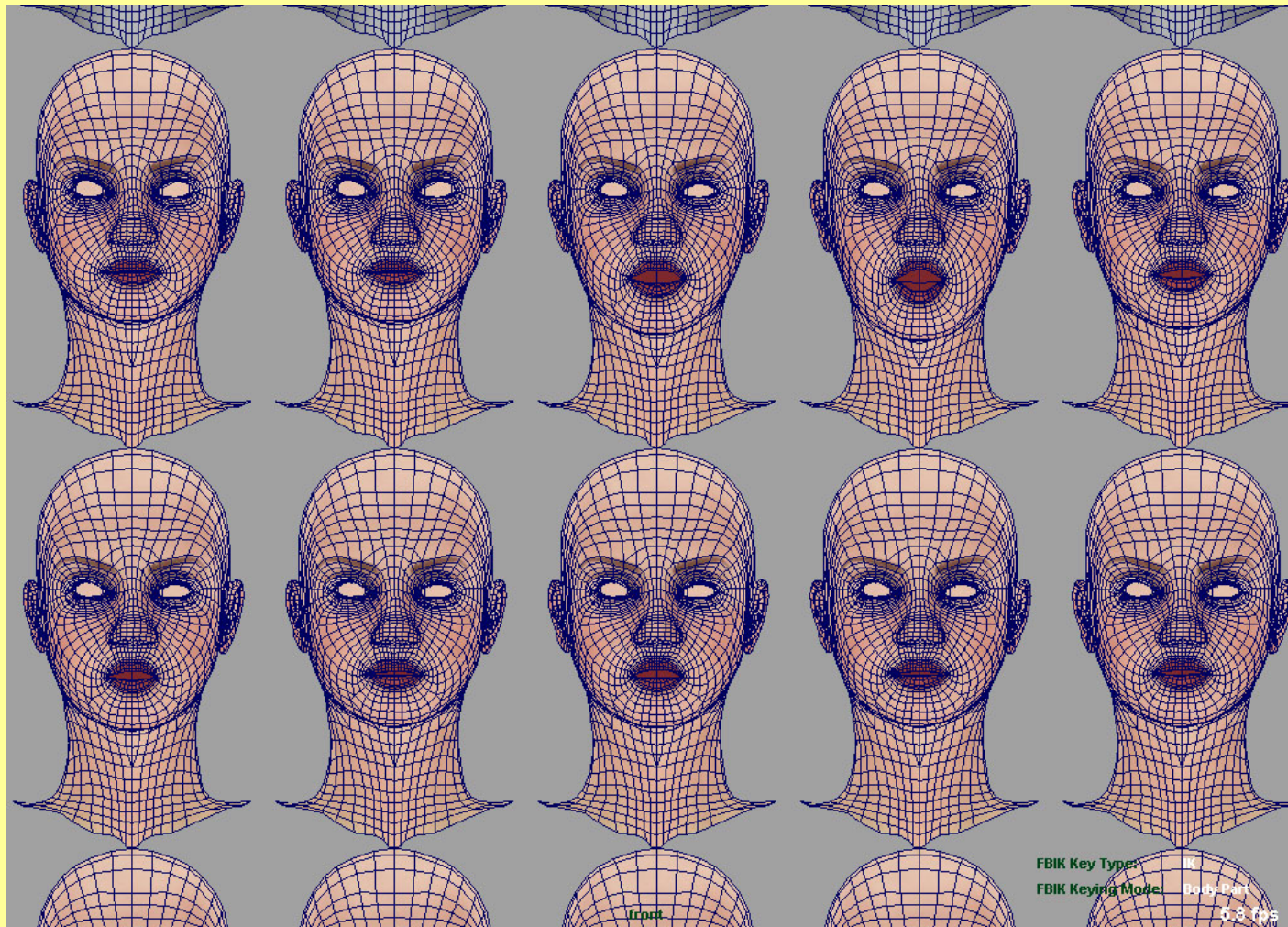


# Expression Blendshapes

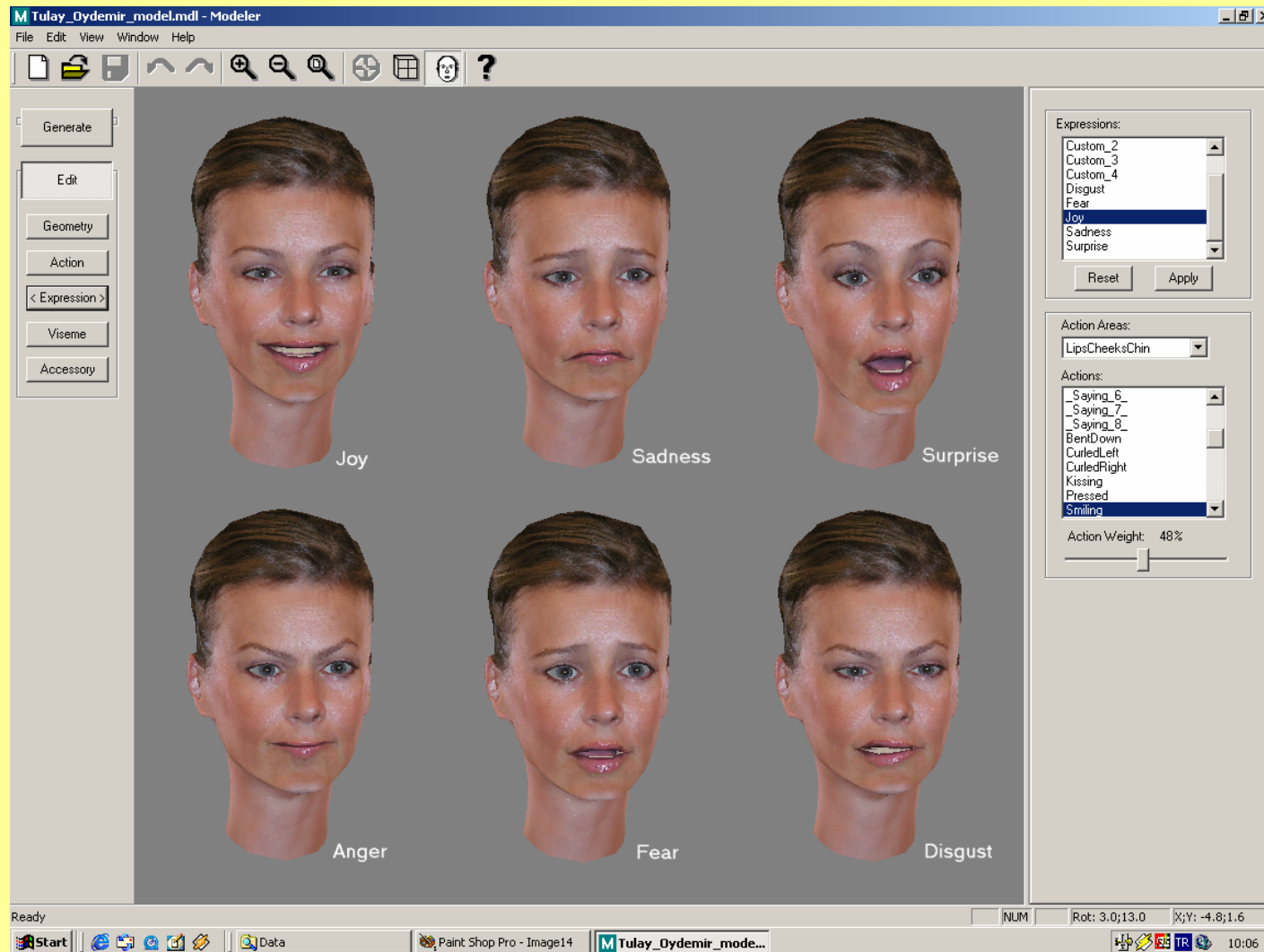




# Viseme Blendshapes

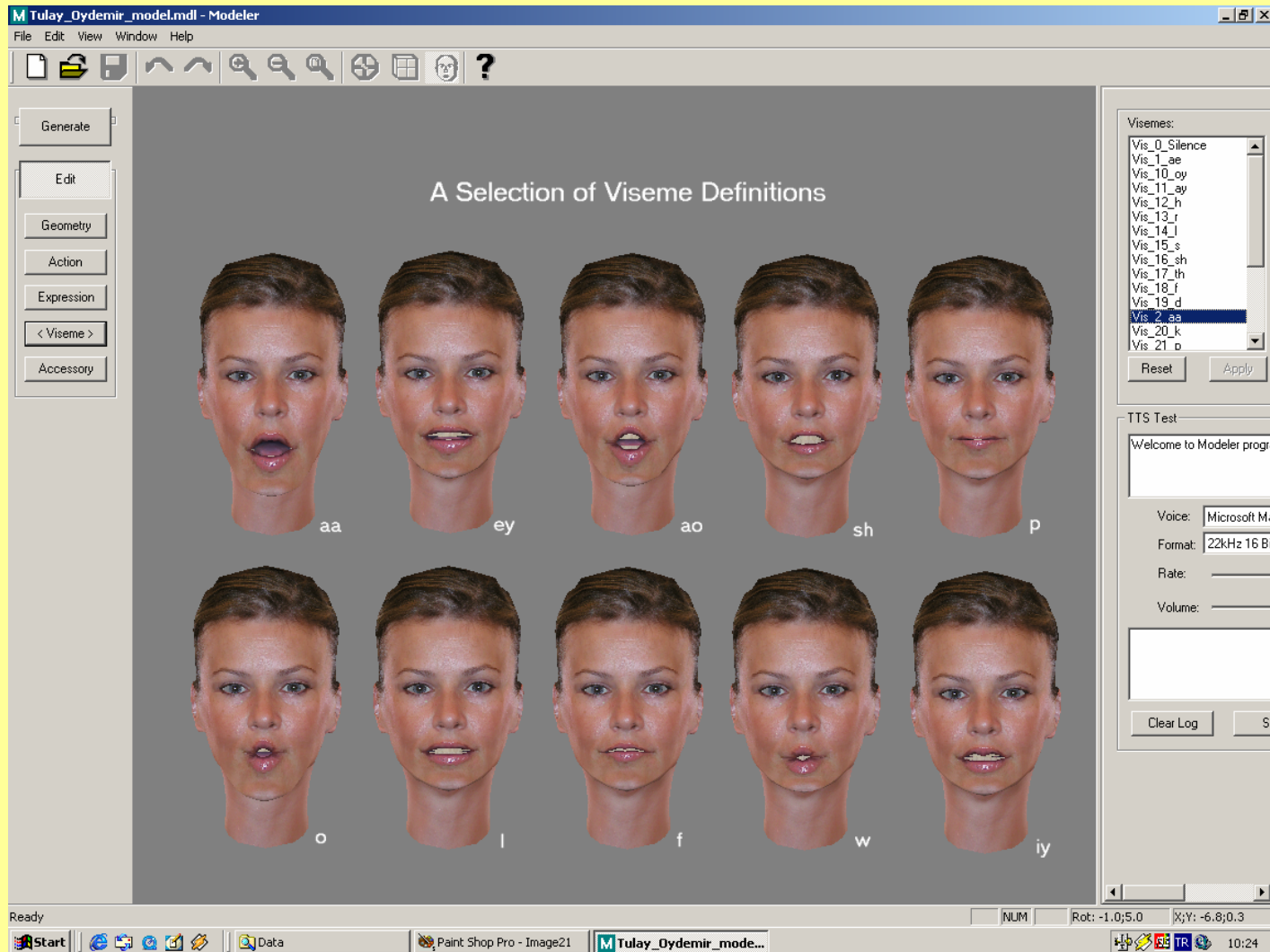


# Expressions





# Visemes

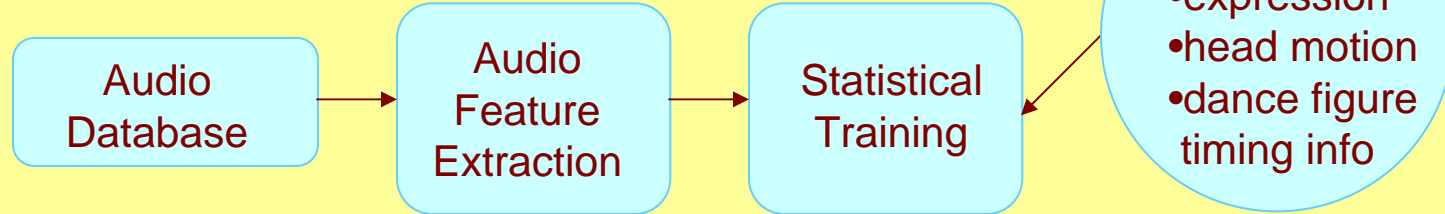


# Audio-Driven Face Animation

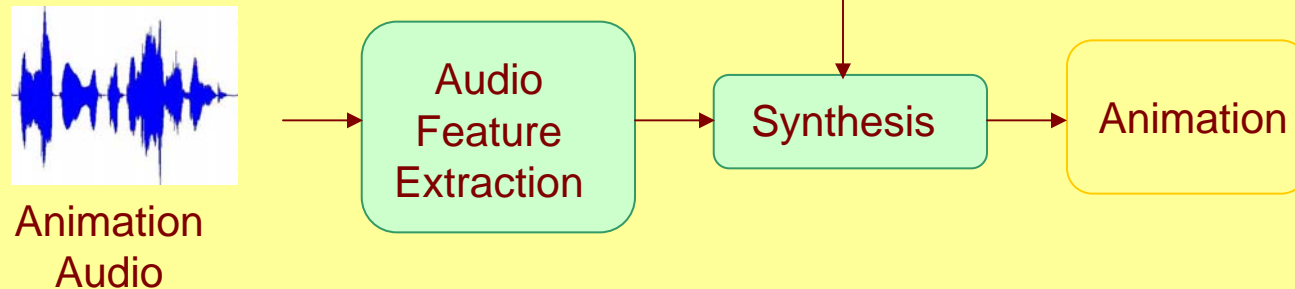
- Speech/music for animation control
- Auto-generate speaker & language independent facial animation from speech:
  - Lip synchronization (lip-sync)
  - Expression
  - Head Motion

# Audio-driven Animation Analysis & Synthesis

Analysis



Synthesis



# Lip Synchronization

- Determine mouth shapes during speech
- Viseme (mouth shape)
  - Basic unit for lip-sync,
  - Animation parameters for all possible mouth shapes
- 16 standard visemes in facial animations

# Advanced Rendering

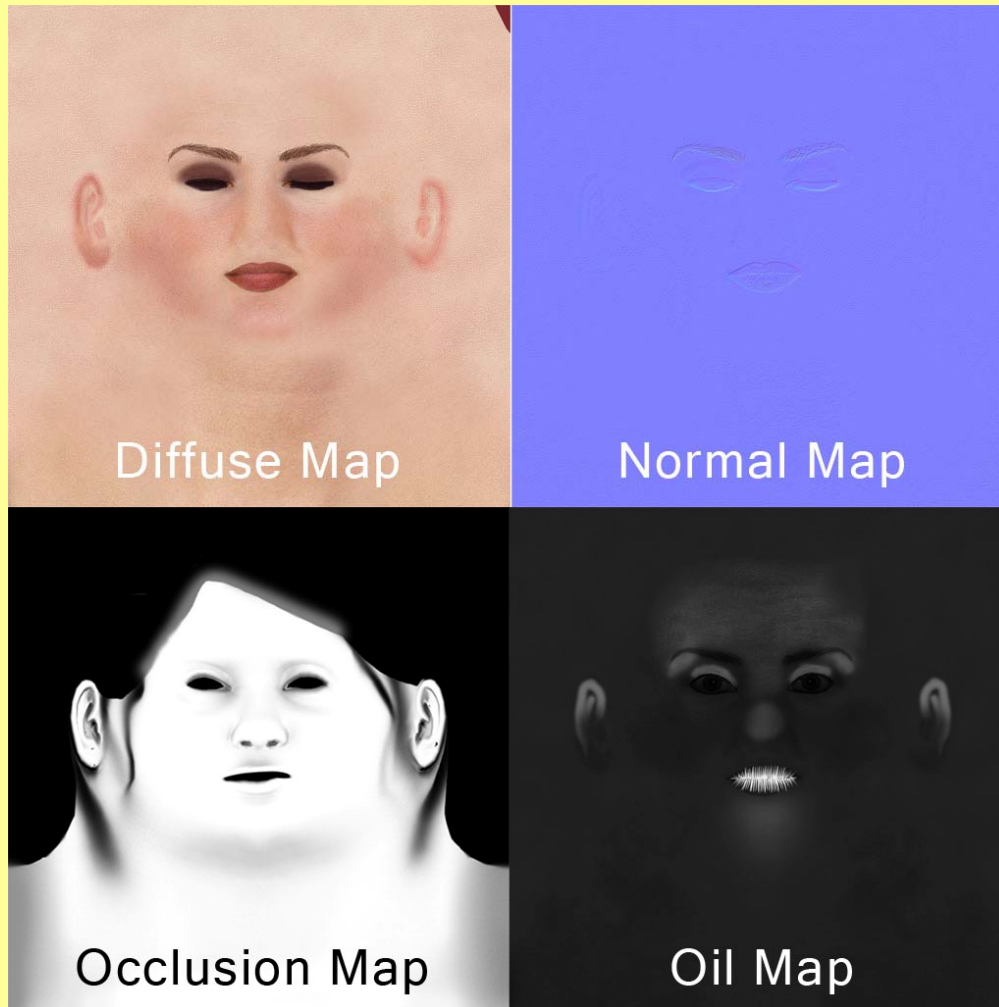
- Shaded face model
- ~3000 polygons, 2k x 2k textures



# Real-time Rendering

- GPU based rendering with vertex and pixel shaders
- Skeletal and blend-shape animation
- Dynamic shadow-casting lights
- Bump mapping
- Skin shading with subsurface scattering
- Global illumination by cube maps and ambient maps
- Crease maps

# Skin Texture Maps



# Skin Shading

- Real-time skin shading with subsurface scattering
- Dynamic shadows including self-shadowing





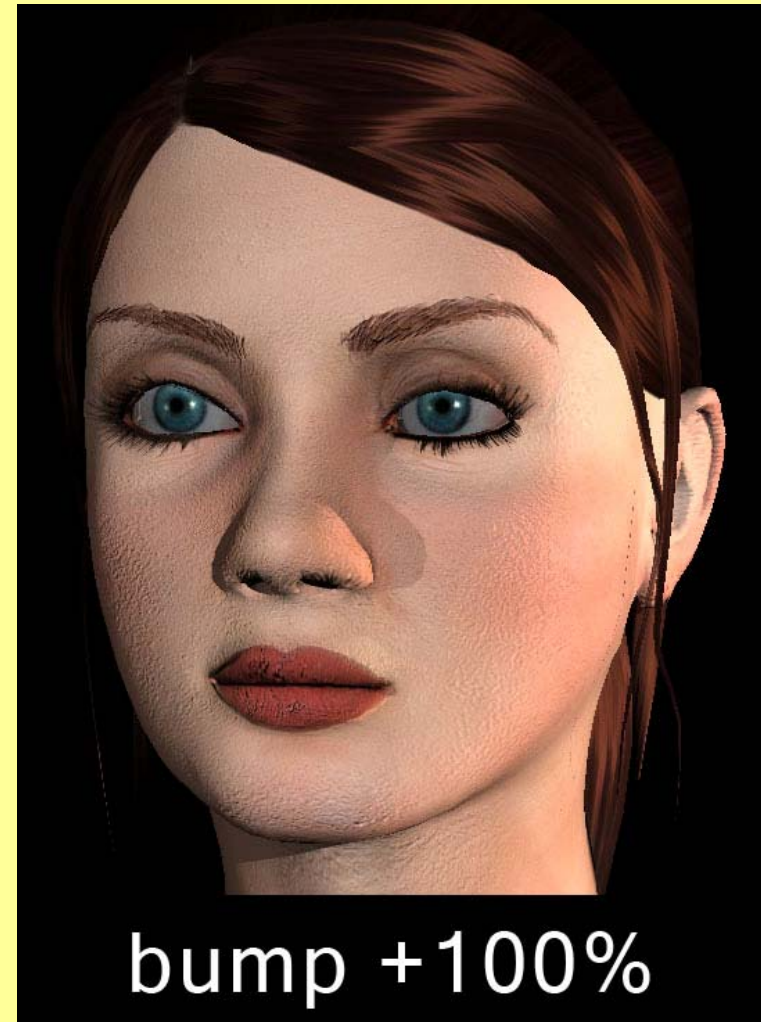
# Skin Shading (Diffuse)



# Skin Shading (Specular)



# Skin Shading (Normal)



# Facial Expressions



# Eye Controls



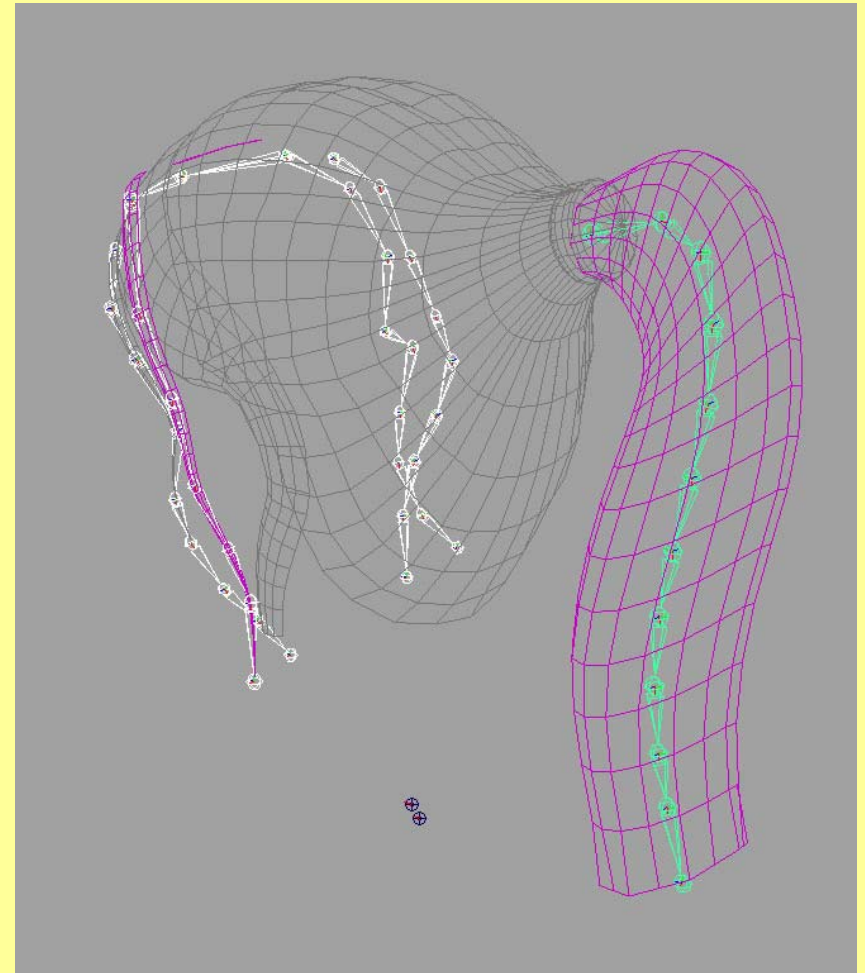
# Hair Modeling

- Hairstyling
  - Geometry of the hair, density, distribution, and orientation of hair strands.
- Hair simulation
  - Dynamic motion of hair, collision detection between the hair and objects
- Hair rendering
  - Color, shadows, light scattering effects, transparency



# Hair Animation

- By fitting a skeleton
- Simple but not suitable for all hairstyles

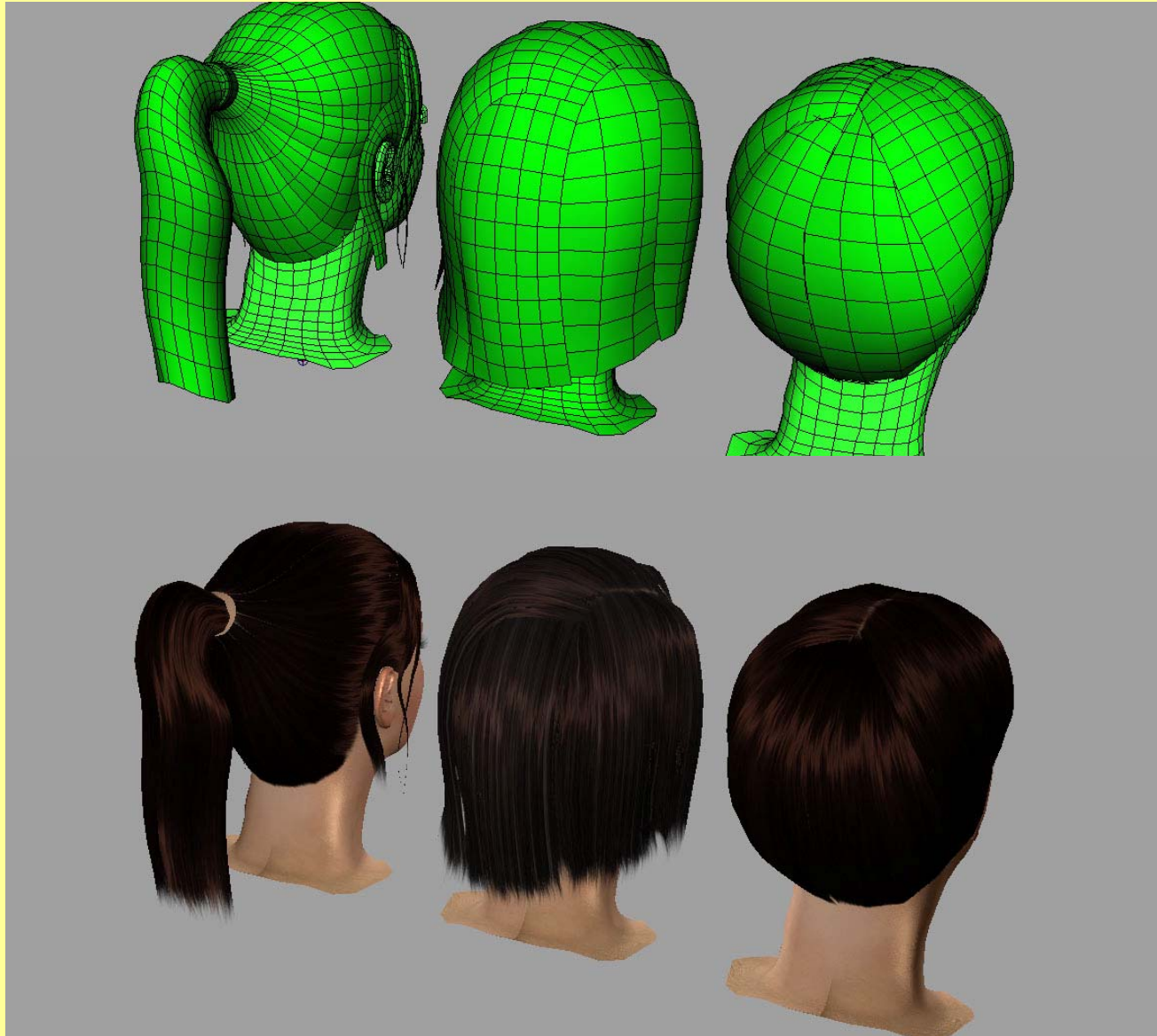


# Hair Styling



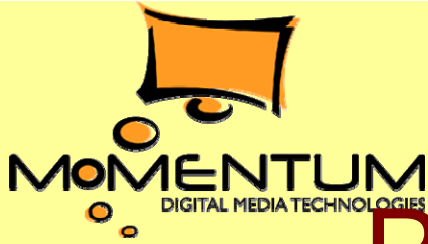


# Hair Styling



# Applications

- Can be incorporated into any 3D rendering environment
  - PC and console games
  - TV and movies
  - Mobile messaging
  - Lip reading

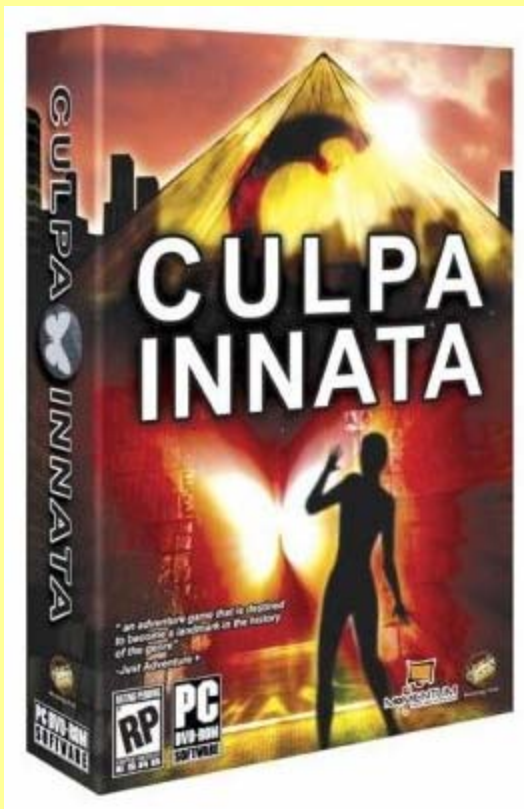


# PC & Console Games

- Many game genres need human animation:
  - Role-playing games (RPG)
  - Puzzle-adventure
  - First-person shooter (FPS)
- In-game cinematic cutscenes with dialogues
- Momentum's Culpa Innata released worldwide in Fall 2007
  - 40+ main characters
  - 1400+ cutscenes
  - Animation localization for 5 languages

[www.momentum-dmt.com](http://www.momentum-dmt.com)

[www.culpainnata.com](http://www.culpainnata.com)



# Work Started on CI2

