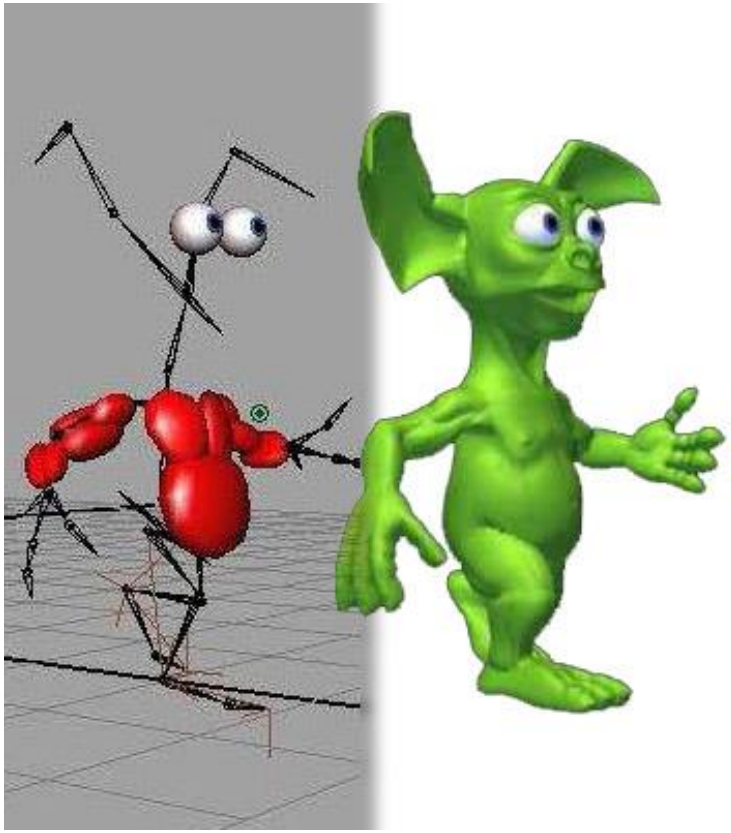
# 199: Anatomy and psychorealism



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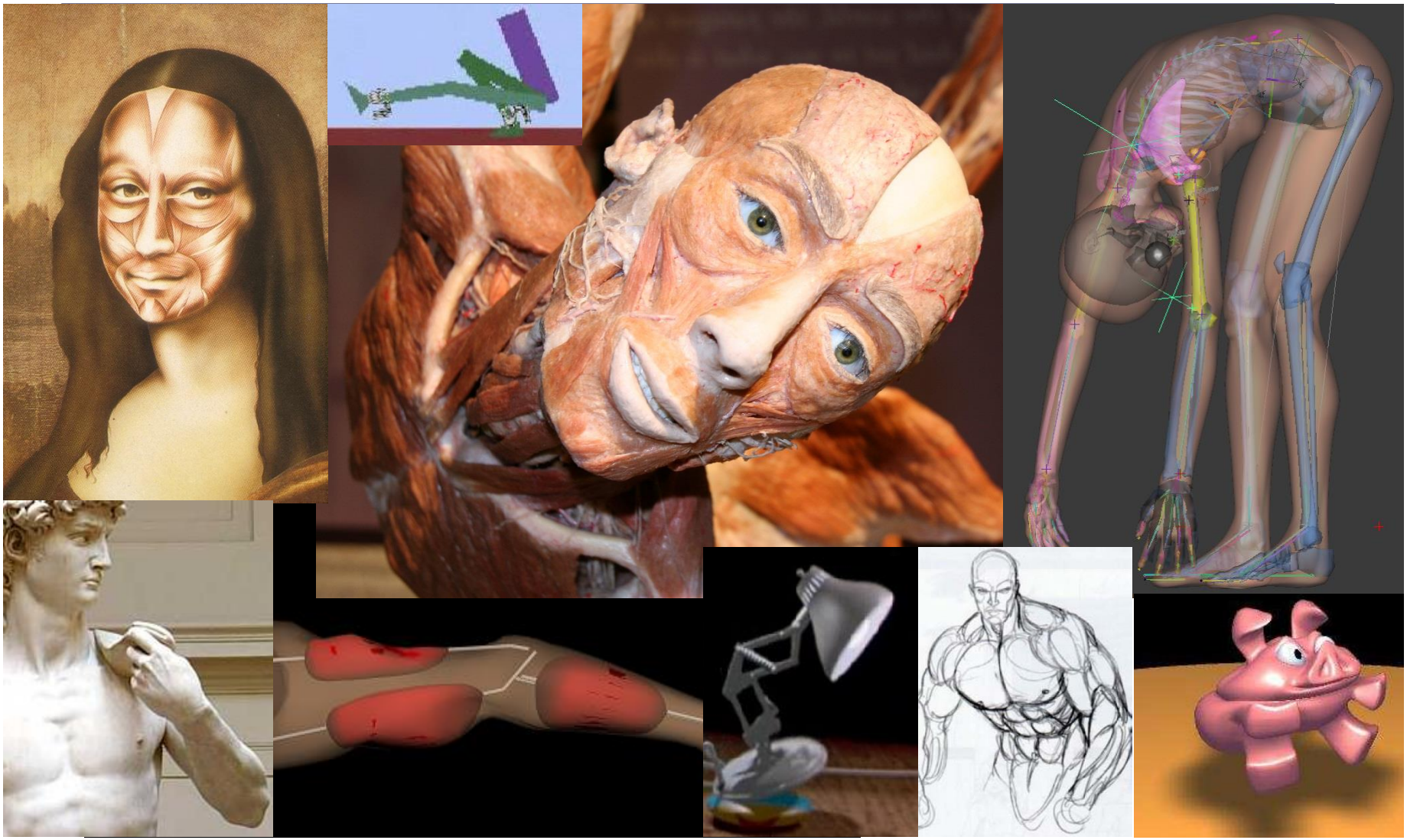
# Anatomy



# Overview

- Understanding anatomy.
- Hand modeling and simulation: a case study.
- Anatomic considerations in *Ryan*.

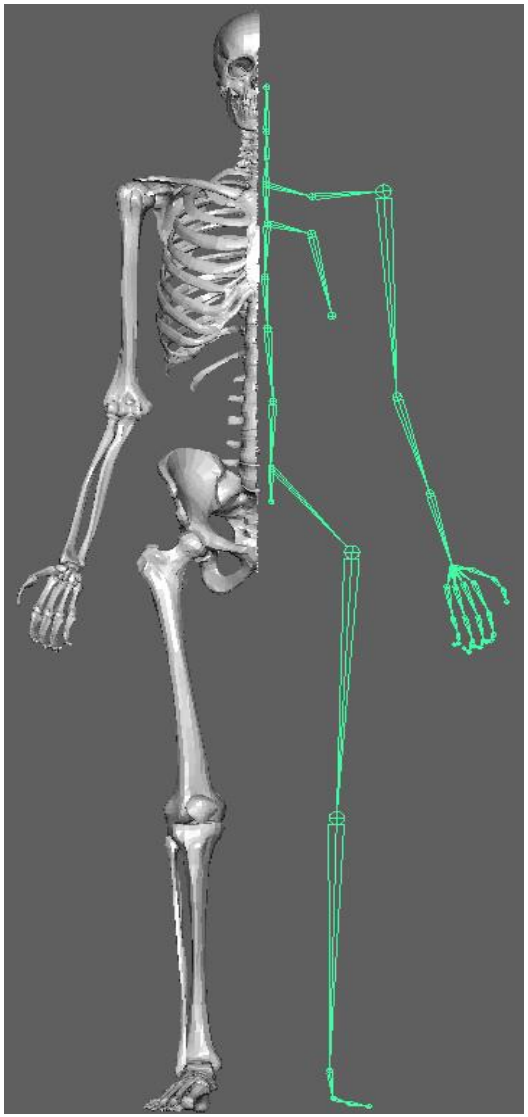
# Understanding Anatomy

Image Credit: Bodyworlds

# Layered Approach

- Skeletal.
- Muscle.
- Skin and underlying tissue.
- Hair, nails, blemishes.
- Clothes and accessories.

# Human Skeleton



- Human bones =206, CG approx. 40.
- Human bones flexible, 6 DOF joints.
- CG bones rigid, 3DOF Kinematics.
- Human bones have connective tissue called ligaments.
- Muscle attached to bone by tendons.

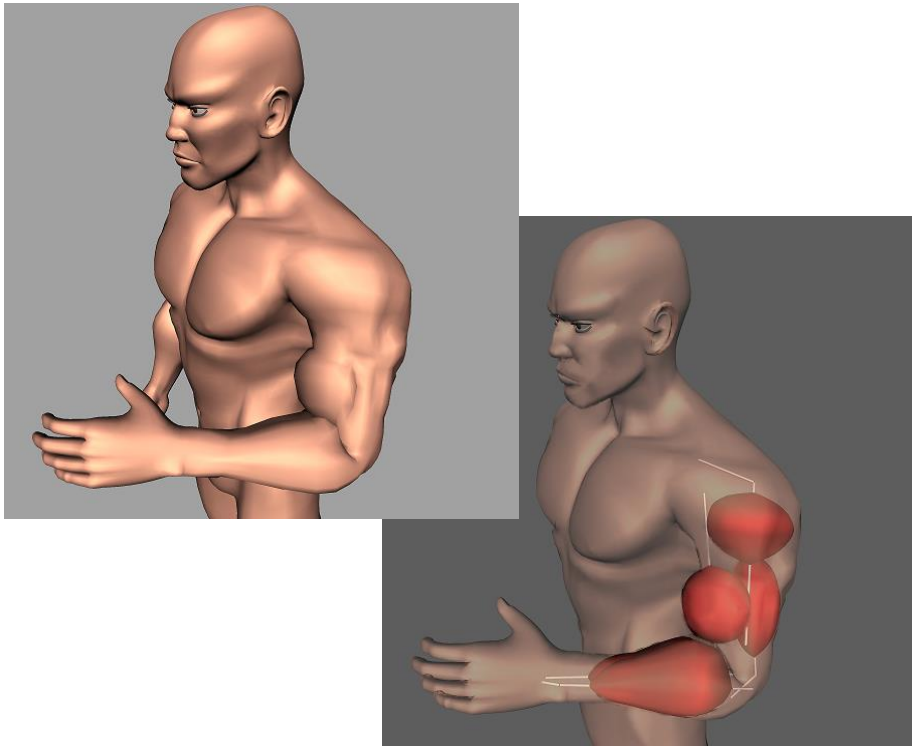
# Skeletal control interfaces

- More DOF = more control (both GOOD & BAD).
- Interfaces that capture the domain of specialized motion makes working with experts easier.
- Complex motion with environmental interaction is best left to physics and motion capture.
- Even simple abstractions of the human form are rooted in understanding the underlying anatomy.
- An anatomic model could establish a ground truth for realistic character animation.

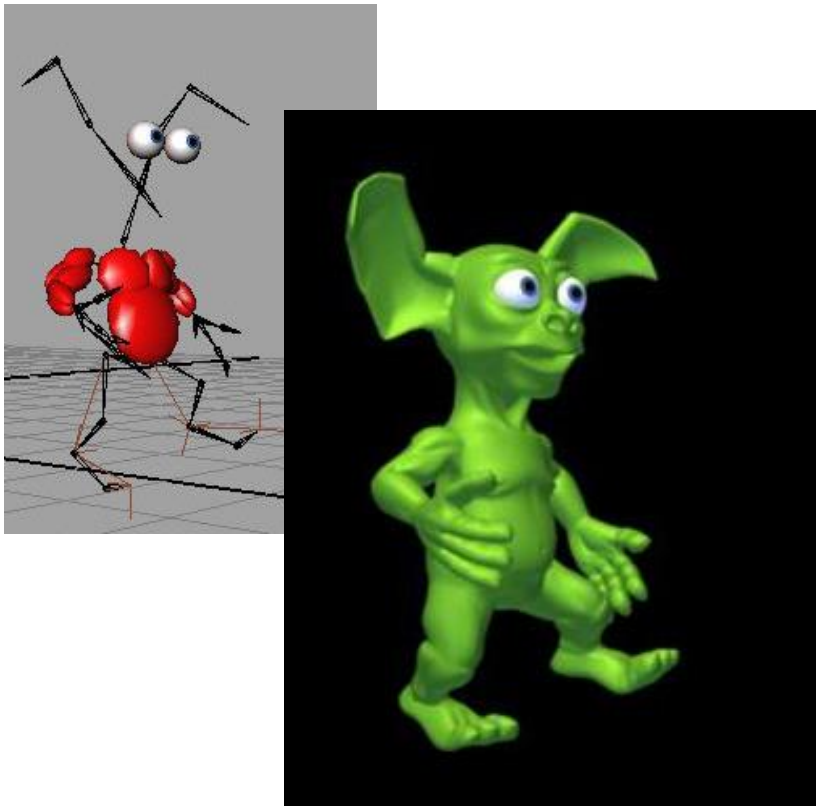
# Skeletal models

- Robot-like
  - **Human bones = 206, CG approx. 40**
  - **Human bones flexible, 6 DOF joints. CG bones rigid, 3DOF**
- Skeletal control
  - **Kinematic**
  - **Dynamic**
  - **Procedural**
  - **Motion Capture**

# Believable anatomy (muscles)

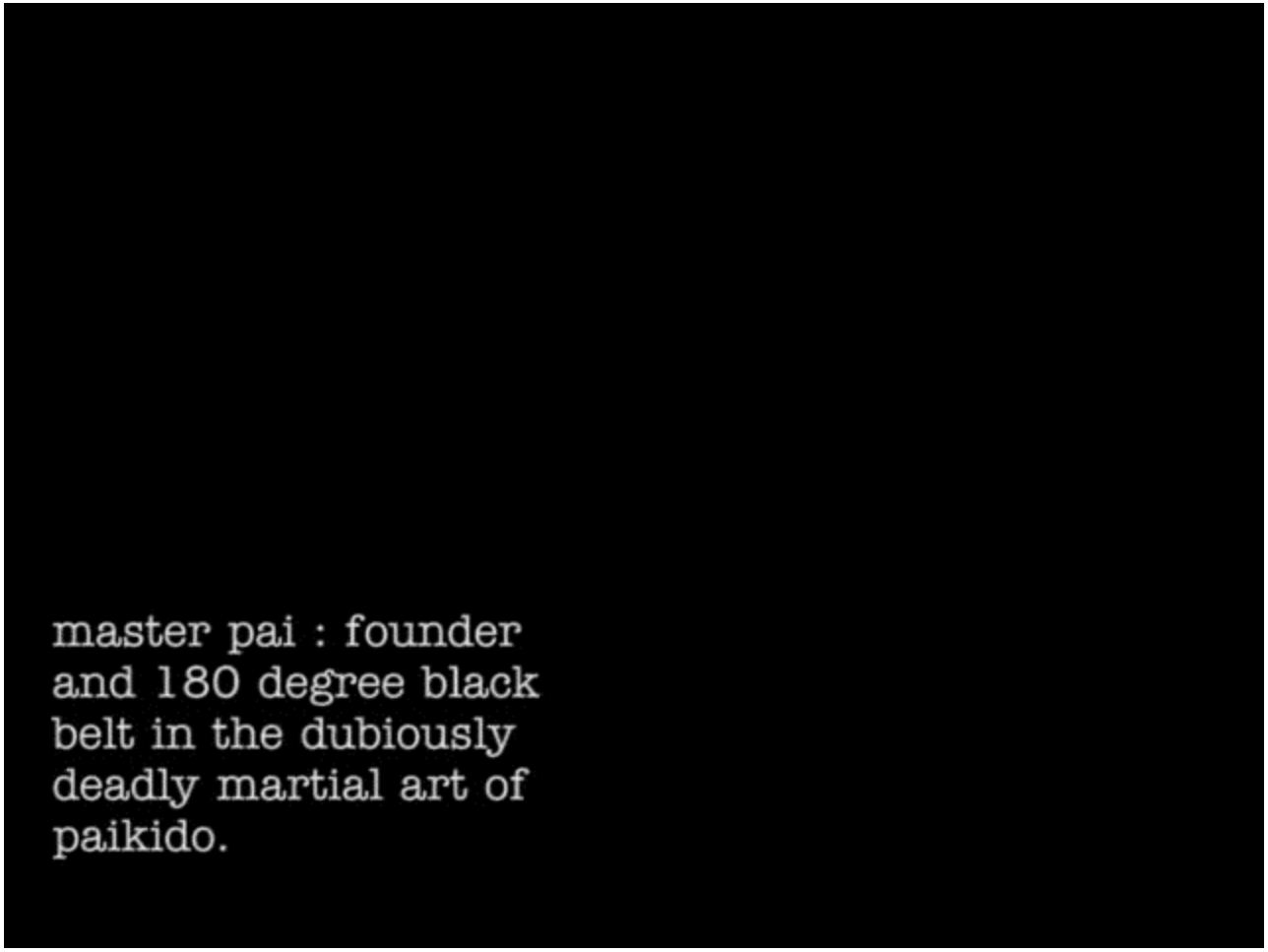


Fit muscles



Deform muscles and tissue

# Believable anatomy (muscles)



# Acquisition and exploration

# The Human Hand

Inside-out or Outside-in?

Helping hand

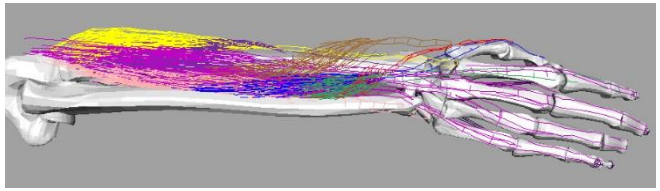
Handrix

ASL Project

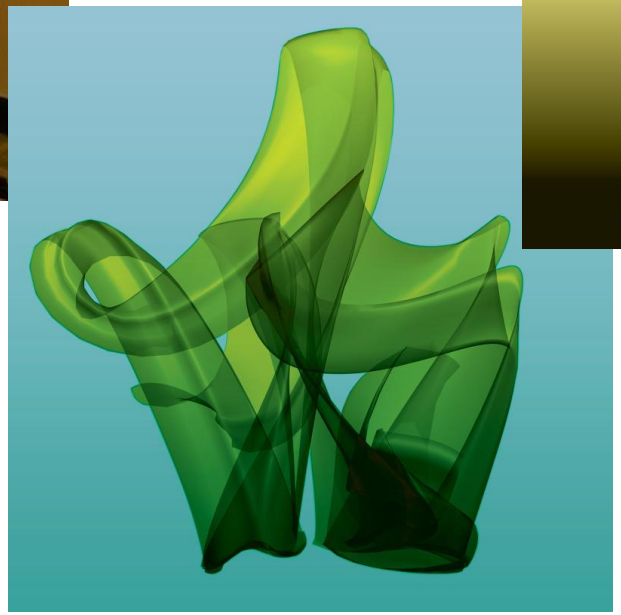
Musculoskeletal data acquisition

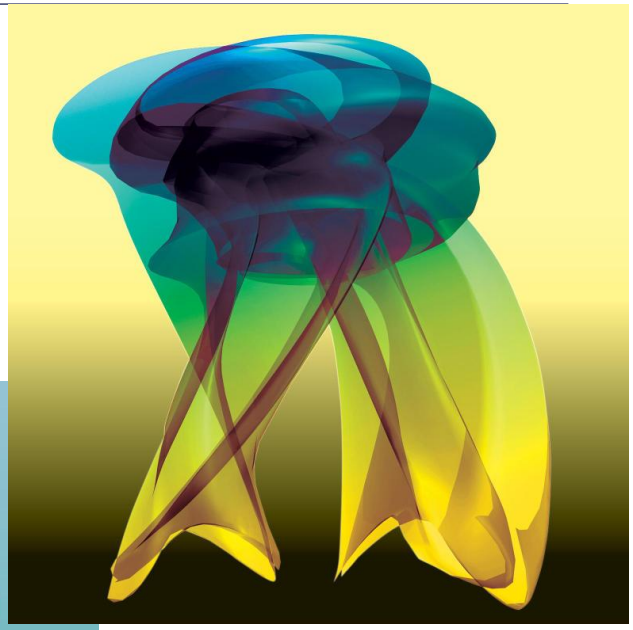
Exploration, Simulation, Synthesis, Visualization

External shape & Motion data acquisition



# The Deaf Cultural Center ASL Project

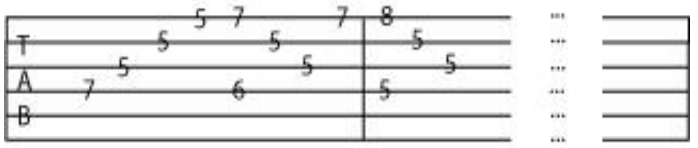




Unite

Diverse

# Handrix (Inspiration)




# Helping Hand

How do forearm and hand muscles produce hand motion?

**Problem**

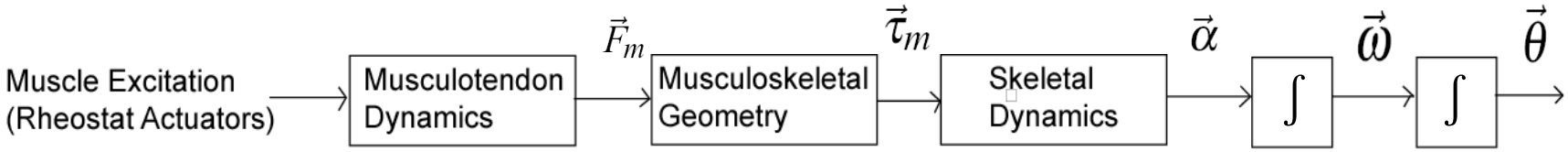
- Neurologic control maps 29 bones, 16 joints and 41 musculo-tendon units to 23 degrees of freedom.

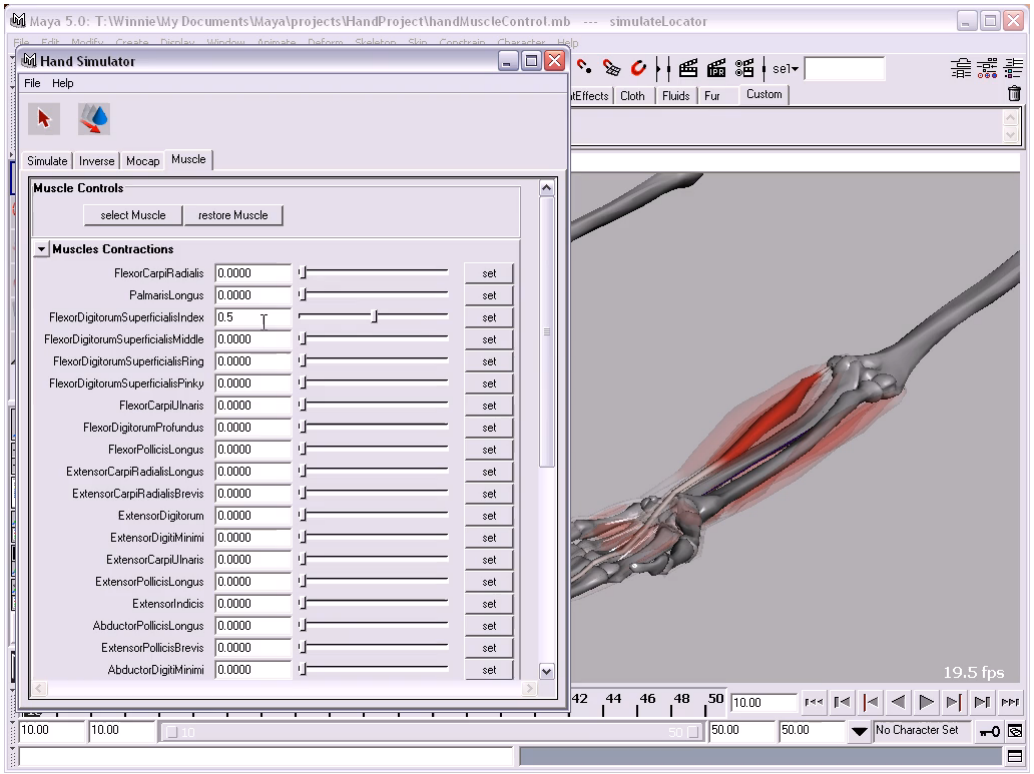
**Our Goal**

Construct a modular system for the exploration, simulation, synthesis and visualization and understanding of hand function.

# Forward Simulation

- Compute body motion given muscle *excitations.*




FDS index set with excitation of 0.5.

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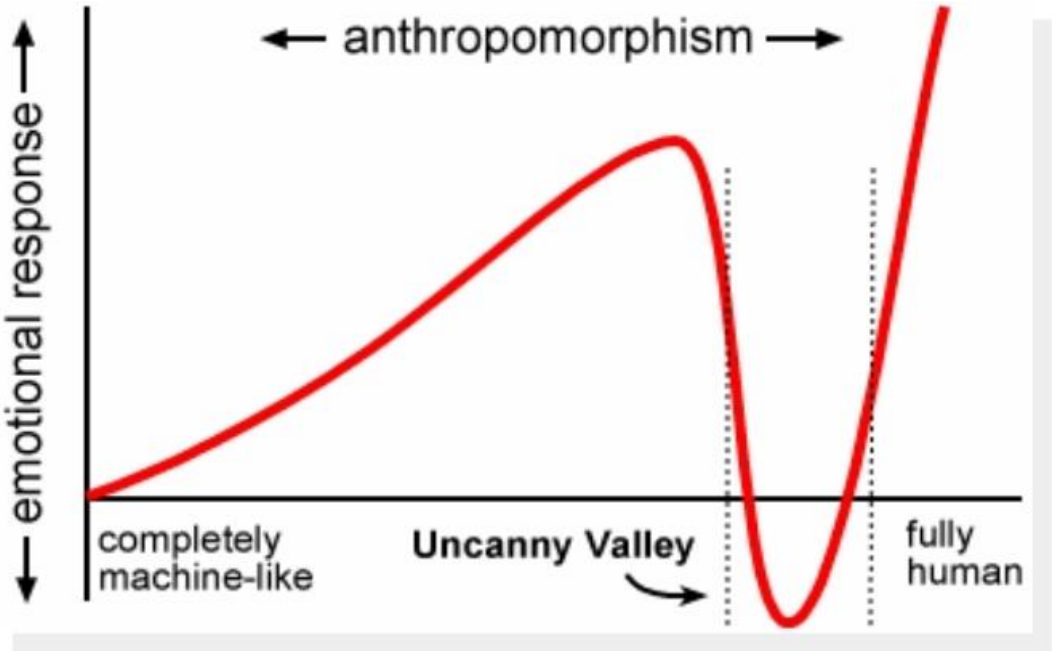
# Anatomic considerations in animation

- **Squash and Stretch.**
- Anticipation.
- **Follow Through and Overlapping Action.**
- **Slow in and Out.**
- Exaggeration.
- **Secondary Action.**
- Appeal.
- Timing and Motion.
- Staging.
- **Straight Ahead Action and Pose-to-Pose Action.**
- **Arcs.**

# Anatomic considerations in *Ryan*

# Animating anatomy (Believability vs. Reality)

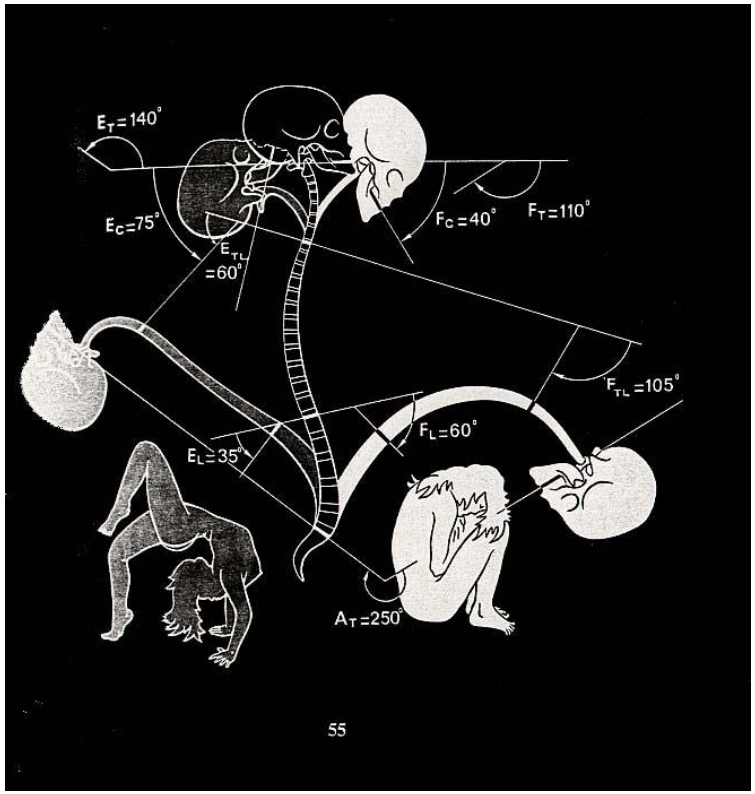


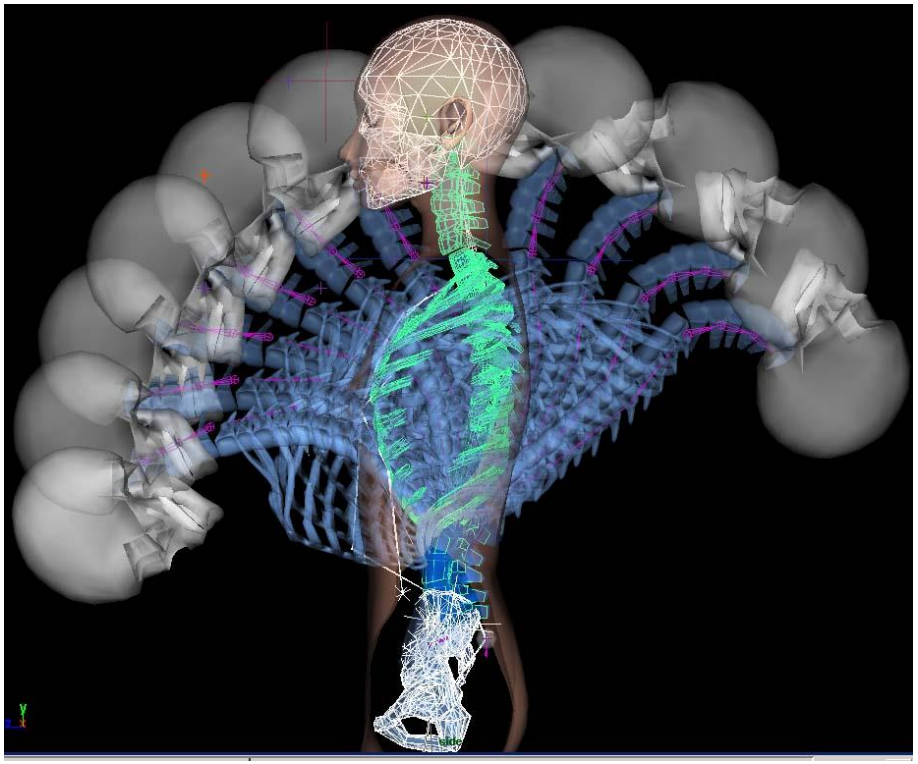

Masahiro Mori 1970

# Believable anatomy (skeletal control)


Image Credits: Michael Paulus

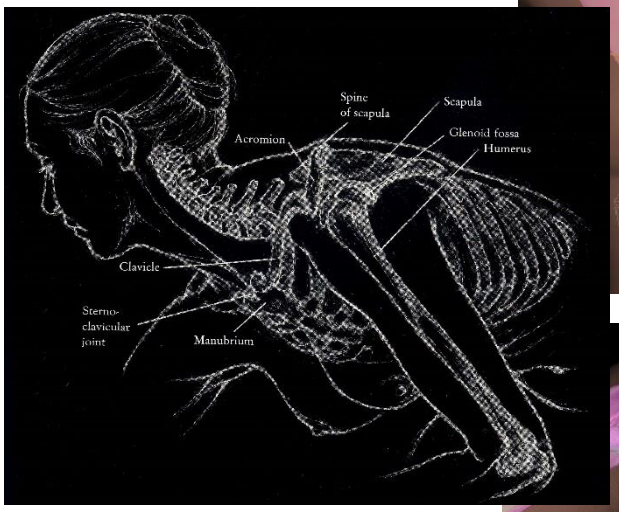
# Believable anatomy (spine and shoulder control)

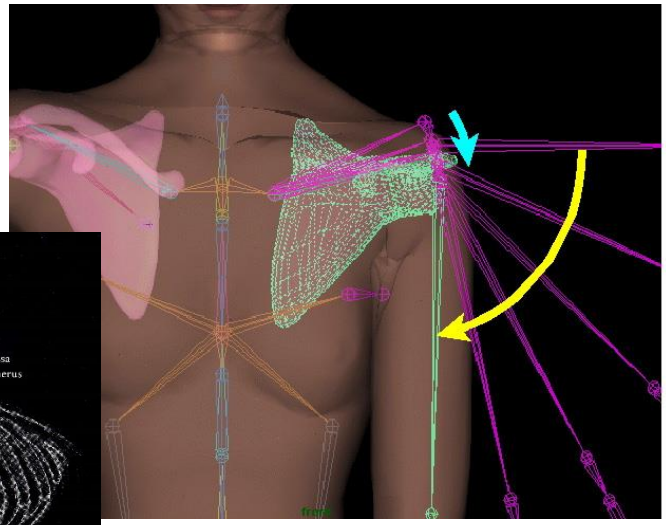


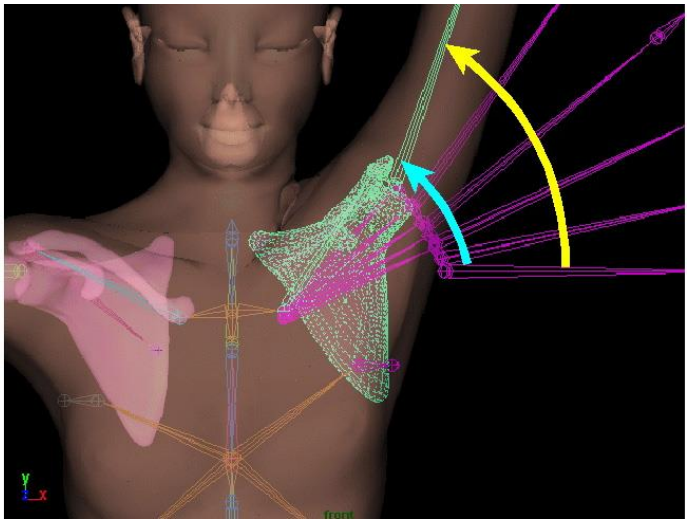



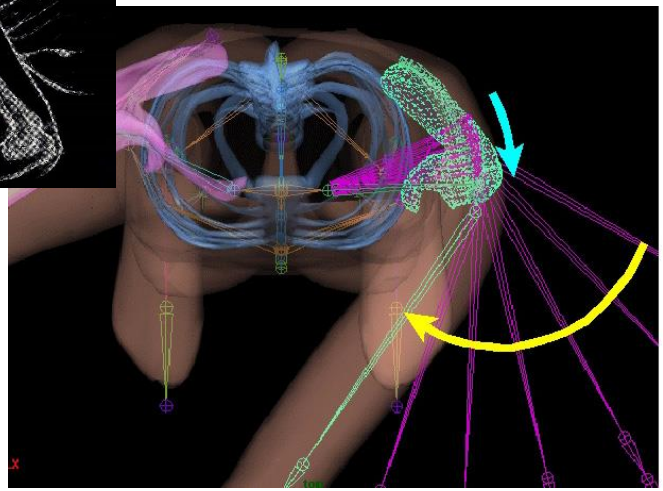
Flex

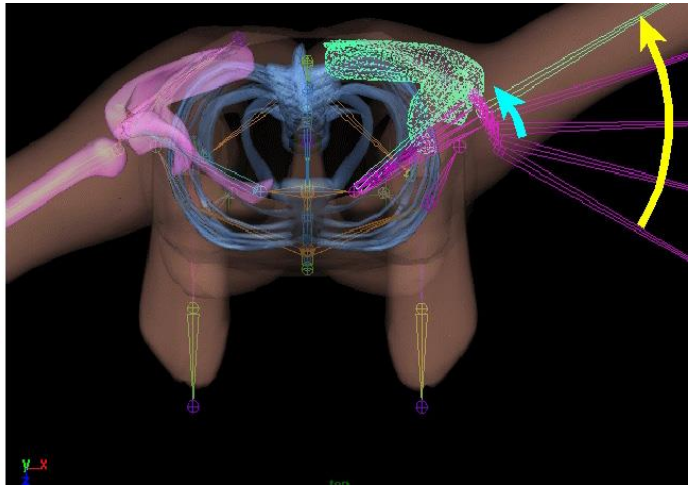
# Believable anatomy (spine and shoulder control)



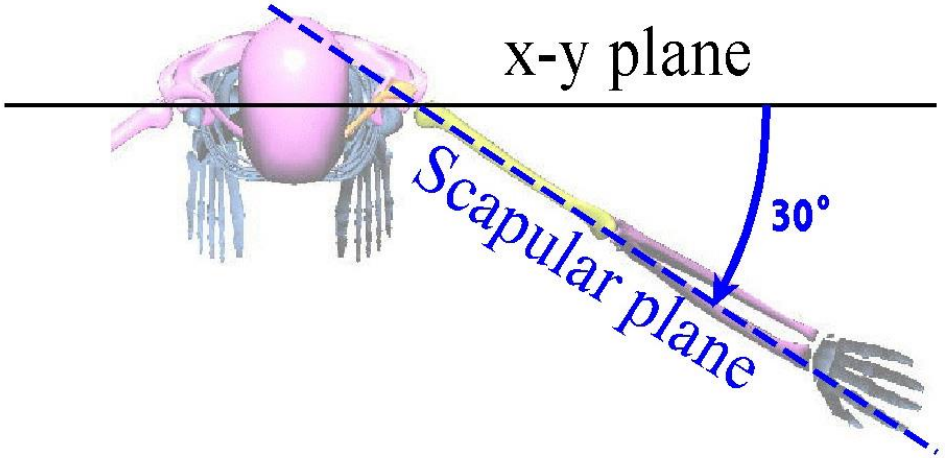



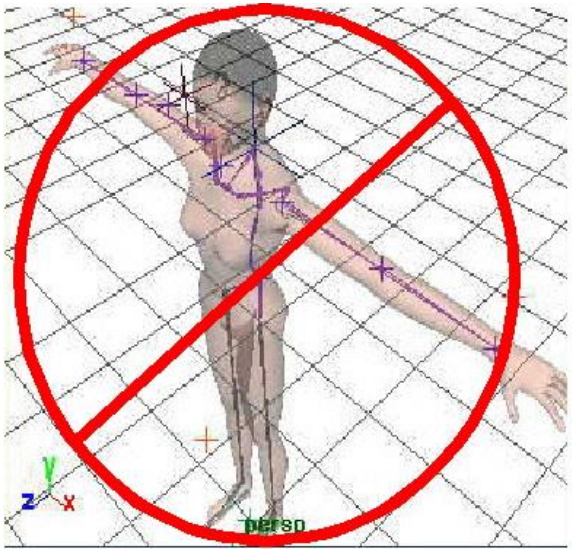


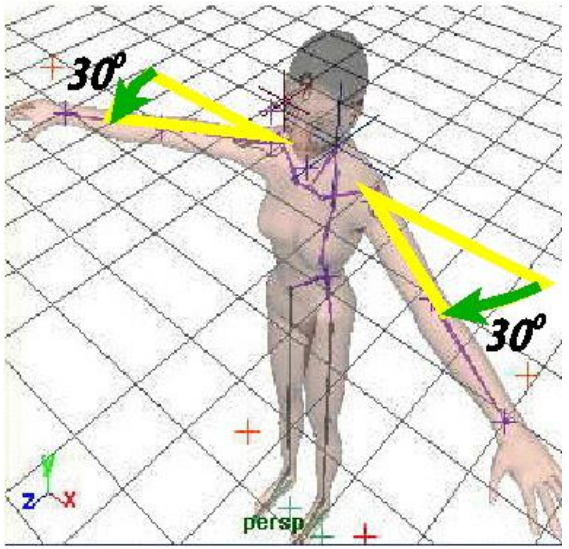




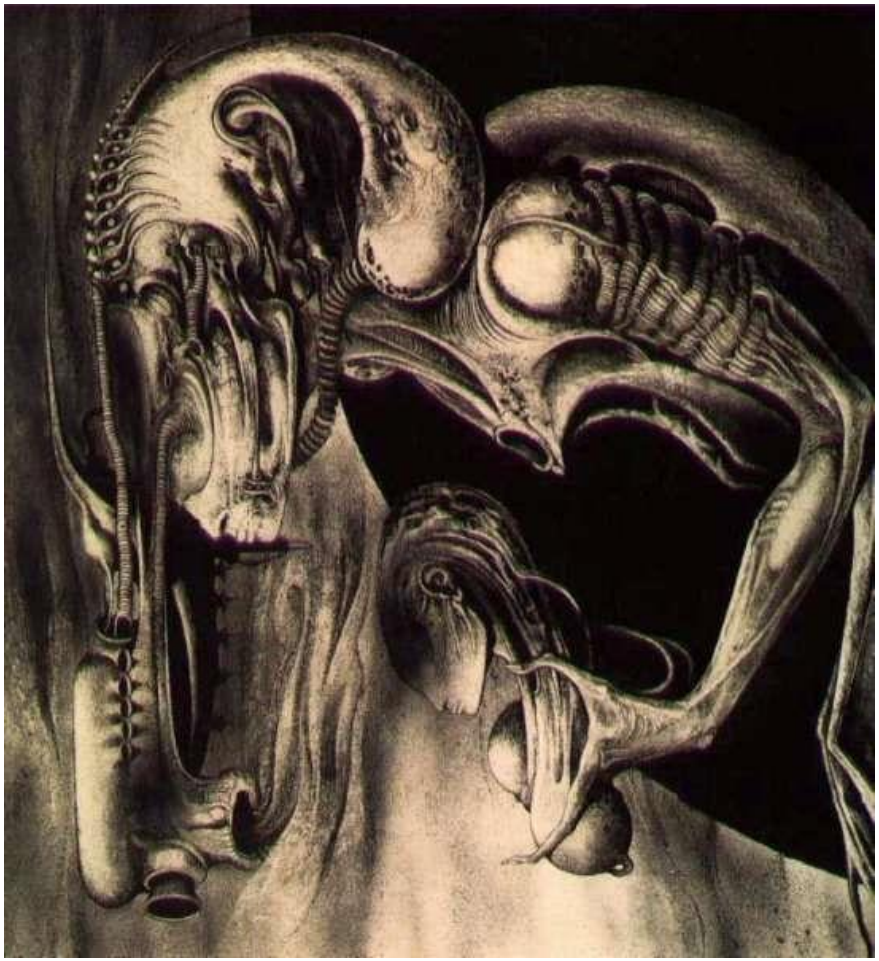
# Believable anatomy (spine and shoulder control)



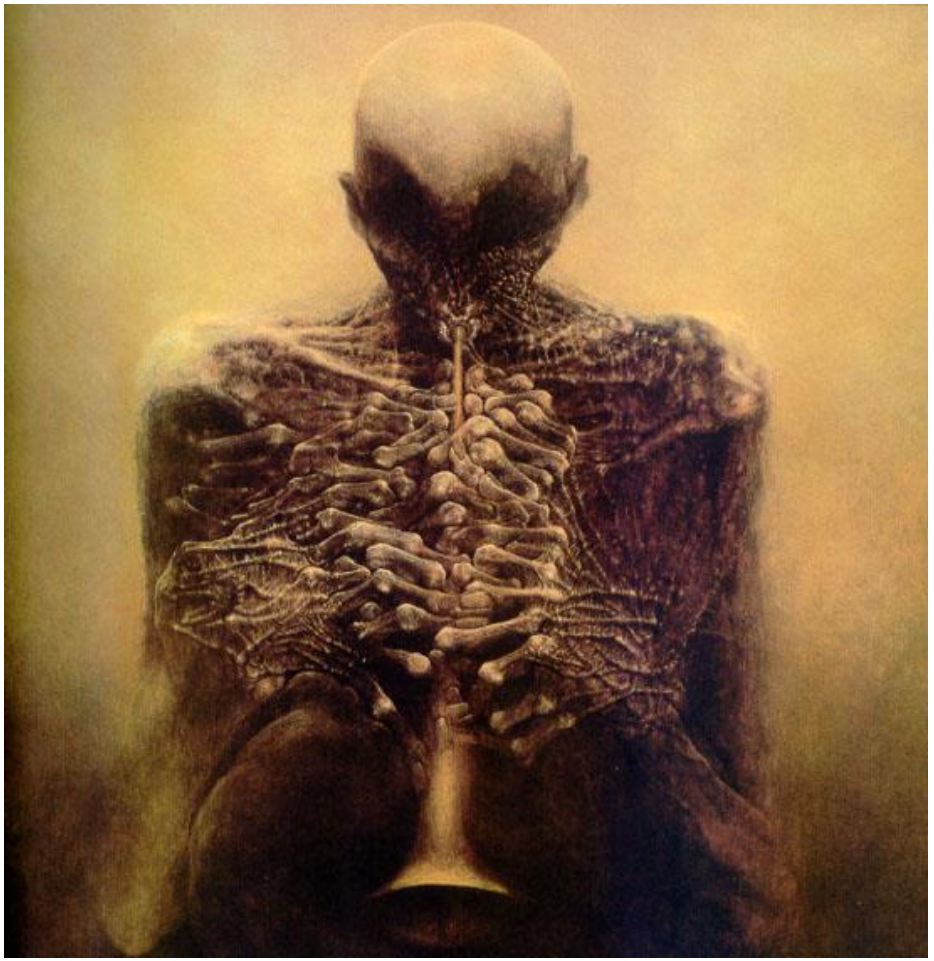



# Alternative anatomies

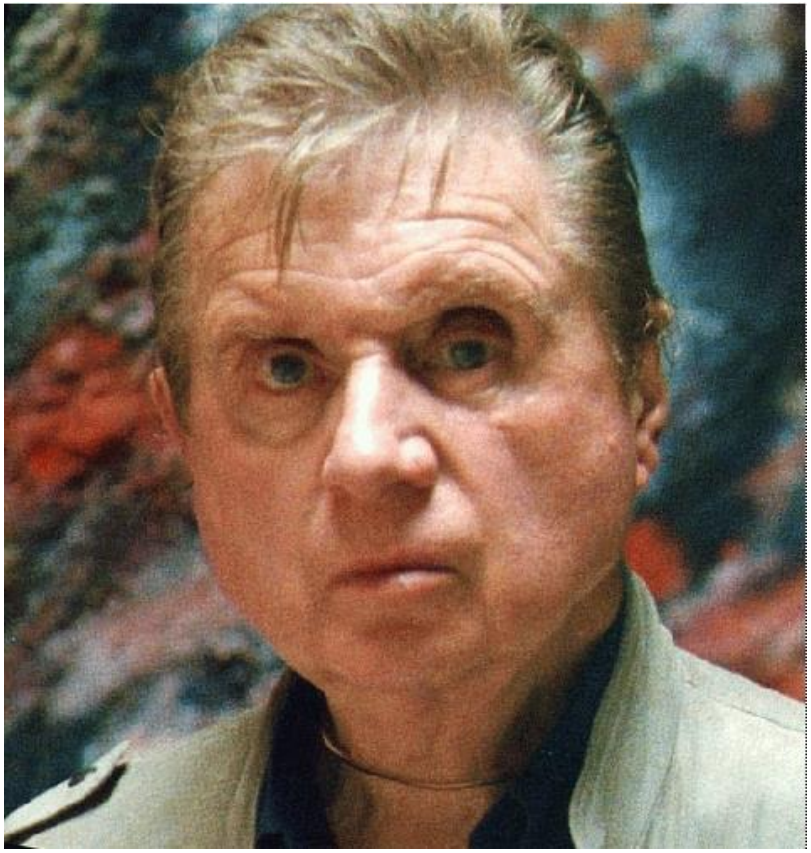


Giger



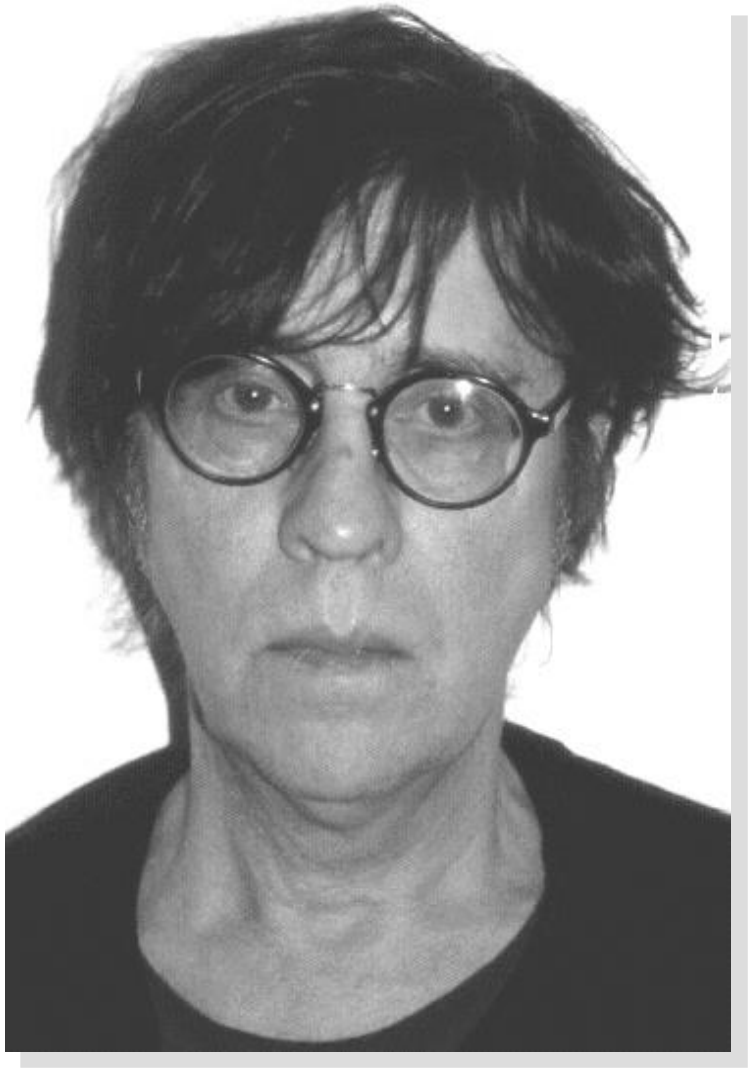
Beksinski

# Alternative anatomies



Bacon

# Alternative anatomies (Ryan)



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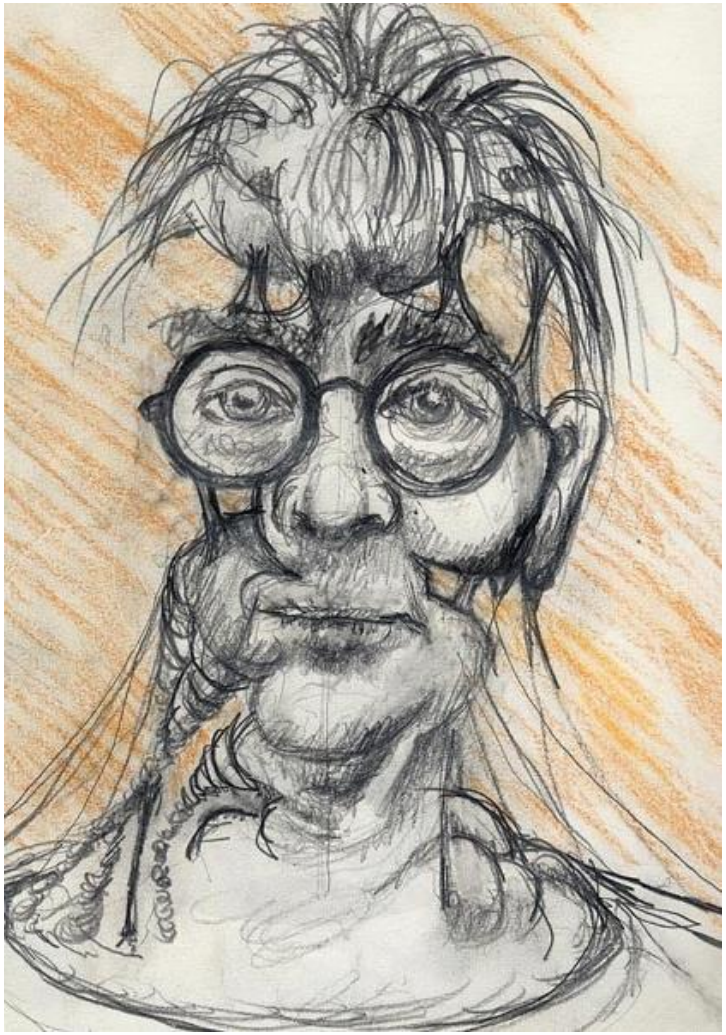

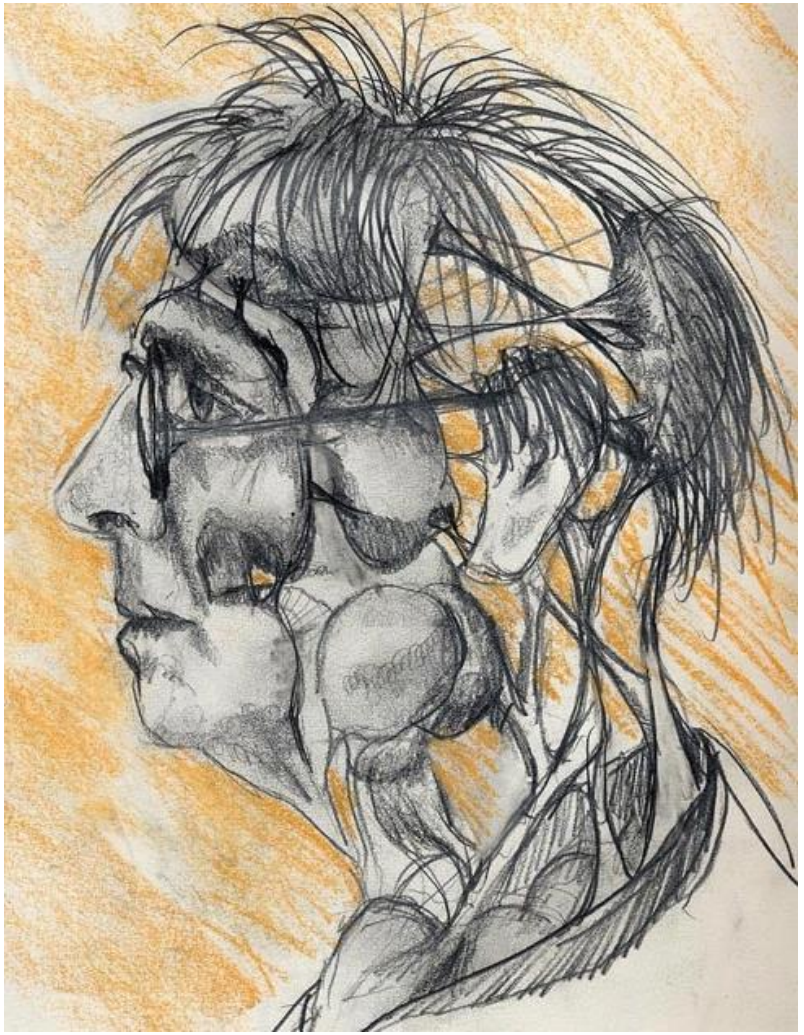

# Summary

- Understanding anatomy (Bodyworlds).
- Hand modeling and simulation: a case study.
- Anatomic considerations in *Ryan*.

**MESSAGE:**

**ANATOMY IS IMPORTANT FOR ANIMATION**

# Acknowledgements

Ryan Larkin (died Feb. 14, 2007), Chris Landreth, Gunther von Hagens, David Baas, Anne Agur, George ElKoura, Eugene Fiume, Nancy McKee, Winnie Tsang, Mike Pratscher, Patrick Coleman, Alexis Angelidis, dgp lab members, Bruce Mau, Deaf Cultural Center, NSERC, MITACS, NFB.