

Visualization in HPC

By Randall E. Hand

Lockheed Martin - ISGS

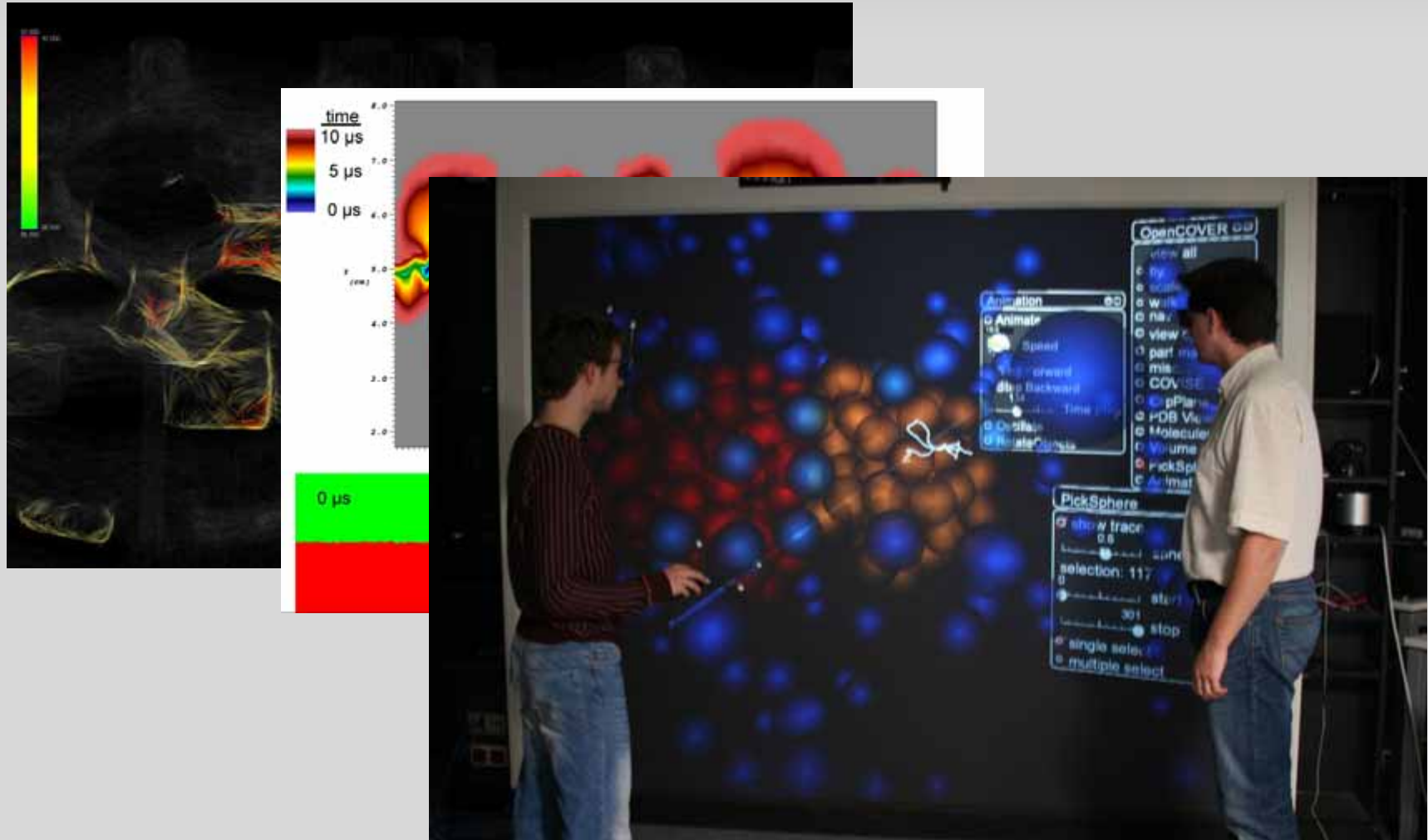
DoD HPCMP - DAAC

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2008

What's wrong with Visualization in HPTC

By Randall E. Hand

Visual Analysis



Jonathan C. Bennett*, William F. Heard, PE,
Michael J. Ruff, PE, Ryan D. Steiner

Use of the Naval Hydrocode Gemini to Simulate In-Air Explosions and Predict Shock Conditions in Field Fortifications



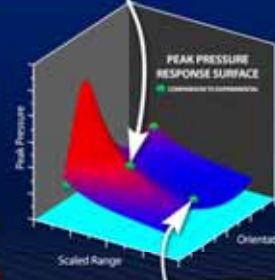
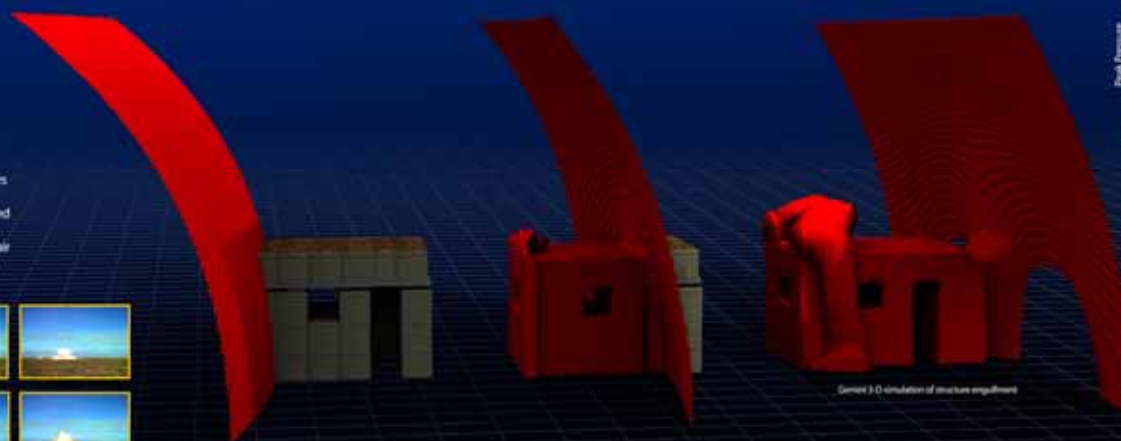
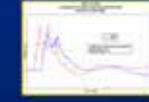
This research effort's focus has been development of an algorithm to support rapid, blast effects vulnerability assessments for expedient field fortifications. The capability to perform this type of assessment does not exist within the warfighters' tool kit; therefore, successful completion will demonstrate a valid approach to addressing a relevant warfighter need.

The approach to algorithm development has been to utilize the U.S. Army Engineer Research and Development Center's high performance computing capability to create a virtual test bed, in which large numbers of simulations can be performed to quantify internal shock conditions as a function of range, charge location, etc. After validating simulation results through multiple large blast experiments, discrete data points are fed into the statistical analysis software Design-Expert®, which subsequently produces a multi-dimensional response surface. The response surface can then be used as a simple tool to predict shock conditions as a function of multiple independent variables.

The code used to perform simulations is the first-principles hydrocode Gemini. Gemini is managed by the U.S. Naval Surface Warfare Center, and has been largely benchmarked against underwater explosions. Therefore, an additional benefit of this effort is to benchmark the code against in-air explosions, which will assist in expanding code validation into areas of Army calculational interest.



Gemini 3-D simulation of non-typical charge detonation

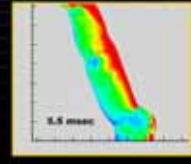


Multi-dimensional response surface to predict internal peak pressure

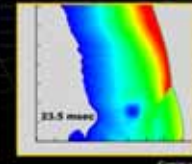
Gemini 3-D simulation of structure engulfment



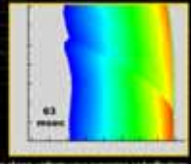
Australian Defence Force (ADF) Fort 853, Wooreena, South Australia



1.5 msec



33.5 msec



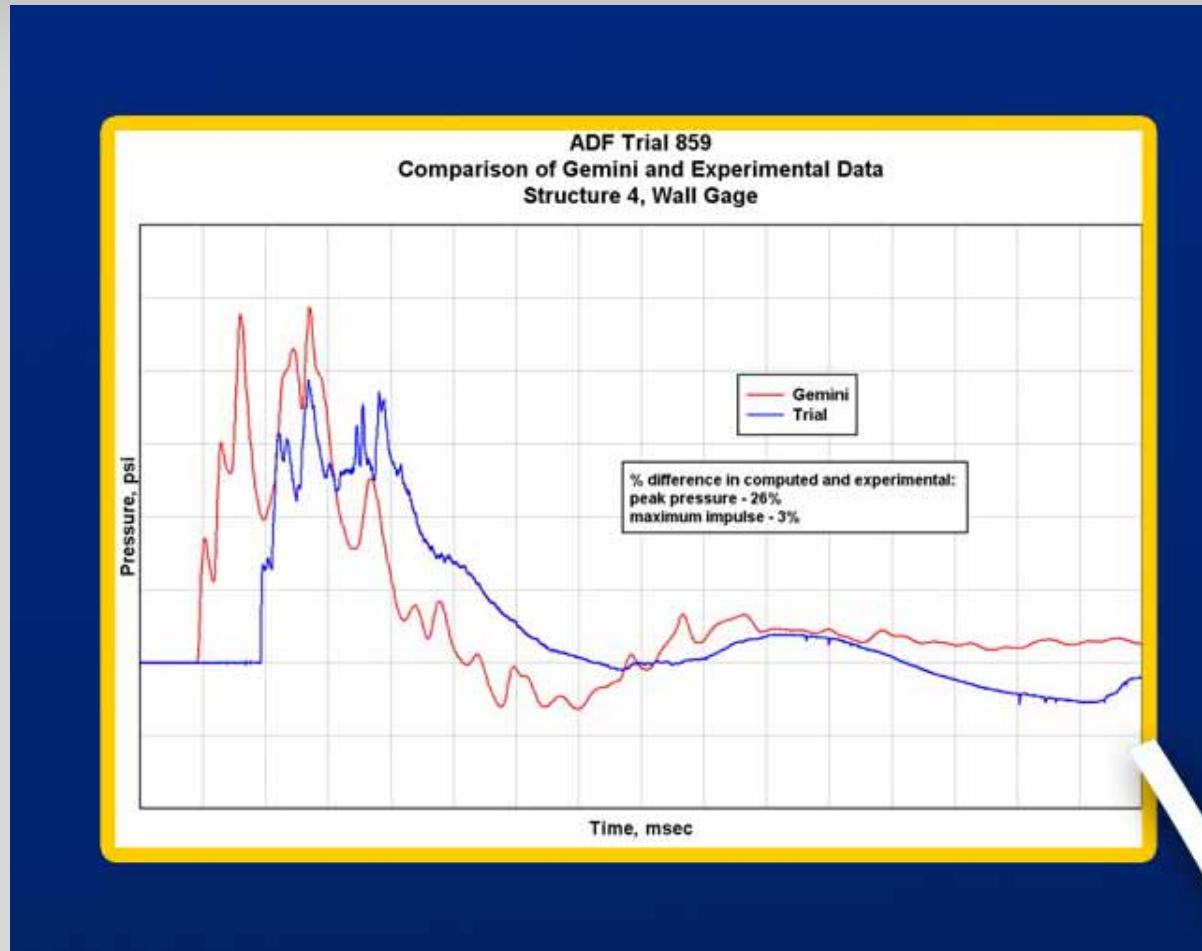
63 msec

Gemini capture of non-uniform wave expansion and reflections

This effort has shown that a simple predictive tool for blast effects on expedient field fortifications can be successfully generated through use of a virtual test bed and statistical analysis tools. Gemini results have been compared to results from physical experimentation and have shown good agreement in timing, amplitude and impulse for conditions in the free field as well as inside the structures. Therefore, it is concluded that for the scenarios considered, Gemini is capable of yielding valid simulation results, and can be accurately used for response surface population. To extend this effort, recommendations should be considered to further validate Gemini in other scenarios and expand the response surface into additional domains.

Experiment





Use of the Naval Hydrocode Gemini to Simulate In-Air Explosions and Predict Shock Conditions in Field Fortifications



Jonathan C. Bennett*, William F. Heard, PE,
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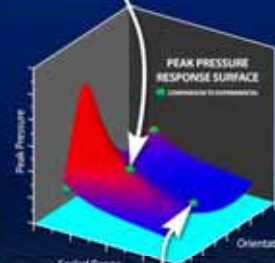
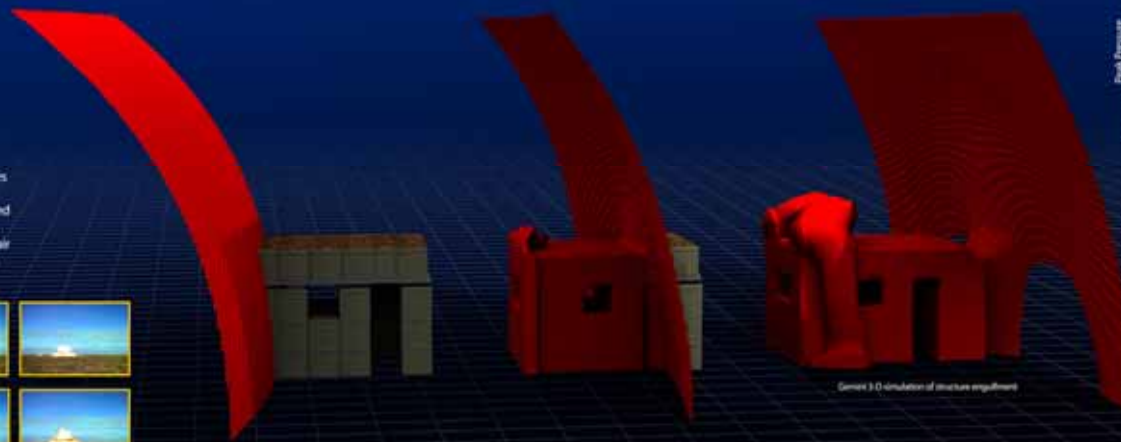
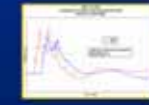
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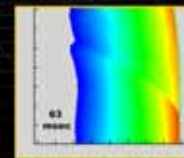
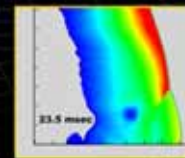
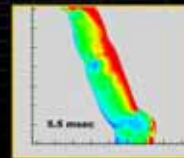
Gemini 3-D simulation of non-typical charge detonation



Multi-dimensional response surface to predict internal peak pressures



Australian Defence Force Test 875, Woomera, South Australia

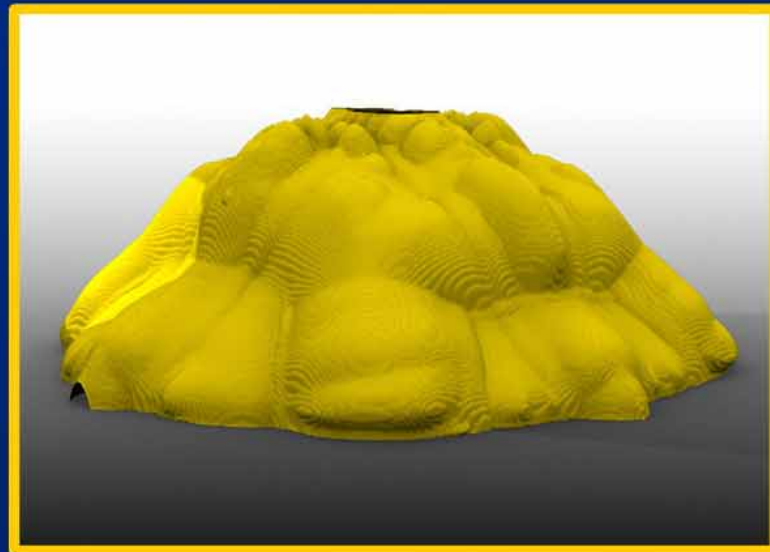


Gemini capture of non-uniform wave expansion and reflections

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Gemini 3-D simulation of non-typical charge detonation


In the DoD HPCMP


- Approximately 5,000 Users
- 4 Major Shared Resource Centers
- Users spread Nationwide





Expertise


UDAAC


 **Dr. Michael Stephens**
DAAC Lead


 **Paul Adams**
Visualization Team Lead


 **Randall Hand**
Senior Visualization Scientist

 **Tom Biddlecome**
Senior Visualization Scientist


 **Richard Walters**
Senior Visualization Scientist


 **David Longmire**
Video Production


 **Kevin George**
3-D Animator/Designer


 **Miguel Valenciano**
3-D Animator/Designer

CDAAC

 **Jerry Clarke**
DAAC Lead

 **Rick Angelini**
Computer Scientist

 **Eric Mark**
Computer Scientist

 **John Vines**
Visualization Team Leader


 **Mark Boldstad**
Computer Scientist

Image courtesy Dr. Balu Sekar, WPAFB

Hardware

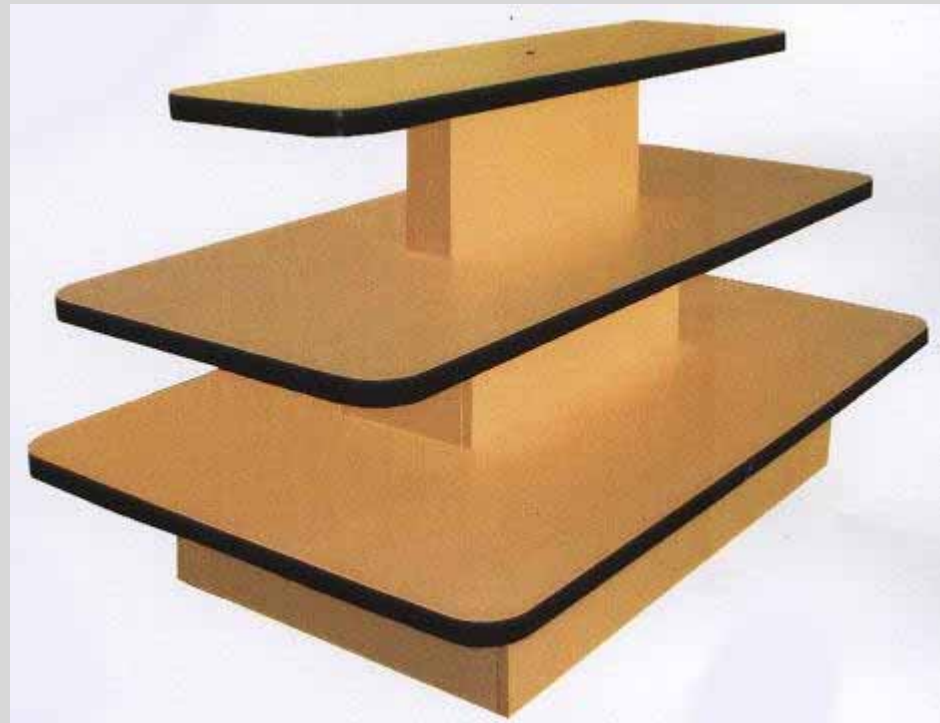


Software



Tiers of Service

- 3 Tiers of service



1: Custom



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2: Collaborative

- Knowledgable Users
 - Guidance, Assistance, Training



3: Community

DAAC
Data Analysis and Assessment Center

HOME | About Us | Forum | News | Wiki | Gallery | Software | Help

Welcome to Visualization.HPC.Mil, RandallHand @Publi [LogOut]

ez viz Helps DoD Researchers Refine Airborne Laser Targeting System

ez viz Helps DoD Engineers build better field fortifications

QUICK LINKS

- How can I get a viz account?
- Where can I find viz software?
- What HPC systems support viz?
- Where can I learn more about viz?
- Who can help with my visualization?
- How can I try ezViz?

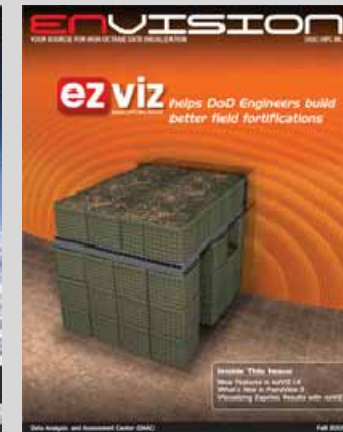
New to Viz?

How can visualization benefit you? Simply put -- better insight into your data. Techniques such as [isosurfaces](#) and [streamlines](#) help you to find features in the data. [Read more...](#)

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Helping users help themselves

<http://daac.hpc.mil/>

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User Response

- **Awesome !!!** Thank you Randall ! You really did this fast.
 - Jay Ratcliff, ADCIRC Visualization
- **Great!** Looks magnificent!! (sic)
 - Nayan Patel, LDI Breakup Visualization

User Response

- So far ezVizGeneric has been nice because I can **make pictures without having to transfer data** back to home. (...) There is definitely promise to get some heavy use out of ezViz.
 - David Hebert, MITgcm Visualization

User Response

- I work closely with Doug Dommermuth at SAIC and he had used it on sapphire in the past. I'm new to running it, so I just modified a script that he gave me. It worked great and really **helps to reduce the size of our data sets** so we can download them in a reasonable amount of time.
 - Thomas O'Shea, Flow around a Ship Hull

User Response

- The ability to produce quick visualizations **ensures valid integration of models** and allows for spot checking of jobs submitted through the portal. For these tasks, we have found ezViz to be an invaluable tool.
 - Tom Logan, ARSC HPC Users Newsletter 382

User Response

- My bosses are loving this right now. We'll finally have something to show the guys who are less scientifically inclined when they visit that they will remember as being "neat" and something they can understand. **It's hard to explain things sometimes without good visualization..**
– David Wooddell

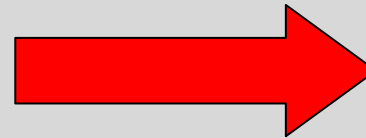
User Response

- In the past we've been operating in a 'download and visualize' mode, but I simply cannot download my simulations anymore in any reasonable time. **I must produce visualization on the MSRC's now....**
- ezViz seems like the only practical option at the moment for non-interactive visualization of certain types of data. I've been told that the scripting for ParaView is completely unwieldy.
 - Peter Mardahl

What's Broken?



Once upon a time...



Then things got bigger..



And Now..

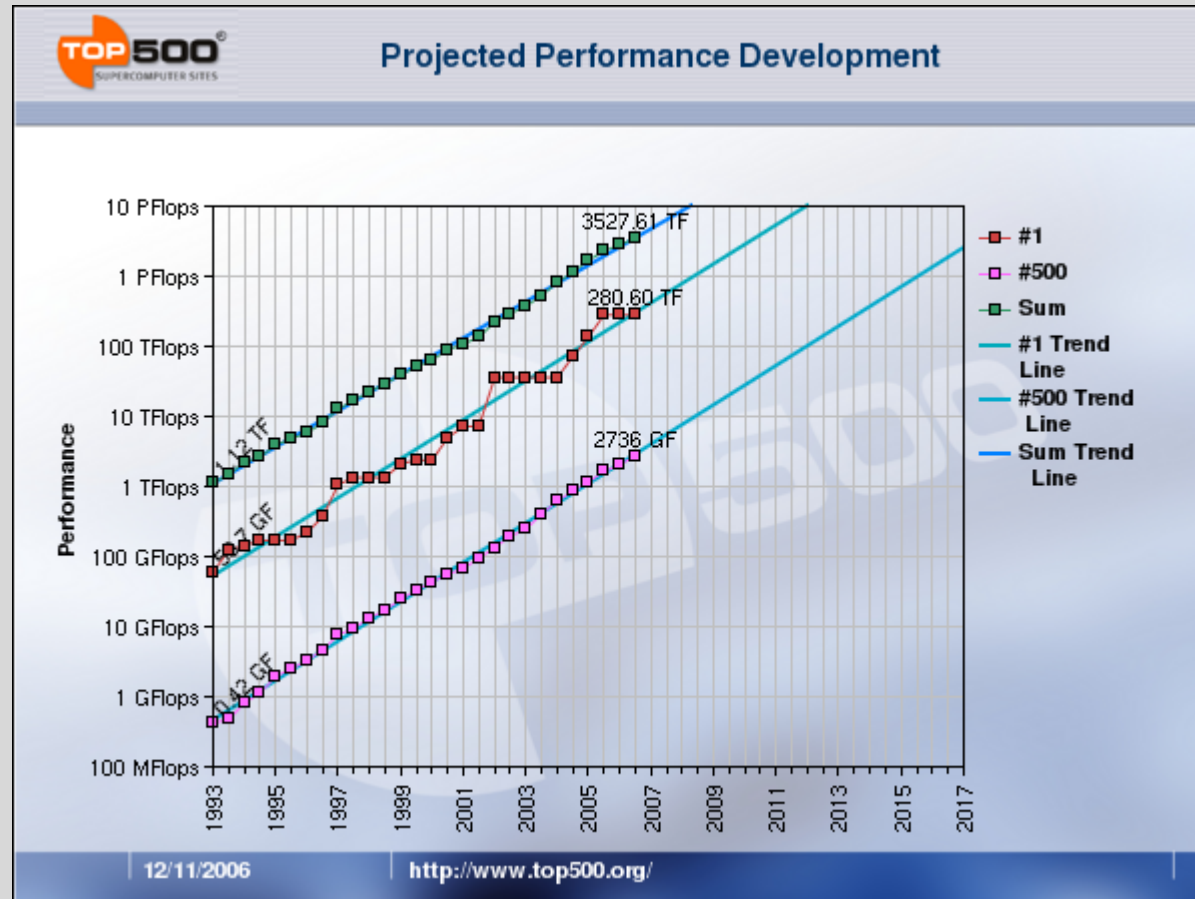


And Next



- 2.3 PetaFlops

Even more...



Too Much Data



- Bigger Simulations, same old tools

Overflow = Data Loss

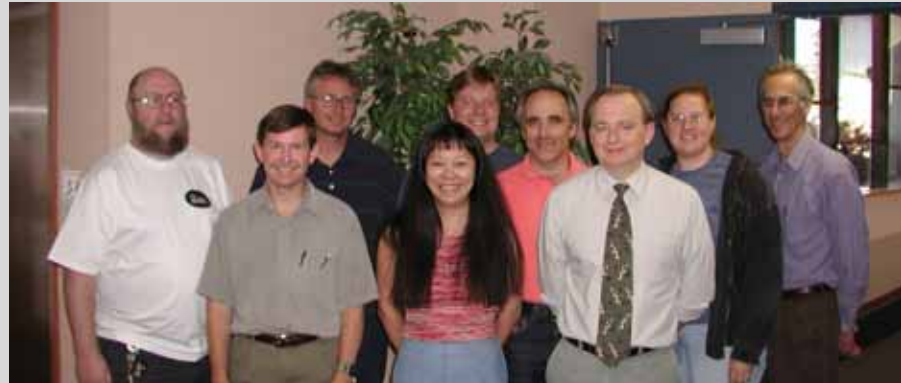
- Analysis becomes a limiting factor to Simulation



Who to blame?



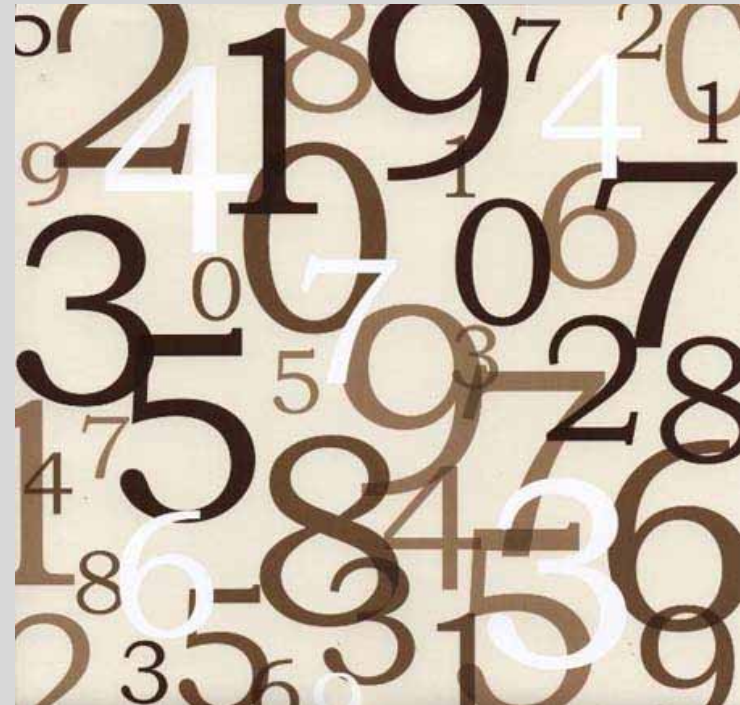
Managers?



Users?

Managers

- No consideration for Analysis
- All Simulation
 - Benchmarks
 - Hour Allocations
 - Project Awards

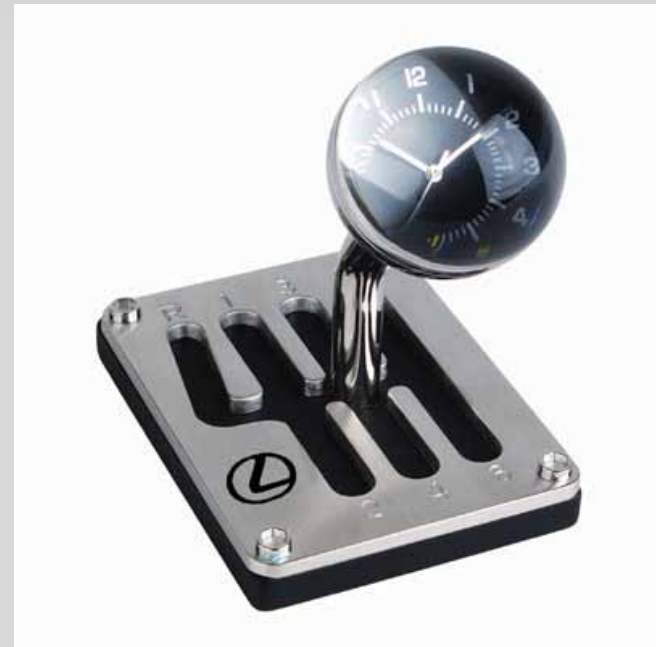


Users

- Free analysis with every simulation!



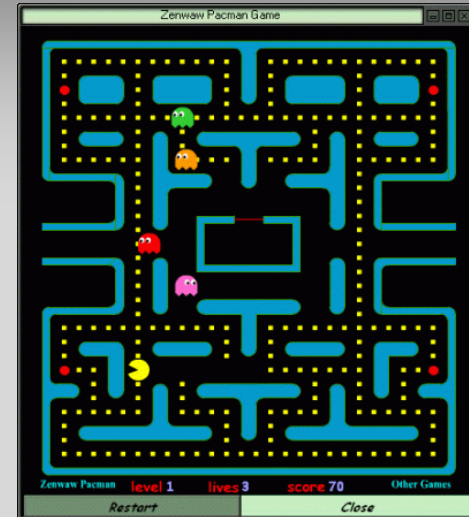
Shift our Thinking



- Analysis & Visualization is a *primary requirement*

What do we need **today**?

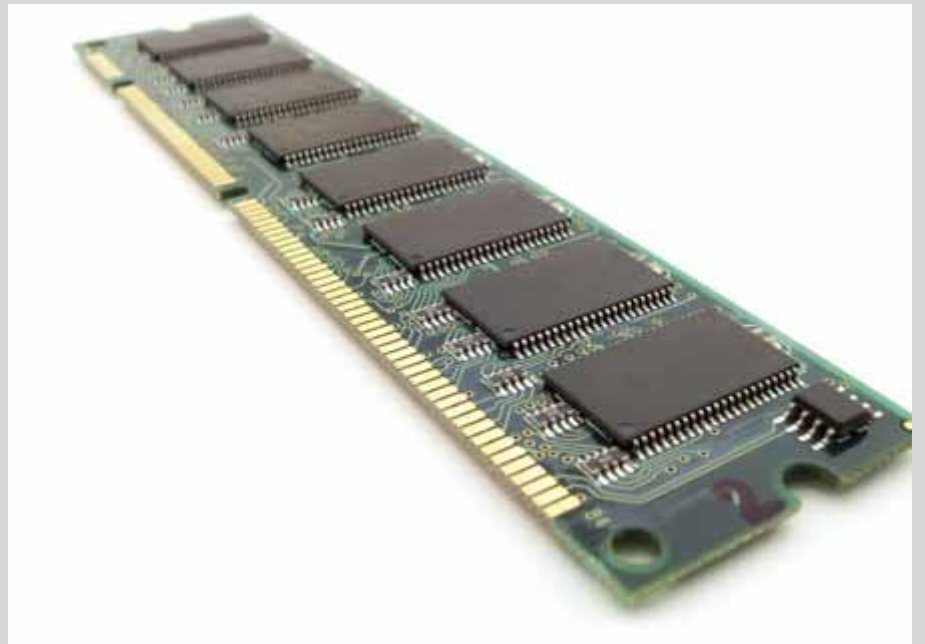




- Modern HPC's are not configured for Visualization needs

Large-Memory Nodes

- *Really large memory*
 - 64G
 - 128G

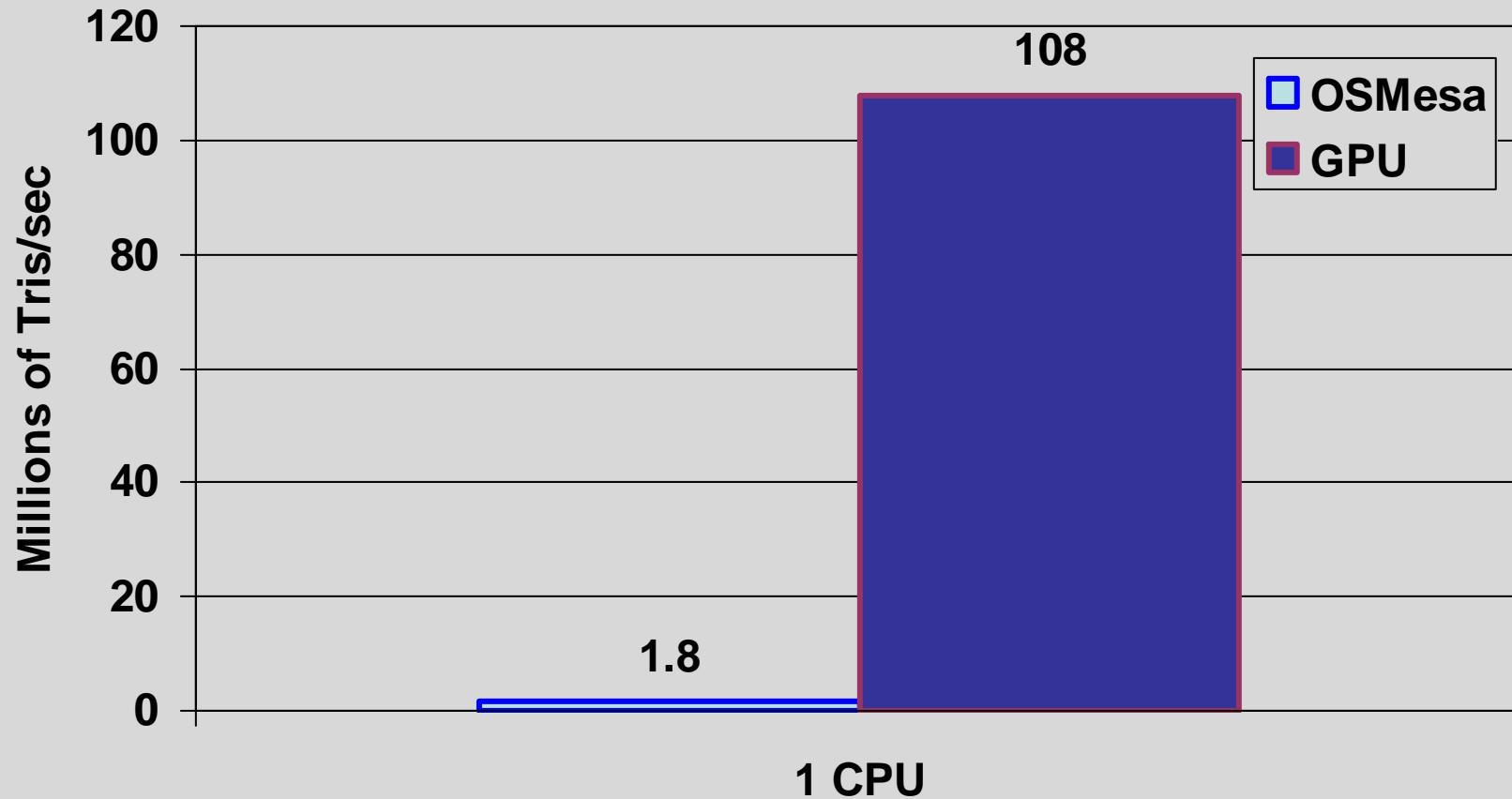


Graphics Cards

- Hardware Accelerated Graphics



Hardware vs Software

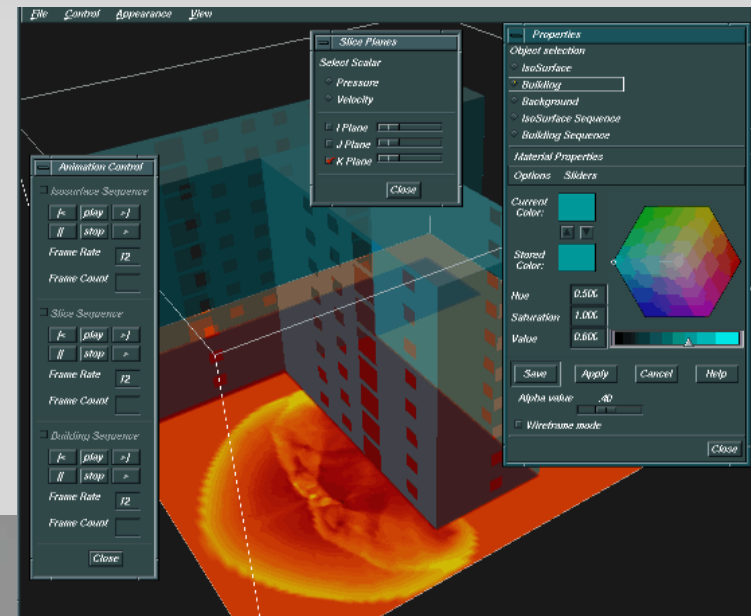


Remote Desktops

- Users need access to displays on HPCs



Make Viz Possible



What do we need **tomorrow**?

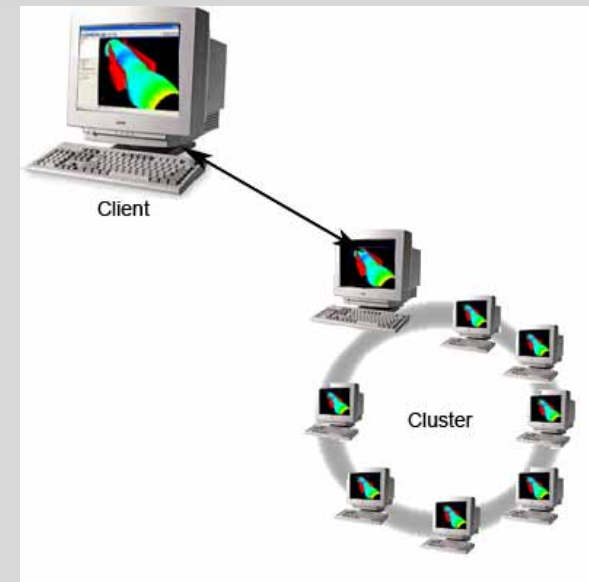


Smarter Tools



Architecture

- Multi Core
 - Low memory per CPU
- Headless Nodes
 - Client-Server



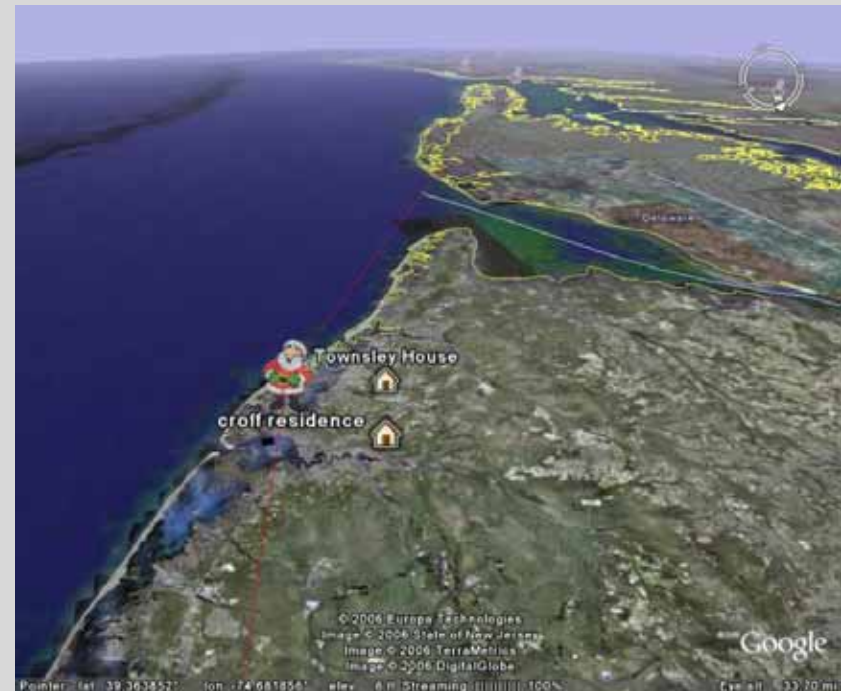
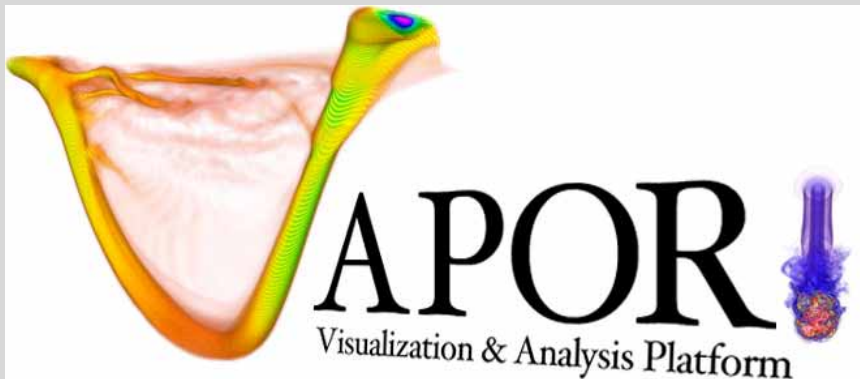
Architecture

- Queueing systems



Algorithms

- Data Decomposition
- Resolution Dependence



Specialists



Training

- Viz Techniques & Software change fast



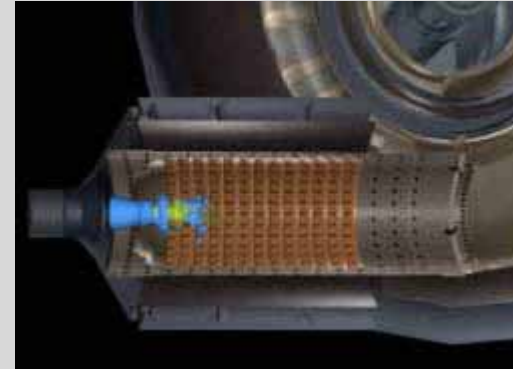
Training

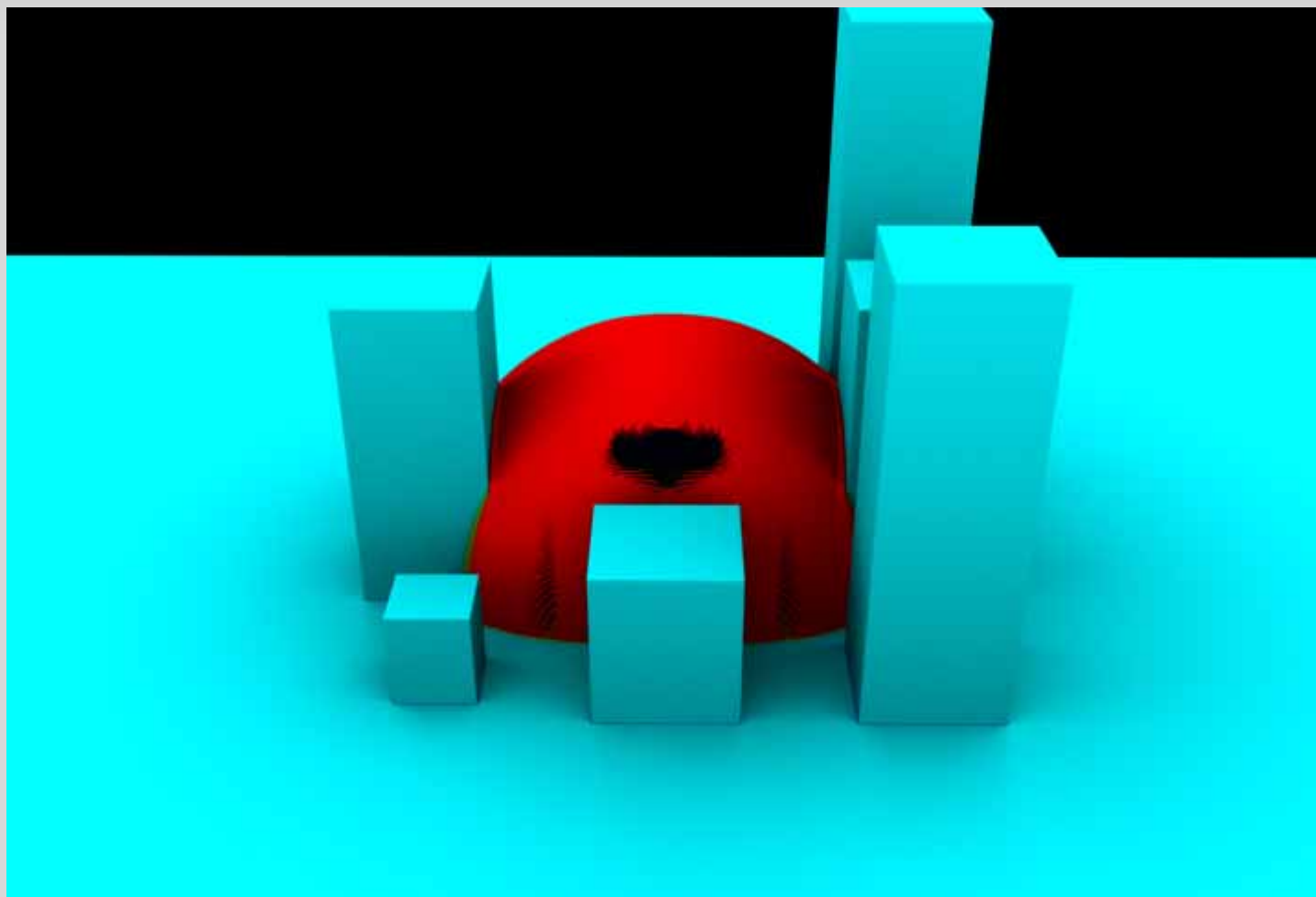


- After all, only the scientist is qualified to make conclusions about his data.

Conceptual Renderings

- Fusing conceptual renderings with simulated data can increase understanding



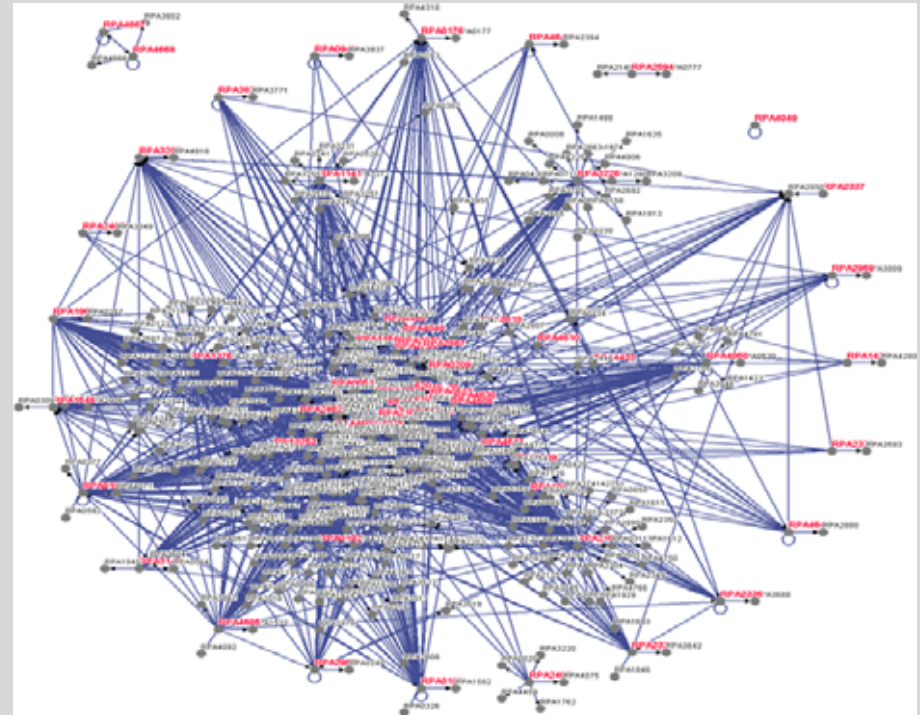


Make Visualization Effective

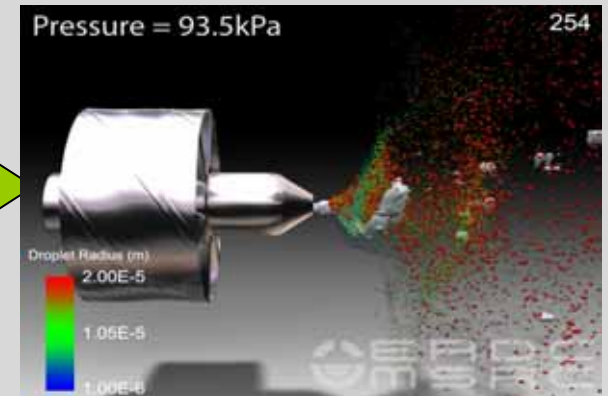
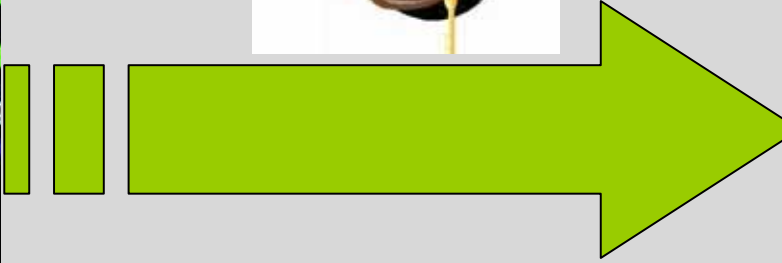


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Analysis is harder than ever.



Help users unlock their data.



To find new information buried within the data

- Randall Hand
- <http://daac.hpc.mil>

