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What is a Display Wall?

- Large AND High-resolution combined
- Not front projection (step right up)
- Few (no) other display systems can provide both simultaneously
Why a Display Wall?

Wall....Huh, Yeah... What is it Good For?

War -- Whitfield & Strong, Motown, 1969 performed by Edwin Starr

- When is large scale and high-resolution simultaneously desirable?
  - Large images where both zoom and context are needed
  - Putting many different images/windows up simultaneously
  - Where multiple individuals need to see & interact with image & each other
Where are Display Walls and What Are They Good For?

- Computer science research facilities
- Oil companies
- Scientific supercomputing & modeling

From scv.bu.edu
Examples of Display Walls Used for Actual Teaching
Healthcare Settings Where These Characteristics MAY BE Present

- Scale & zoom
  - Histology, pathology, anatomy, cellular/neural networks, etc., etc.?
- Multiple images/windows
  - Clinical-path correlation; multi-modality radiology; command center, etc., etc.?
- Multi-person interaction
  - Group teaching & learning
Immersive Interactive Room in Li Ka Shing Center for Learning and Knowledge

- New medical education building at Stanford School of Medicine
- 28,000 sq foot Immersive Learning Ctr
  - 1000 sq foot Immersive Interactive Room
  - Display wall(s) proposed for this room
- If we build it, will they come?
  - (What is it good for?)
Immersive Learning in the Li Ka Shing Center (to open March, 2010)

Entire Basement is Immersive Learning Center
28,000 sq ft
lkc.stanford.edu

Medical School only
No nursing, pharm, dentistry
Immersive Learning Center (ILC)

- SP (pt actor) clinic
- Mannequin-based Simulation
- Part-task Training
- Virtual Reality
- Wet/Dry Classroom
Current (Tentative) Plans for Immersive Interactive Room

- Display Wall(s)
- Telepresence & mixed-reality simulation
- Collaboration & Development
Project Goals

- Assess the current state of the technology
- Content availability
- Build a prototype
- Create usage scenarios and gauge faculty interest
- Develop recommendation
Timeline 2007/2008

- Oct/Nov - Research and site visits
- Dec - Order hardware
- Jan - Build!
- Feb - Confirm pilots and begin content development
- Mar/Apr - Finalize content and pilot in courses
- May/Jun - Finish pilots analyze data
- Jun/Jul - Develop recommendation
Build Prototype

- “Small Wall”
- 3x3 30’ displays
- Apple Hardware
- Compare various software packages
Educational Uses

- Research says
- Technology dissemination
- Barriers
- Pilot results
- Next steps

HIPerWall UC Irvine
Research Says (not!)

- Focused on technology
  - Some use for research purposes
  - Little research on educational uses
  - No research on learning outcomes
- UC Santa Cruz, GeoWall
Roger’s Bell Curve

- **Innovators** - the risk takers willing to take the initiative and time to try something new
- **Early Adopters** - tend to be respected group leaders, the individuals essential to adoption by whole group.
- **Early Majority** - the careful, safe, deliberate individuals unwilling to risk time or other resources
- **Late Majority** - those suspect of or resistant to change. Hard to move without significant influence
- **Laggards** - these are those who are consistent or even adamant in resisting change. Pressure needed to force change.

(Diffusion of Innovations. Rogers, 2003)
Barriers

- Content generation
  - Crazy big images!
- Space
Use Scenarios

- Documentation of use educational use scenarios
- Creation of appropriate pedagogic content for a variety of courses and learning activities
- Pilot several activities
Documenting

- Show
- Tell
- Listen
- Document
Innovators: Andy Connolly

- Movie
Pathology: Man in the Pan

- **LEARNING CONTEXT:**
  One pathologist meets with a group of 6 students in the Fleischmann Labs, gives a small lecture, and then they move to the Pathology wing. The dissected organ must stay in the wing due to HIPAA requirements. Students crowd around the specimen and look at the screen to see high-resolution macro captures of the specimen.

- **LEARNING PROBLEM:**
The benefit of having a small group for sessions like this is that students can get up close and see the specimens in high-detail. The current setup does not allow for large high-resolution viewing. It is currently impossible to obtain an extremely high-resolution image from a specimen immediately in front of the group.

- **SOLUTION:**
A DisplayWall would allow a compacted Pathology room to show extremely high resolution images of very fresh specimens to groups of students.
Histology: Virtual Microscopy

- **LEARNING CONTEXT:**
  In the Human Health and Disease course as well as Histology, students use microscopes in small groups in the Fleischmann Labs to see details in cells and pathology slides. Both courses are beginning to use virtual microscopy (Google maps-style imaging) as references for students or in required course sessions.

- **LEARNING PROBLEM:**
  When viewing images on a microscope or projection screen, students often must zoom in extremely far to see the small structures and then don’t learn the context of what they are looking at.

- **SOLUTION:**
  Students will benefit from seeing tiny structures in the context of a larger portion of the slide than is normally visible in a microscope and projection screen. The Display-Wall will allow for the reference best-example slides with a very large viewing area. These slides will be accessible to students at home and in the computer labs, as well, via Aperio or Zoomify viewers.
Anatomy: Prosection

- **LEARNING CONTEXT:** Students in Human Anatomy watch lectures about the human body and then work in groups to dissect their own cadavers immediately afterwards. Many dissections require lots of time to prepare. The students may spend lots of time doing tedious work that does not involve learning.

- **LEARNING PROBLEM:** Dr. Whitmore: one deficiency in Human Anatomy is that we don’t teach the inner ear. There is value in teaching students about the ossicles, but it’s so tiny and it’s so bloody difficult to dissect that we’ve never done it before. Our photographs in the atlas are in some ways limited because of the need to show orientation but also details. The pages are just not big enough.

- **SOLUTION:** Faculty will do a detailed prosection of the middle ear and document the steps with a high-resolution still camera. They will create a detailed slideshow of images and show it to students using the DisplayWall.
Observations

- Ease of use
- The “Touch” factor
- Different control devices
- Small Wall vs. Big Wall
Next Steps

- More content (other disciplines)
- Continue to pilot
- Document and publish results
- Educational outcomes
- New interfaces
Display Camera’s Effective Pixels
Captured Image on 3X3 Tiled Screens
High Resolution Images

- HDTV (1080p)
  1920x1080 (X)
- Canon Mark III 21.1 MP digital Camera
  (5616 X 3744) (10X)
- One Giga Pixel Image
  over (30,000 X 30,000) (500X)
- Very Large 10 GP Images
  (100,000 X 100,000) pixels (5000X)
Need to Display More Pixels

- Maintain spatial relationship while preserving the resolution
- See great details within context
- Improve Productivity
The Most Common Resolutions

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<th>Width x Height</th>
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<tr>
<td><strong>SVGA</strong></td>
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<tr>
<td><strong>QXGA</strong></td>
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30" WQXGA (2560X1600) LCD

HDTV 1080p (UWXGA)

WQXGA Dual Link DVI
One Computer Can Support a Few Monitors

2560x1600

2560x1600

1

Mac
Resolution that Matters

Most Graphics Cards/Drivers Support Less Than 4k X 4K Texture Size

8K X 8K Quite Common for Game PCs
Need More Computers Working Synchronously
Existing Application Programs
(Consume OS Mouse & Keyboard Events)
Current operating systems won’t run multiple machines

3 Mice
Have Three
(2560X3200)
Not One
(7680X3200)
Mouse Space
Interact Through a Pointer Indirection

7680x3200 Display Resolution 2560x1600 Pointer Resolution

Controller (2560x1600) Interaction Resolution
Display Wall & Controller
Pointer Devices

- Mouse
- Wireless (Gyration) Mouse
- Game Controller (Wireless)
- iPhone interface
A 3X3 Tiled Display Wall
3X3 30” Monitors
Display an Image to the Wall

- Partition a Big Image into Many Sub-Images.
  - CPU, GPU, Memory

- Transfer Pixel Data of Each Sub-Image to the Responsible Computer.
  - Network, CPU

- Computer Assembles and Resizes the Pixel Data into a “Texture” that can be Rendered to the Screen and Accelerated by the Graphics Card.
  - GPU, CPU, Texture Size Limit
Display Images on the Tiled Screens

Source Image

2560x1600

TileViewer & Quartz Composer Visualizer

Mac

Mac

Mac
Small Prototype Display Wall

Source Image

PC

Native & SAGE(SDL)

2560x1600

(OpenGL)

TileViewer & Quartz Composer Visualizer

1 2 3

Mac

4 5 6

Mac

Mac

GIR Annual 2008

STANFORD

SCHOOL OF MEDICINE

CISL
“Small Wall” Prototype Hardware

- Nine 30” Apple Cinema (2560X1600) monitors
- Six Intel Macpros
  - Intel Xeon, Dual Boot for Mac Leopard and Windows, 2GB RAM
  - ATI XT1900 Graphics Card
    - Each card drives up two monitors
- One PC
  - Intel Quad Core Q6600, 2GB RAM
  - Two Nvidia GeForce 8800 Superclocked GTX Cards
    - Support four (2560X1600) monitors
- 1 G Network
Image Sources

- Large High Digital Images
  - Produced by Aperio’s ScanScope System
    - (up to 100,000 x 100,000 SVS Files)
- Digital Images Captured from a Canon 21.1 MP Camera
  - (5616 X 3744)
- Movies & PDF Files (up to 4K X 4K)
- Create/Capture from (3D) Software
- Live Capture of a Computer Screen

Each Image Source Can be Independently Zoomed and Panned
Software Solutions

- Can’t buy the software at Frye’s or Amazon
- No operating system for the kind of environment
- Currently being developed in research labs
- No universally agreed upon standards
“Small Wall” Software

- **TileViewer** (UCI) (CG, OpenGL, LibTIFF, etc.)
- **Quartz Composer & Quartz Composer Visualizer** (Apple) (OpenGL)
- **SAGE**- Scalable Adaptive Graphics Environment (UIC – EVL) (SDL)

--- Limit to 32-bit Operating Environment
TileViewer

Images Over 30,000 X 30,000

View Archives
UCI Tileviewer

- **Benefits:**
  - Display Giga-Pixel Image Files Efficiently
  - Display QuickTime Movie Files (up to 4K resolution)
  - Easy Viewing Navigation (Pan and Zoom)
  - Display Screen Capture of a Client Computer

- **Drawbacks:**
  - Closed System without a System Development Toolkit
  - Not Available and Won’t be Free
Quartz Composer & Visualizer

Up to 4K X 4K
Quartz Composer & Visualizer

**Benefits:**
- Easy to Use Graphics Tools and Effects
- Many Patches Available (Provide or Process Data or Images)
- Customizable with Many Samples and Templates
- Growing Developer Community

**Drawbacks:**
- Mac Only
- Not Efficient for High Resolution Images
  - Problems with Image over 4K in resolution
SAGE Framework

OpenGL Simulation

High Resolution Image
SAGE  Scalable Adaptive Graphics Environment

**Benefits:**
- Distributed Computing Architecture for Visualization
  - Migrating from One Computing Environment to Another
  - Scale In Terms of Amount of Data and Resolution
- Decouple Graphics Rendering from the Graphics Display
- Complete Open Source, Heterogeneity and Scalability
- Well Modulized, Cross Platform Development Framework
  - SAGE Receiver, Free Space Manager, SAIL, UI

**Drawbacks:**
- Research Oriented, Developments are Required
Conclusions

- **TileViewer** is an Easy and Efficient Software for Visualizing Very High Resolution Images

- **Quartz Composer & Visualizer** Can Visualize up to 4k X 4K Images on a Tiled Display with Many Effects

- **SAGE** Provides a Good and Flexible Framework for Developing Visualization and Collaboration Solutions (Dynamic Streaming of Graphics)
Performance Can be Enhanced

- Software Needs to Take Advantage of Hardware Capabilities to Avoid Bottle Necks

- **CPU** – Multi-Core Processors (Quad Core 4 CPUs)
- **GPU**
  - Nvidia GeForce 9800 GX2 (30-50% faster)
    - 768 gigaflops raw shading power
    - Filter 76.8 billion pixels per second
  - ATI Radeon 4870x2 coming up
  - **GPGPU** (General-Purpose Computations on GPUs)
- **Network** → 10G
- → 64 bit OS and Supporting **Drivers** and **Libraries**
Citations

URL’s

- DisplayWall Project:
  http://summit.stanford.edu//research/displaywall.html
- UCI HIPerWall:
  http://hiperwall.calit2.uci.edu/
- SAGE:
  http://www.evl.uic.edu/cavern/sage/index.php
- Quartz Composer:
- Li Ka Shing Center:
  http://lkc.stanford.edu/