Jungle shot from "Madagascar"

CNM 190, pt 2
Advanced Digital Animation
Lec 03 : Art Direction on Madagascar / Effects 1

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Overview

Shannon

- Art directing Madagascar
- Critiquing our artistic look for our two pieces

Marilyn

- Opportunities @ PDI for you!

Dan

- Special Effects
  - History
  - Mechanical
  - Optical
- Pure CG film FX
- Fluids
- Particles

Special Effects (SFX) History

en.wikipedia.org/wiki/Special_effects
www.filmsite.org/visualeffects1.html

- The first special effect was done in 1895 who used a dummy to simulate the beheading of Mary Q of Scots!
  - "Stop tricks" like this are still used on YouTube today!
- Used "when scenes can't be realized by normal means"
- In CG animations, very similar case! What's "normal"?

1895: The first SFX!

CGI special effects used in Star Wars Episode III

Mechanical Effects

en.wikipedia.org/wiki/Special_effects

- Aka "practical" or "physical" effects
  - Used during live shots
- These include
  - Mechanized props
  - Scenery
  - Bullet hits
  - Pyrotechnics
  - Wind, rain, snow, etc
- Outside the scope of this class – Mech E?

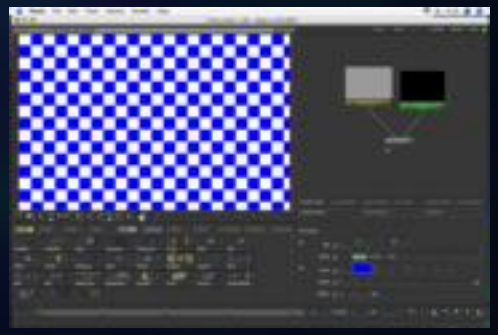
R2D2 is a mechanical special effect

Optical Effects

en.wikipedia.org/wiki/{Special_effects, Optical_printer}

- Aka "visual" (CGI) or photographic" (optical printer) effects
  - Manipulations of the photographed images
- These include
  - Stop tricks, miniatures, mattes, dolly zoom, bluescreen, wire removal, morphing, match moving, and computer-generated imagery (CGI)

An optical printer used for optical effects



Apple Shake, for compositing CGI SFX

In purely CG films, what are SFX?

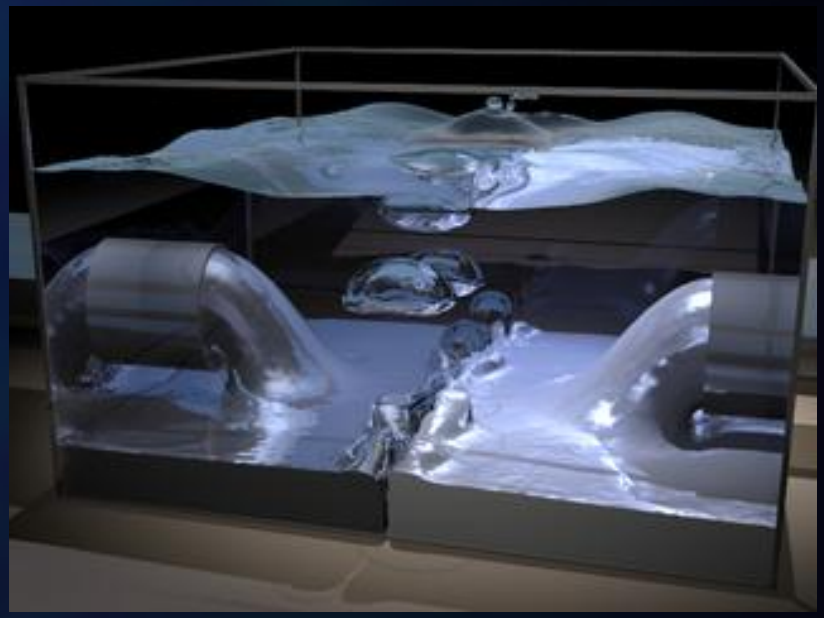
- Typically things that require specific technical attention
- Natural phenomena
  - Smoke, fire, fog, snow
  - Fluids (water, rain, etc)
- Character-related SFX
  - Cloth simulations, hair, fur
  - Footsteps in sand
  - Crowds & mobs
- Often, a problem starts as SFX and evolves into a tool that animators simply use in the pipeline!

CG Smoke by Ron Fedkiw
(with Andrew Selle and Nick Rasmussen)

Fluid Simulation

graphics.stanford.edu/~fedkiw/
www.cs.berkeley.edu/b-cam/

- When to use fluids?
  - Ocean simulation? No! That's easy enough with Perlin noise and waves of different frequencies (called 2D height field simulations)
  - Typically with mediums (fire, smoke, bodies of water with splashiness, fog, snow drifts
- Fluids interacting with other sims (cloth, other fluids, melting) is hard!



Multiple Interacting Liquids by Ron Fedkiw (w/Frank Losasso, Tamar Shinar & Andrew Selle)

Fedkiw, O'Brien fluid sims

Fluid Simulation Basics

www.cs.ubc.ca/~rbridson/fluidsimulation/
en.wikipedia.org/wiki/Navier_Stokes

- Navier-Stokes equations
  - These describe the motion of fluids (liquids & gases)
  - Derived from conservation of mass, energy, angular momentum & momentum
- Momentum equation
  - Really just F=ma, in that it tells you how fluid accelerates due to forces acting on it
- Incompressibilty cond.
  - Fluid volume in = out
- Advection is the flow of particles through field u

Momentum equation

$$\frac{\partial \vec{u}}{\partial t} + \vec{u} \cdot \nabla \vec{u} + \frac{1}{\rho} \nabla p = \vec{g} + \nu \nabla \cdot \nabla \vec{u}$$

Incompressibility condition

$$\nabla \cdot \vec{u} = 0$$

- u is velocity
- ρ is density
  - (water = 1000kg/m^3)
- p is pressure
- g is gravity, or "animator"
- ν is kinematic viscosity
  - How viscous is fluid
- ∇p is pressure gradient
- $\nabla \cdot u$ is divergence of velocity

Fluid Simulation Meshes

www.cs.ubc.ca/~rbridson/fluidsimulation/
en.wikipedia.org/wiki/Navier_Stokes

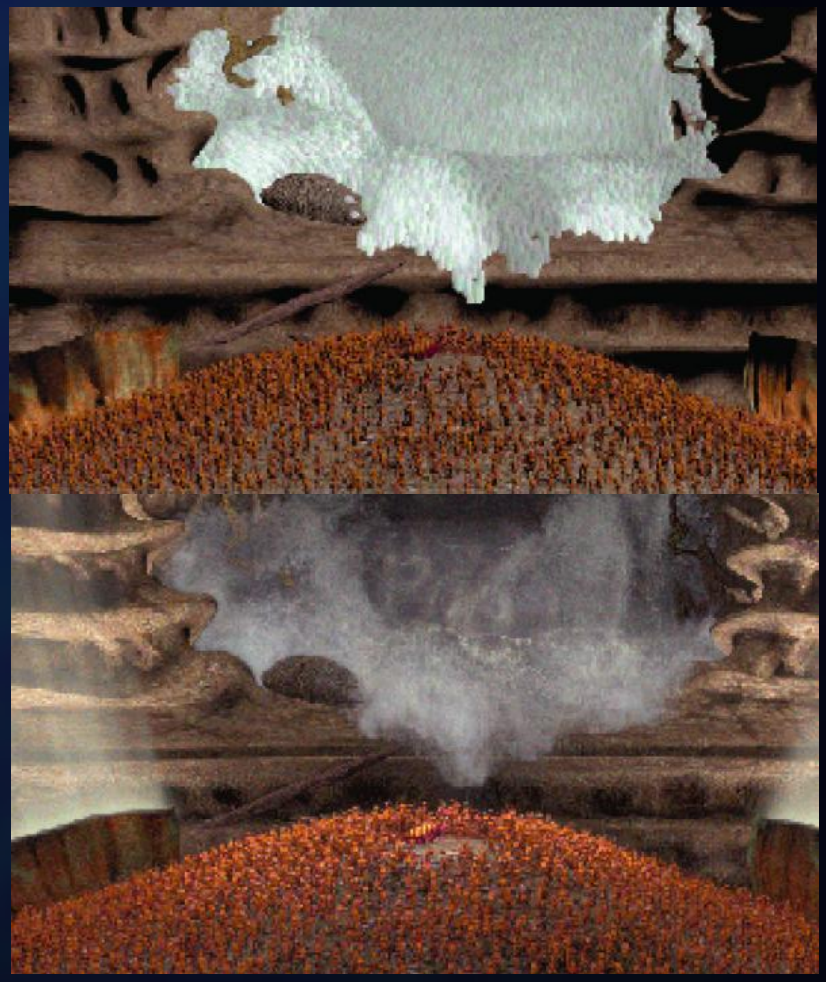
- Lagrangian viewpoint
  - Moving mesh
  - World is a particle system
  - Track where particles go
  - "Floating w/wind in balloon"
- Features
  - Good for solids
  - Bad for fluids
    - Significant deformation and topology change

- Eulerian viewpoint
  - Static mesh
  - Point in space fixed
  - Measure as things go by
  - "On ground, wind blows"
- Features
  - Good for fluids
  - Bad for solids
    - Harder to track moving material quantities

Particles : cheap & useful!

en.wikipedia.org/wiki/Particle_systems

- Particle parameters
  - Spawning rate, angle
  - Initial velocity vector
  - Particle life
  - Color and variations
  - Should have noise here!
- Simulation
  - Update, Render, repeat
  - Friction, objects, gravity, flows (e.g., vector fields) modify location + velocity
  - Particle-particle collisions usually not checked
  - Particle death (fade $\alpha \rightarrow 0$)



accad.osu.edu/~mpalazzi/AC753W05/Computer%20Graphics%20World%20-%20ANTZ-PIRATION.pdf

Particles : …and ubiquitous

www.nextlimit.com/realflow/cs_poseidon.htm

- Particles used for
  - Spray, drips, rain
  - surging & pouring water
  - Drips
  - Explosions
- Particles allow binding!
  - One can bind anything to a particle, very useful
- Particles affect the surroundings sometimes
  - In the shot at the right, water carries objects in the hall
- Rendering
  - Metaballs common

CIS Hollywood (small effects house) with early RealFlow rigid body dynamics test

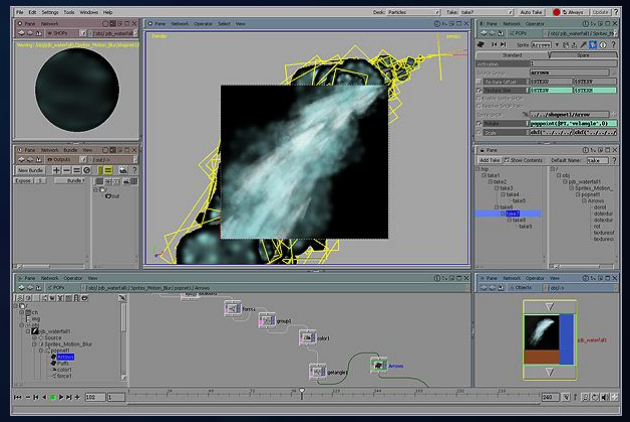
Final composite for Poseidon "Broadway" shot

Fluid Simulation Software

www.autodesk.com/maya
www.nextlimit.com/realflow/
www.sidefx.com

- Maya
  - (only in Autodesk Maya Unlimited)
  - 2D Solver (height field)
  - 3D Fluid Solver
- Realflow (RF4)
  - Python scripting at heart
  - Used in many big films
  - Fluids, surfaces, particles
- Houdini
  - Particle motion
  - Fire, white water, insects, crowd sims

RF4



Water simulation in Houdini Master

Software Demos

Conclusion

- Particles and Fluids and a world of effects
  - Fluid techniques now readily available in today's SW
  - 2D height fields used for simple ponds, oceans
  - If solving fluid problem, Euler solution on fixed grid
    - This is still a very active area of research. It's not solved!

Shot from Madagascar with ocean water effects in the background