

# **OpenVDB at DWA**

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DreamWorks Animation

**Jeff Budsberg**  
FX Lead

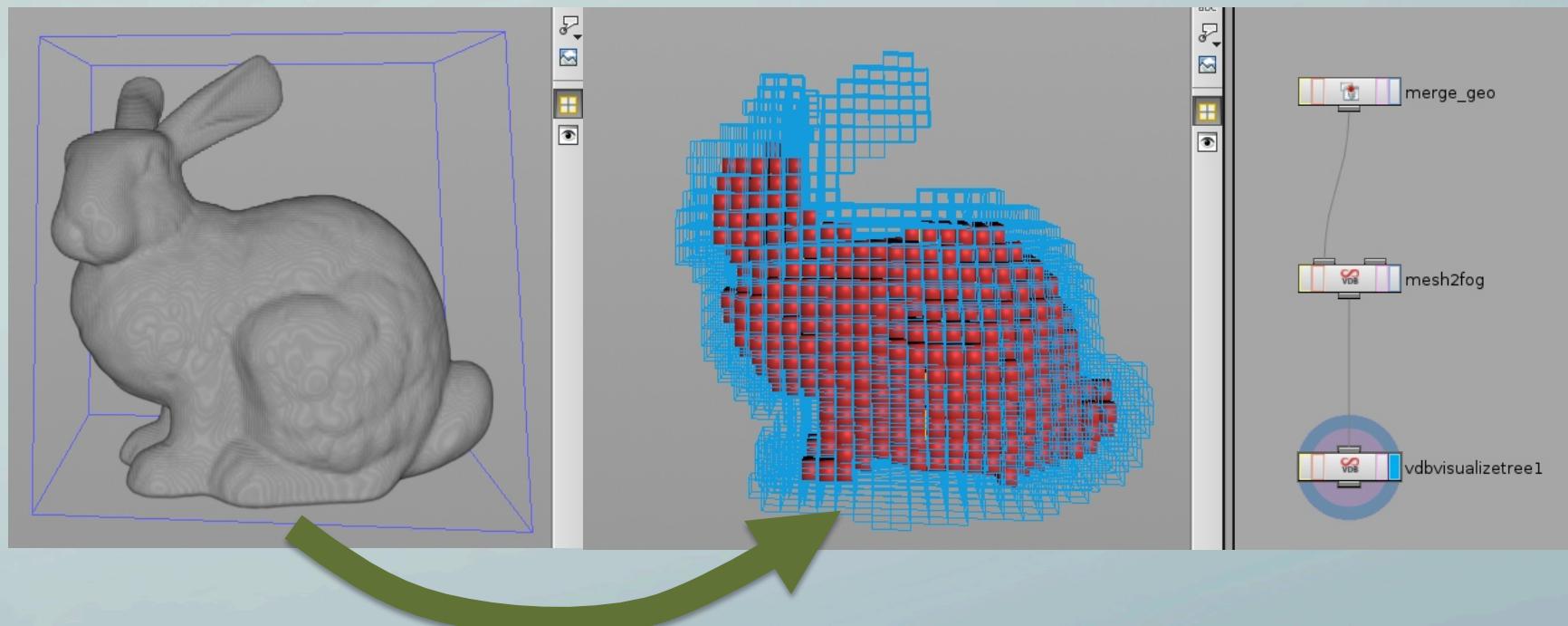
# Talk overview

- Toolset
  - Houdini SOPs
- Applications
  - Clouds
  - Liquids
  - Advection
  - Fluids
  - Deformation
  - Fracture
  - Visualization

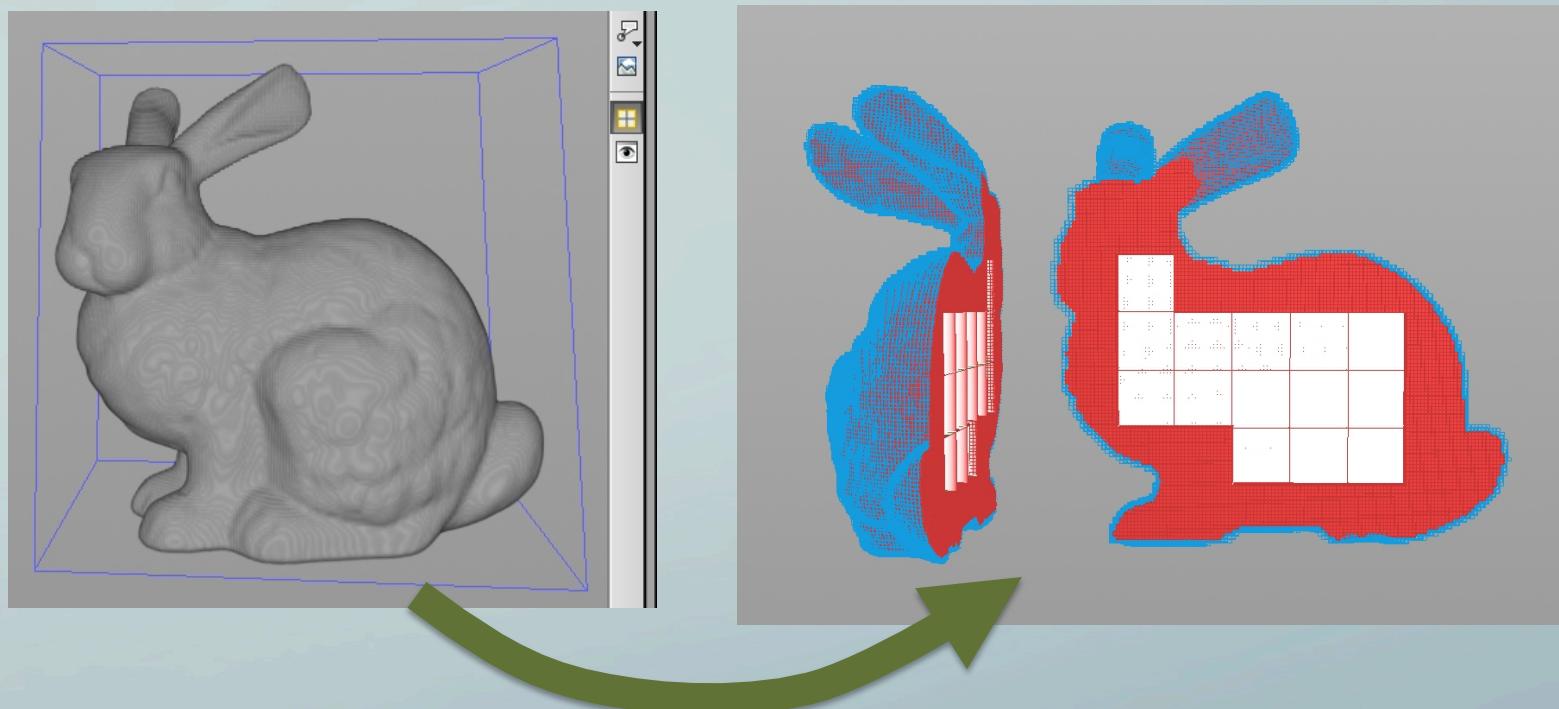
# Toolset

- Exposed as a collection of Houdini SOPs
- A first-class citizen as a primitive
- At DWA
  - Native Houdini SOPs
  - OpenVDB
  - Custom production nodes

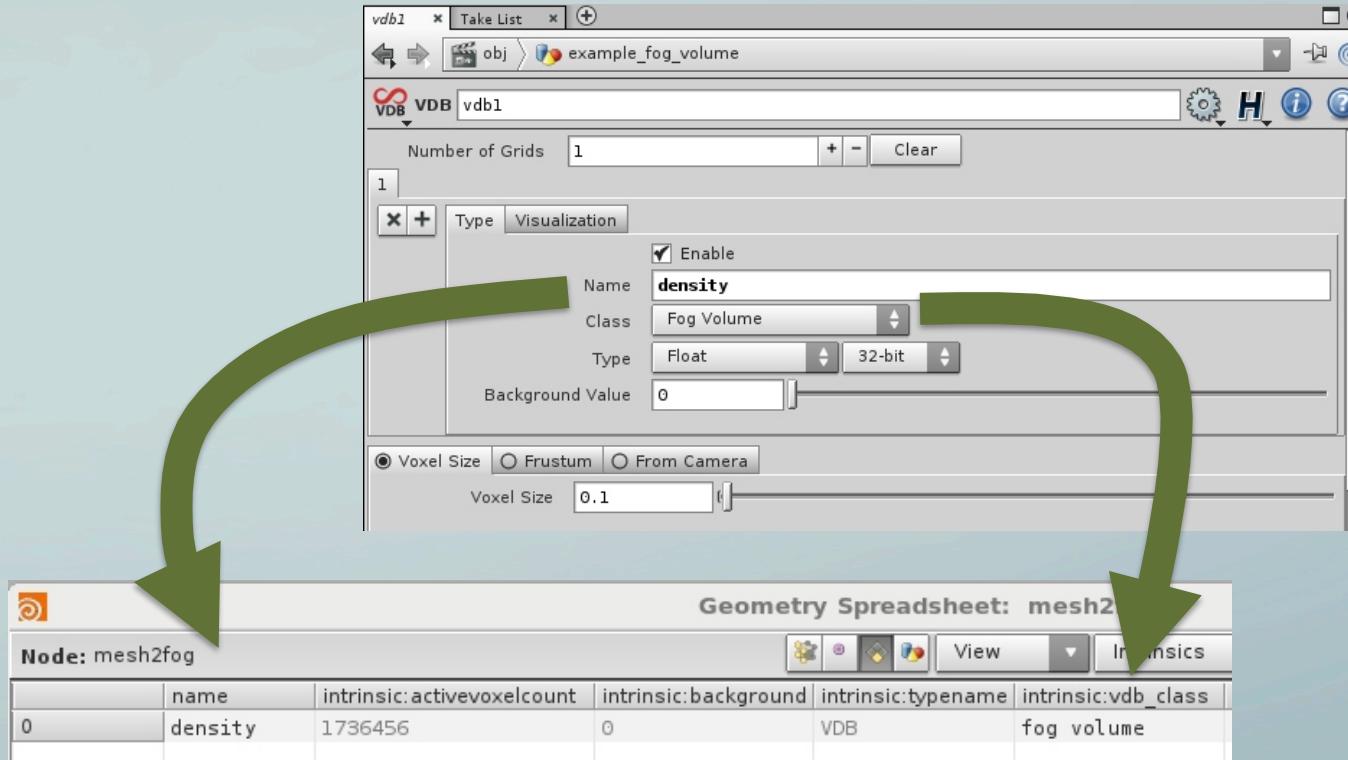
# Volume Creation



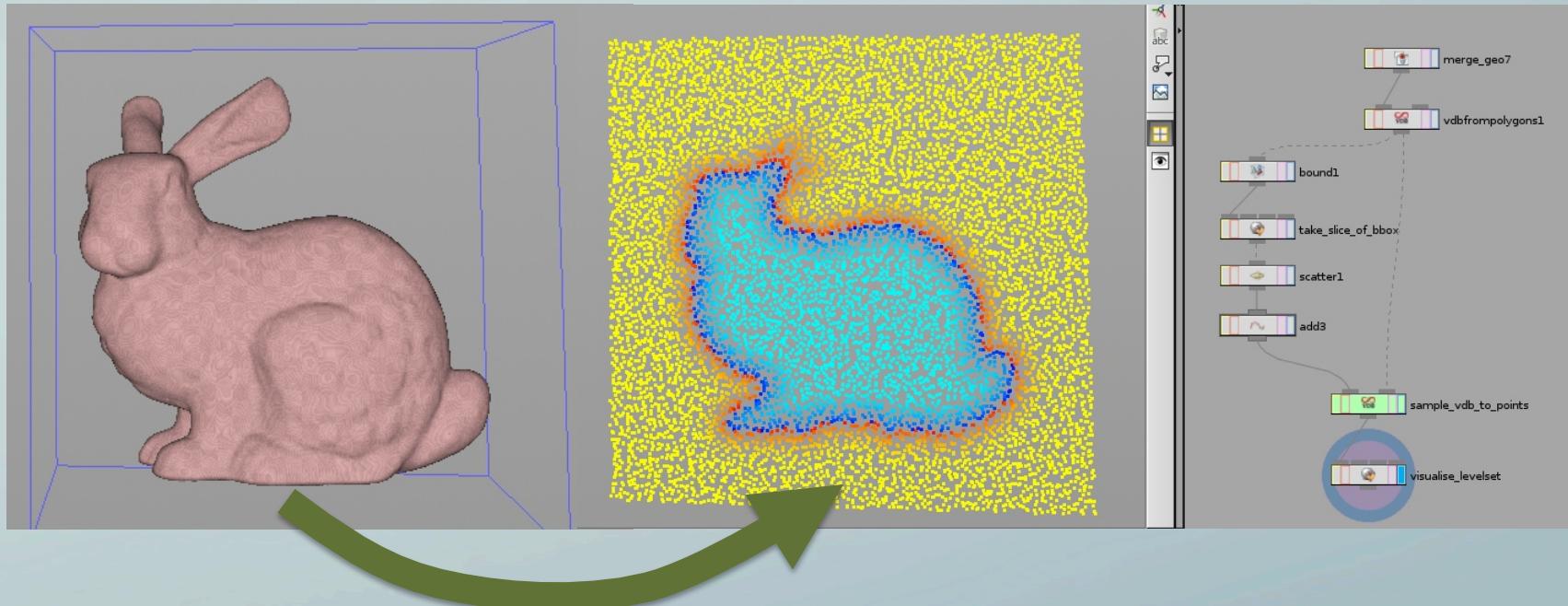
# Volume Creation



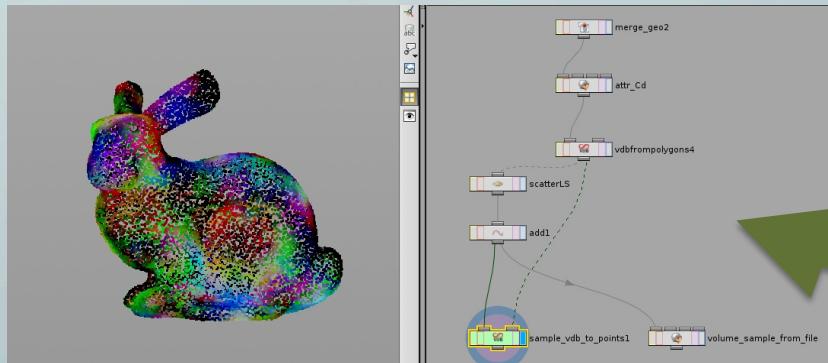
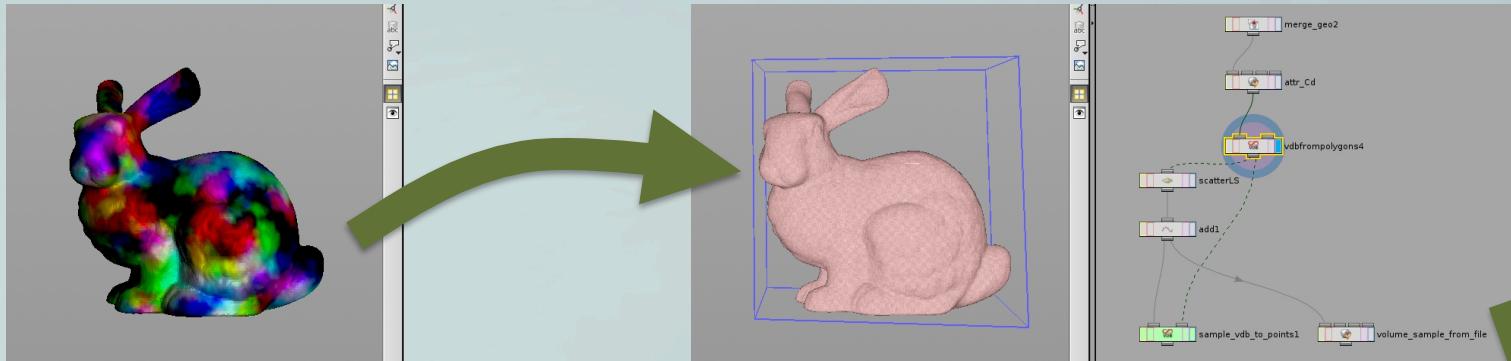
# Volume Creation



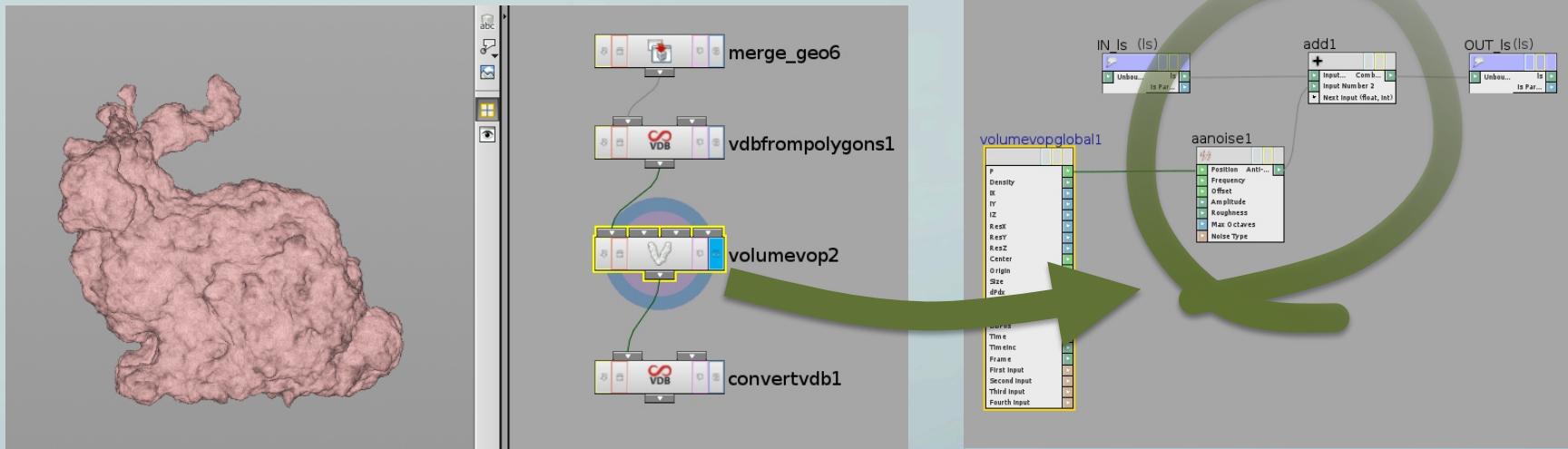
# Level Sets



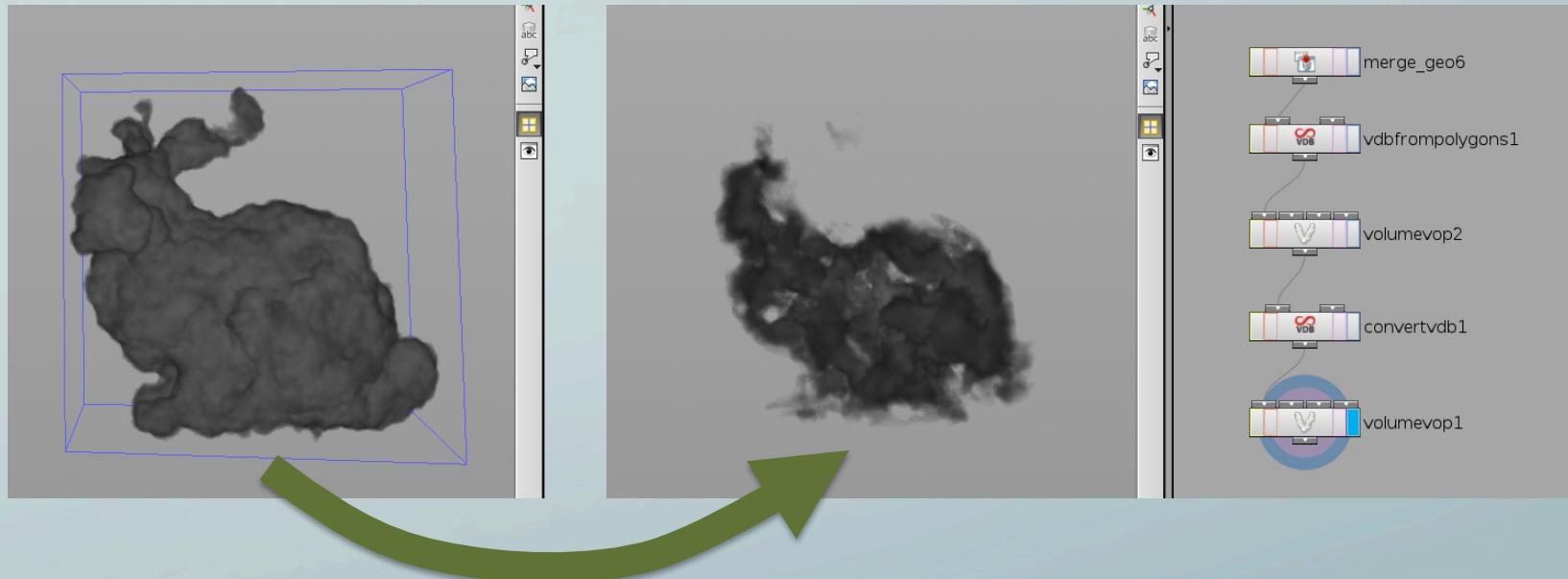
# Arbitrary Grids



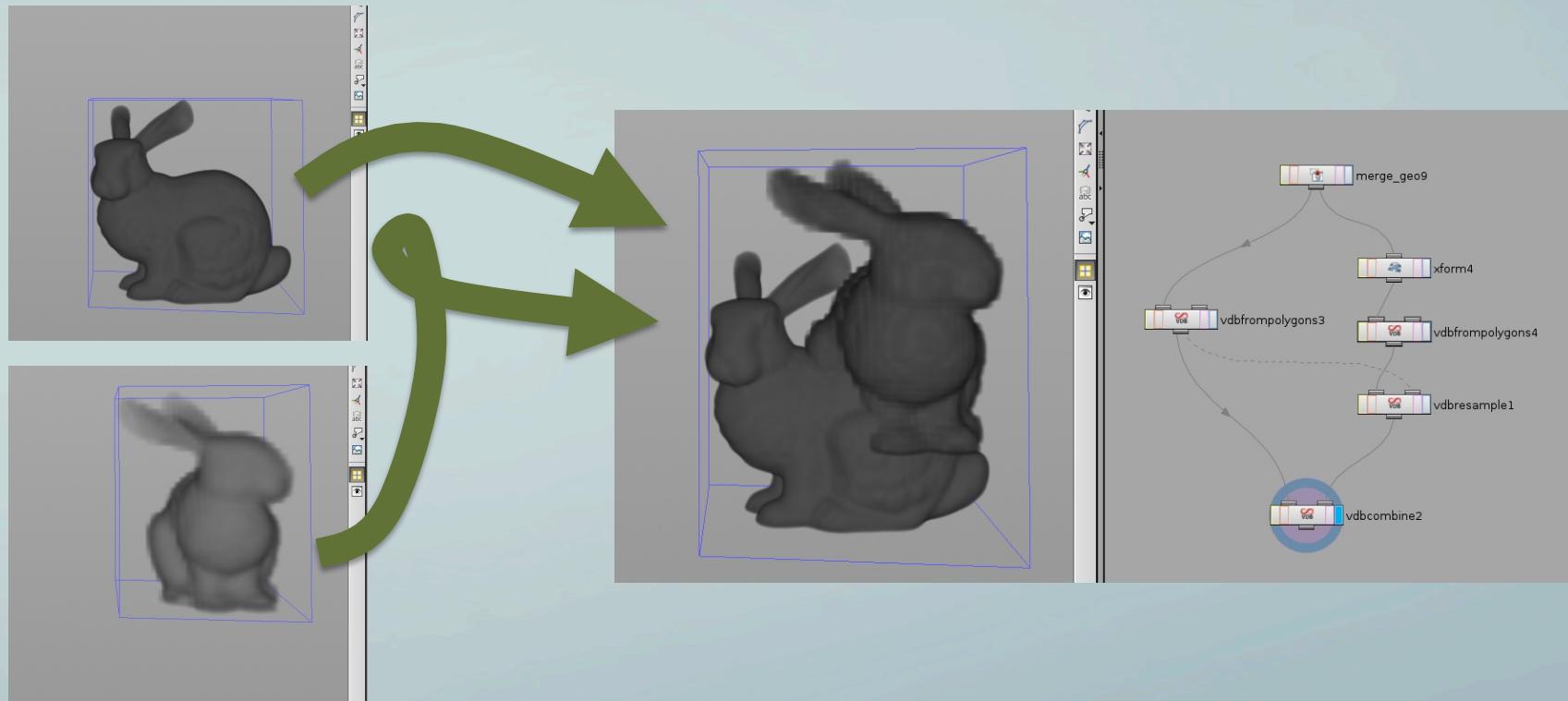
# LS Manipulation



# LS to Fog



# Combining Grids



# Talk overview

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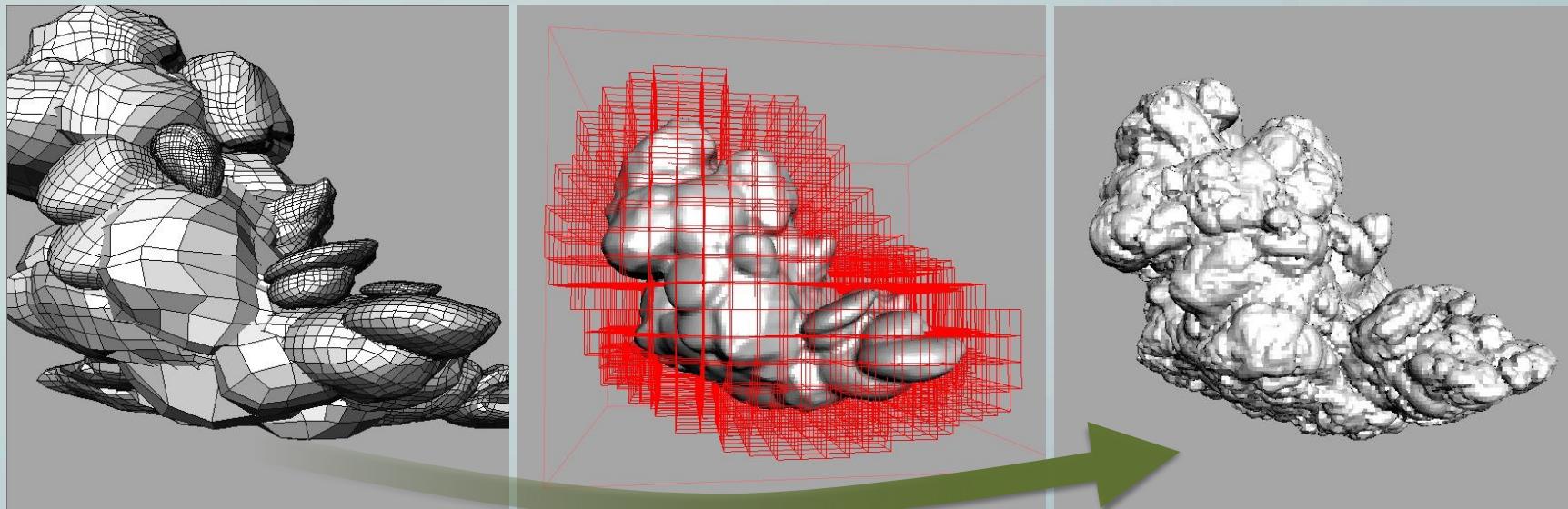
# Clouds



# Clouds

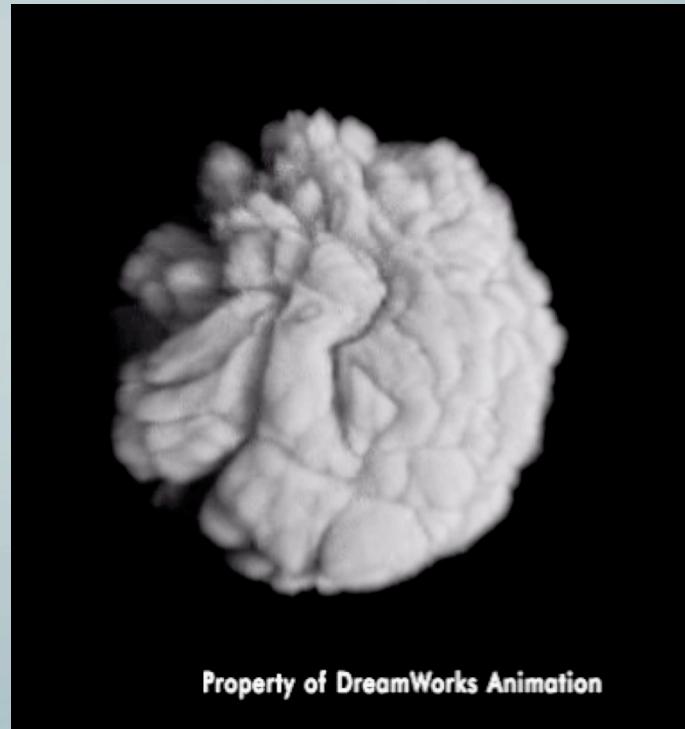
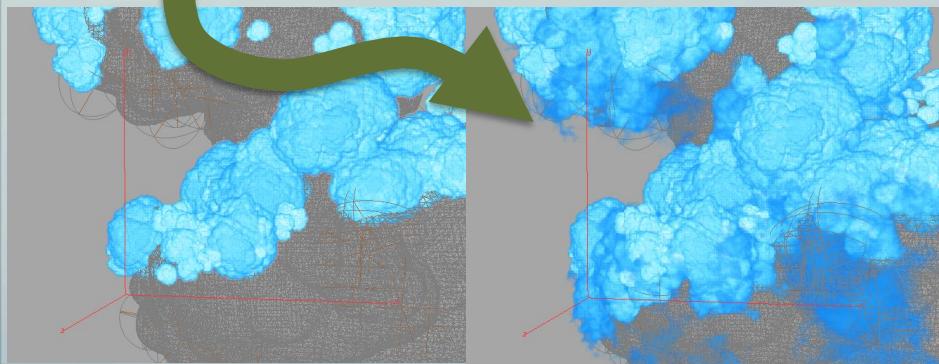
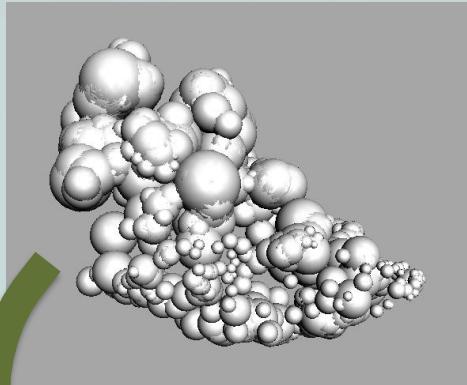


# Cloud Modeling



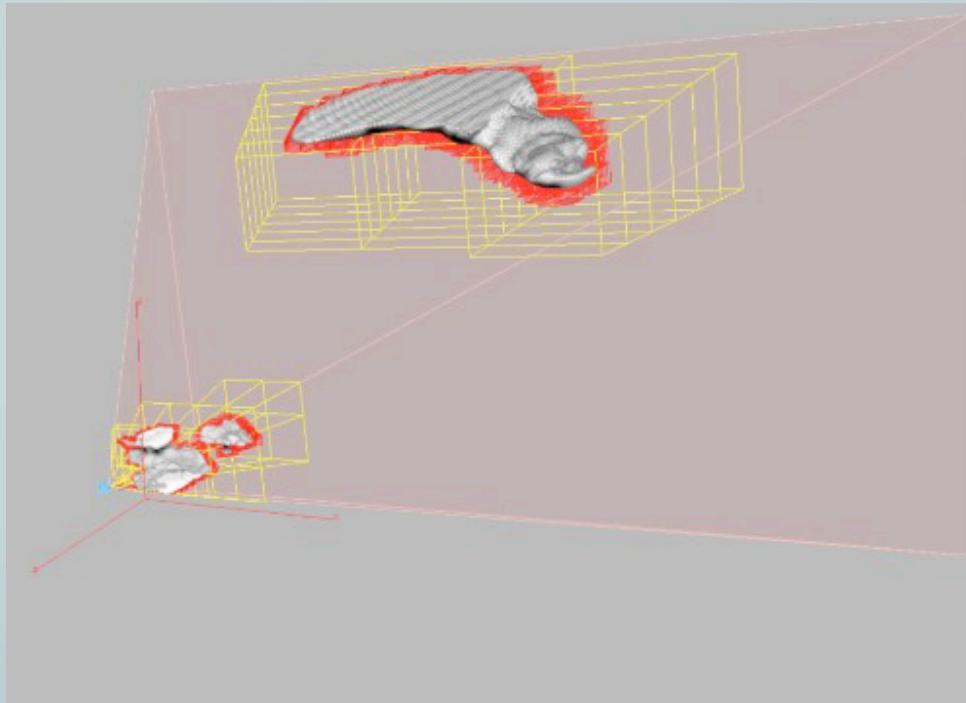
Miller, B., Museth, K., Penney, D. and Bin Zafar, N. Cloud modeling and rendering for Puss in Boots.  
ACM Siggraph Talks, 2012

# Spherical Pyroclasts

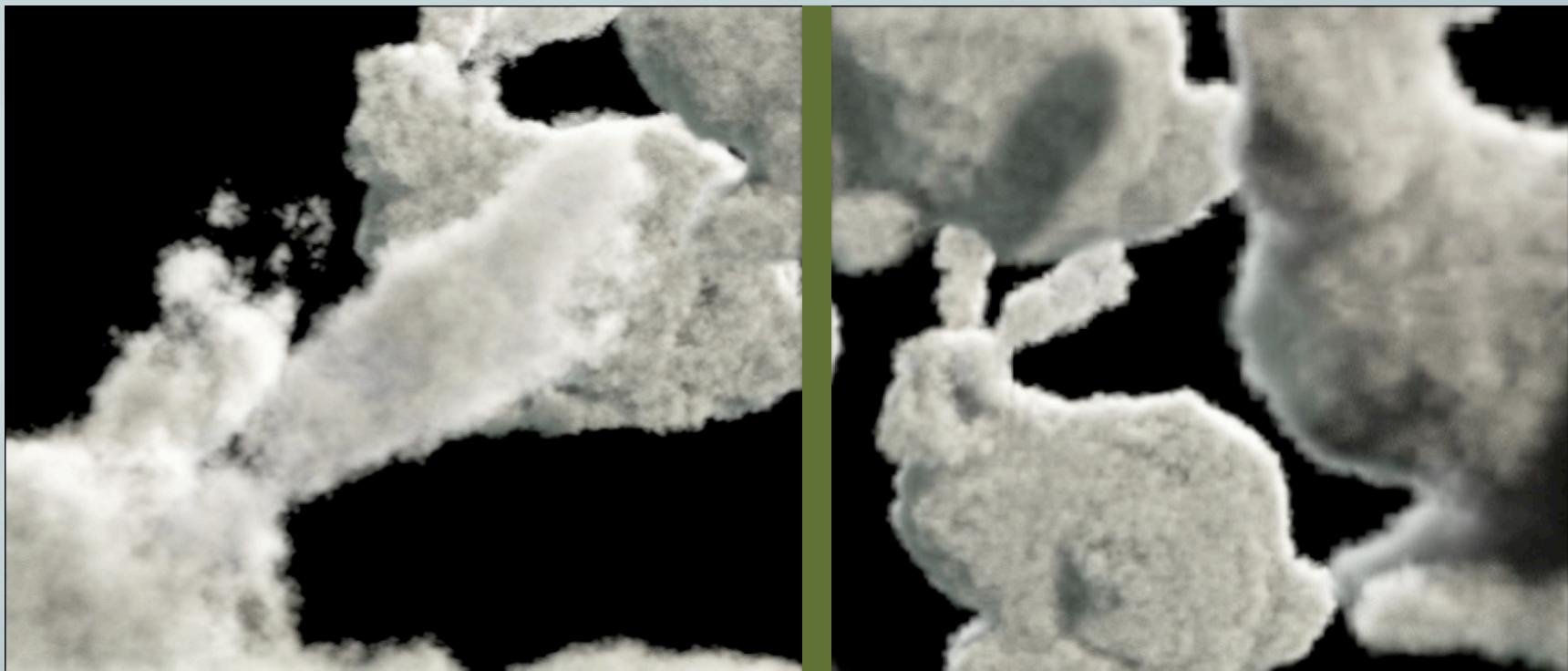


Property of DreamWorks Animation

# Frustum Buffer



# Frustum Buffer



# Liquids



Budsberg, J., Losure, M., Museth, K., Baer, M. Liquids in The Croods. DigiPro, 2013

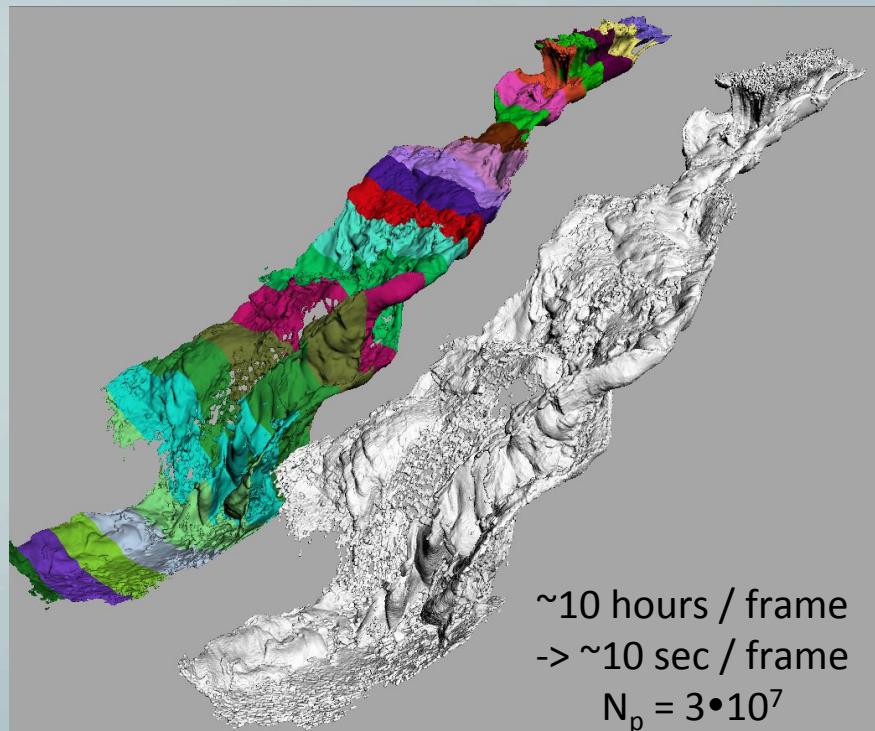
# Liquids



Budsberg, J., Losure, M., Museth, K., Baer, M. Liquids in The Croods. DigiPro, 2013

# Particle Surfacing

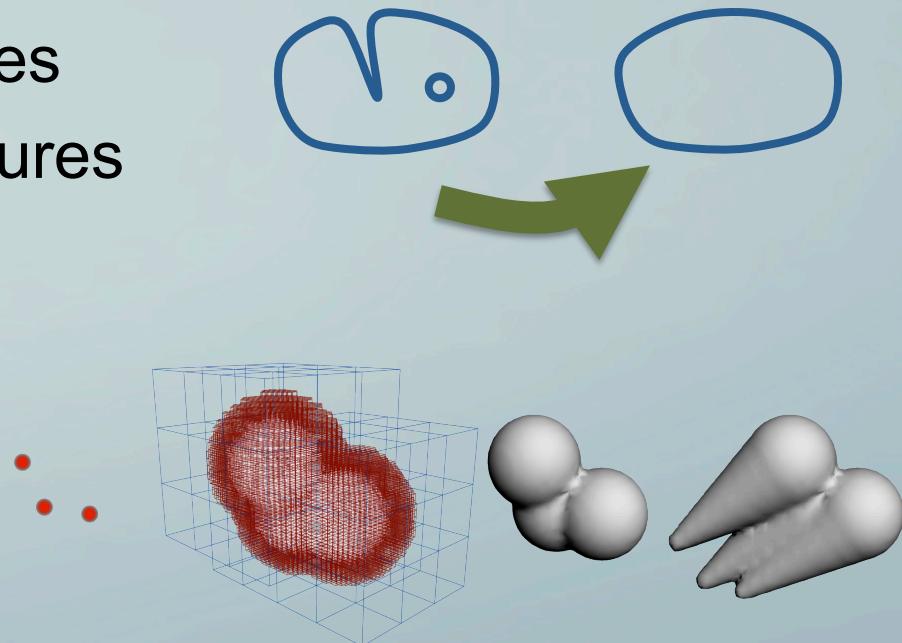
- Monolithic solutions inadequate



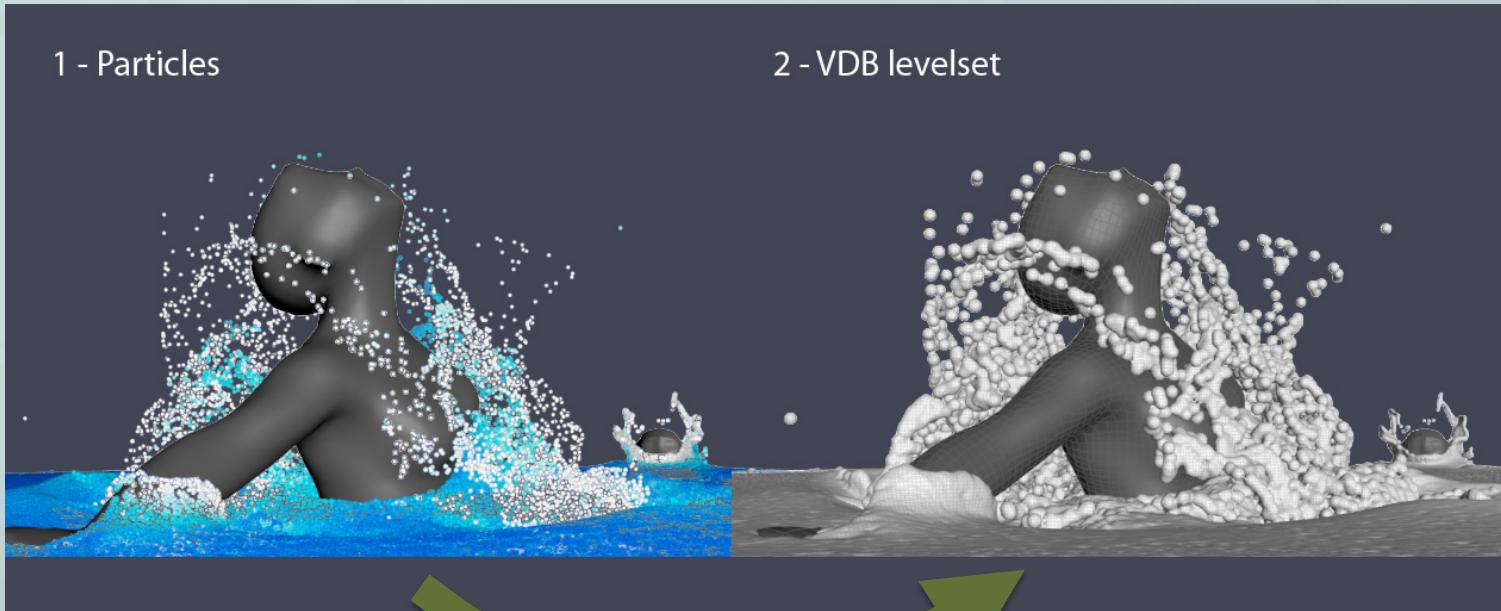
~10 hours / frame  
-> ~10 sec / frame  
 $N_p = 3 \cdot 10^7$

# Particle Surfacing

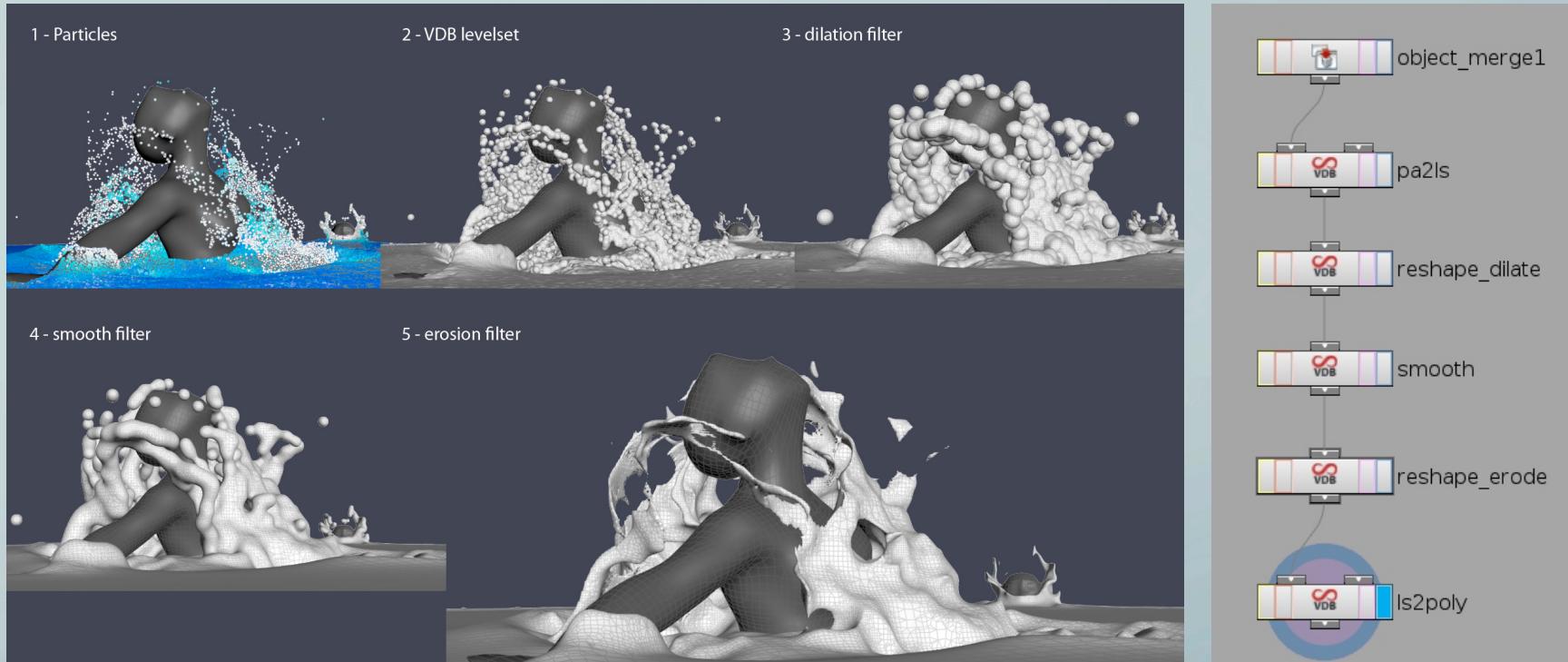
- Artists want control
  - Remove artifacts / holes
  - Accentuate sharp features
  - Smooth flat areas
  - And make it fast!



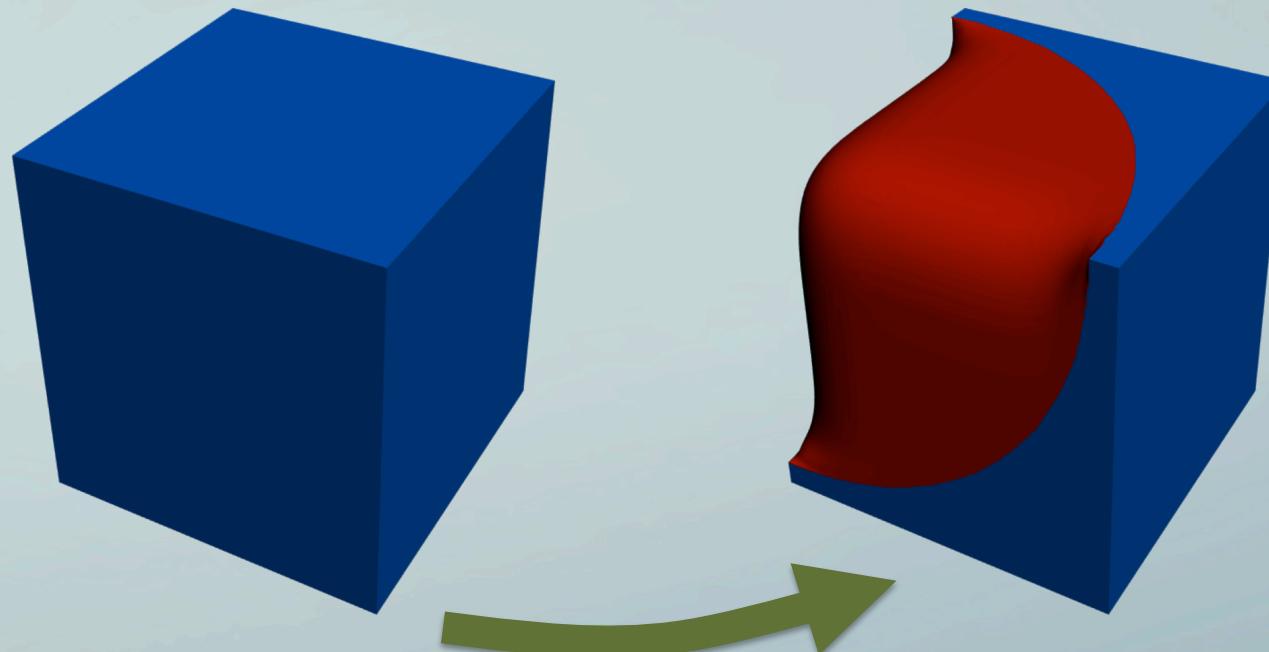
# Particle to LS



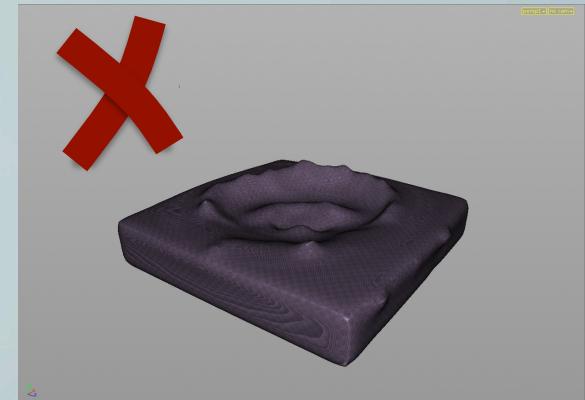
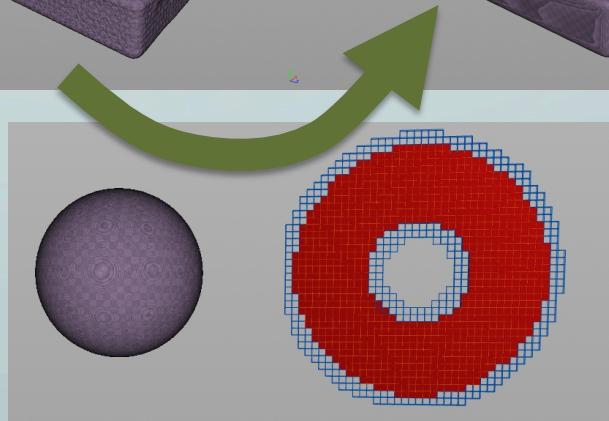
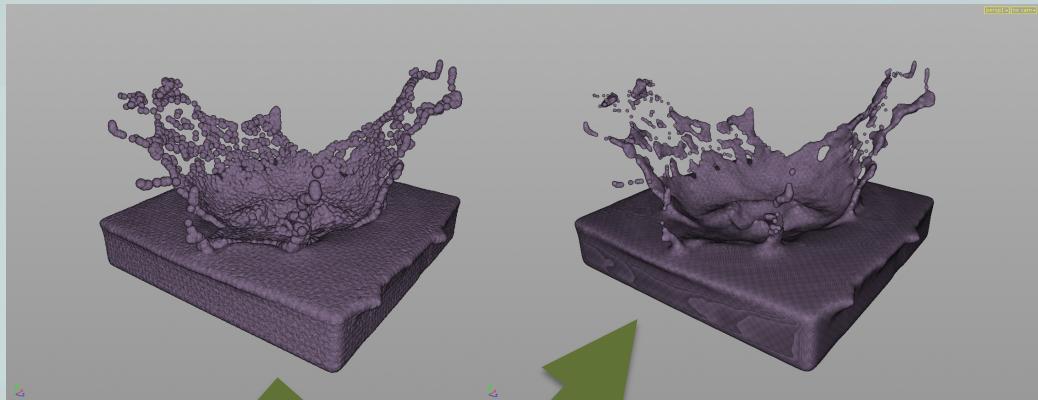
# LS Filtering / Morphological Ops



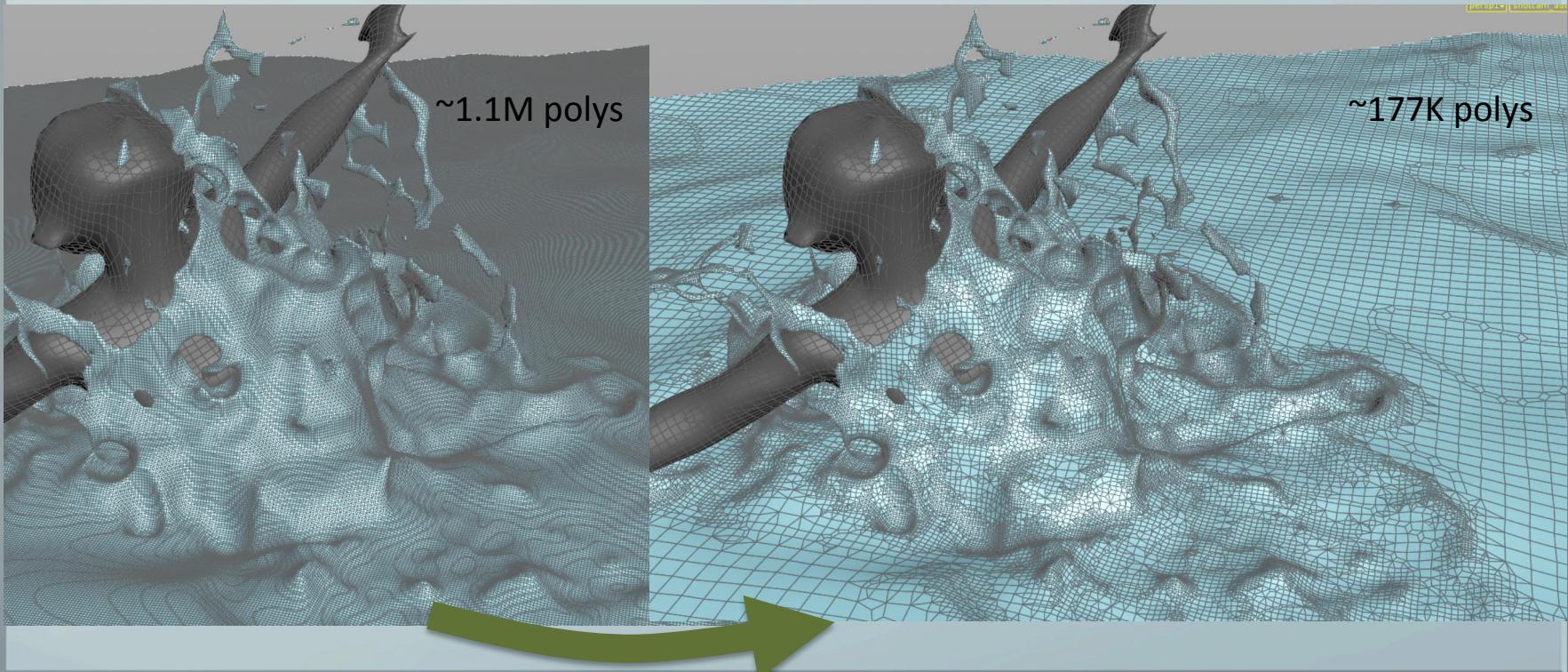
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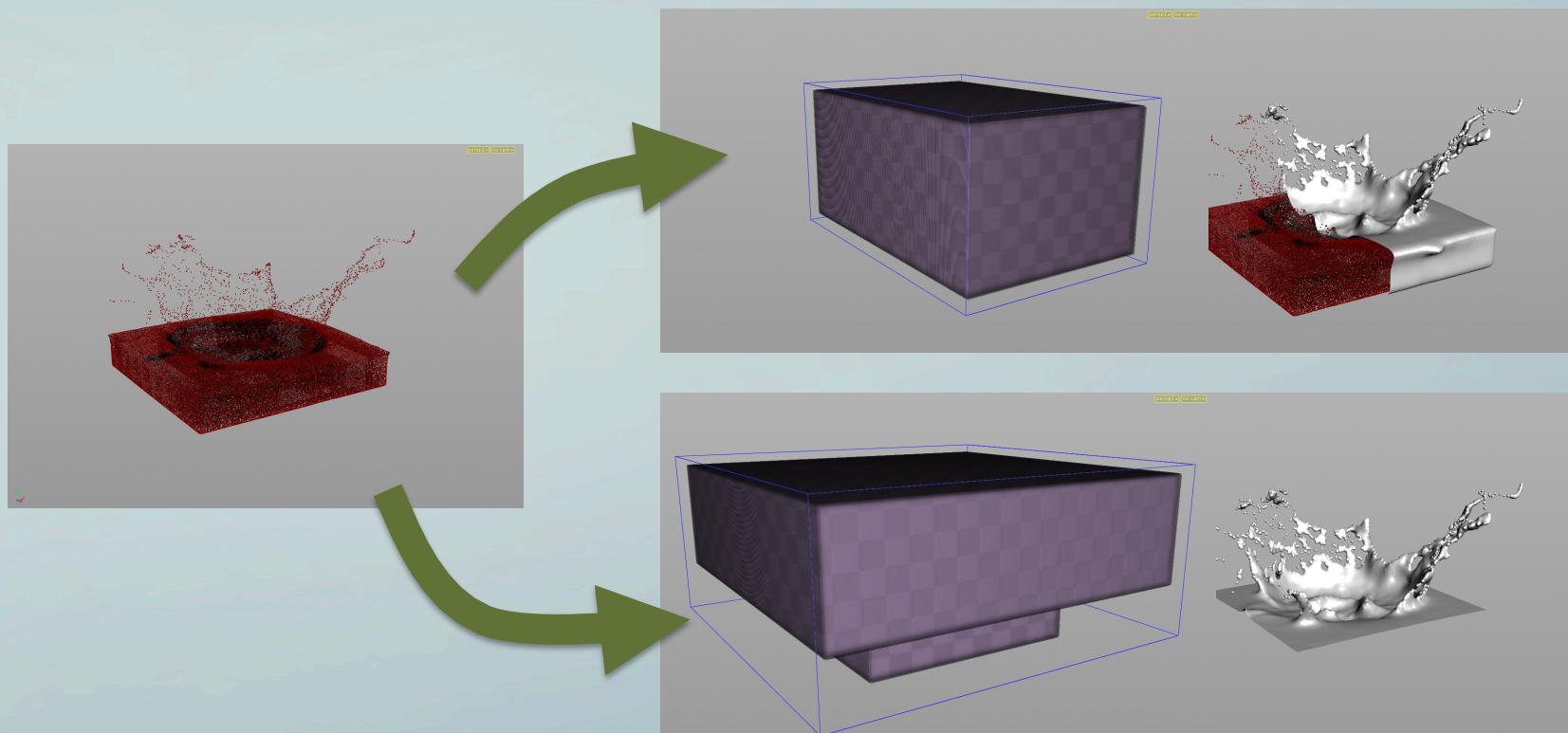
# LS Filtering / Morphological Ops



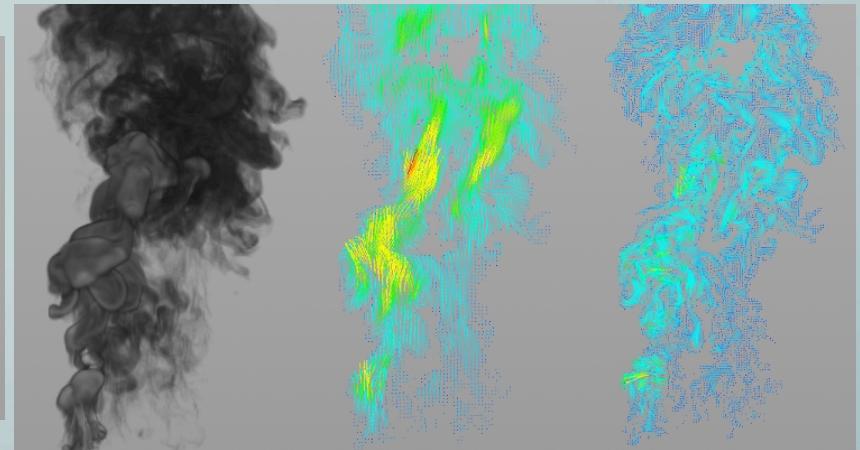
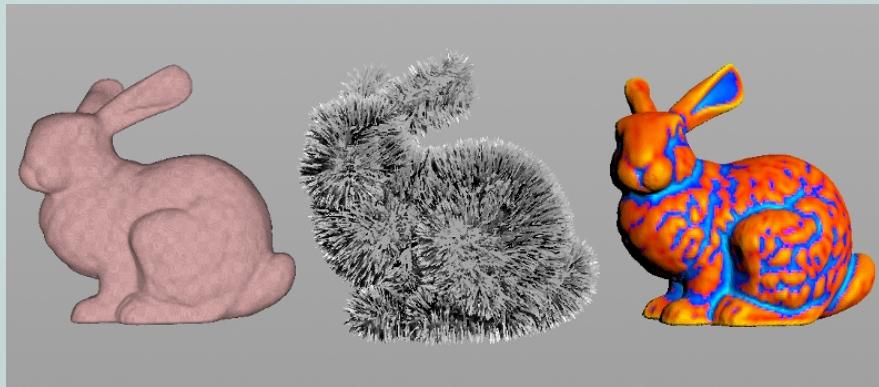
# Adaptive meshing



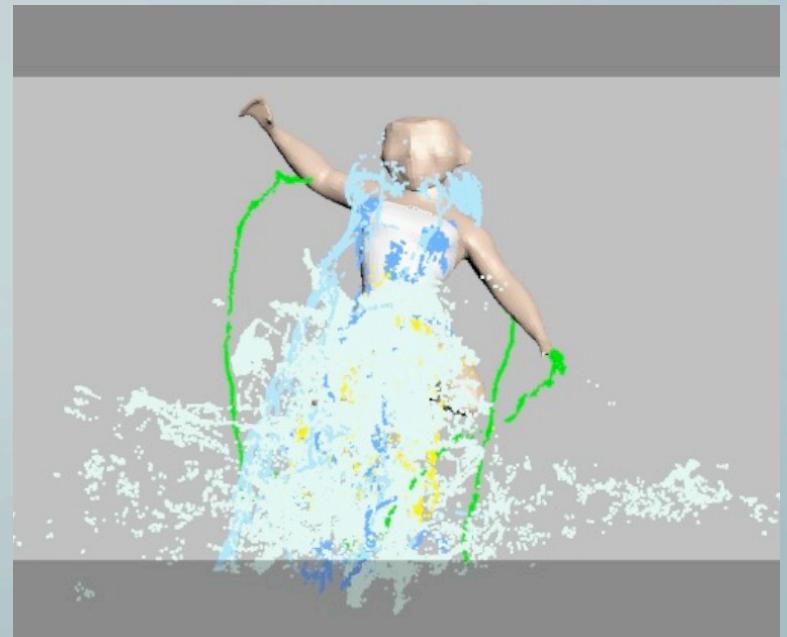
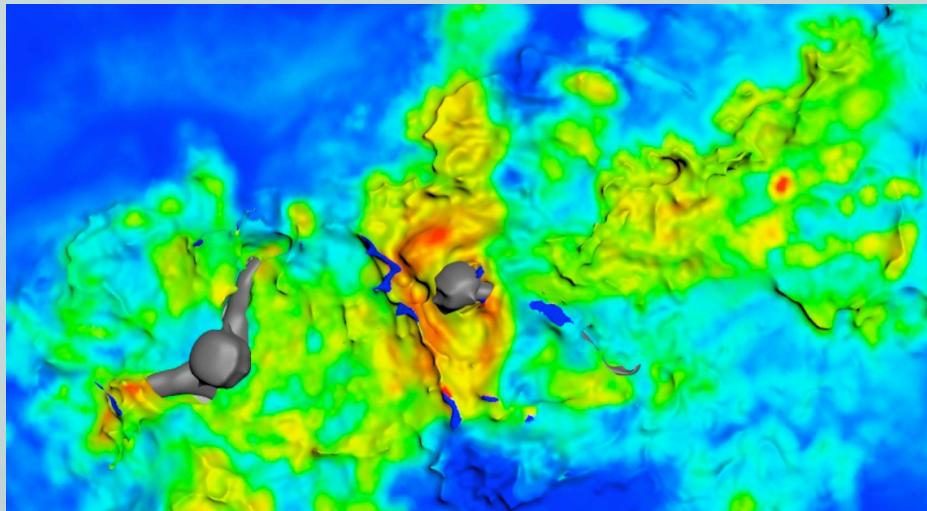
# Masked meshing



# Grid Analysis



# Grid Analysis

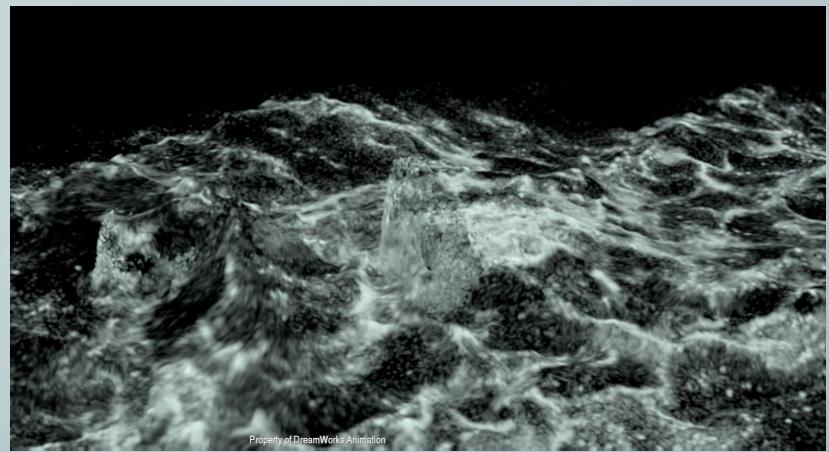
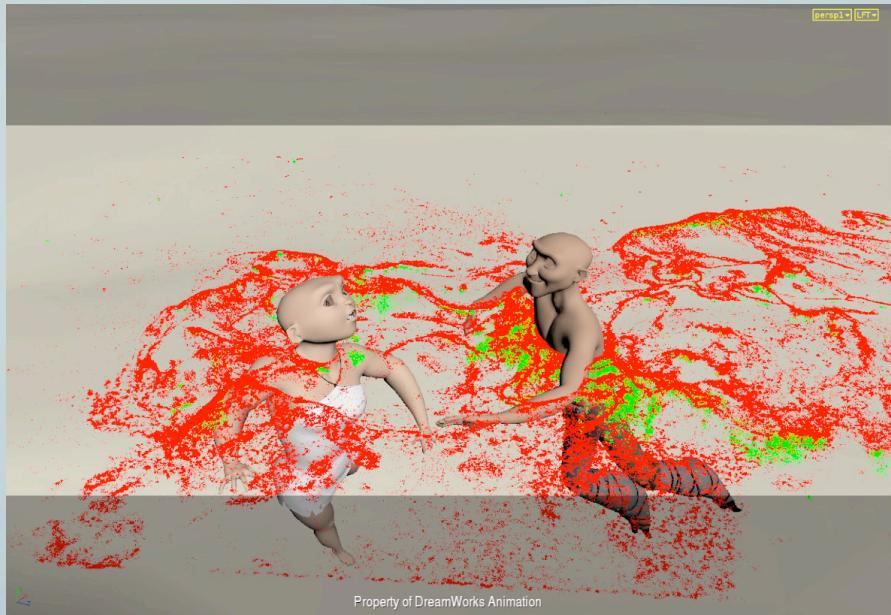


# Grid Analysis



Property of DreamWorks Animation

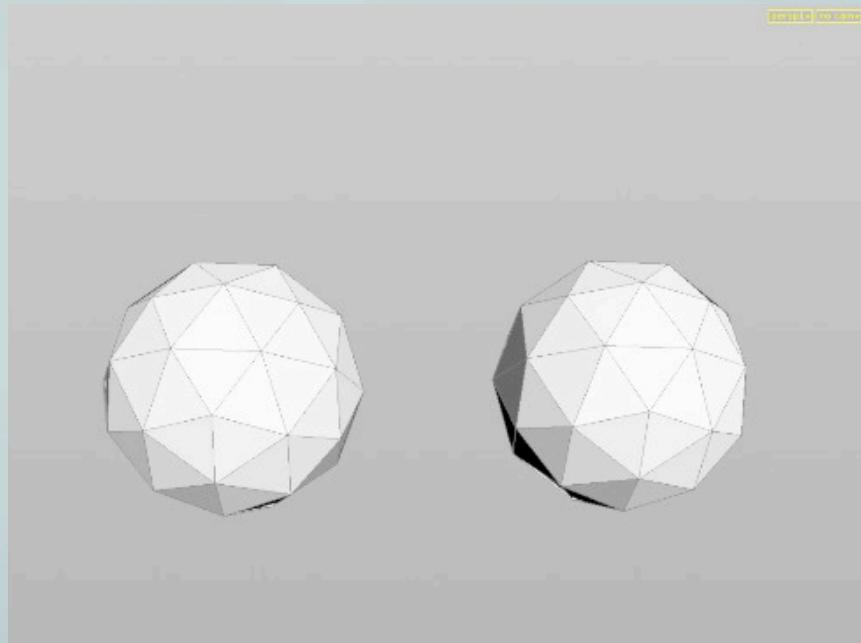
# Constrained advection



# Vector Fields

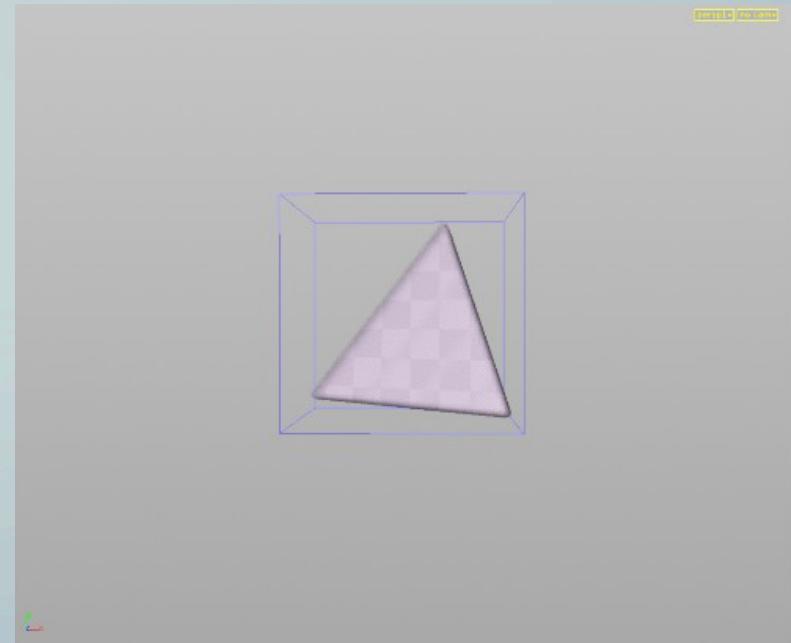
$F(x, y, z) = \hat{y}x - \hat{x}y$

# Advection



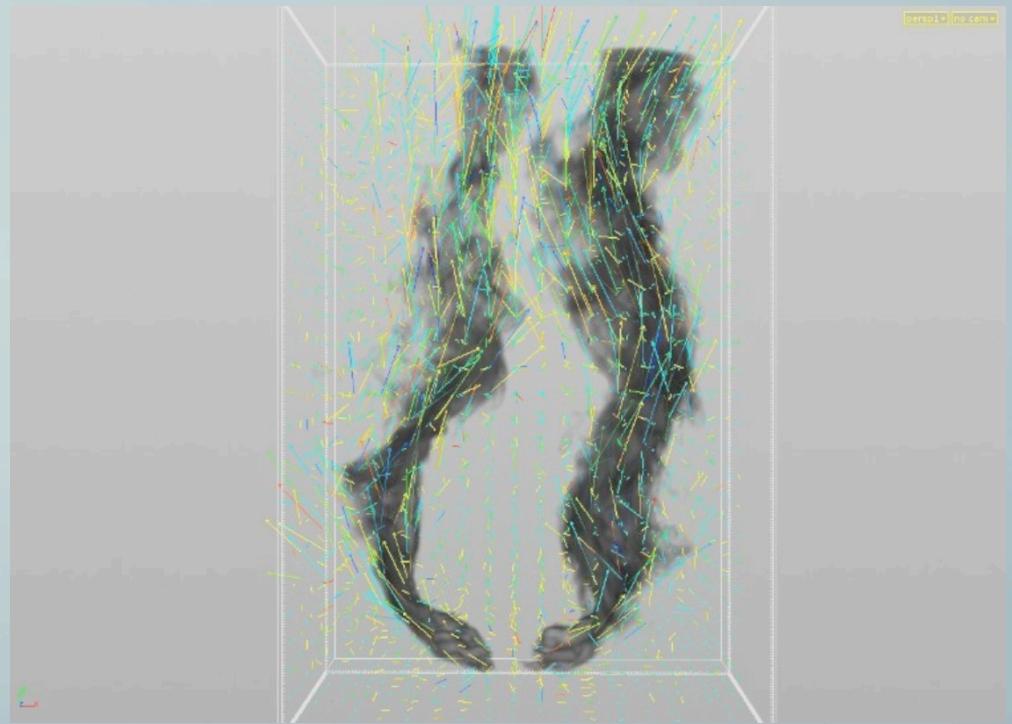
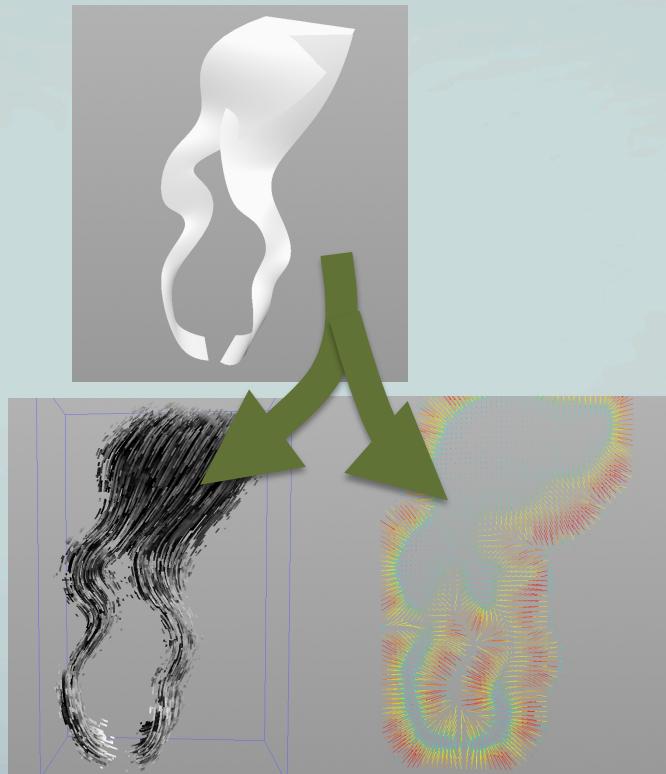
Forward Euler

Runge-Kutta 4<sup>th</sup> order



Level Set

# Flow fields



# Flow fields



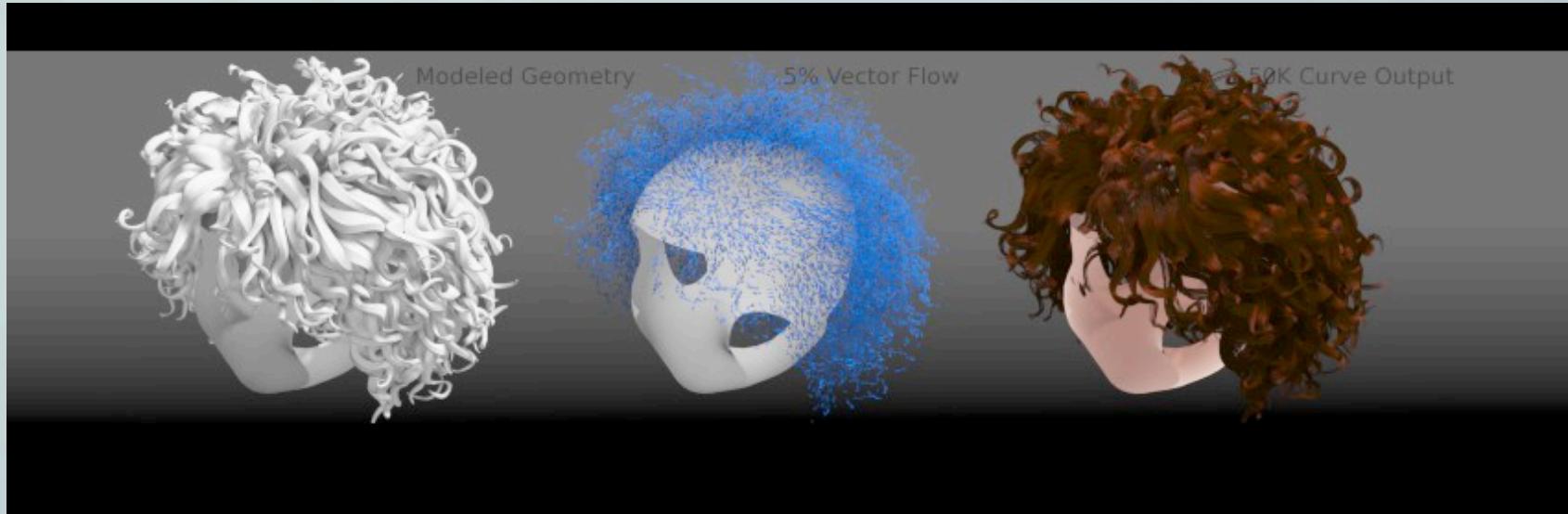
Property of DreamWorks Animation



Property of DreamWorks Animation

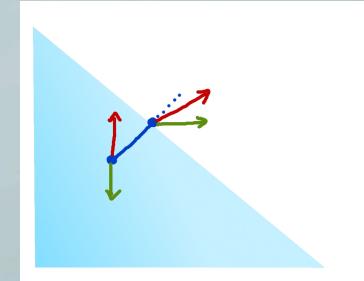
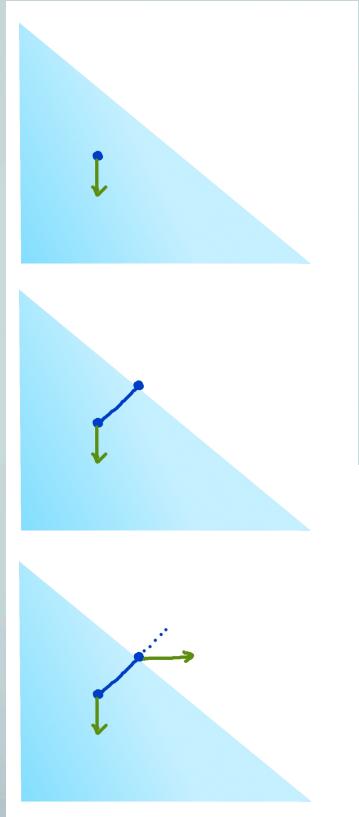
- Lipton, D., Museth, K., and Sutherland, B. Jack's Frost: Controllable Magic Frost Sim. for *Rise of The Guardians*.

# Flow fields

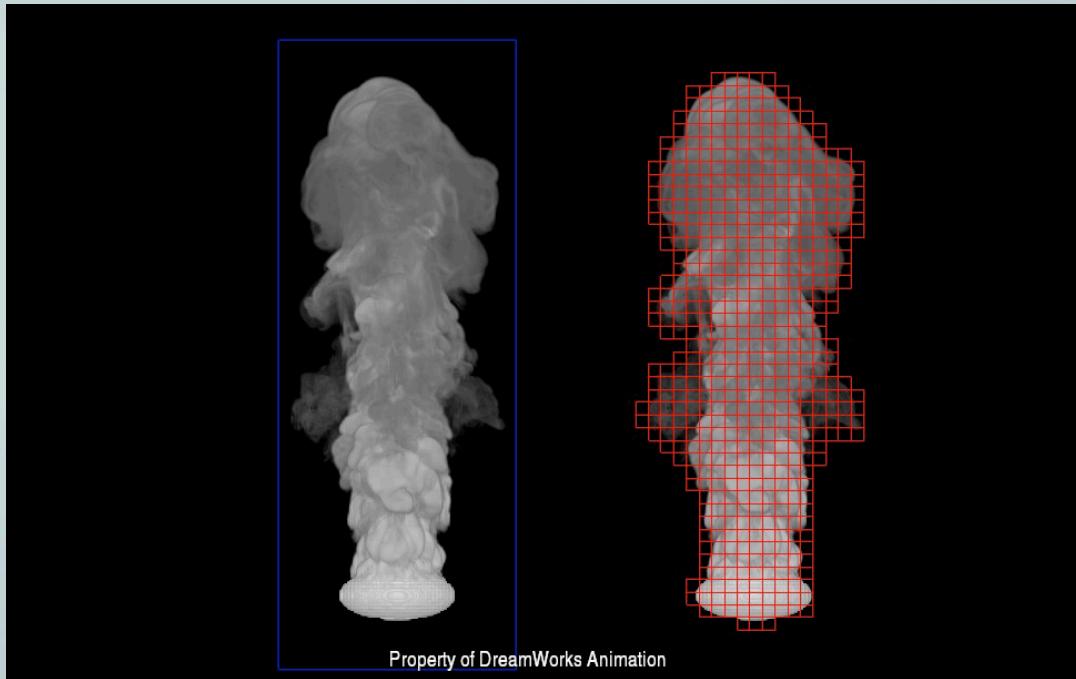


- Ghoniem, A. and Museth, K. Hair growth by means of sparse volumetric modeling and advection.

# Collisions



# Fluid simulation



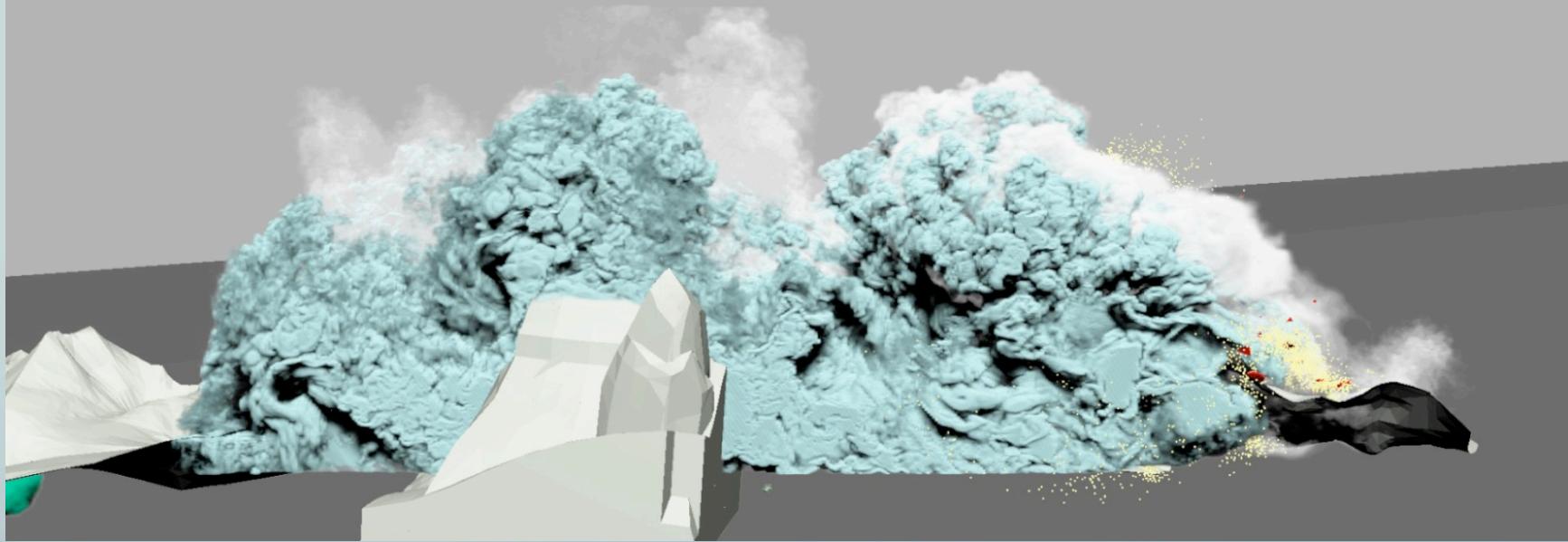
Henderson, R. Scalable fluid simulation in linear time on shared memory multiprocessors. DigiPro, 2012

# Fluid simulation



# Fluid simulation

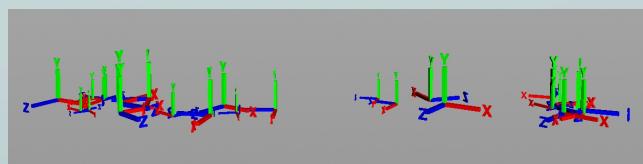
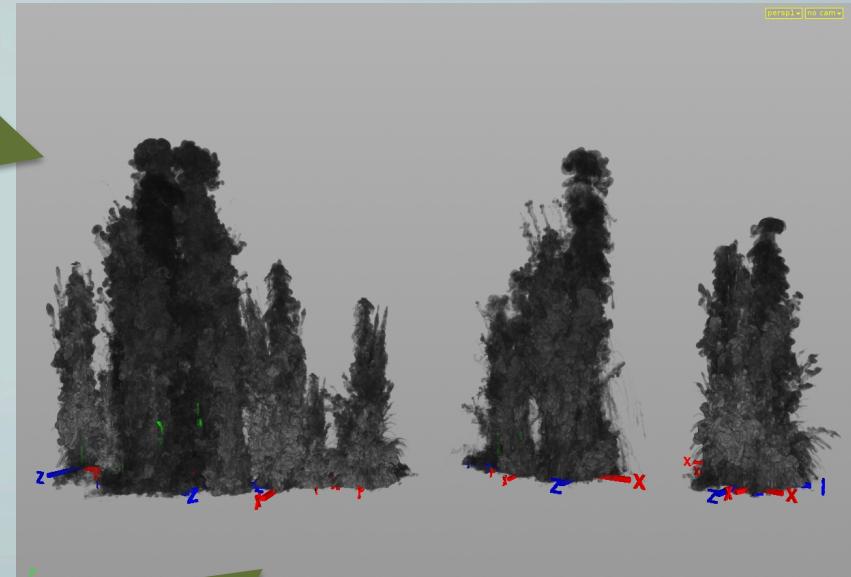
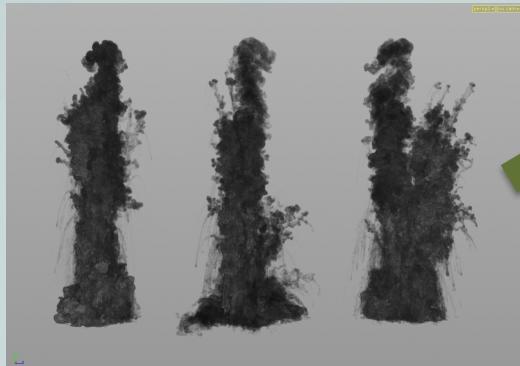
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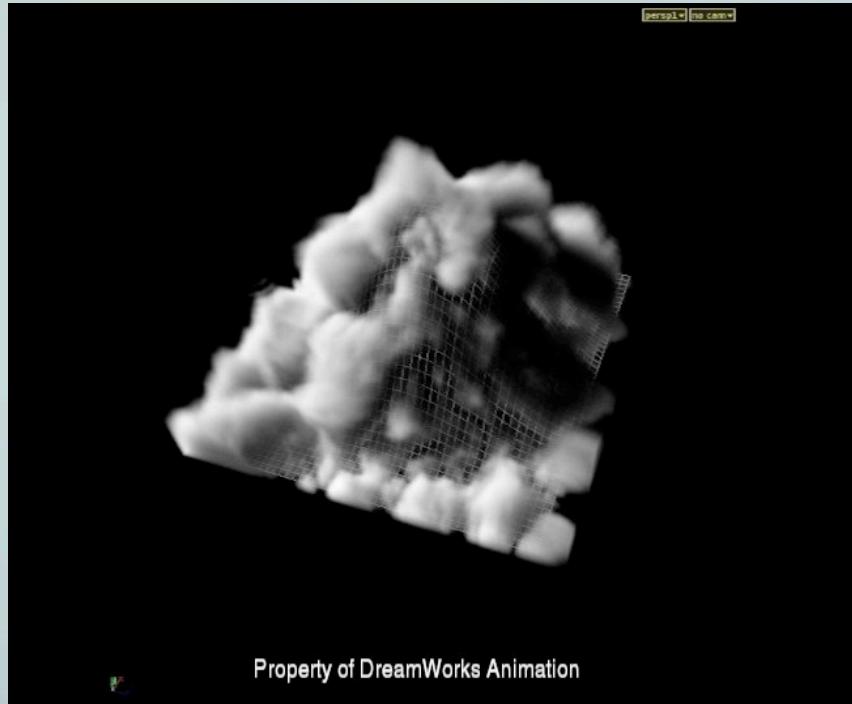
# Fluid simulation



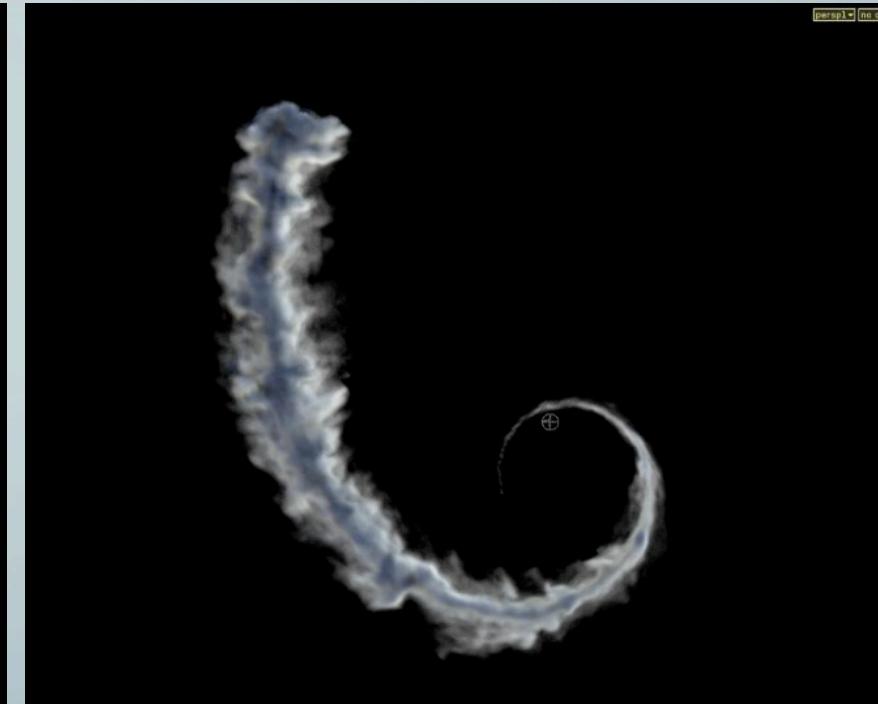
# Volume stamping



# Volume deformation



Property of DreamWorks Animation



SIGGRAPH 2013

Property of DreamWorks Animation

# Volume deformation



# Fracture



Property of DreamWorks Animation

Alden, M., Melich, G. and Museth, K. Efficient and seamless volumetric fracture. ACM Siggraph Talks, 2012

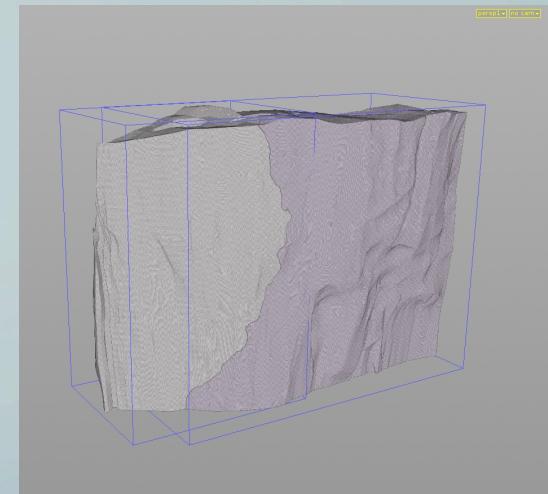
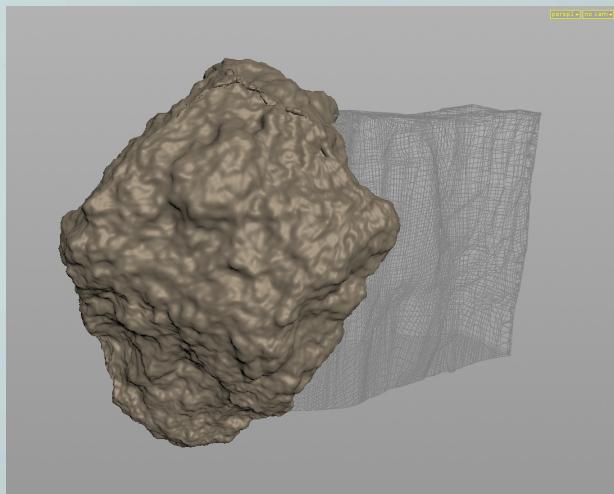
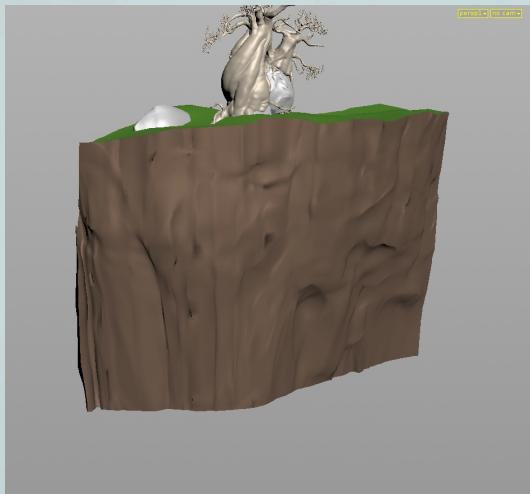
# Fracture



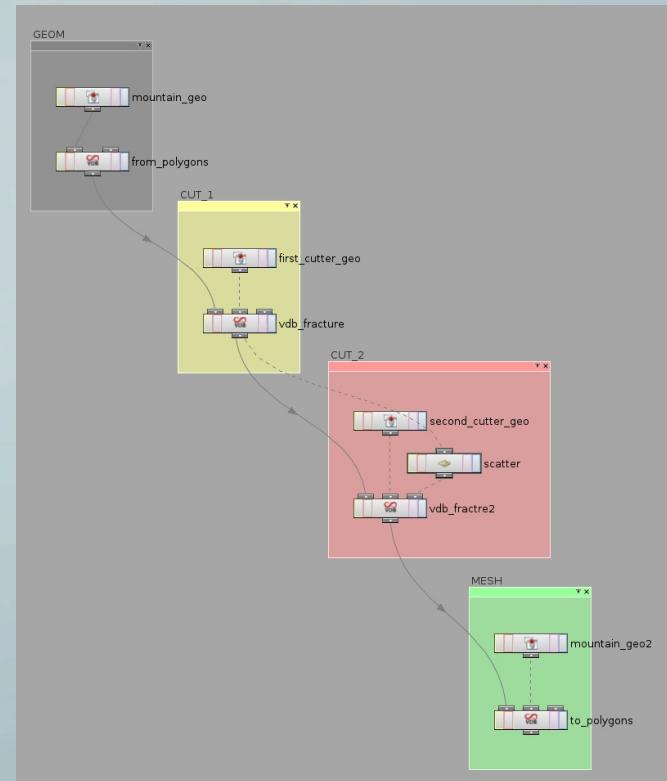
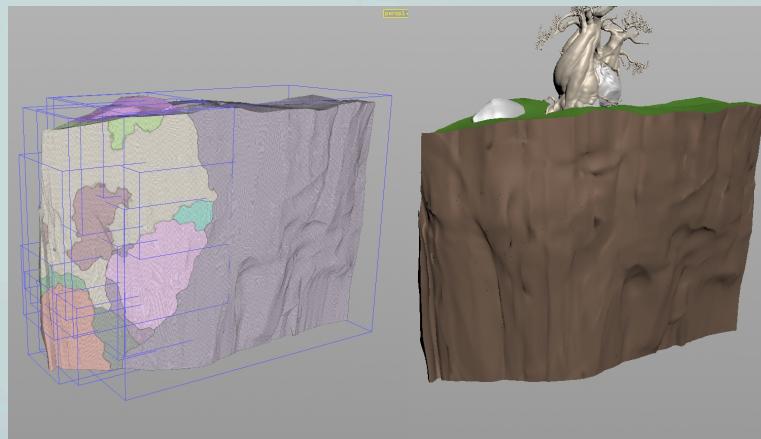
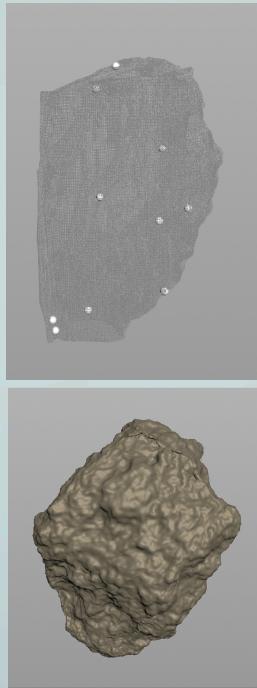
Property of DreamWorks Animation

Alden, M., Melich, G. and Museth, K. Efficient and seamless volumetric fracture. ACM Siggraph Talks, 2012

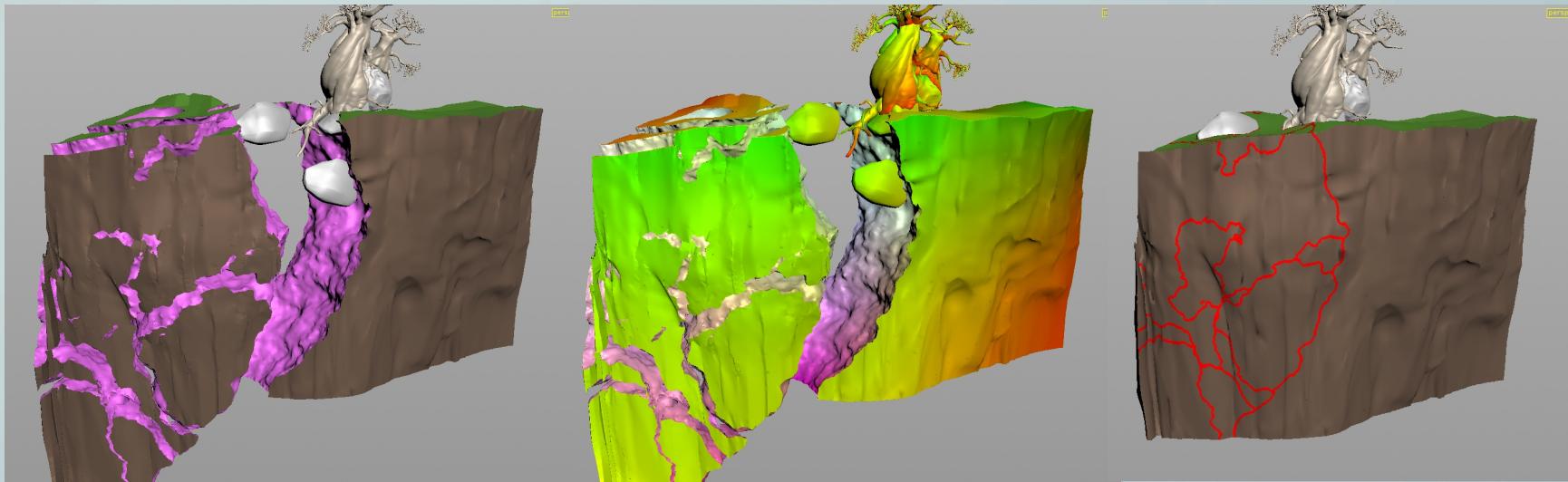
# Fracture



# Fracture



# Fracture



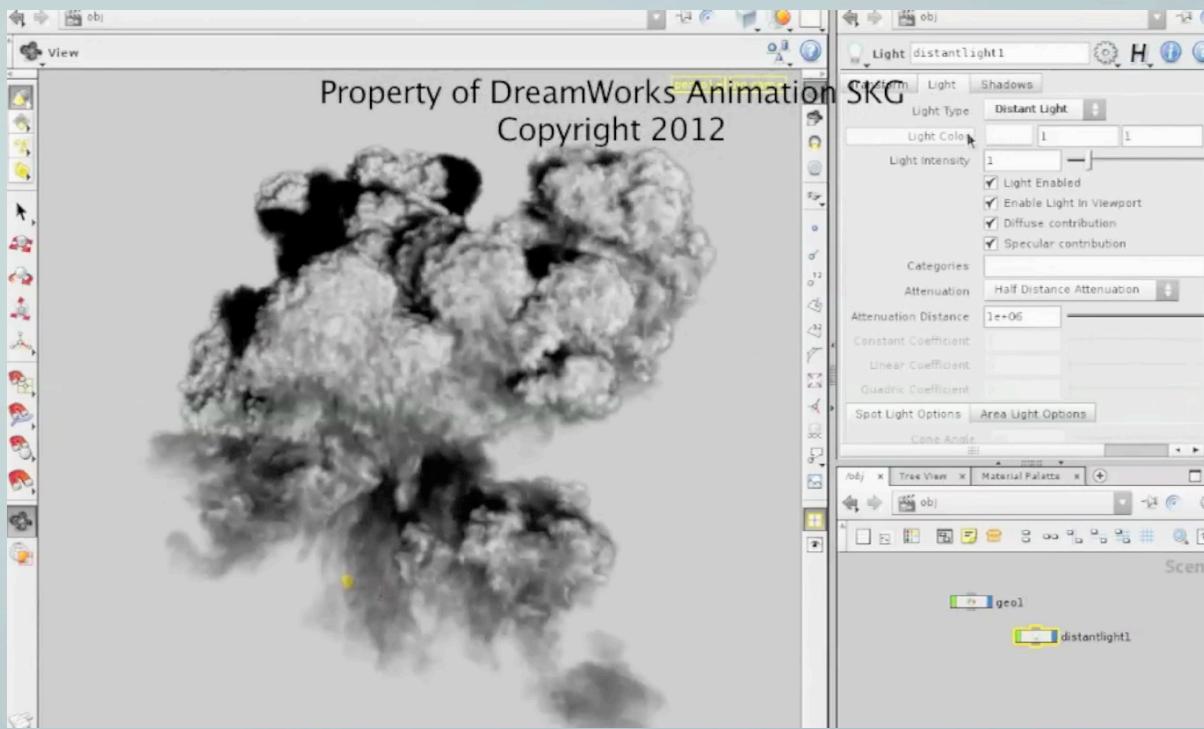
# Visualization



Property of DreamWorks Animation

Matthews, M. Amorphous: An OpenGL Sparse Volume Renderer. ACM Siggraph Talks, 2012

# Visualization



# Conclusion

- Modular Houdini toolset in SOPs
- Fast & efficient operations on huge datasets
- Easy to make new tools!
- Tons of applications

# Thanks!

FX R+D

Ron Henderson  
Mark Matthews  
Nafees Bin Zafar  
Patrick Kelly  
Devon Penney  
Michael Losure  
Brett Miller  
Matt Titus  
Can Yuksel  
Jason Mayer  
Matt Baer

# Questions?

Forget to ask something?  
[www.openvdb.org/forum](http://www.openvdb.org/forum)