Character Animation: Trends and Techniques from Recent Research
First, a look at traditional animation...
Principles of Traditional Animation
[Lasseter, SIGGRAPH 1987]

• Stylistic conventions followed by Disney’s animators and others

• From experience built up over many years
  – Squash and stretch -- use distortions to convey flexibility
  – Timing -- speed conveys mass, personality
  – Anticipation -- prepare the audience for an action
  – Followthrough and overlapping action -- continuity with next action
  – Slow in and out -- speed of transitions conveys subtleties
  – Arcs -- motion is usually curved
  – Exaggeration -- emphasize emotional content
  – Secondary Action -- motion occurring as a consequence
  – Appeal -- audience must enjoy watching it
Principles of Traditional Animation

The famous half-filled flour sack, guide to maintaining volume in any animatable shape, and proof that attitudes can be achieved with the simplest of shapes.
Squash and Stretch

Use distortions to convey flexibility
Squash and Stretch
Use distortions to convey flexibility

Defines the rigidity of the material

Gives the sense that the object is made out of a soft, pliable material.

Elongating the drawings before and after the bounce increases the sense of speed, makes it easier to follow and gives more snap to the action.

In moving the circle (representing the ball) down and back up, it was discovered that the ball would seem to have more weight if the drawings were closer together at the top and spaced farther apart at the bottom.

Then, if the bottom drawing was flattened, it gave the appearance of bouncing. Elongating the drawings on each side made it easier to follow and gave more snap to the action. Thus, the beginnings of Squash and Stretch.
Timing & Motion

Timing can also indicate an emotional state

Consider a scenario with a head looking first over the right shoulder and then over the left shoulder

No in-betweens - the character has been hit by a strong force and its head almost snapped off
One in-betweens - the character has been hit by something substantial, e.g., frying pan
Two in-betweens - the character has a nervous twitch
Three in-betweens - the character is dodging a flying object
Four in-betweens - the character is giving a crisp order
Six in-betweens - the character sees something inviting
Nine in-betweens - the character is thinking about something
Ten in-betweens - the character is stretching a sore muscle
Anticipation

Prepare the audience for an action

Don’t surprise the audience
Direct their attention to what’s important
Follow Through and Overlapping Action

The termination of an action and establishing its relationship to the next action

Audience likes to see resolution of action
Discontinuities are unsettling
Secondary Action

Motion occurring as a consequence
We’re going to look at the technology, but in the end, it’s all about the story and the acting....
Outline

Motion Capture
Assessing results from the motion capture revolution

Physically-based Simulation
Making animations more realistic and of-the-moment?

Artist Tools for Character Animation
Giving total control back to the artists

Artist Tools for 2D Image Creation and Animation
The Motion Capture Revolution

Motion capture labs became accessible about 15 years ago....

Advances have led to performance capture as seen in Avatar

http://www.youtube.com/watch?v=L6JXUoWeZ7Q
The Motion Capture Revolution

What if we can’t afford to capture an entire script?

What if we want new real-time performances in response to user actions?

Vision: create a vast database of human activities, interactions, emotions for general use.
Motion Capture Databases

Okan Arikan’s research stands the test of time for real-time scripting

Motion Capture Databases

Alla Safonova’s research creates beautiful scripted results in a longer offline process.

key: allow interpolation between existing motions

Alla Safonova and Jessica K. Hodgins
Construction and optimal search of interpolated motion graphs
Motion Capture Databases

Jehee Lee has created elegant real-time editing tools for captured motion data

Manmyung Kim, Kyung Lyul Hyun, Jongmin Kim, Jehee Lee,
Synchronized Multi-Character Motion Editing,
ACM Transactions on Graphics (SIGGRAPH 2009), Vol. 28, No. 3, August 2009
Motion Capture Databases – Challenges

What about hands?
Motion Capture Databases – Hands

We can create physical simulations from motion capture data to help us achieve realistic hand-object contact.

Motion Capture Databases – Hands

We can create physical simulations from motion capture data to help us achieve realistic hand-object contact.

Lessons learned:

Separating passive and active control makes it easier to set control parameters.

Joint limits are important, and easy to extract from motion data.

Palm geometry is important for grasping.

Motion Capture Databases – Hands

Karen Liu creates animations from captured or preset grasping poses and the assumption that people try to maintain *constant hand joint torques* during manipulation.

C. Karen Liu, Dextrous Manipulation from a Grasping Pose, in ACM Transactions on Graphics (SIGGRAPH) 2009
Motion Capture Databases – Challenges

What about faces?
Motion Capture Databases – Challenges

What about skin deformation?

Motion Capture Databases – Skin Deformation

Jessica Hodgins promotes full capturing of skin deformation during dynamic activities.

Experimental Results

Motion Capture Databases – Skin Deformation

Jessica Hodgins promotes full capturing of skin deformation during dynamic activities

Motion Capture Databases – Skin Deformation

Jessica Hodgins promotes full capturing of skin deformation during dynamic activities

Physically-Based Simulation

Victor Zordan demonstrates use of physical simulation to capture that moment of impact

Dynamic Response for Motion Capture Animation

Dynamic Response for Motion Capture Animation
Zordan, V. B., Majkowska, A., Chiu, B., Fast, M.
ACM SIGGRAPH 2005
Physically-Based Simulation

Victor Zordan demonstrates use of physical simulation to capture that moment of impact

Interactive Dynamic Response For Games

Interactive Dynamic Response for Games
ACM SIGGRAPH Sandbox Symposium 2007
Physically-based simulation is also great for standing balance.

Momentum Control for Balance
Macchietto, A., Zordan, V.B., Shelton C.,
Physically-Based Simulation

Pose-control graphs combined with dynamic simulation are making a powerful comeback recently

SIMBICON: Simple Biped Locomotion Control
KangKang Yin, Kevin Loken, and Michiel van de Panne
ACM Transactions on Graphics (Proc. ACM SIGGRAPH 2007)
Physically-Based Simulation: Pose Based Controllers

Van de Panne’s group combines their own pose-based controllers with task-level information for characters that convey some level of intent.
Physically-Based Simulation: Pose Based Controllers

Herzmann’s group augments pose-based controllers with optimization to produce more humanlike walking.

Physically-Based Simulation: Controllers using Muscle Models

However, maybe we really need muscles:

Flexible Muscle-Based Locomotion for Bipedal Creatures

Physically-Based Simulation: Physics based deformation

Recent research shows how finite element techniques can fit into the workflow of the artist

Physically-Based Simulation: Physics based deformation

Recent research shows how finite element techniques can fit into the workflow of the artist.

Efficient elasticity for character skinning with contact and collisions
A. McAdams, Y. Zhu, A. Selle, M. Empey, R. Tamstorf, J. Teran and E. Sifakis
Artist Tools for Animation

Artist development tools for Spore indicate an exciting trend

Artist Tools for Animation

We are working to create direct control of a running simulation

Artist Tools for Animation

Real-time control requires new techniques for fast simulation of deformable bodies

Painting in the gradient domain creates new opportunities for the artist

Local tools for layering elements can be used for creation of images and animations
Outline

Motion Capture
Assessing results from the motion capture revolution

Physically-based Simulation
Making animations more realistic and of-the-moment?

Artist Tools for Character Animation
Giving total control back to the artists

Artist Tools for 2D Image Creation and Animation