Advanced Visualization Instrumentation

Jason Leigh
Professor of Computer Science
Director
Electronic Visualization Laboratory,
University of Illinois at Chicago

Laboratory for Advanced Visualization & Applications
University of Hawai`i at Mānoa
Electronic Visualization Laboratory

• Established in 1973
• Director: Jason Leigh
• 10 full-time staff
• Currently 15 funded grad students, 4 undergrads
• Interdisciplinary CS, Art, Biomedical, Communications Depts working in partnership with universities, research labs, non-profit orgs and industry.
Advanced Displays as Instruments for Bringing Big Data into Focus

General Motors

CAVE (1992)
eScience Components

Advanced Visualization

Data Processing and Analytics, HPC, Tools

Data Capture Instrumentation

Dissemination and Data Services

BIG DATA

Paul Bonnington
MONASH University e-Research Centre
The Quality of the Instrument Can Determine The Quality of the Insight

Percival Lowell

Lowell Observatory
Flagstaff Arizona

Mars – 1895
Took Us 70 Years To Resolve That Controversy

NASA Mariner Missions
1970s
How Do Mortals Deal With Complexity & Scale in Data?

Will Self, English novelist known for crafting complex narratives with weaving story lines

www.will-self.com/writing-room
Merging Northwest & Delta Airlines

IN THE BEGINNING: BRIDGING
In the months around October 2008, when the merger was closed, there was a flurry of “bridging” projects: opening up access between the airlines’ computer systems so each could see what the other was doing. A priority was to quickly show customers the benefits of the merger.

THE NEXT STEP
About five months after the merger, the two airlines began “cross-fleeting,” when critical systems like reservations had to start talking to each other. But they remain separate operations.

ONE AIRLINE, ONE BRAND
Delta received final government approval to operate as a single airline in January 2010. At that point, all the computer systems could be switched to unified platforms. Many, like reservations and seat availability and pricing, had to be switched over at the same time.

AIRPORTS AND GATES
Orange notes indicate changes in customer service at airport counters and kiosks.

ALLIANCE PARTNERS
Bright green notes were for updates in coordinating with the airlines’ partners, like Air France-KLM.

LOYALTY PROGRAMS
Light blue notes show steps in integrating customer loyalty programs.

AIRPORT OPERATIONS
Pink notes represent airlines’ interaction with the airports — coordinating gates, flights and communications with the control tower.

AIRCRAFT CONTROL
Light purple notes were for changes in the systems that keep track of where flights are, rerouting and cancellations.

A photograph of the master guide, taken by Delta Air Lines, in its headquarters in Atlanta in September 2008.
How Do Mortals Deal With Complexity & Scale in Data?

BMW’s Wall of Inspiration
Depicts trends in context of Time, Fashion and Architecture
How Do Mortals Deal With Complexity & Scale in Data?

Antarctic Drilling Program
Documenting features is done by hand, on paper
Managing Scale & Complexity in Teams

“War” Rooms / Project Rooms help us come together to solve problems that are too complex for us to individually manage.
Common Behavior Patterns

- Spread information out
- Organize information in a variety of ways- e.g. spatially
- Link between information
- Teams are needed to solve big problems & with big data
- Make the result persistent for later referral
The Continuum (2000)

Technology Research Education and Commercialization Center

- People can work in parallel in these spaces & therefore faster
- They never want to go back to the old way of doing things

Leigh, J., Johnson, A., Park, K., Nayak, A., Singh, R., Chowdhry, V., DeFanti, T.

Amplified Collaboration Environments

VizGrid Symposium, Tokyo, Japan, 11/01/2002 - 11/01/2002
To Experiment With These Ideas...

100 Megapixel LambdaVision Display Wall
Scalable Adaptive Graphics Environment

www.sagecommons.org
Working with SAGE

Manage content through multi-user, multi-modal interfaces (touch, laptops, ...)

[Image of a large screen with various visualizations and people interacting with it.]
### SAGE User Community

**Over 107 Sites (58 U.S. and 49 Global)**

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<th>Saudi Arabia</th>
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  - University of Texas at Austin, Texas Advanced Computing Center (TACC)
  - University of Washington, Zoom Digital Signage
SAGE Walls Are Great For...

Showing Context & Detail in Data at the Same Time

GenoSAGE: High Density Genomic Data Visualization

Visualizing hundreds of Lactobacillus genes.
SAGE	
  Walls	
  Are	
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  For…

Showing	
  Context	
  &	
  Detail	
  in	
  Data	
  at	
  the	
  Same	
  Time
SAGE Walls Are Great For...

- Supporting Data Rich Collaboration
- Integrating Disparate Pieces of Evidence
- Comparing Stories About The Data
Benefits of Large High Resolution Display Environments

• Reduced window switching, see detail & context simultaneously [Czerwinski03, Ball05]
• Helps externalize the working memory of teams [Andrews10]
• Increases parallel processing amongst team members [Park03]
• Improves location memory of information [Tan01]
• Reduces gender performance gap in navigation tasks in VR [Tan03]
• Perceptual scalability: helps user performance keep pace with increasing data size [Yost07]
• Results in greater confidence in conclusions drawn when able to see all info at once [Ball05]
• Users begin to look for higher level patterns & relationships (i.e. they start to look for the bigger picture) [Reda12]
References

CoreWall

www.corewall.org

ANDRILL, McMurdo stations, Antarctica

JOIDES Resolution Drill Ship

LDEO, Columbia University, NY
At LacCore, all visiting users and in-house users take CoreWall for granted in the sense that they cannot imagine conducting initial core description or deciding on sediment sampling scheme without its use. They see features they cannot see with naked eye. For most lake cores, CoreWall is indispensable for visual correlation of cores from different areas within one lake.

I once spent 2 weeks of 8+ hour days, with actual 1.5 meter long cores out on a table trying to correlate 5 cores (each 6 to 9m long) all collected from within 20m of each other. The task can now be accomplished in 2 to 3 days with high resolution images and geophysical parameters such as magnetic susceptibility displayed on CoreWall.

Also at 11 of 13 EarthCube end-user and disciplinary workshops, on-demand 3-D or 4-D visualization of different types of geologic data was at the very top or close to the top of the wishlist.

The Clast Utility plugin to Corelyzer that Julian devised allowed all the clast counting/characterization of a km of core to be done on screen instead of laid out down the floor of a lab. Makes experiment repeatable and quality controlled.

Obviously, things like CoreWall were devised to be scaleable so they work on small screens as well if needed in the field or some ones laptop but you lack the context and ability of putting multiple cores next to each other, other data, etc..

The earth sciences in particular spend a good amount of effort examining lots of physical specimens and spatial relationships and ability to put them together in a visual environment is a tremendous advantage. Actual real estate, graphical tools, etc. make a big difference in how well and quickly you can evaluate this material or situation.
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-- Emi Ito – Lacustrine Core Repository – U of Minnesota

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U of Michigan
Atmospheric Sciences Department
300 Megapixel Wall at Texas Advanced Supercomputer Center (2009)
UC San Diego Calit2, Vroom (2010)
Precision Agriculture

... for agricultural bioengineering

Monsanto Research Centre Bangalore (2011)

www.monsantoindia.com/monsanto/layout/researchcentre
Writing Better Grant Proposals 😊
Merge Benefits of Immersive Virtual Reality with Ultra High Resolution Tiled Display
Passive Stereo LCD Panels

Interleaved Polarizers

Pixels
Polarizer aligned to wrong pixel
Possible Solution
Early Concepts

CALIT2 NexCAVE

The Tie Fighter

The Tootsie Roll
Polarizer aligned to wrong pixel
Why is 3D Worth the Effort?

J-P Metsävainio
NASA ENDURANCE

Environmentally Non-Disturbing Under-ice Robotic ANtarctic Explorer
Visualization of Crime Data
5-Million Atom Simulation from Argonne National Laboratory’s Advanced Leadership Computing Facility
Visualization Class Surrounded by Visualizations
CAVE2 at Monash University, Australia

80 Displays – 80 Megapixels
Other lenses...

- Large Hadron Collider
  - $9 Billion

- 30 Meter Telescope
  - Starts construction 2014
  - Can observe planets around stars other than our Sun
  - See 13 Billion light years away
  - $1 Billion
Science & Engineering at the Extreme

24 hour test of technology

Why does Audi spend $125M per year to whiz 3 cars around a track?
Same Reason We Participate in Conference Challenges

- Push the limits of our technology to:
- Attempt new applications of the technology
- Discover what breaks under stress.
- E.g. 1G, 10G, 100G Networking Infrastructure
The research trickles down to the product line
The research enables the realization of affordable systems for end-users
“If you want to build a ship, don’t drum up the men to gather wood, divide the work, and give orders. Instead, teach them to yearn for the vast and endless sea.”

- Antoine de Saint-Exupéry

(Pioneering Aviator & Author of The Little Prince)
For More Info!

• SAGE BOF at SC : Tues 12:15 in 501
• VisTech Workshop at SC: Fri 8:30 in 205
• www.evl.uic.edu
• www.youtube.com/evltube
• jasonleigh.me

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