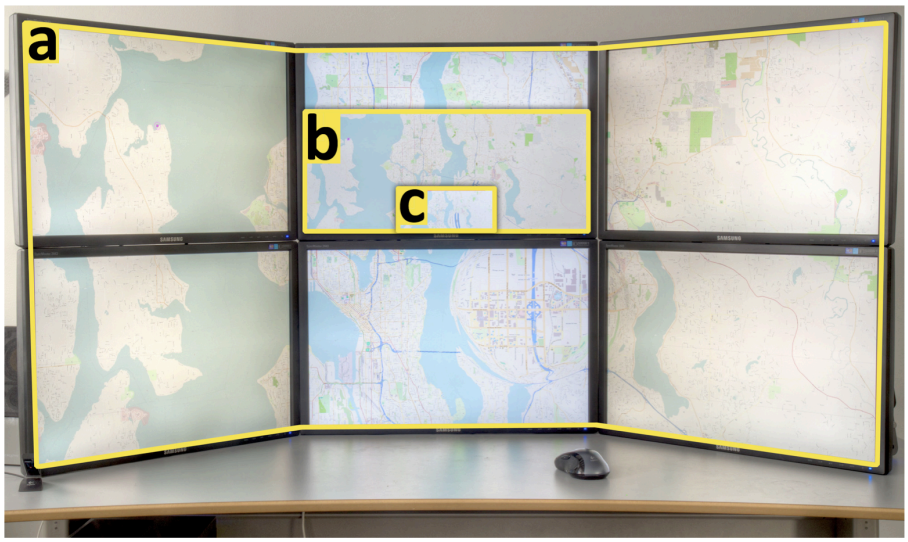
Displays



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- Homework for Thursday April 14th:
  Progress Post #1: <depends on project>
- Homework for Thursday April 22nd:
  Progress Post #2: Using Visualization for Debugging
  - Bloopers
  - Designing & interpreting intermediate visualizations
- Tuesday April April 26th: In-class work session
  - Have a specific item you want viewer/user feedback about (teams have 2 distinct items)
  - Targeted demo of your project one-on-one to 5 classmates (teams split up)
  - Give & receive specific (& possibly overall) feedback
- Homework for Thursday April 28th:
  Progress Post #3: Design of a formal user study
  - Summarize the results of your "pilot study" on Tuesday
  - If you had unlimited time/money….
    How could you validate the effectiveness of your final project?

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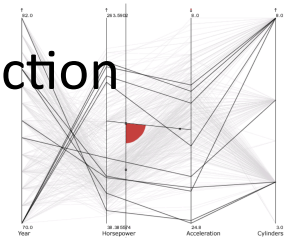
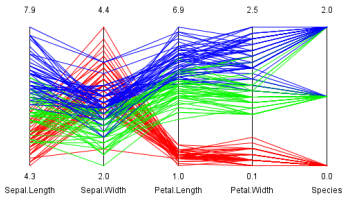
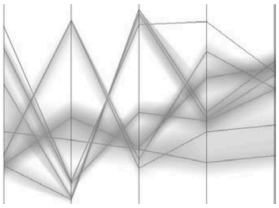
Visual Response to Interaction

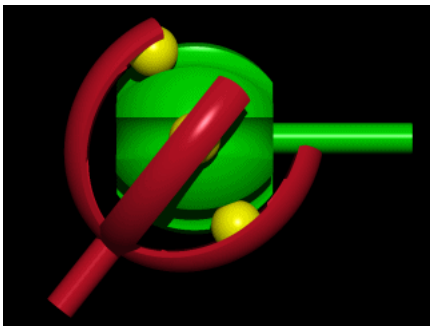
- Hide/Unhide elements
  - Increase/Decrease level of detail
  - Change camera/magnification
  - Add text labels
- Highlight element(s)
  - Change color
  - Change transparency
- Motion
  - Showing time simulation
  - User can rearrange for clarity/exploration



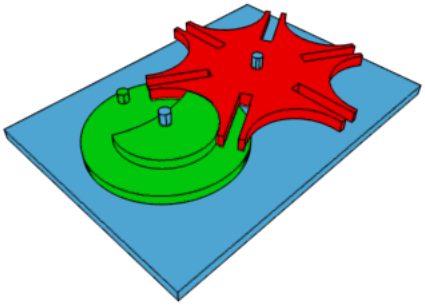


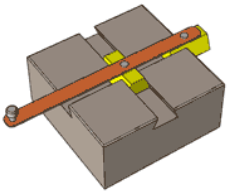


Animation Explaining Mechanical Parts

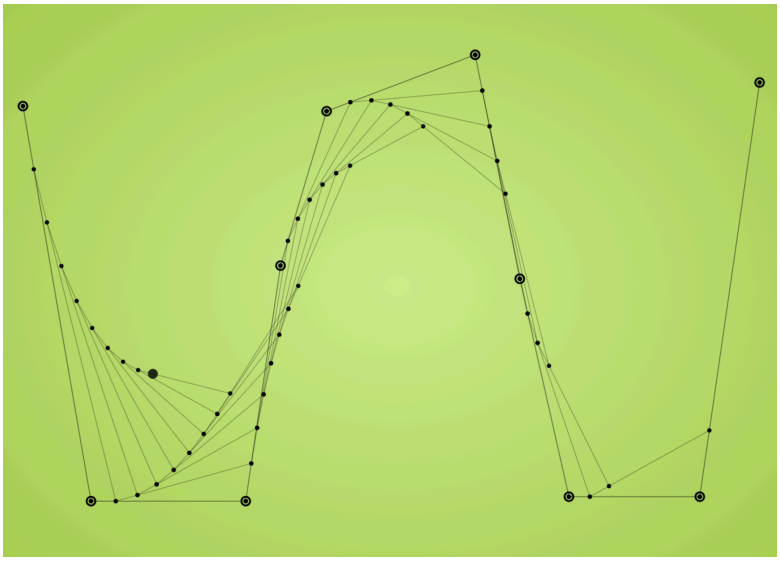


http://imgur.com/gallery/FvCTr

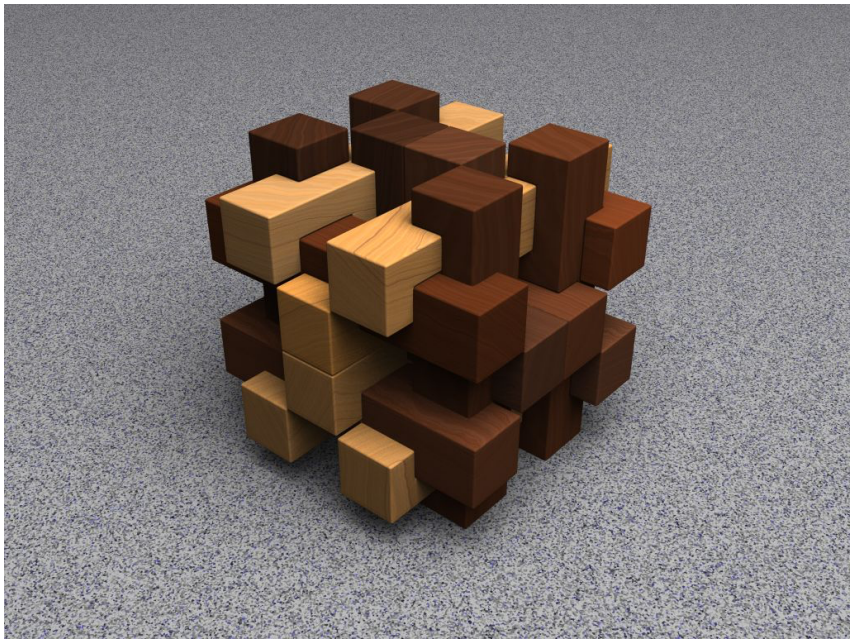




Animation to explain an algorithm

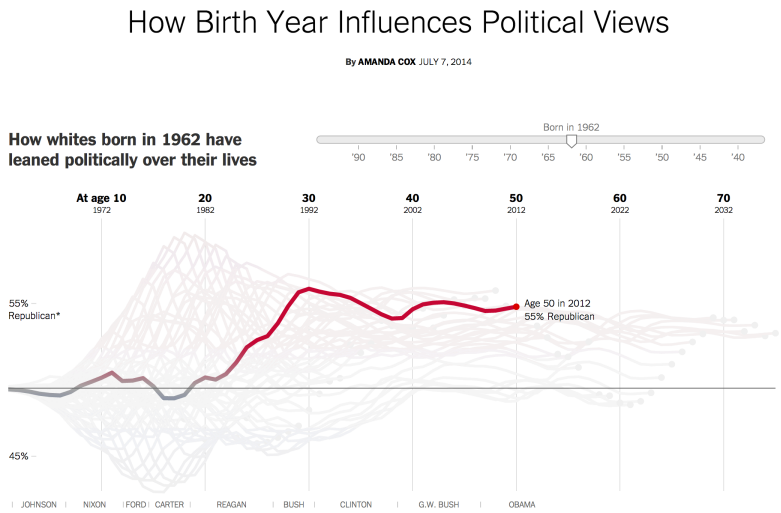


http://tholman.com/bezier-curve-simulation/



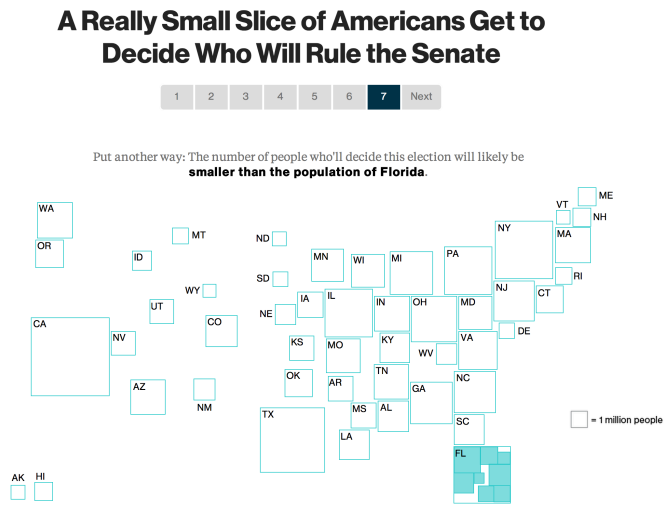
Justin Legakis http://legakis.net/justin/gallery_burr.html

Quite interesting for "Just" a Slider



http://www.nytimes.com/interactive/2014/07/08/upshot/how-the-year-you-were-born-influences-your-politics.html?partner=rss&emc=rss&_r=2&abt=0002&abg=1

Motion for attention/continuity



http://www.bloomberg.com/politics/graphics/2014-who-votes-in-midterms/

https://i.imgur.com/Gzsq5HS.jpg

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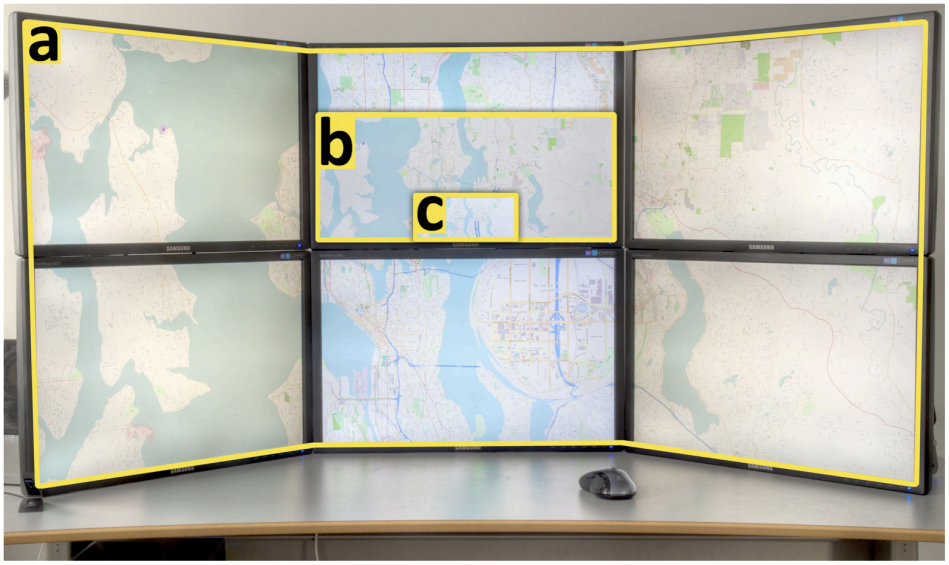


Figure 1: How do visualization techniques perform at different display sizes such as (a) 13.8, (b) 1.5, or (c) 0.17 megapixels?

- Prior work
  - Most visualization studies are done on standard size displays
  - Large displays allow more information to be shown, and improve task performance & user satisfaction
  - Physical navigation is easier on large displays
- This paper studies:
  - Different technologies: focus+context, overview+detail, & zooming
  - Display sizes: 13.8 (5769x2400), 1.5(1920x800), & 0.17(640x267) megapixels
- Research Questions:
  - If a technique works well to improve small scale visualization, will it also improve large scale visualization?
  - Which tasks take best advantage of a large display visualization?

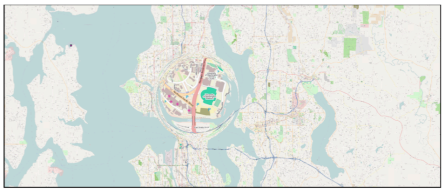


Figure 4: The focus+context interface at Medium display size.

Figure 5: The overview+detail interface at Medium display size containing an overview window in the upper-right corner.

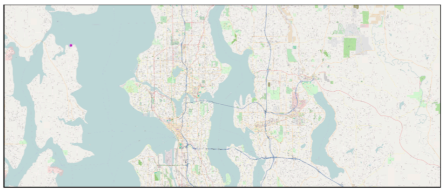
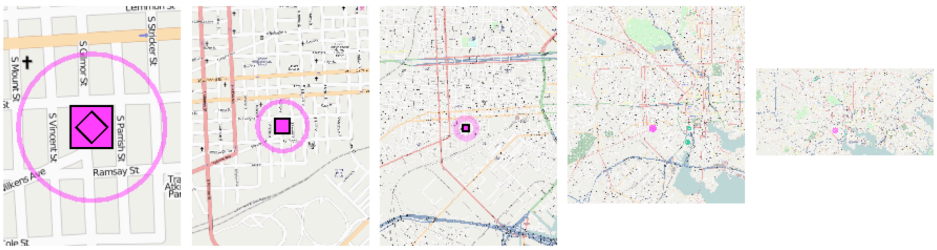


Figure 6: The zooming interface at Medium display size.

- A *within-subjects design* was used in which three factors were varied:
  - display size (Small, Medium, Large)
  - interface (Focus+Context, Overview+Detail, Zooming)
  - task type (Navigate, Compare, Trace)
  - 27 combinations (shuffled order for different participants) * repetitions of each combination
  - ~1 hr 15 min per participant
- For the Tasks:
  - Had to be at max zoom level to read/click on element
- Measurements:
  - Time to complete, accuracy, mental effort (subjective)



1 3 9 27 85

- Completion times:
  - Overview+detail (7.9s)
  - zooming (9.6s), less effective for compare tasks
  - focus+context(14.9s), much worse on small!
- Participants preferred Overview+detail, focus+context least preferred
  - Targets hard to see in compressed portion of fisheye lens
  - Pointing precision of the lens was poor
  - … but focus+context not used (less used?) in gaming, it could be people just aren't familiar with it
- Medium display preferred
  - Fit their field of view
  - Large required too much visual search & too much head movement
  - Overview+detail difficult to use with large display
  - Display bezels distruptive to fisheye use for route tracing

- Surprised that large display isn't faster for all tasks.
- Diminishing return with screen size
- Fisheye (focus+context) required more time to find the object
- Are the slow times because physically turning head is difficult/slow? Or because we are not good at finding small item in large field of view?
  - The portion of the screen we can *analyze* is still limited!
- Programming on a large monitor requires more time searching screen (compared to laptop) -- *self-reported subjective measurement…*
- When working with many monitors
  - "even though cannot focus on all of them at once, it's easier to turn my head than navigate a virtual UI"
  - Helpful to see visual change updates in the peripheral
  - Each task is only on one monitor

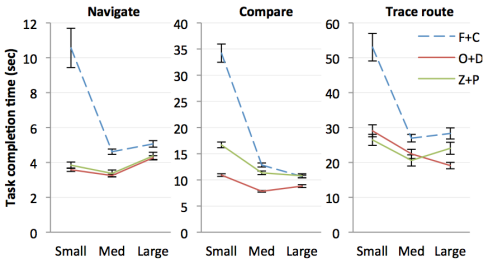


Figure 8: Average completion times for the three task types with focus+context (F+C), overview+detail (O+D), and zooming (Z+P) at different display sizes. Error bars show standard error of the mean.

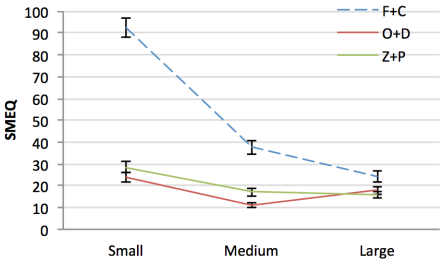


Figure 10: Average Subjective Mental Effort Questionnaire (SMEQ) ratings with focus+context (F+C), overview+detail (O+D), and zooming (Z+P) at different display sizes. Higher values indicate higher effort. Error bars show standard error of the mean.

- Also measured mouse travel distance
  - moved most on large display, least on small
  - moved more on overview+detail, less on focus+context
  - Time before mouse first moves assumed to be search time? Might not be accurate.
- Less time zooming & panning with mouse & less time using overview display with large display
- Surprised that the route following was worse on large displays. Contradicts prior studies (but those studies did not require mouse interaction along the route) ["particularly disappointing"]
- More work needed to standardize methodology to reproduce results between studies
- Visualization techniques (may) require adaptations to perform optimally on different display sizes
- Lengthy & complete discussion!

- Very Experiment Driven, lots of measurements
  - Detailed setup, exact hardware, viewer distance from screen, etc. Confident study could be reproduced!
- Presentation of #s in prose -> instead as a table?
- (Good description of) limitations
  - Only used 2D map data (overview+detail is particularly a natural & effective fit for maps)
  - Does the trend continue with even larger displays? Projectors? Huge 4K projectors? Vertical monitors?
  - How does it work with touch?
  - How does it work with viewer at different angle?
  - Curved displays?
- Writing comments
  - Performance means search time, not fps
  - "literature" w/o citations assumes reader very familiar with this field
  - Not all terminology defined at the start

- Study was too broad (& not enough data – just 19 participants, word-of-mouth recruiting bias) to solidly answer questions, especially since it contradicted some previous results! More research needed!
- Would have liked to see more formal hypotheses before their experiment was conducted, not so wide open exploratory
- Compare same information content (same # of icons) on small vs large displays [other paper!]
- Would be nice to have wrapup with recommendations for people making visualizations that target multiple display sizes
  - What is the "perfect" display size?

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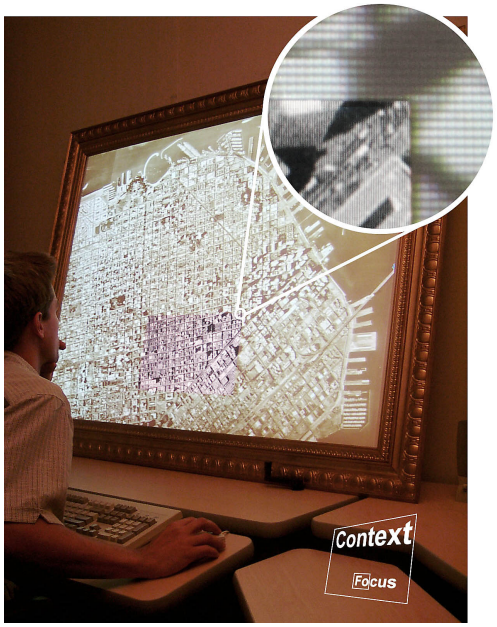
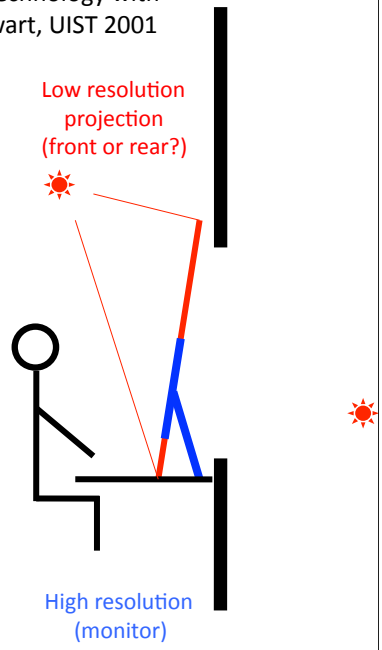
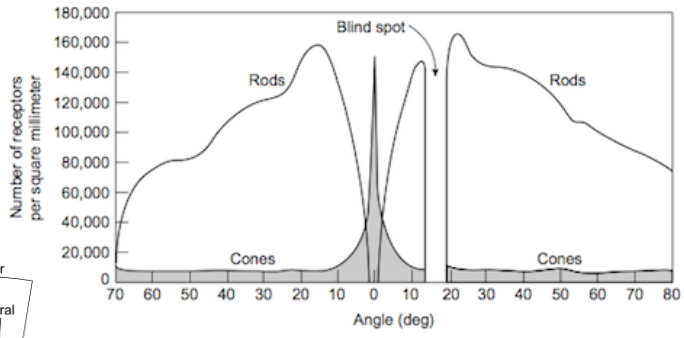
- Display size vs information space vs scale
- Large displays often have low resolution or pixel density
  - Distance from viewer to display
  - Apple's "Retina" displays
- This paper:
  - Fixed-information-space experiment: used maps of the same size for all display sizes, which allows for absolute comparisons of performance measures, but causes scale ratios to vary.
  - Variable-information-space experiment, varied the map size relative to display size so that the scale ratios are constant across display sizes, but does not allow direct comparisons because performance with maps of different sizes is measured.

- This study shows that these visualizations do not benefit from a "large" (multi-monitor) display
  - When targets are visible at all zoom levels
  - When interaction is required
  - When target search time is included
- Why not ask which technique is best for each display size?

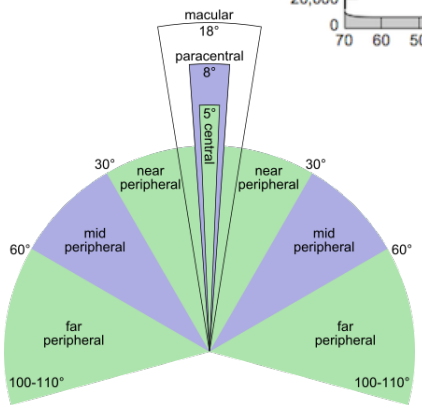
"Focus Plus Context Screens: Combining Display Technology with Visualization Techniques", Baudisch, Good, & Stewart, UIST 2001







http://www.uxmatters.com/mt/archives/2010/07/updating-our-understanding-of-perception-and-cognition-part-i.php



https://en.wikipedia.org/wiki/Peripheral_vision

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Jones, B., Sodhi, R., Murdock, M., Mehra, R., Benko, H., Wilson, A. D., Ofek, E., MacIntyre, B., Shapira, L. RoomAlive: Magical Experiences Enabled by Scalable, Adaptive Projector-Camera Units. ACM UIST, 2014.

http://projection-mapping.org/roomalive-uist/

Interaction Technology Applications? Implementation Challenges?

- Color compensation? Non white surfaces?
- Can't move furniture after calibration
- Windows & different lighting?
- How accurate is the touch?
- How adaptable to odd shaped rooms, partial rooms?
- Audio – is surround sound necessary, will it add something, make more immersive, what if target audience member is moving, multiple people
- Seems expensive, power, not home use, but permanent installation charge admission
- Interactive puzzle experience, group, solve riddles (escape the room), adding augmented reality would be interesting
- How does perspective work for multiple viewers for synthetic 3 objects?

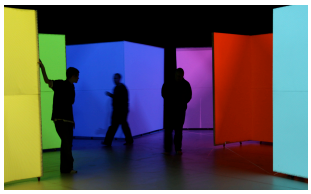
Dynamic Projection Surfaces for Immersive Visualization

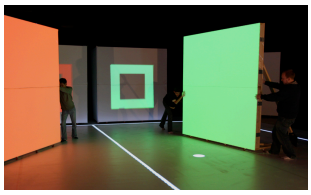
Theodore C. Yapo, Yu Sheng, Joshua Nasman, Andrew Dolce, Eric Li, and Barbara Cutler

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

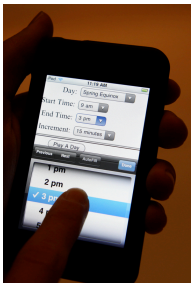
Our System Goals/Requirements

- 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

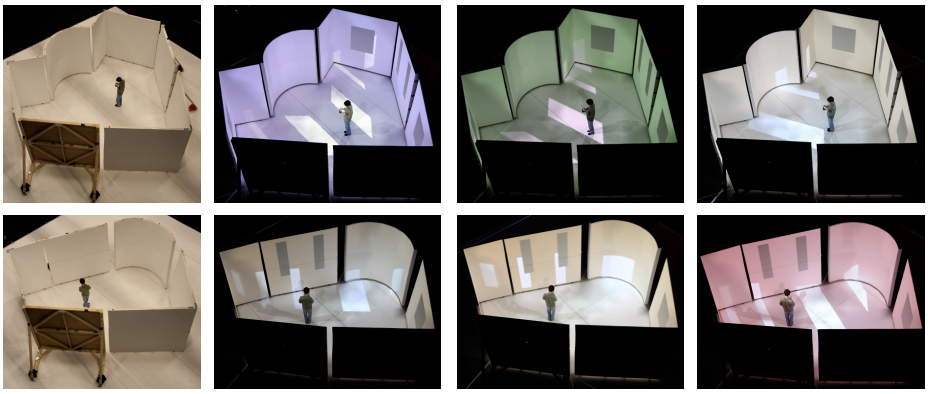




Architectural Daylighting Design

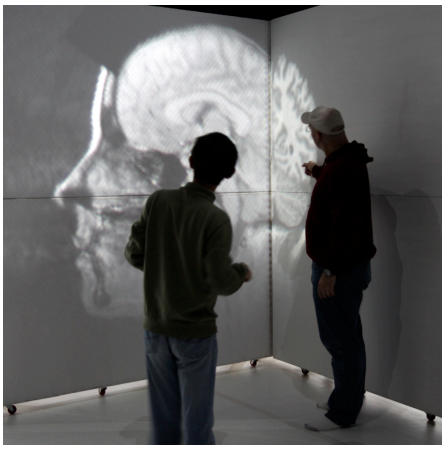


- Windows, wall colors, & time of day controlled through iTouch interface



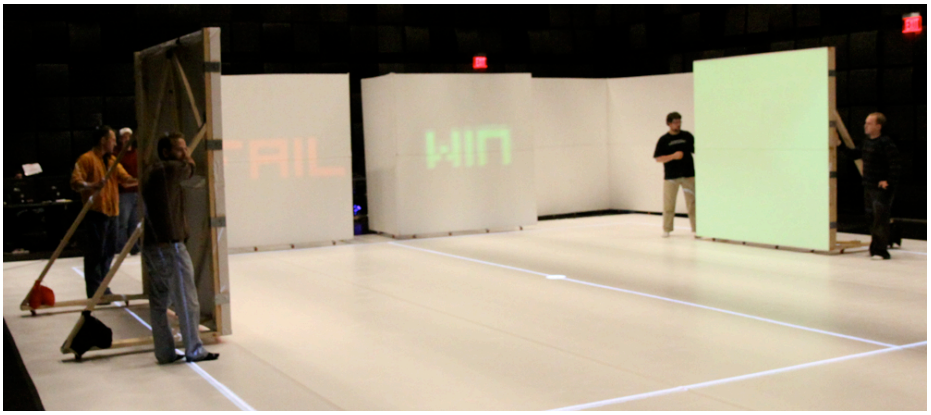
Volumetric Visualization

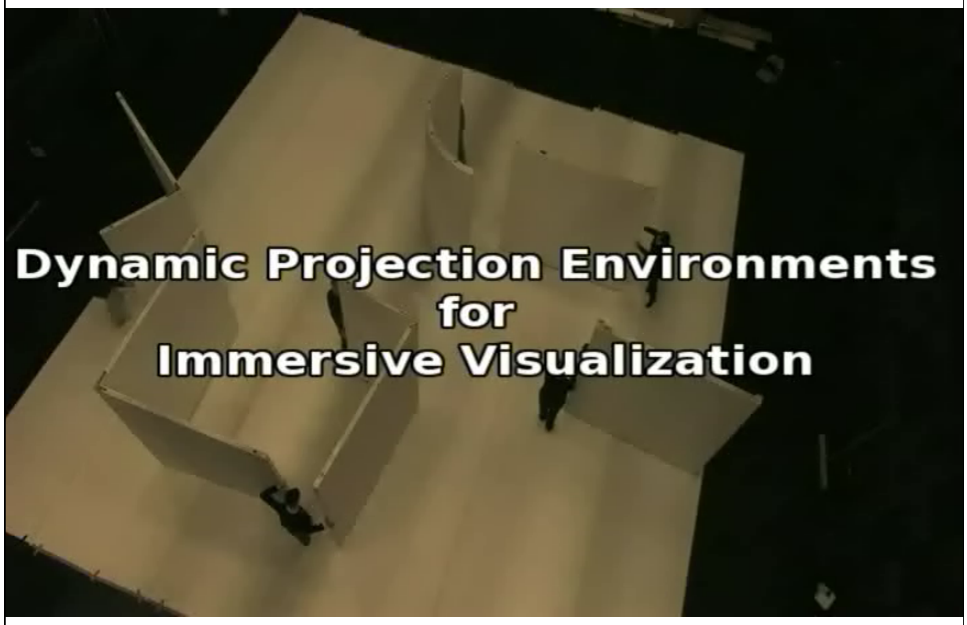
- Cross sections of a 3D medical dataset virtually placed within the projection volume



General User Interface Elements

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





Panorama from Gehua Yang, DualAlign

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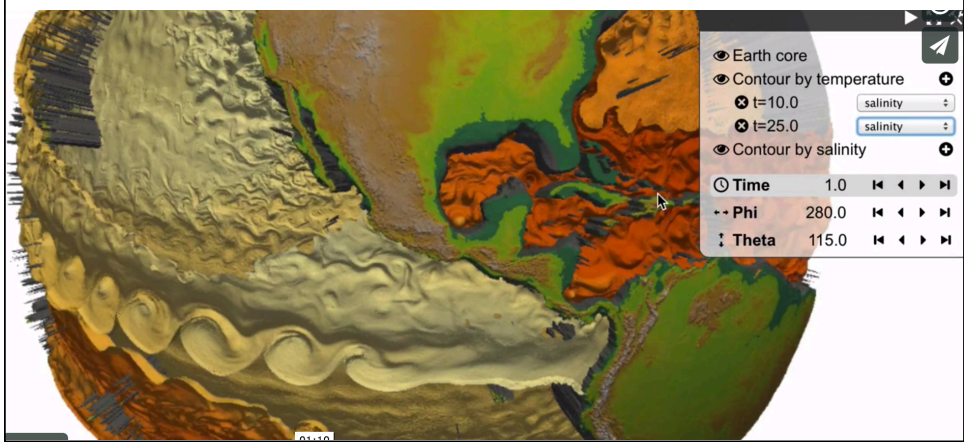
"An Image-based Approach to Extreme Scale In Situ Visualization and Analysis", Ahrens, Patchett, Jourdain, Rogers, O'Leary, & Petersen, Supercomputing 2014



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"Scalable Parallel Distance Field Construction for Large-Scale Applications", Yu, Xie, Ma, Kolla, & Chen, IEEE TVCG, VIS 2015