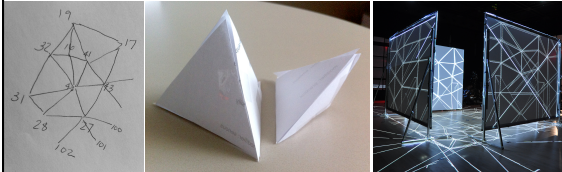


## Interaction, User Interface Design, and Visual Debugging

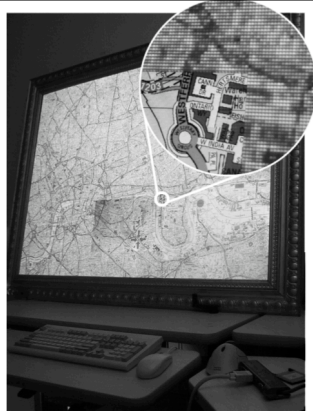


## Today's Class

- **This Week's Readings**
- Traditional Interaction Devices
- Spatially Augmented Reality
- Examples of Visualization for Debugging
- Upcoming Schedule
- Assignment #8
- Next Week's Readings

## Readings for Next Week:

- "Focus Plus Context Screens: Combining Display Technology with Visualization Techniques", Baudisch, Good, & Stewart, UIST 2001

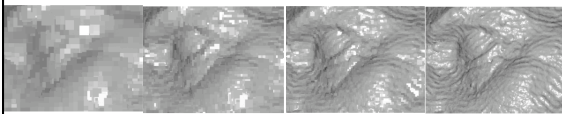


## Focus plus Context

- Human Perception: rod & cone density in fovea
- Compare to "mini-map" view
- Print offers higher resolution than computer screen
- Gap between tiles in a tiled display distracting
- Prior work on "document lens", where high resolution area is moveable (rather than moving document to fixed high-resolution area)
- Informal comparisons to dual head setups

## Readings for This Week:

- "QSplat: A Multiresolution Point Rendering System for Large Meshes", Rusinkiewicz & Levoy,
- SIGGRAPH 2000



## Design Criteria & Guaranteed Interactivity

- Low powered computer
  - portable
- Interactive visualization
  - E.g., find holes in data -> suggest new scan points
- 127 million points
- Pixel size
  - Screen Space criteria
  - Visibility culling
- File layout & streaming data, pre-fetching


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### Traditional Interaction Devices

- Keyboard
  - Press a key
  - Hold a key
- Joystick
- 3D mouse (3D Connexions Space Navigator)
- Mouse
  - Left button
  - Middle button
  - Right button
  - Single click
  - Double click

### Dynamic Projection Surfaces for Immersive Visualization

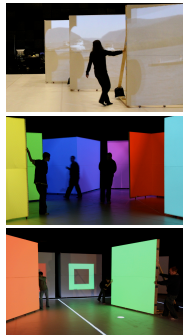


Theodore C. Yapo, Yu Sheng, Joshua Nasman, Andrew Dolce, Eric Li, and Barbara Cutler

*PROCAMS 2010 IEEE International Workshop on Projector-Camera Systems, June 2010*


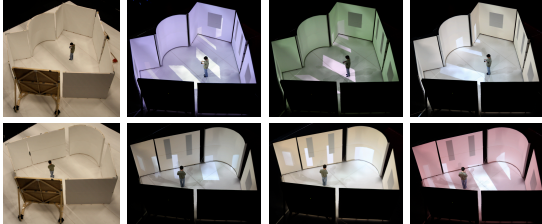
### Our System Goals/Requirements

- Large, human-scale projection environment
- People move freely within the space
- Projection surfaces can be moved interactively
- Varying illumination conditions
- Robust & real-time tracking and display



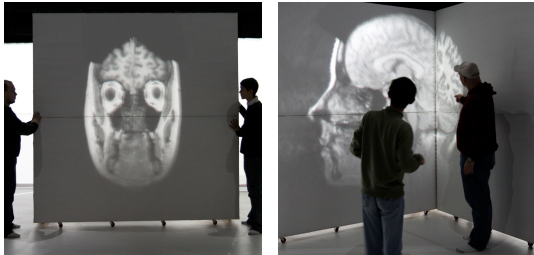
### Architectural Daylighting Design

- Windows, wall colors, & time of day controlled through iTouch interface

### Volumetric Visualization

- Cross sections of a 3D medical dataset virtually placed within the projection volume

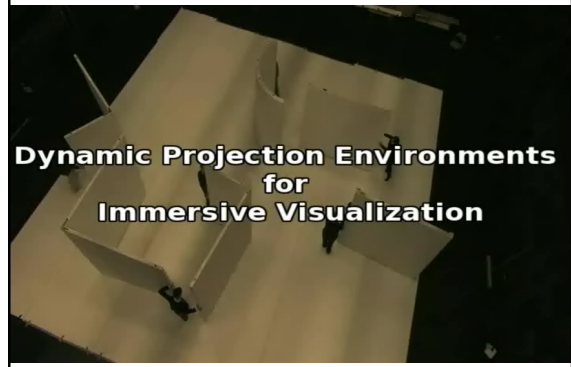


### General User Interface Elements

- Projection surfaces as input devices
- No instruction necessary to play the game!



### Dynamic Projection Environments for Immersive Visualization



Panorama from Gehua Yang, DualAlign

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### "Advanced" Debugging

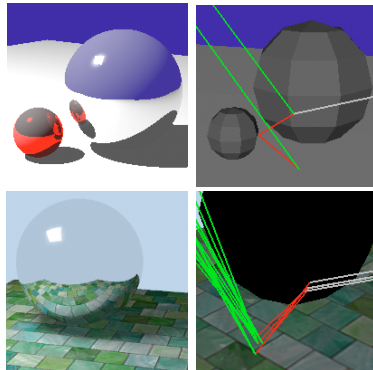
Applies to software development, and other sciences too!

- Debugging Level 1:
  - Remove syntax errors in compilation
- Debugging Level 2:
  - Produces an answer
- Debugging Level 3:
  - Matches the output provided by the instructor
- Debugging Level 4:
  - Hypothesize system behavior
  - Develop & run experiments
  - Collect data & analyze results
  - Validate (or repeat process)



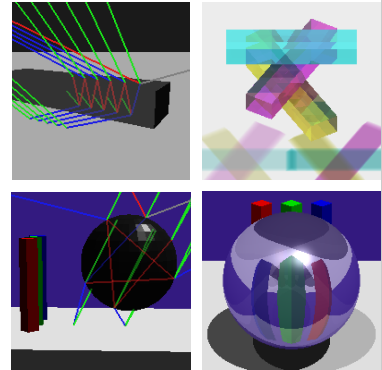
### Ray Tracing

- Debug angle & direction of reflection, shadow, & refraction rays
- Solution: Draw the rays traced for a single pixel, use color for different ray types



### Ray Tracing

- Debug angle & direction of reflection, shadow, & refraction rays
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### Traversing Spatial Data Structures

- Solution: Draw solid box for each visited cell
- Solution: Draw solid quad for each cross cell face

### Mesh Connectivity

- Maintain consistent orientation of triangles
- Visualize surface self-intersections
- Solution: Color the "back" side blue
- Maintain connectivity through local simplification and subdivision operations
- Solution: Color edges with only 1 triangle neighbor red

### "Watertight" Model Construction

- Red = edge with only 1 triangle neighbor
- Yellow = edge with > 2 triangle neighbors (non manifold)
- Green = triangle with zero area
- Blue = triangle that is neighbor to a zero area triangle

### Mesh Topology

- Neighborhood & local editing
- Lots of print statements:

```

Triangle 206: 31 32 42
Triangle 207: 31 42 28
Triangle 208: 41 19 17
Triangle 209: 42 41 43
Triangle 210: 28 42 27
<etc.>
    
```

- Solution: Draw by hand
- This graph drawing could be automated!

### Visibility & Smooth Projection

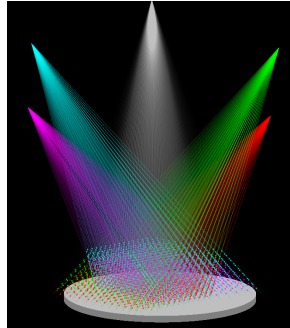
- Occlusions & Projector Visibility
- Fade in/fade out for transitions
- Make sure the sum of all projectors = 1
- Solution: Visualization the number of projectors each patch can see
- Solution: Visualize blending weights for each projector

### How Tetrahedra Fill Volumetric Space

- Drawing on (in 2D) didn't work
- Creating an OpenGL visualization didn't work (even with transparency)
- Solution: build lots of paper & tape models

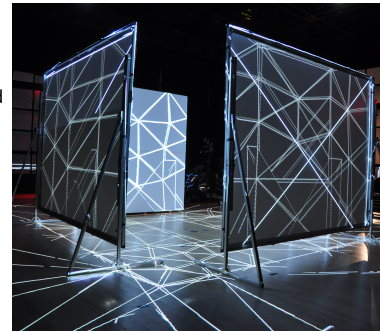
## 4x4 Calibration Projection Matrices

- Sanity check position & direction of camera & each projector
- Understand distribution of calibration error
- Solution: Render all point samples in a common coordinate system



## Projection

- Validate the projector world coordinate calibration
- Solution: Project the mesh from each projector, verify that the images closely align



- Surprisingly, this became one of our more popular “demo”s & this image made the RPI 2010 Research calendar

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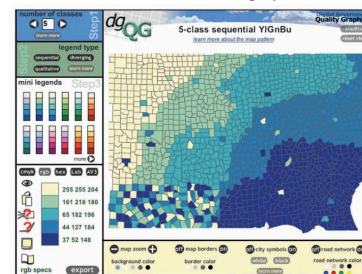
- Week of April 2<sup>nd</sup>
  - Assignment 8: Experimenting with Color [ [motivation & problem definition & visualization design & visualization revision](#) ]
- Week of April 9<sup>th</sup>
  - Assignment 9: Final Project Progress Report [ [data collection / visualization execution](#) ]
- Week of April 16<sup>th</sup>
  - Assignment 10: User Feedback [ [analysis & visualization revision](#) ]
- Tuesday April 24<sup>th</sup>: Final Project Due [ [presentation](#) ]
- Wednesday April 25<sup>th</sup> & Wednesday May 2<sup>nd</sup>: Final Project Presentations [ [presentation](#) ]

## Homework Assignment 8: *Final Project week # 1* Experimenting with Color

- Shades of grey
- Black & white
- Flat color, gradient, or textures
- Light vs. dark background
- Target medium: Large screen vs. tiny screen vs. projection vs. printed
- Colorblind aware (e.g., red/green)
- Many colors: cool vs. warm tones, etc.
- Focus: Visualization Revision (primary)  
Design & Presentation (secondary)

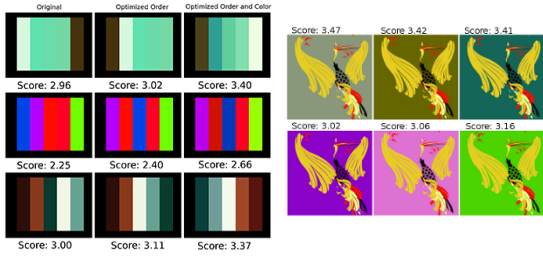
## Readings for Next Week:

- “ColorBrewer.org: An Online Tool for Selecting Colour Schemes for Maps”, Harrower & Brewer, The Cartographic Journal



Readings for Next Week:

- "Color Compatibility From Large Datasets", O'Donovan, Agarwala, & Hertzmann, SIGGRAPH



Readings for Next Week:

- Colin Ware, "Quantitative Texton Sequences for Legible Bivariate Maps," *IEEE Transactions on Visualization and Computer Graphics*, 2009.

