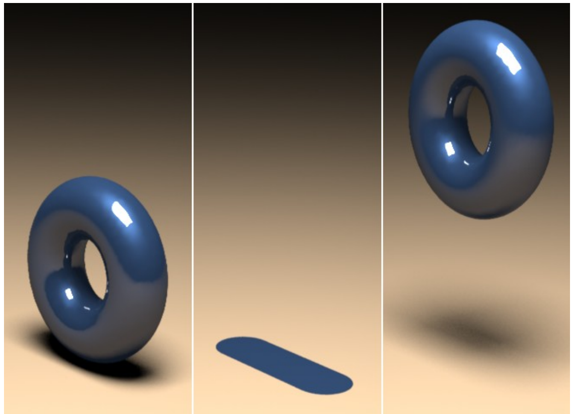
Cloth and Hair 2008

A summary of cloth and hair animation papers from SIGGRAPH, SCA, and CASA 2008.

CSE 888 with Dr. Rick Parent
presented by Michael Andereck
at The Ohio State University
October 28, 2008

Categories we'll look at today

- Hair Rendering
- Hair Animation
- Gross Cloth Animation
- Fibrous Cloth Animation

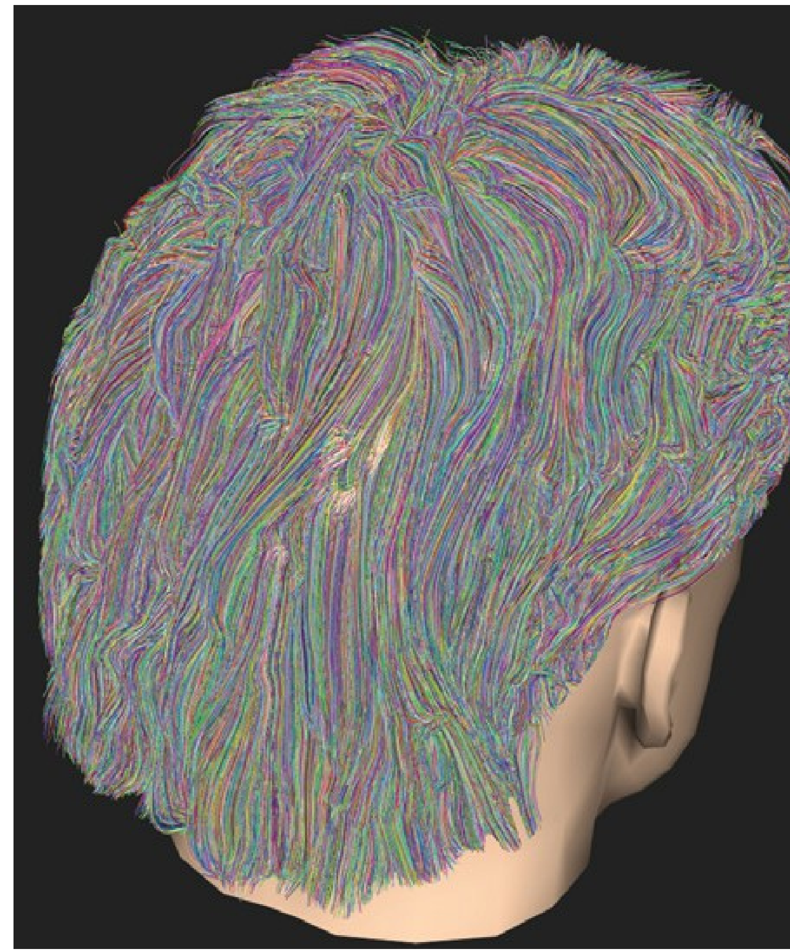


Hair Rendering

- "Hair Photobooth: Geometric and Photometric Acquisition of Real Hairstyles," Paris et al (Adobe, UCSD, MIT), SIGGRAPH 2008.
- "Efficient Multiple Scattering in Hair Using Spherical Harmonics," Moon et al (Cornell), SIGGRAPH 2008.
- "Dual Scattering Approximation for Fast Multiple Scattering in Hair," Zinke et al (Bonn, Texas A&M), SIGGRAPH 2008.

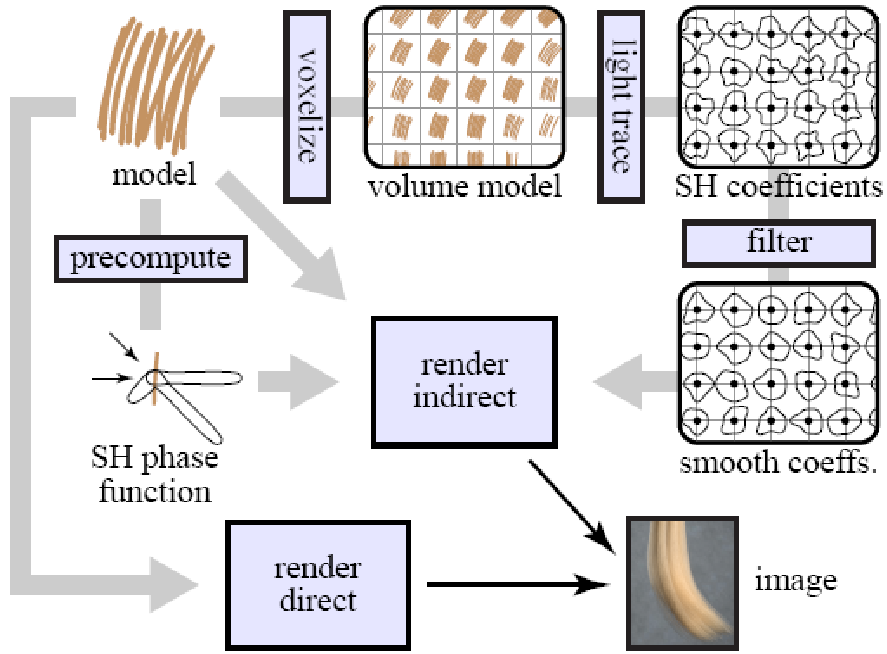
Hair Photobooth

- Hair model acquired by photo-scanning method, capturing fiber position and orientation to improve on visual hulls model.
- Detailed geometric model created from scan with hole filling from scalp to surface.
- Rendering can then be performed under arbitrary lighting and camera angles.
- Modeling takes ~10 hours and rendering takes 90-140s on a standard PC.



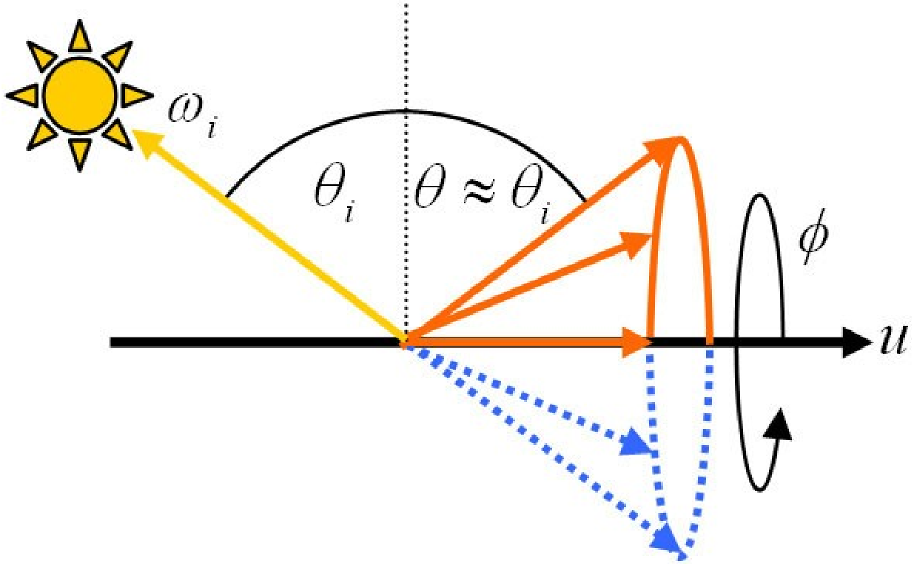
Efficient Multiple Scattering

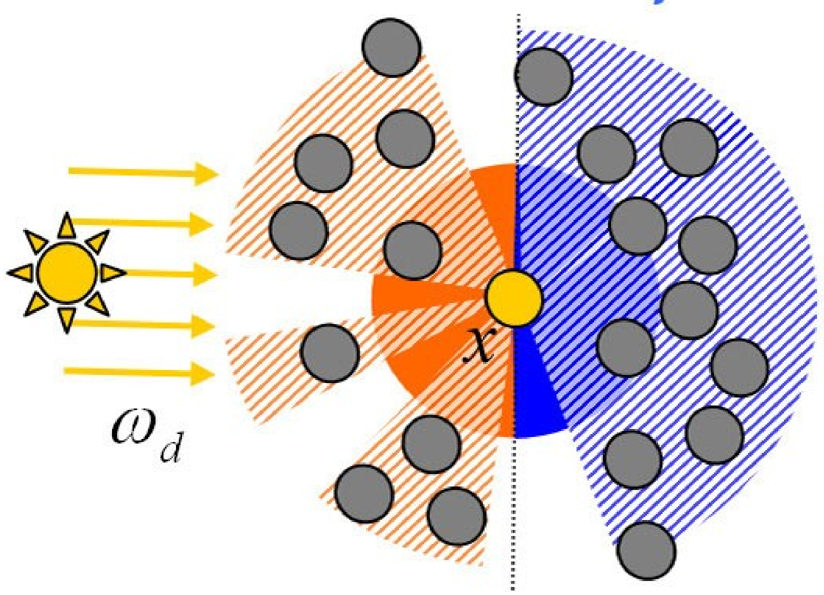
- Light scattering is critical to realistic hair rendering, particularly light colored hair
- Previous models have been too expensive, or have taken poor approximations
- This model uses a two-pass method similar to photon mapping, storing the spherical harmonics in a 3D grid space, rather than a photon-by-photon method, for more efficiency.
- The second pass uses a ray-tracer, integrating the stored radiance against the fiber's scattering function
- The result is visually compelling and 10x faster than photon methods.



Dual Scattering Approximation

- Unlike a photon approach, this method relies on aggressive approximations of the Bidirectional Scattering Distribution Function
- Realistic complex scattering can be achieved at two orders of magnitude faster than unbiased Monte-Carlo path tracing.
- Realistic results can be achieved in real-time on a standard PC



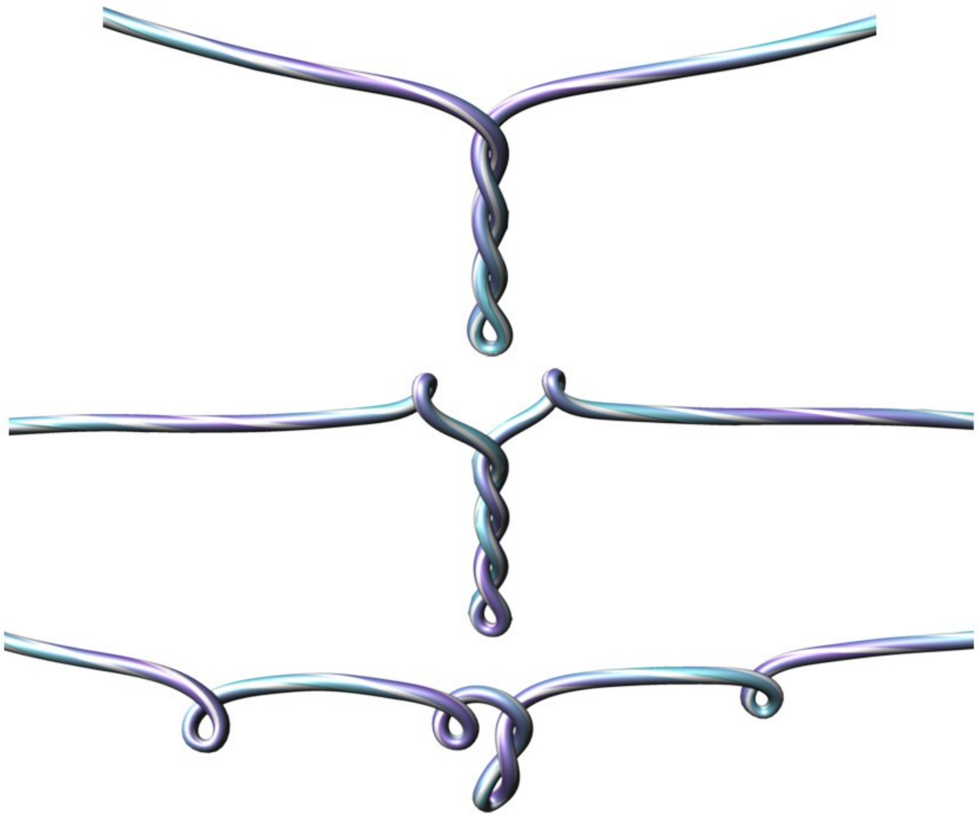


Hair Animation

- “Discrete Elastic Rods,” Bergou et al (Columbia), SIGGRAPH 2008.
- “A Mass Spring Model for Hair Simulation,” Selle et al (Stanford, ILM), SIGGRAPH 2008.

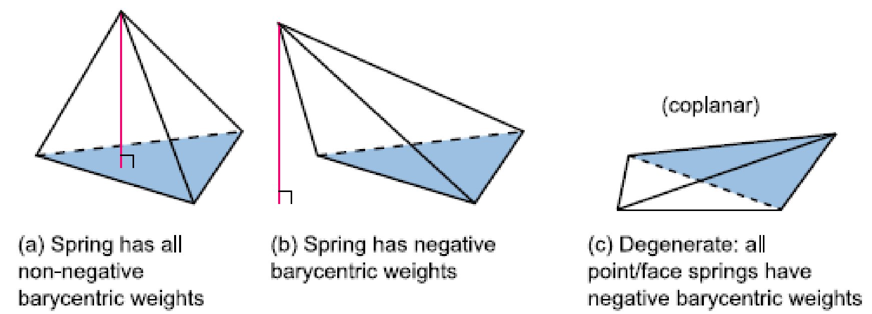
Discrete Elastic Rods

- Treat rods based as how it deviates from the standard Bishop frame.
- Nice results include buckling, dynamic bending, coupling between bending and twisting, knot-tying.
- See Ben's presentation for more information.



Mass-Spring Hair

- Goal is to model every of 100,000 hairs rather than a clumping or continuum model.
- Hairs have characteristics of friction, static attraction, etc.
- Mass-spring model for individual hairs allows for realistic individual hair behavior including clumping, and self- and environment-collisions.
- Altitude-spring based model allows for torsion of hair.
- Expensive but realistic results.



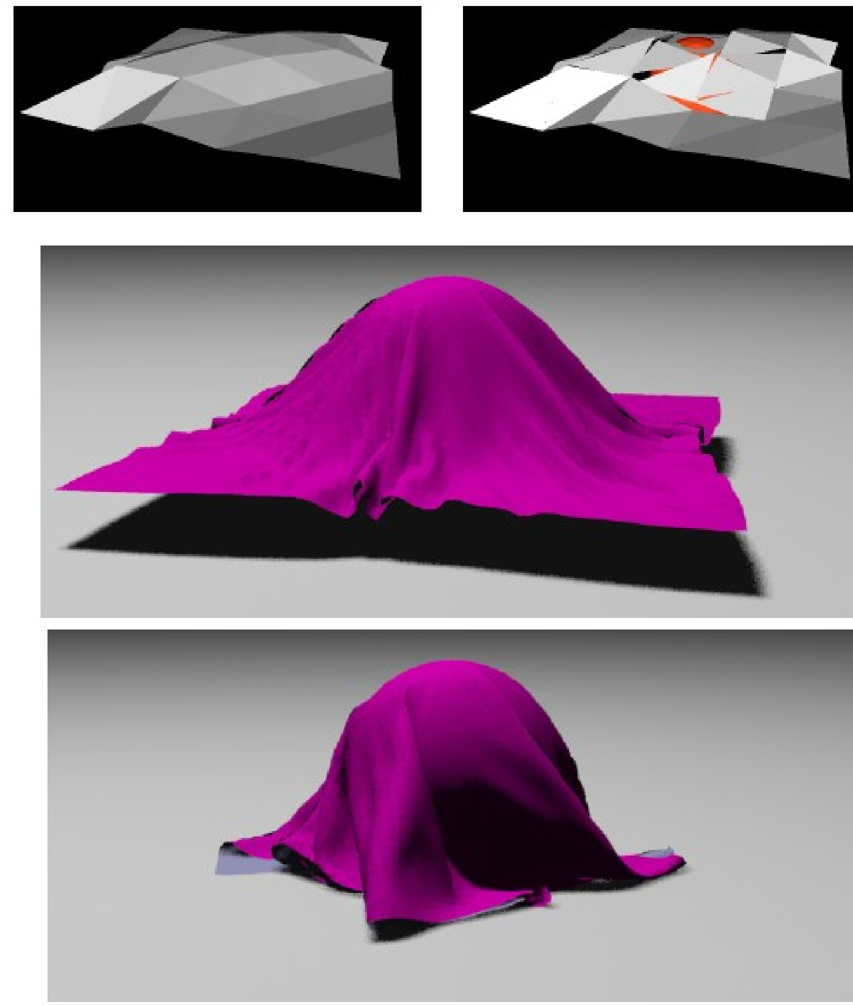
Gross Cloth Animation

- “Modeling yucky stains in cloth,” NOTAPAPER 2008.
- “Animating Developable Surfaces Using Nonconforming Elements,” English et al (British Columbia), SIGGRAPH 2008.
- “A Physically Faithful Multigrid Method for Fast Cloth Simulation,” Oh et al (KAIST), CASA 2008.

Yucky Stains

Animating Developable Surfaces Using Nonconforming Elements

- Present a discretization for physics-based animation of developable surfaces.
- Constrained not to deform in plane, but out of plane.
- This non-conforming approach allows zero in-plane deformation to be a hard constraint, but causes discontinuous meshes.
- Add a ghost mesh to get around this.
- Uses a second-order time-integration method which can yield significant speedup.
- Can run on 100x100 mesh at ~10s/frame



Multigrid Fast Cloth Simulation

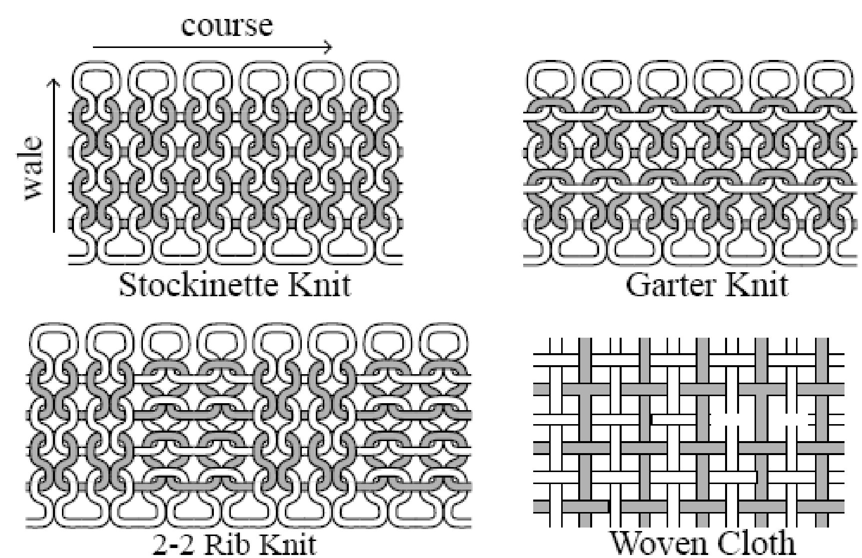
- They present a multigrid method adequate for solving a heavy linear system in cloth simulation in $O(n)$ time, rather than $O(n^{1.5})$ time.
- Difficult to migrate to cloth problems due to lack of physical meaning in levels
- Their algorithm ensures conservation of all physical properties across levels.
- Demonstrations across multiple garment types with 4x speedup in computation over preconditioned conjugate gradient method.

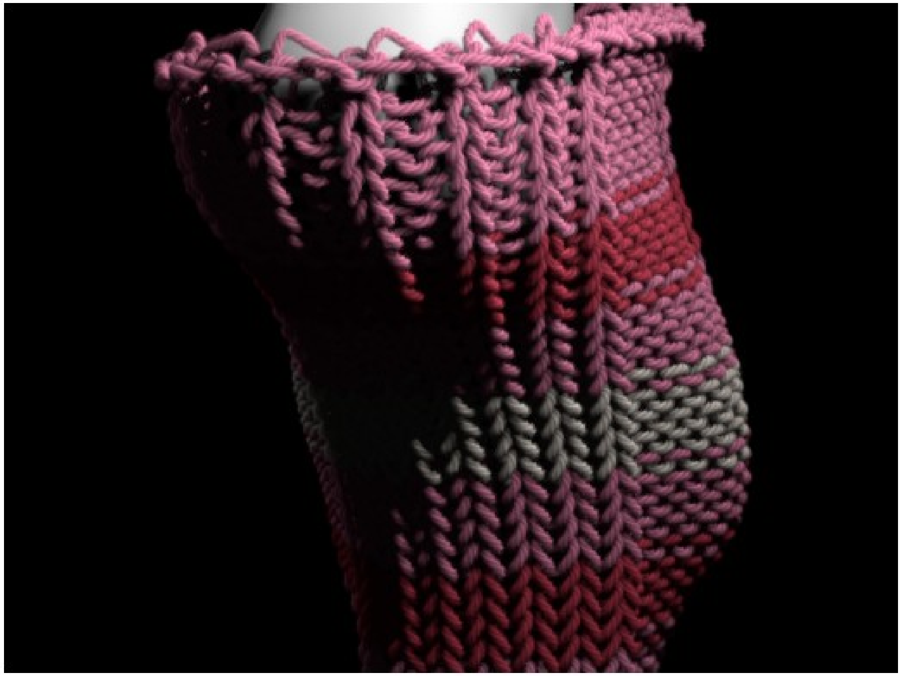
Fibrous Cloth Animation

- “Simulating Knitted Cloth at the Yarn Level,” Kaldor et al (Cornell), SIGGRAPH 2008.
- “Shear Buckling and Dynamic Bending in Cloth Simulation,” Zhou et al (Chinese University of Hong Kong), CASA 2008.

Simulating Knitted Cloth

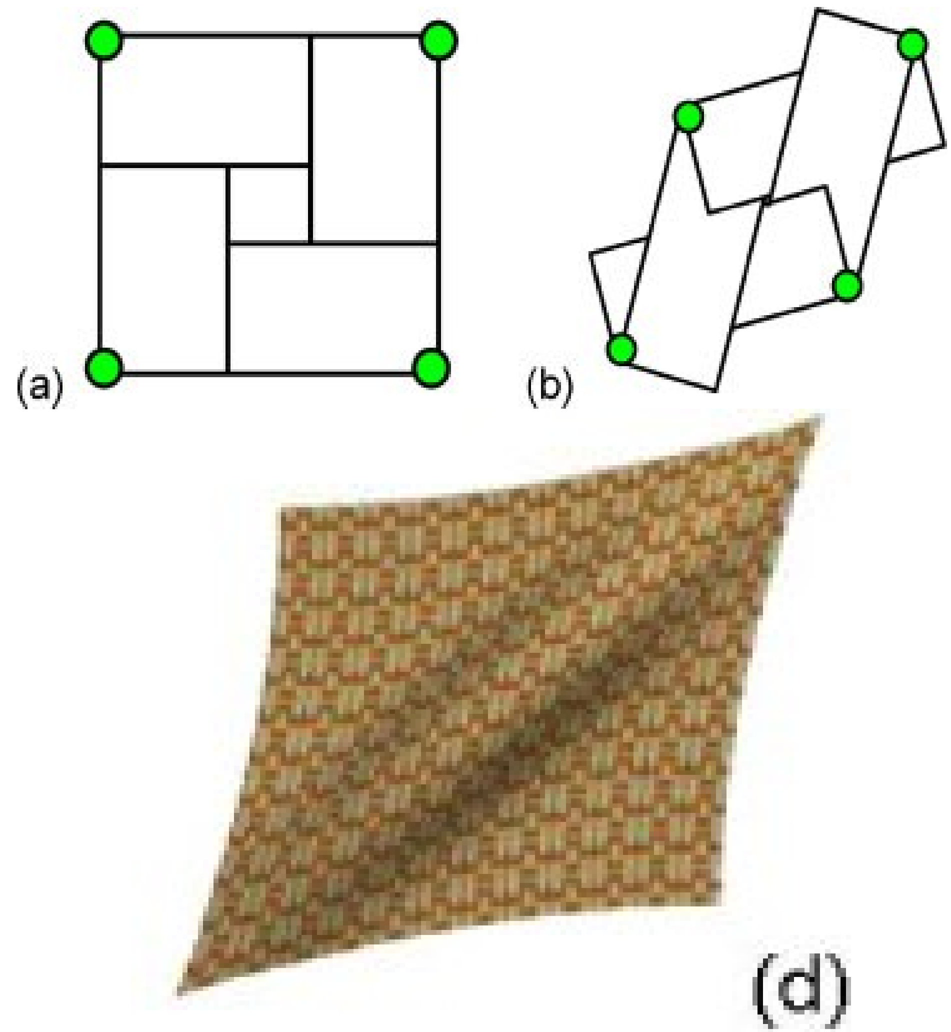
- Knitted fabrics behave differently from woven material.
- This simulation focuses on yarns rather than sheets.
- Yarns simulated as inextensible, but otherwise flexible B-spline tubes.
- Friction among yarns approximated by rigid-body velocity filters.
- Key yarn-yarn interactions mediated by stiff penalties.
- Realistic results with practical off-line simulation rates.





Shear Buckling, Dynamic Bending

- Woven fabrics behave differently than other sheet materials.
- Model shear buckling by simulating the microstructure of weaving.
- Model structural bending based on the thin-shell theory.
- Wrinkles and folds appear and disappear in a more natural way than previous models.



Future Focus

- For the next presentation, I will focus on the fibrous cloth animation papers.