Physically Based Modelling
Hall of Fame

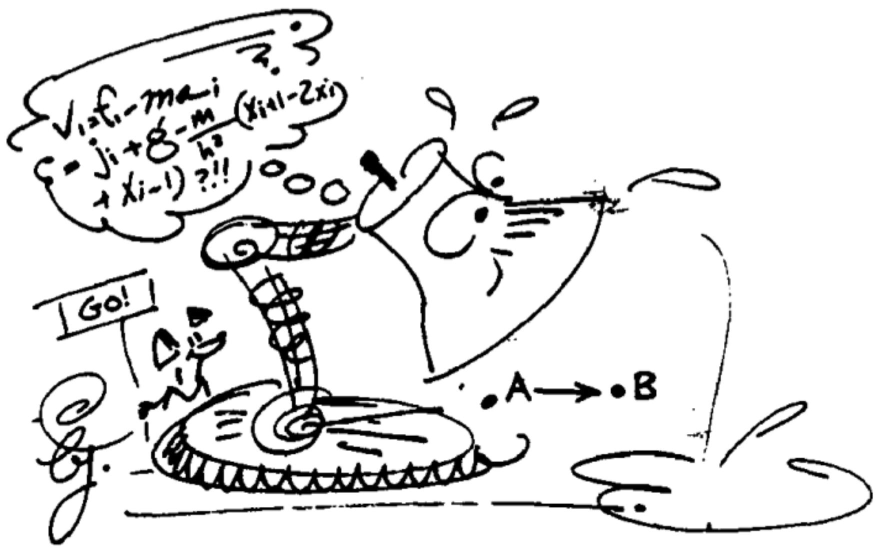


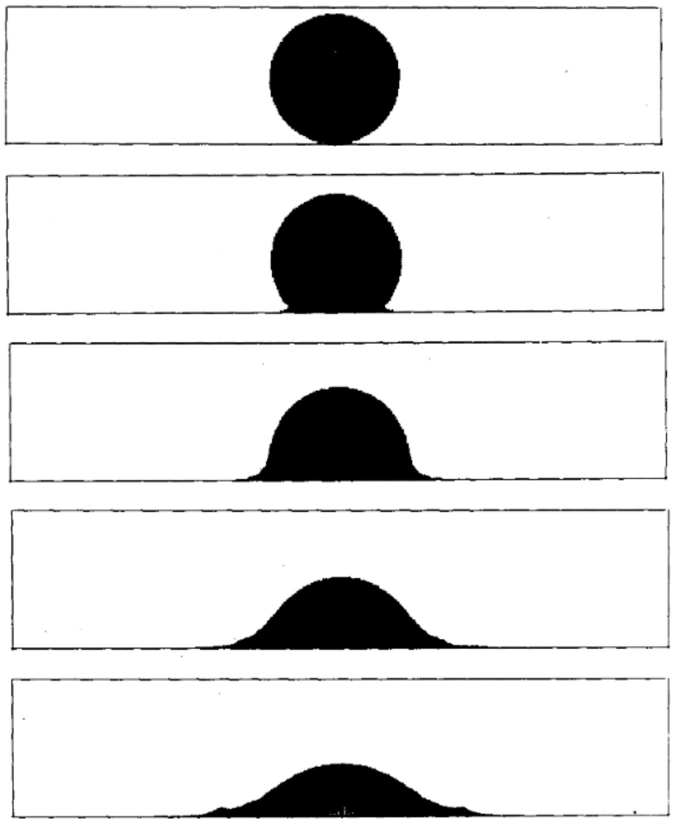
Figure 8: Spacetime constraints: a cartoonist's view. (c) 1988 by Laura Green, used by permission.

Credit: Computer Graphics, Volume 22, Number 4, August 1988

Modelowanie fizyczne w animacji komputerowej

Maciej Matyka

David Potter
F.Harlow J.P. Shannon



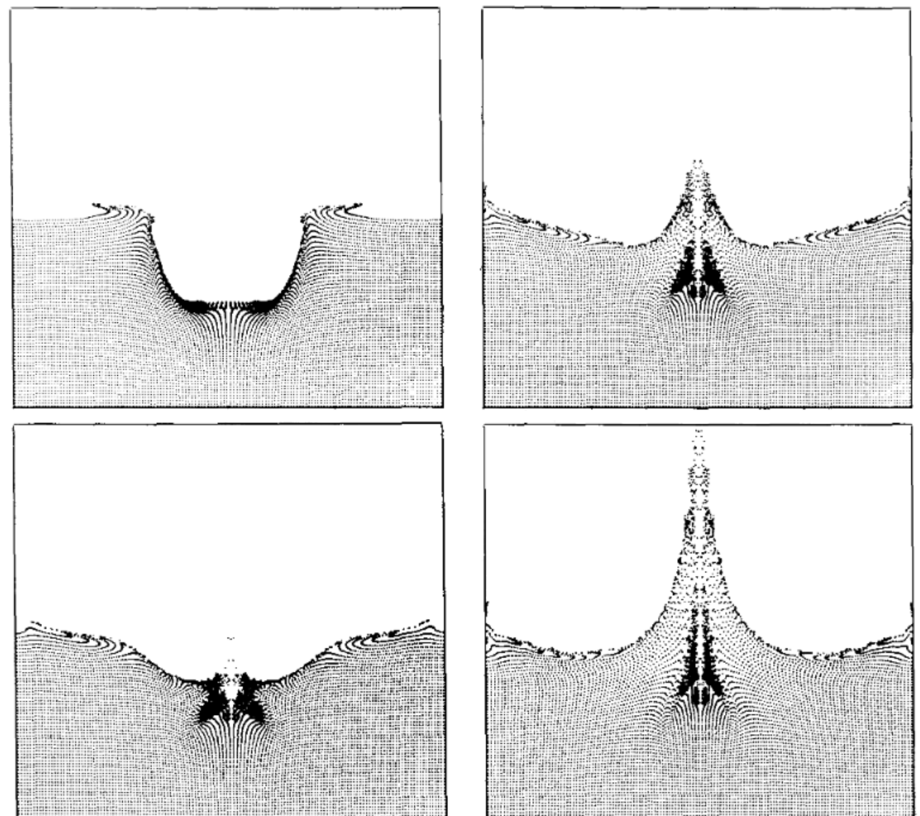


FIG. 13. Deep-pool splash of a drop of radius 5.0 and impact speed 4.0, with $(gR)^{1/2}/u_0=0.177$. The frames are at times $t=10, 20, 25, 35$.

- metoda MAC
- symulacje płynów

JOURNAL OF APPLIED PHYSICS VOLUME 38, NUMBER 10 SEPTEMBER 1967 The Splash of a Liquid Drop

Dimitris Metaxas
Nick Fostern

Senior Research & Development team-member, Nick Foster, has been awarded an **Academy of Motion Picture Arts and Sciences** (A.M.P.A.S.) Technical Achievement Award for his software development in the field of water simulation systems (...) in the hit computer-animated feature film, ANTZ (…)

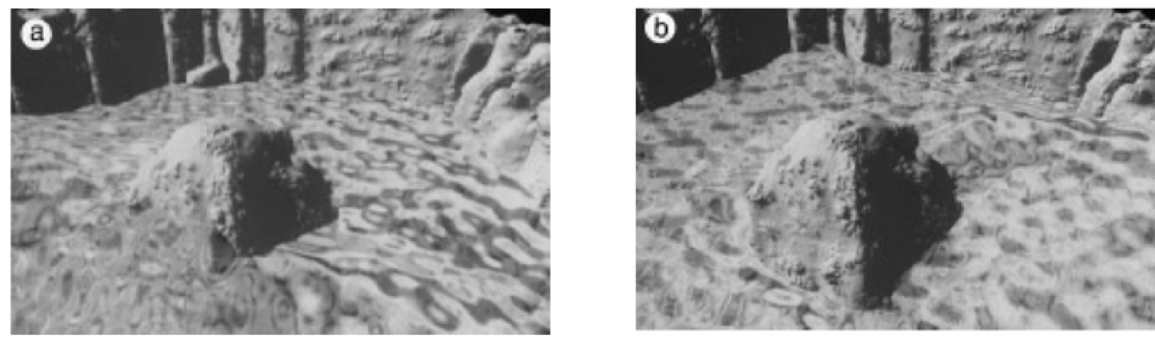
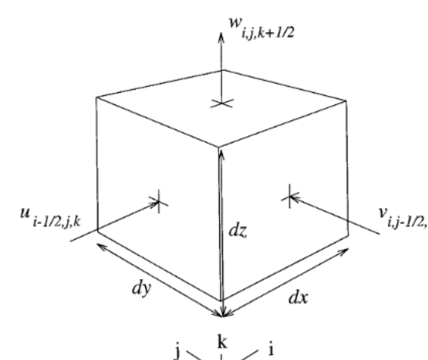


FIG. 10. "Moonlight Cove." Two ocean waves crash into a shallow cove. Pressure and velocity effects throughout the water volume manifest themselves at the surface, (a) and (b).

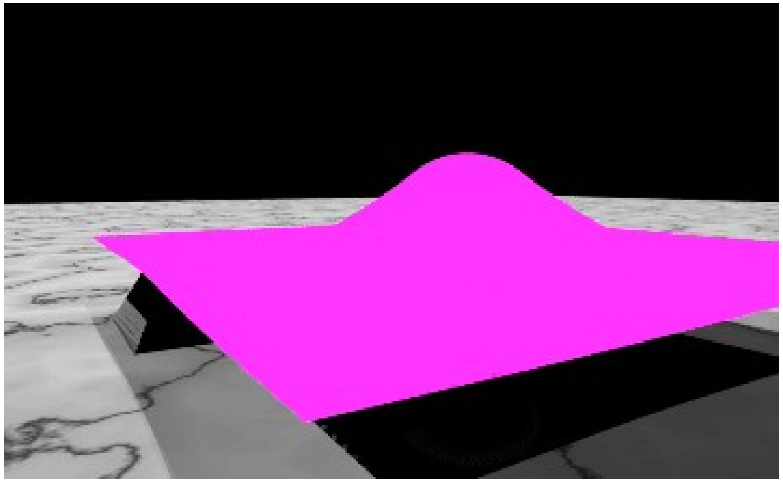
Realistic Animation of Liquids (1999)
(They adopted MAC to Fluids in Movies)



https://www.youtube.com/watch?v=rcmwYKgrijs
ANTZ 1998 Water Drop [720p].mp4

Ron Fedkiw

Industrial Light + Magic, Stanford



- fluids
- cloths
- soft bodies
- Level Sets
- computational physics
- Special effects
- machine learning

Terminator 3: Rise of the Machines

Star Wars: Episode III - Revenge of the Sith

Poseidon

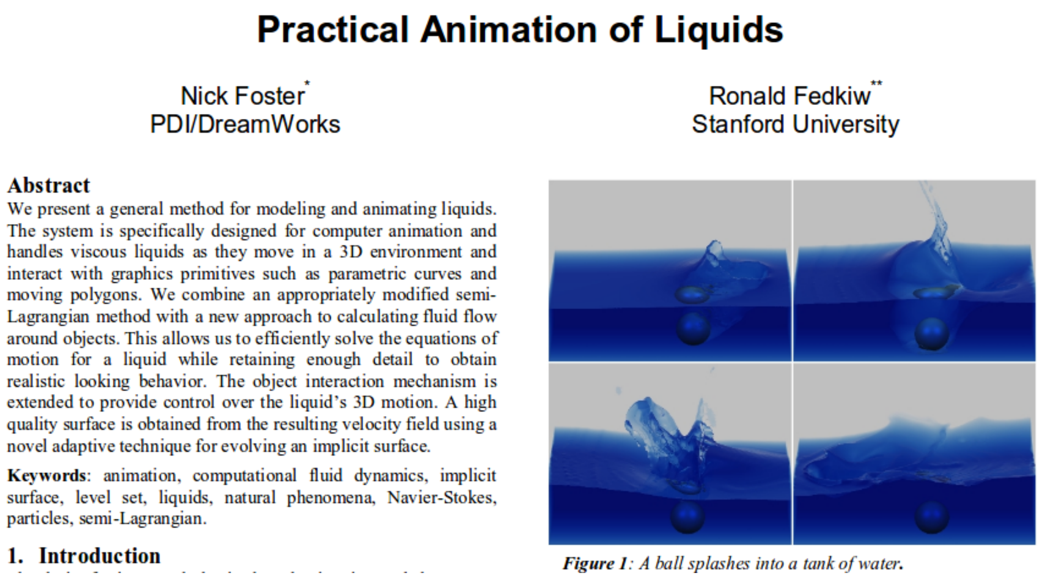
Evan Almighty

Kong: Skull Island

Shrek

http://physbam.stanford.edu/~fedkiw/

Nick Fostern   Ron Fedkiw



Practical Animation of Liquids

Nick Foster[*]
PDI/DreamWorks

Ronald Fedkiw[**]
Stanford University

Abstract

We present a general method for modeling and animating liquids. The system is specifically designed for computer animation and handles viscous liquids as they move in a 3D environment and interact with graphics primitives such as parametric curves and moving polygons. We combine an appropriately modified semi-Lagrangian method with a new approach to calculating fluid flow around objects. This allows us to efficiently solve the equations of motion for a liquid while retaining enough detail to obtain realistic looking behavior. The object interaction mechanism is extended to provide control over the liquid's 3D motion. A high quality surface is obtained from the resulting velocity field using a novel adaptive technique for evolving an implicit surface.

Keywords: animation, computational fluid dynamics, implicit surface, level set, liquids, natural phenomena, Navier-Stokes, particles, semi-Lagrangian.

1. Introduction

***Figure 1**: A ball splashes into a tank of water.*

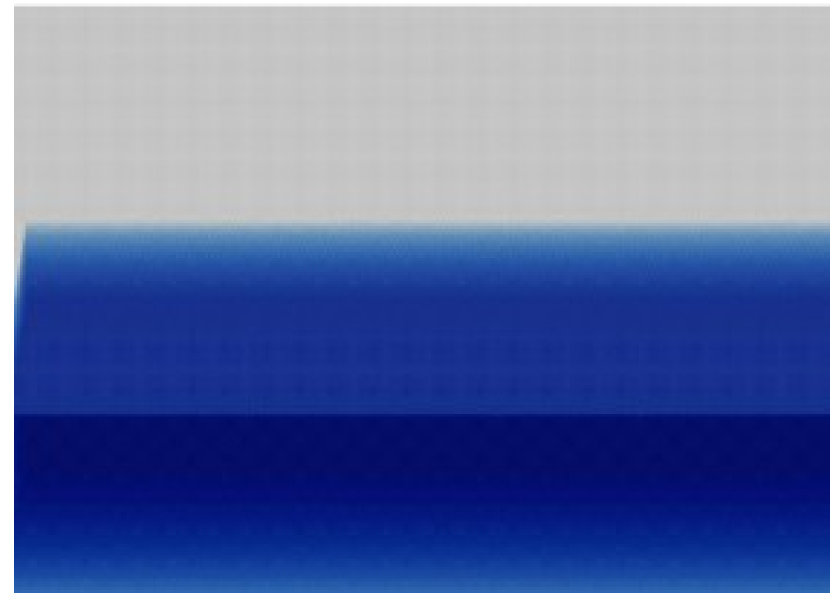


***Figure 7:** A fully articulated animated character interacts with visc*
cells. That resolution is sufficient to accurately model the character
the mouthful of mud later in the sequence. This example runs at three

Craig Reynolds

- Boids

Looker, 1981, The Ladd Company

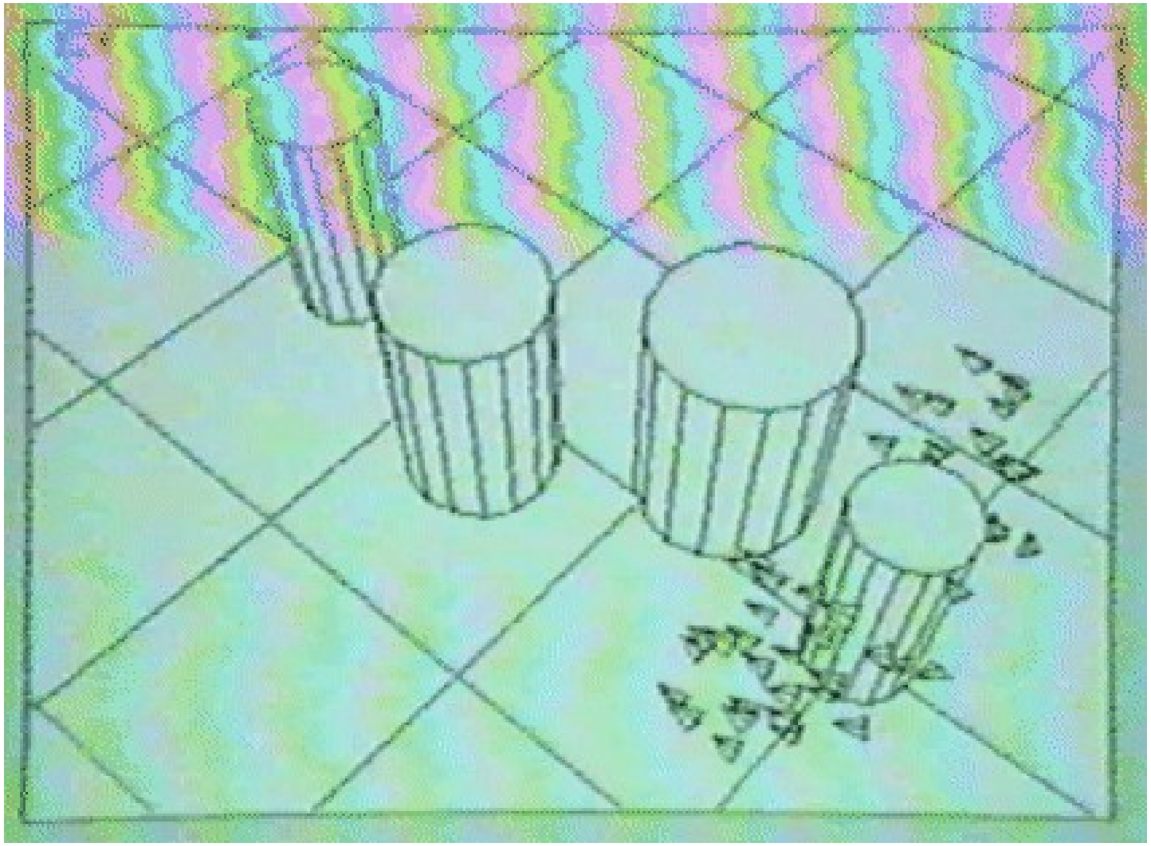
TRON, 1982, Walt Disney Studios

Batman Returns, 1992, Warner Brothers

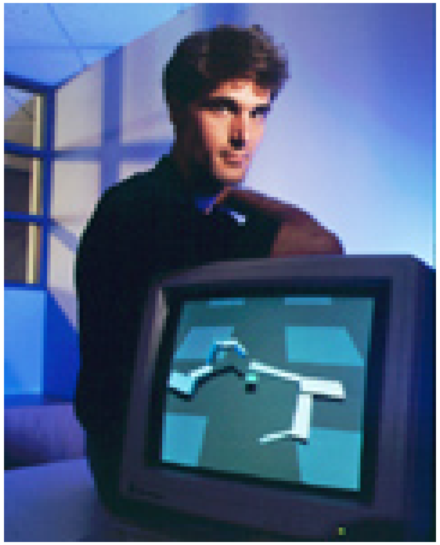
Scientific And Engineering Award

For pioneering contributions to the development of three dimensional computer animation for motion picture production

The Scientific and Technical Awards of the 70th Academy Awards® presented in 1998.

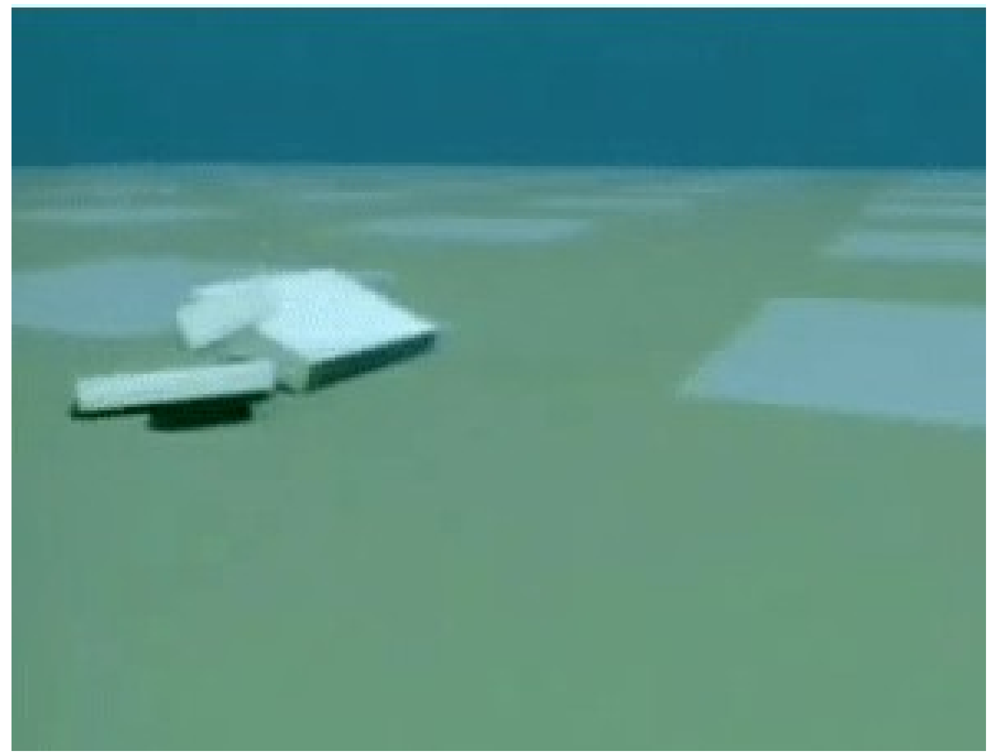


http://www.red3d.com/cwr/boids/



Karl Sims

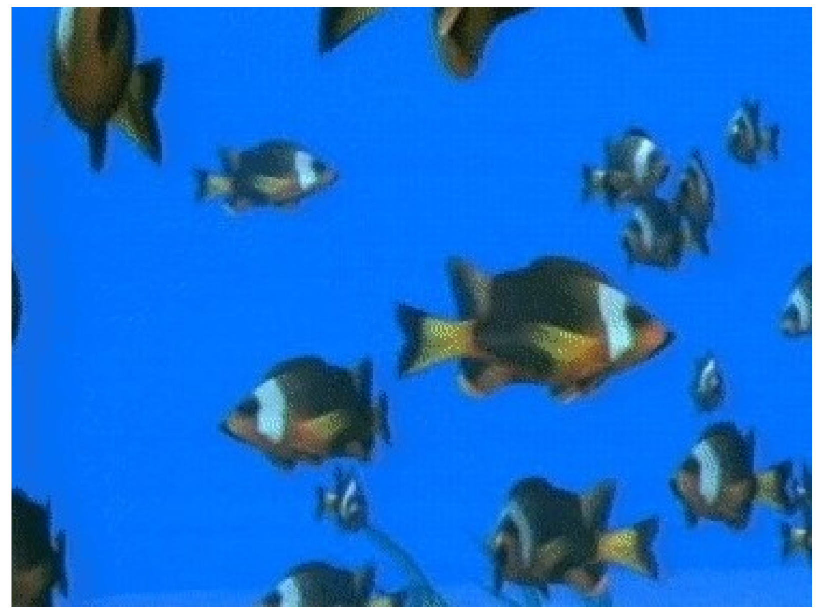
- Genetic Algorithms
- Particles
- Interaction



http://karlsims.com/

Demetri Terzopoulos

Distinguished Professor & Chancellor's
Professor of Computer Science, UCLA



- Computer Graphics
- Computer Vision
- Medical Image Analysis
- Computer-Aided Design
- **Artificial Life**

Artificial Fishes:Physics, Locomotion, Perception, BehaviorXiaoyuan Tu and Demetri TerzopoulosDepartment of Computer Science, University of Toronto1

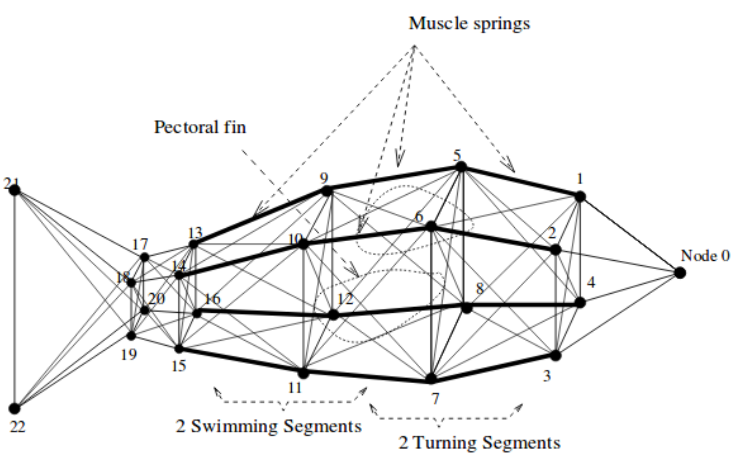
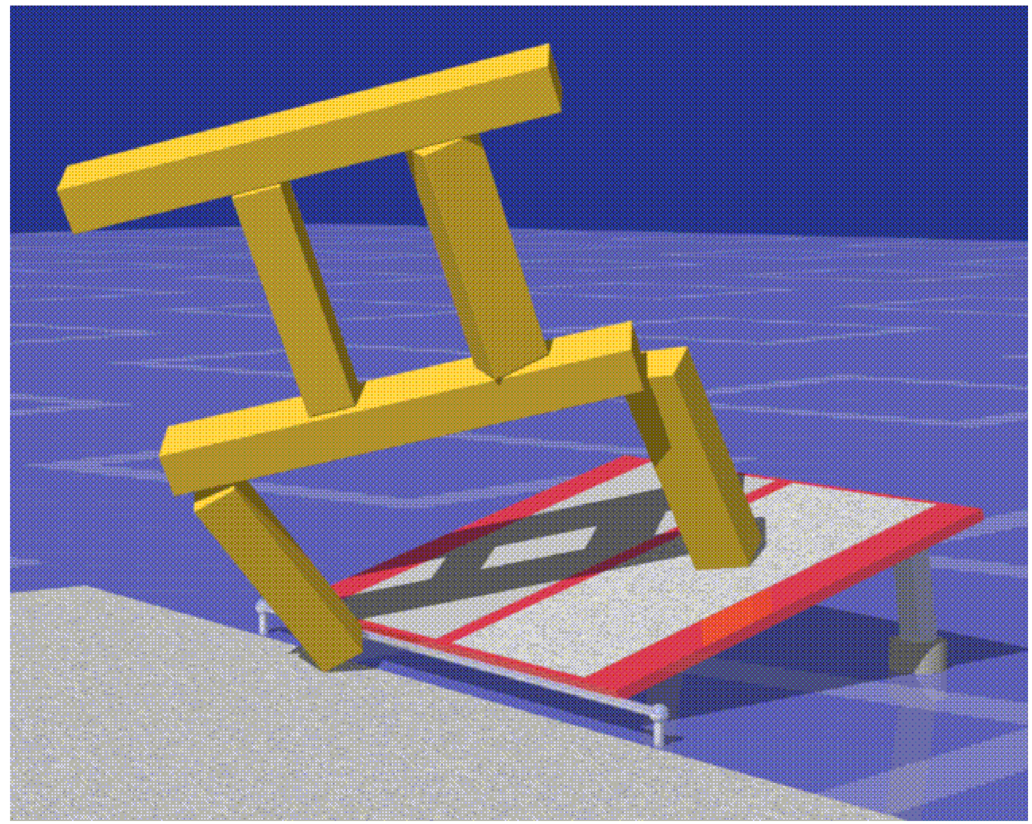


Figure 2: The spring-mass dynamic fish model. Springs are at their rest lengths.

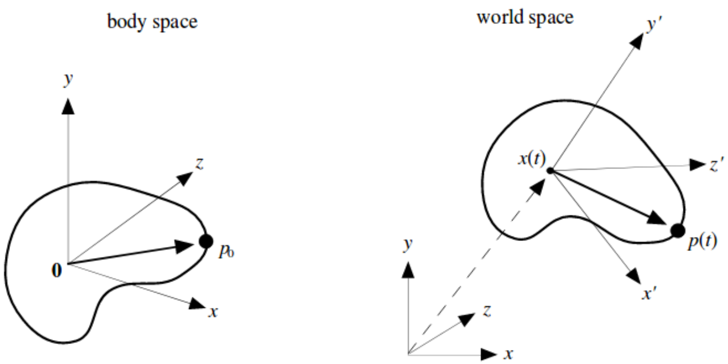
http://web.cs.ucla.edu/~dt/

David Baraff

Pixar



- Rigid Body Dynamics
- Soft Body Dynamics



http://www.cs.cmu.edu/~baraff/pictures/index.html

http://web.cs.ucla.edu/~dt/

John Lasseter

Pixar Animation Studios,

Disney Animation

PRINCIPLES OF TRADITIONAL ANIMATION APPLIED TO 3D COMPUTER ANIMATION

John Lasseter
Pixar
San Rafael
California

https://youtu.be/D4NPQ8mfKU0

Academy Award nomination for Best Animated Short Film

- animation

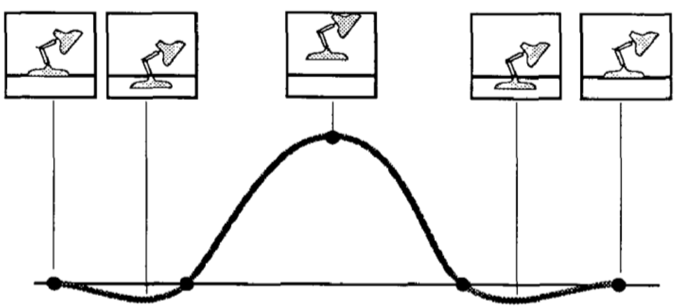


FIGURE 10a. This spline controls the Z (up) translation of Luxo Jr. Dips in the spline cause him to intersect the floor.

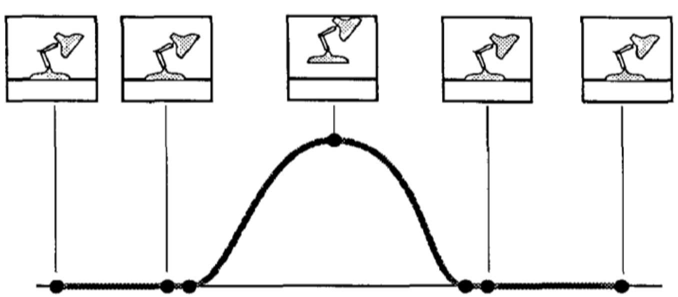
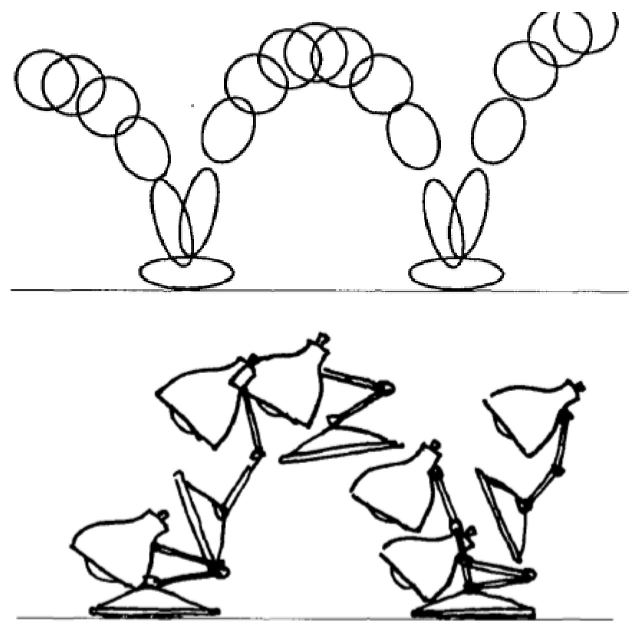


FIGURE 10b. Two extra extremes are added to the spline which removes the dips and prevents Jr. from going into the basement.



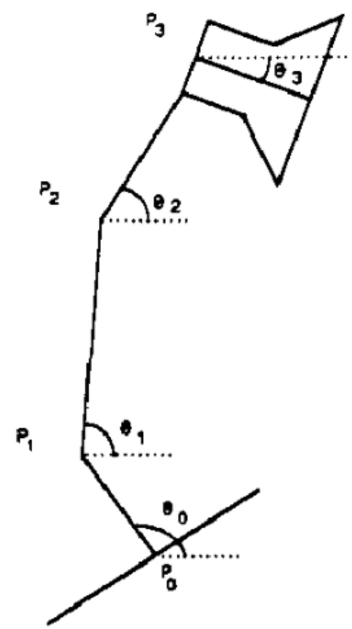
Pixar - Luxo Jr. Pencil Test

https://www.youtube.com/watch?v=SM0Q_MBLIbU

Michael Kass

Pixar

- Spacetime constraints
- CG
- Cloths
- Rendering



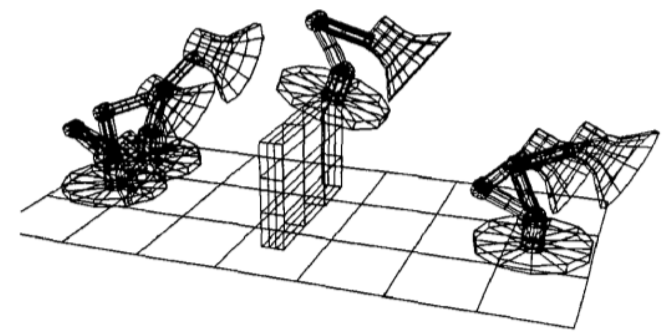
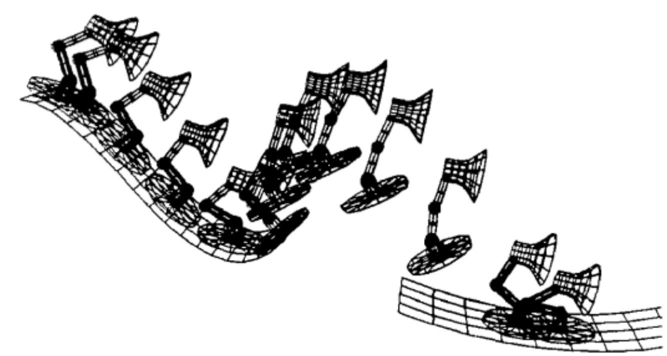


Figure 6: Hurdle Jump



Spacetime Constraints

Andrew Witkin
Michael Kass

Schlumberger Palo Alto Research
3340 Hillview Avenue, Palo Alto, CA 94304

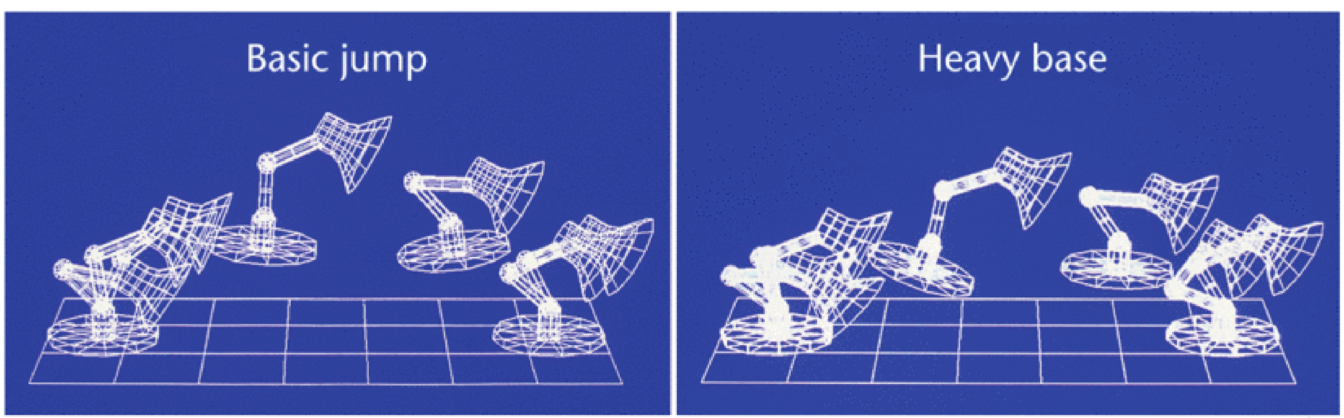
http://graphics.pixar.com/people/kass/

Andrew Witkin

Pixar

In 2006, Witkin received an Oscar along with David Baraff and Michael Kass for his work on Cloth Simulation for Film used in **Cars, The Incredibles, Finding Nemo, and Monsters, Inc..**

- Spacetime constraints
- Cloths



(a) (b)

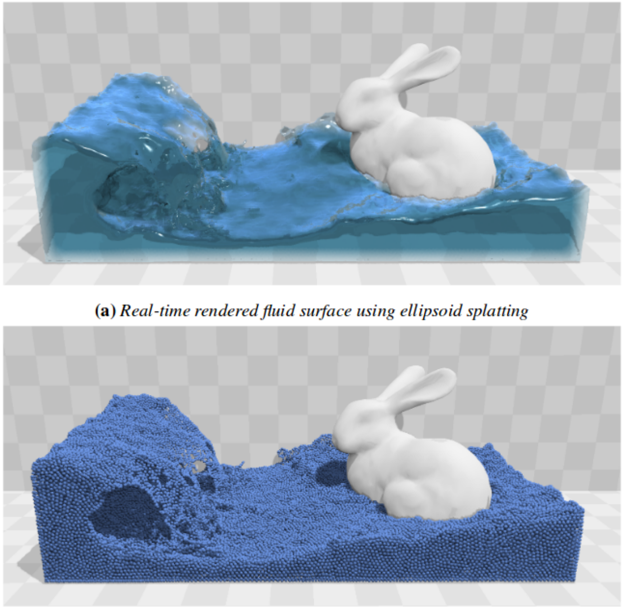
https://www.cs.cmu.edu/~aw/gallery.html

http://ieeexplore.ieee.org/document/5675634/?reload=true

Matthias Müller

AGEIA / NVIDIA

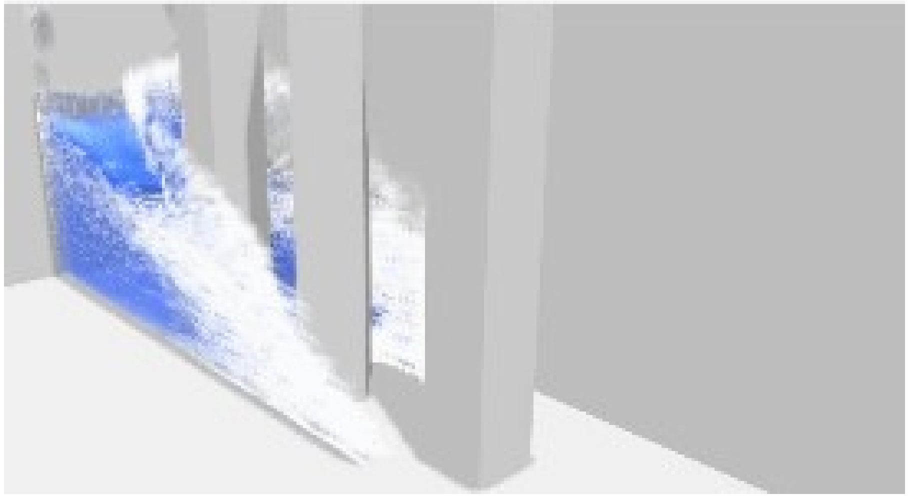
Position Based Dynamics



(a) *Real-time rendered fluid surface using ellipsoid splatting*

(b) *Underlying simulation particles*

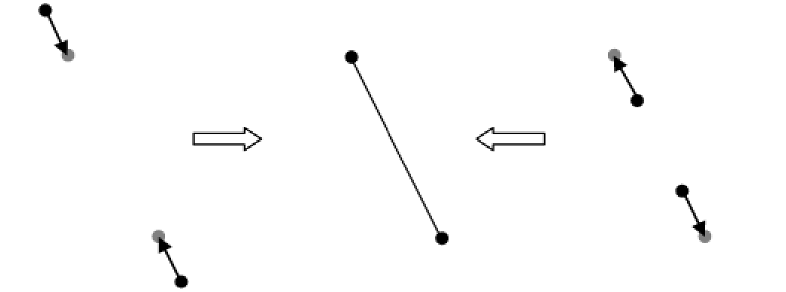
Figure 1: *Bunny taking a bath. 128k particles, 2 sub-steps, 3 density iterations per frame, average simulation time per frame 10ms.*



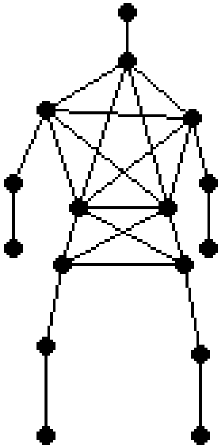
- fluids
- soft body
- rigid body
- constraints

http://www.matthias-mueller-fischer.ch/

Thomas Jakobsen



- Veret Algorithm
- Character Physics
- Became popular



http://www.cs.cmu.edu/afs/cs/academic/class/15462-s13/www/lec_slides/Jakobsen.pdf

Alain Fournier, William T. Reeves

- Ocen animation

Dallas, August 18-22 Volume 20, Number 4, 1986

A Simple Model of Ocean Waves

Alain Fournier †

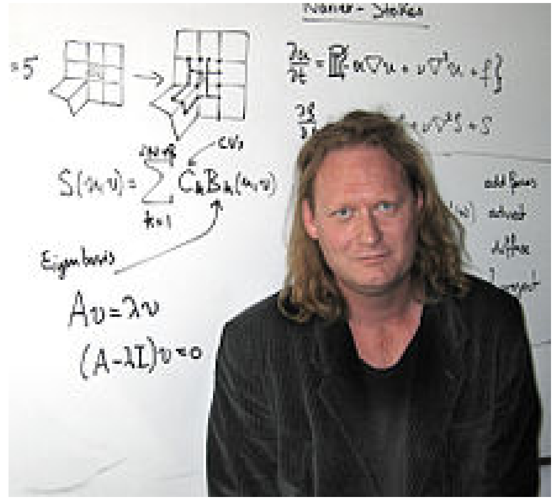
Department of Computer Science
University of Toronto
Toronto, Ontario

William T. Reeves

Animation Research and Development
PIXAR
San Rafael, CA

Figure 16
Beneath the Waves of San Rafael

Stam, J.



- Smoke
- Games
- Simple CFD

https://www.youtube.com/watch?v=t-erFRTMIWA

Jos Stam's 1999 Interactive Fluid Dynamics Demo.mp4

Stable Fluids

Jos Stam*

Alias | wavefront

Abstract

Building animation tools for fluid-like motions is an important and challenging problem with many applications in computer graphics. The use of physics-based models for fluid flow can greatly assist

articles have been published in various areas on how to compute these equations numerically. Which solver to use in practice depends largely on the problem at hand and on the computing power available. Most engineering tasks require that the simulation provide accurate bounds on the physical quantities involved to answer

http://www.dgp.toronto.edu/~stam/reality/Research/pub.html

Nils Thurley

- LBM
- Free Surface
- Turbulence

http://www.ntoken.com/pubs.html

Z ostatniej chwili...

Data-Driven Synthesis of Smoke Flows with CNN-based Feature Descriptors

MENGYU CHU, Technical University of Munich
NILS THUEREY, Technical University of Munich

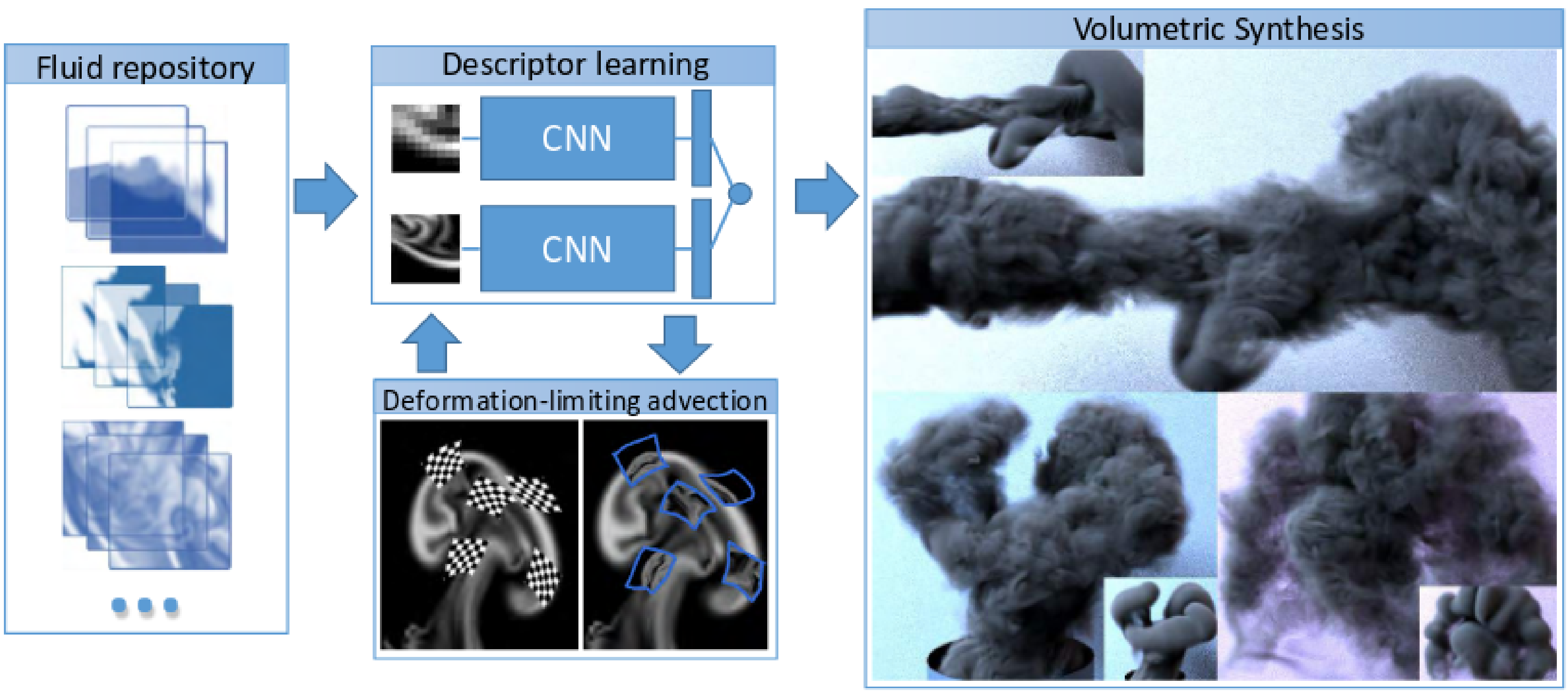


Fig. 1. We enable volumetric fluid synthesis with high resolutions and non-dissipative small scale details using CNNs and a fluid flow repository.

https://arxiv.org/pdf/1705.01425.pdf

Silniki Fizycze

- UNITY
- UNREAL
- BOX2D

To **nie** jest koniec...