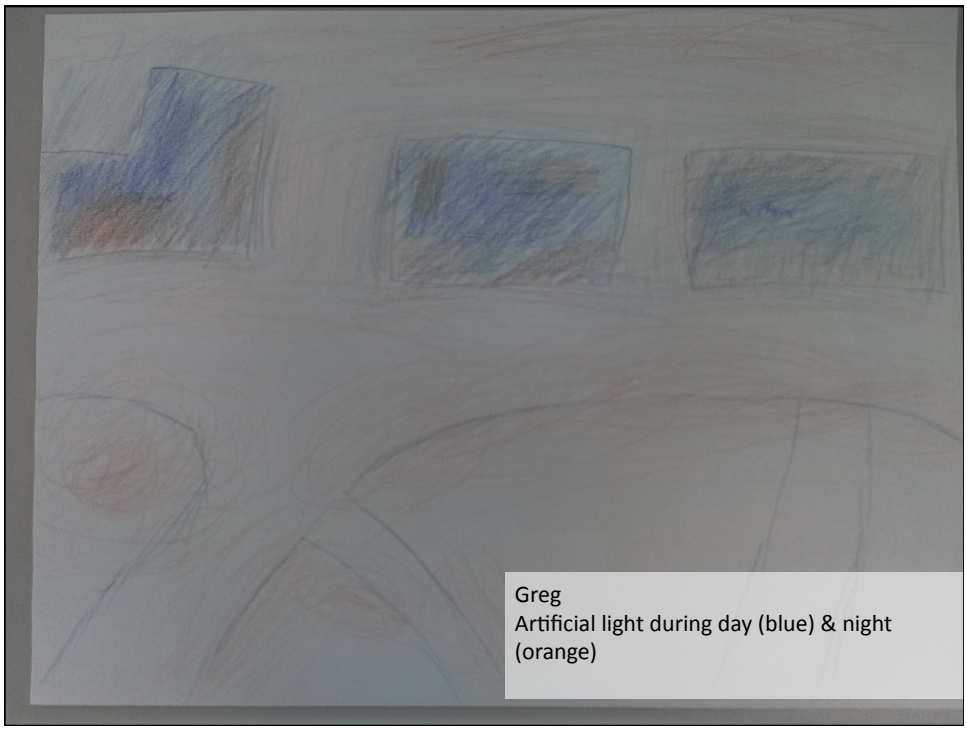
User Studies & Gestalt Psychology

Today

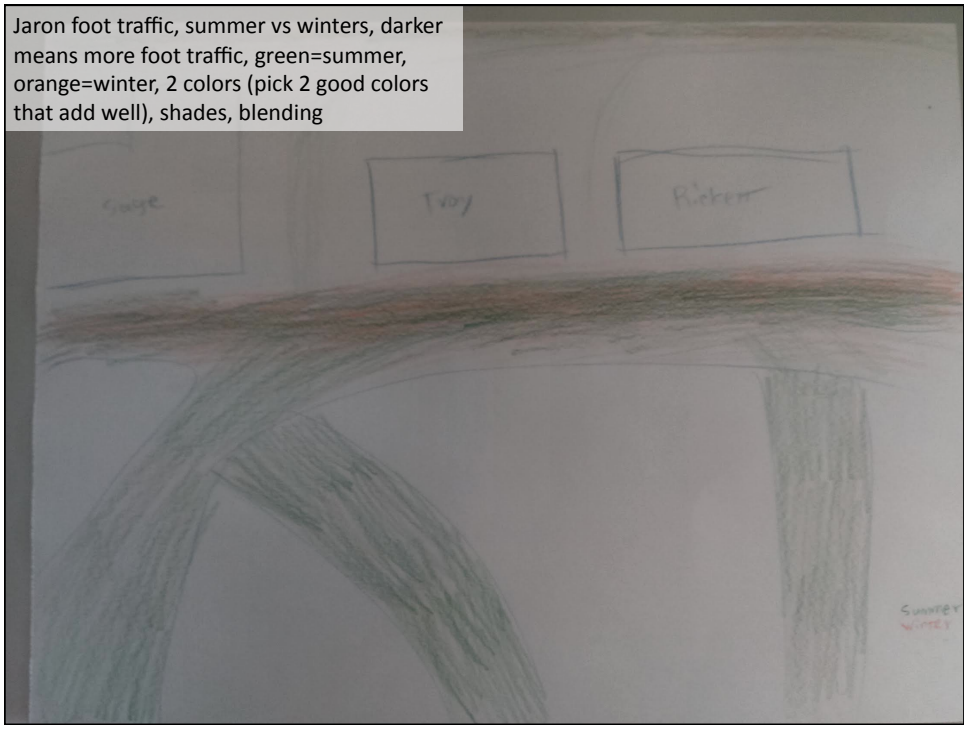
- Friday's Crayon Exercise Discussion
- Mini-Presentations
  - Courtney, Jorel, others?
- HW 5 Discussion
- HW submission server
- Research Example: Gestalt & User Studies

Friday's Crayon Exercise: COLOR!

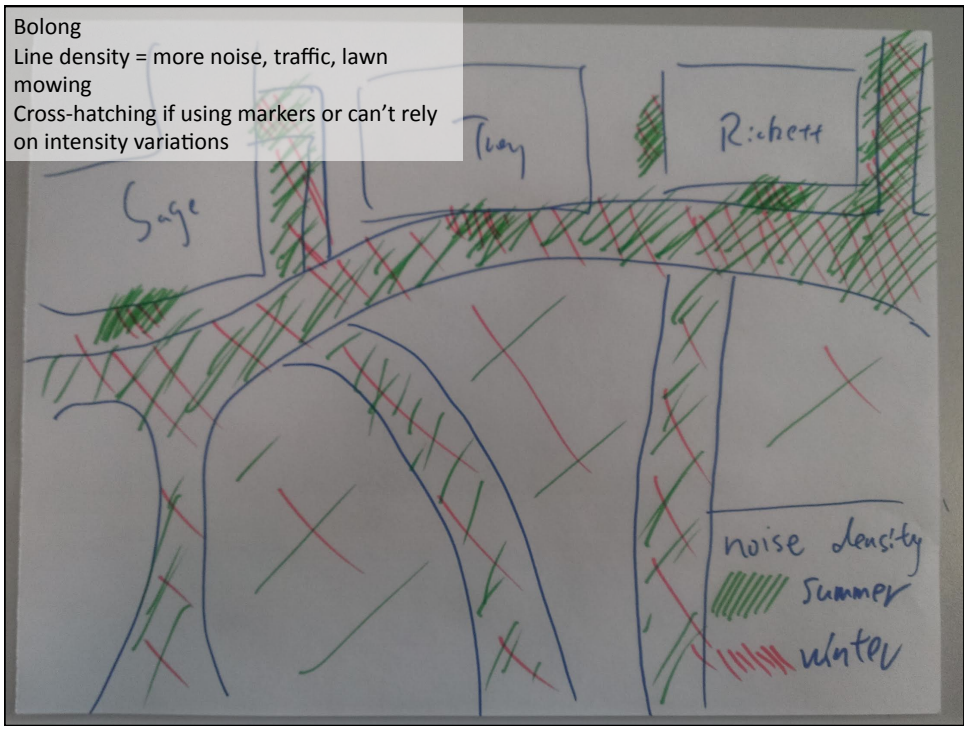
- Form a team of 3 & brainstorm a dataset with
  - an intuitive 2D spatial layout (e.g., a map of the US, the virtual world of a game, floorplan of a shopping mall, regions of the brain, etc.)
  - 3 interesting quantities on that map (e.g., temperature, population density, and how likely the population is to vote Republican)
  - Don't pick the first thing that comes to mind… be creative!
- Each team member gets 2 of these quantities (one primary, one secondary) and makes their own visualization of these quantities in a single image. E.g.:
  - Person A: temperature (vs. population density) on the US map
  - Person B: population density (vs. Republicanism) on the US map
  - Person C: Republicanism (vs. temperature) on the US map
  - Each drawing stands on its own, you are not required to use a common visualization scheme
- Drawing from today's readings… use color very thoughtfully
- Form a hypothesis of the correlations you will find in the data – but you don't need real or accurate data. Feel free to embellish the data to show off your visualization scheme.



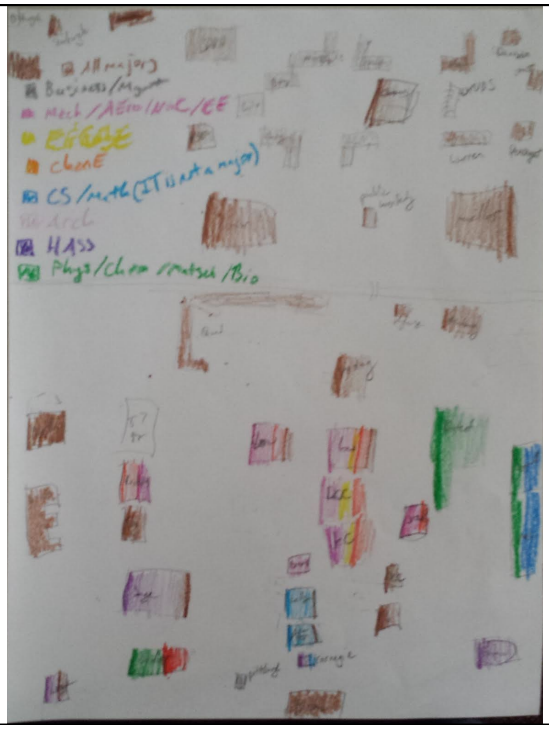
Greg
Artificial light during day (blue) & night (orange)



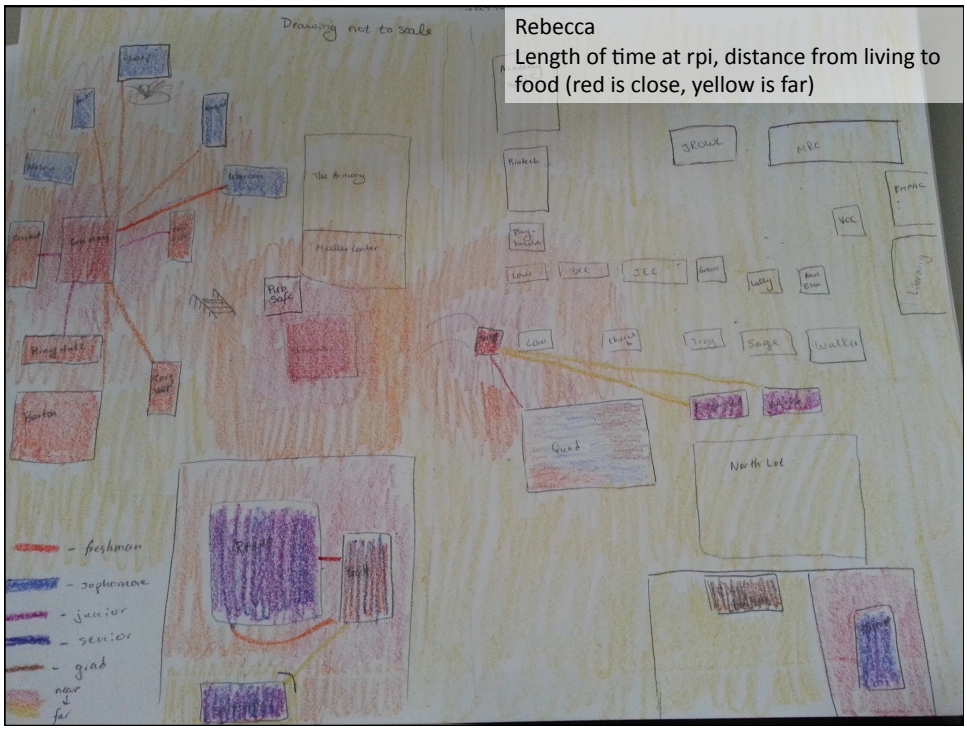
Jaron foot traffic, summer vs winters, darker means more foot traffic, green=summer, orange=winter, 2 colors (pick 2 good colors that add well), shades, blending



Bolong
Line density = more noise, traffic, lawn mowing
Cross-hatching if using markers or can't rely on intensity variations

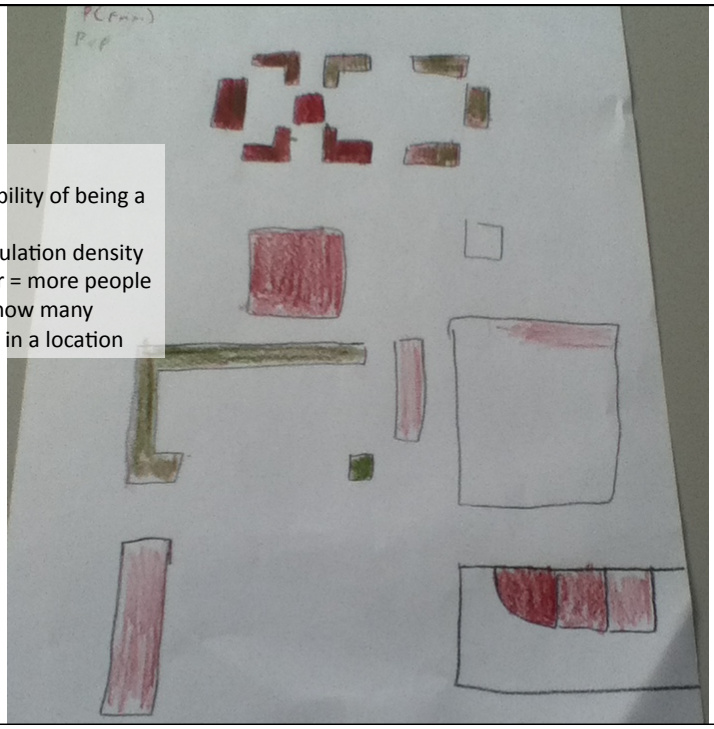


Ian
1 color per major
Lighter, less time at rpi, darker more time at rpi
Brown is a mix of all colors
Too many majors, not enough colors

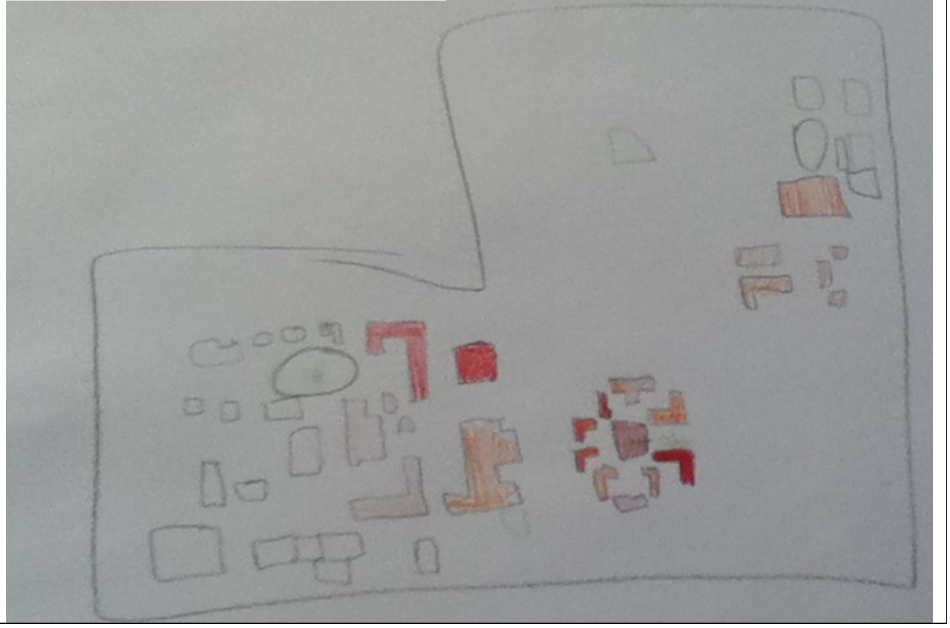


Rebecca
Length of time at rpi, distance from living to food (red is close, yellow is far)

Andrew:
Red = probability of being a freshmen
Green = population density living, darker = more people
Lightness = how many students are in a location

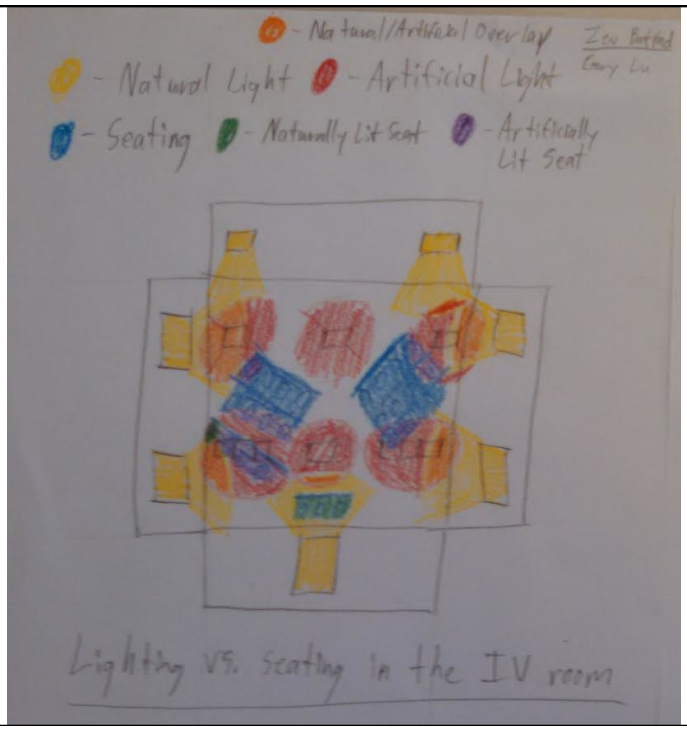


Gerret:
light red-> dark red population (where to hangout), & bugs (yes, insects… not on plots)

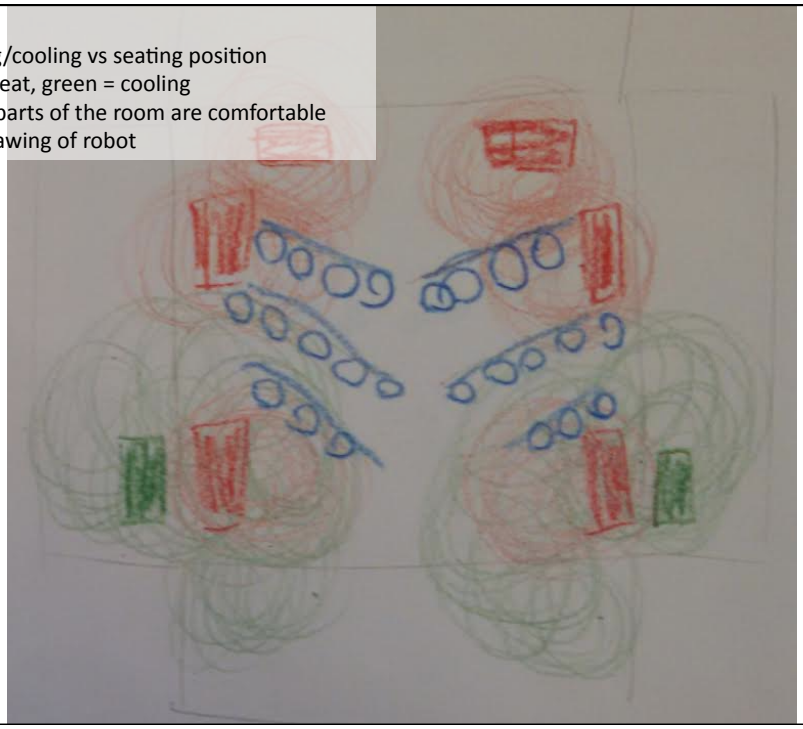


Irene:
freshmen & bugs

Zev
Collapsed lecture room (modified for interest)
Draw conclusions about where you are getting enough light, if natural light is sufficient in some areas (no artificial required)

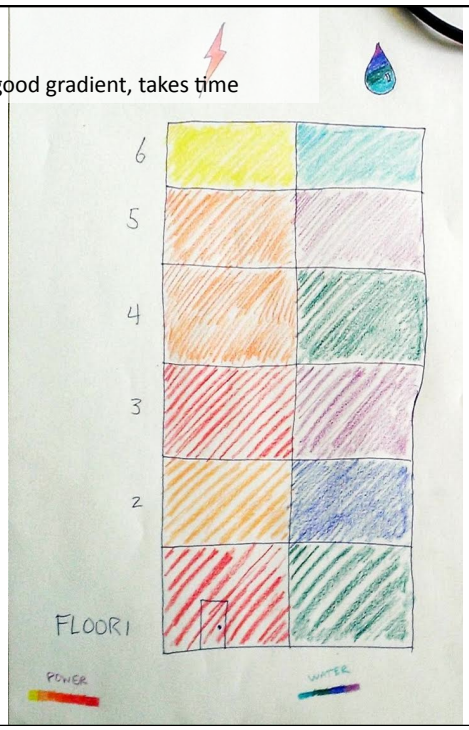


Gary
Heating/cooling vs seating position
Red = heat, green = cooling
Which parts of the room are comfortable
Also drawing of robot

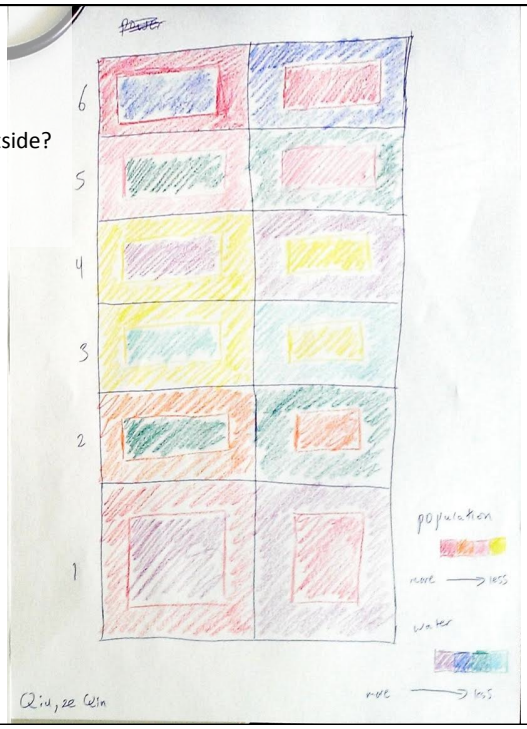


Jesse & Q

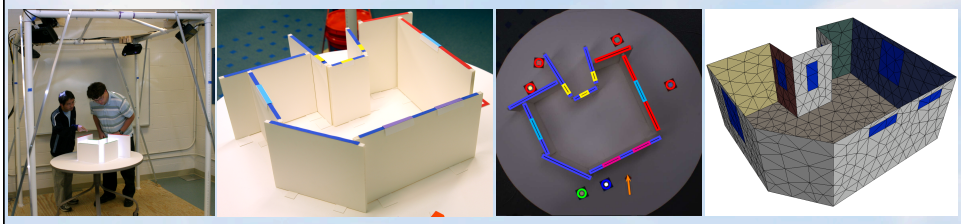
Hard to find good gradient, takes time



Q
Floors in apartment
Population (warm colors)
Water usage (cool colors)
Which one should go on the inside/outside?
(both is good for explanation but is redundant)
Look for outliers low pop high water



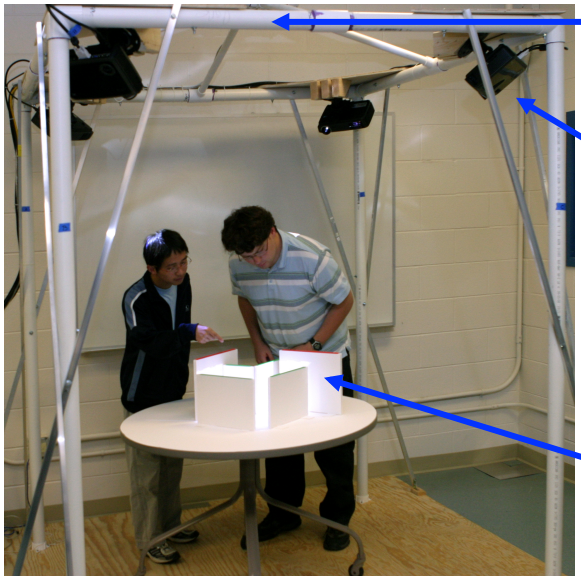
Interpreting Physical Sketches as Architectural Models



Barbara Cutler and Joshua Nasman

Department of Computer Science
Rensselaer Polytechnic Institute

"Virtual Heliodon" for Daylighting Analysis

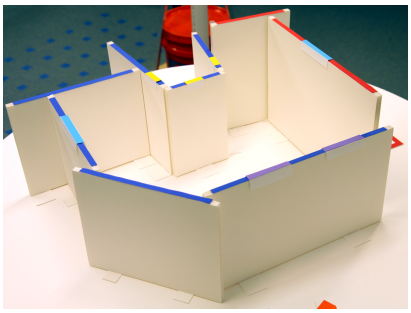


camera to detect geometry

4 projectors to display solution

design sketched with foam-core walls

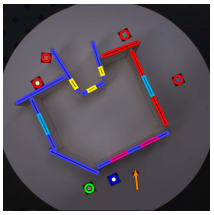
Tangible Interface for Architectural Design



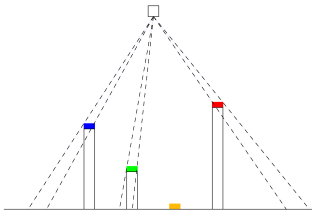
Exterior & interior walls

Tokens for:

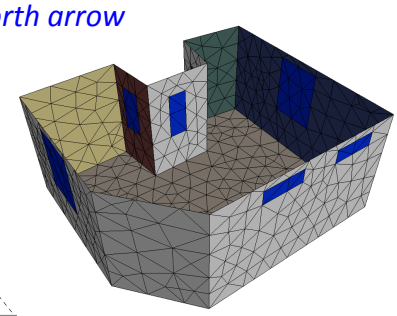
- *Windows*
- *Wall/floor colors*
- *North arrow*



Overhead camera



Projection geometry



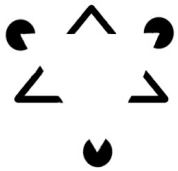
Inferred design

Our Contributions

- Algorithm for automatic interpretation of interior space vs. exterior space
- Construction of a watertight 3D mesh
- User study collected >300 example designs
- Validation of algorithm
  - Compare to annotations by the original designer
- Quantify design ambiguity
  - Compare annotations of a design by other users

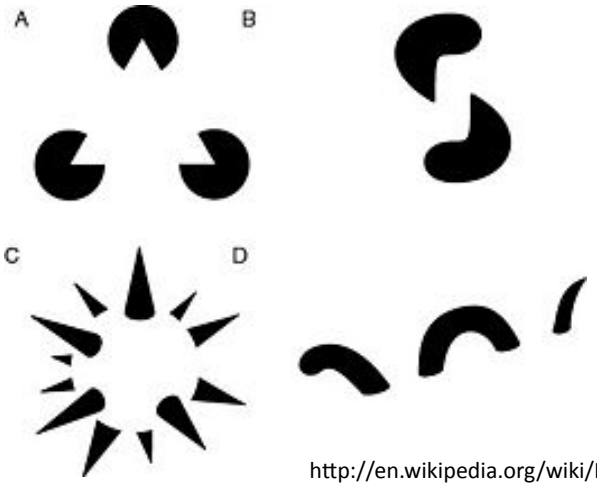
Related Work

- Tangible User Interfaces [e.g., Ben-Joseph et al. 2001]
- Sketch-based Modeling User Interfaces
  [Zeleznik et al. 1996; Igarashi et al. 1999; Dorsey et al. 2007]
- Pen-based Sketch Recognition [e.g., Wacom 2010]
- Automated Recognition of CAD Drawings
  [Aoki et al. 1996; Llados et al. 1997; Ah-Soon and Tombre 2001; Kulikov 2004; Lu et al. 2005]
- Human Vision, Perception, & Gestalt Psychology
  - Seek the simplest explanation for an incomplete diagram
  - Closure, proximity, symmetry, continuity, collinearity, & parallelism



Gestalt Psychology: Reification

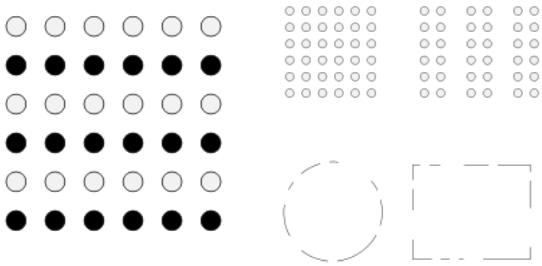
- Constructive or generative aspect of perception



http://en.wikipedia.org/wiki/File:Reification.jpg

Pragnanz: Gestalt Laws of Grouping

- Proximity
- Similarity
- Closure
- Symmetry
- Common fate
- Continuity
- "Good" gestalt (regular, simple & orderly, eliminate complexity & unfamiliarity)
- Past experience

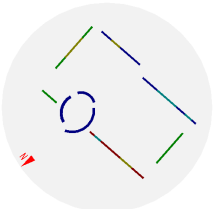


http://en.wikipedia.org/wiki/Gestalt_psychology

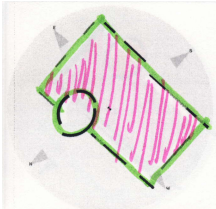
Overview of Algorithm

- Image Processing (our earlier publications)
- Lack of precision in sketch: Should elements be parallel? collinear? perpendicular? tangent?
- Link tangent walls to form continuous chains that divide space into zones
- Determine interior vs. exterior
- Generate floor plan diagram & watertight mesh geometry (more details in our paper)

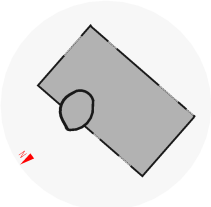
Tolerance Example: Collinearity



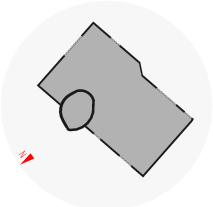
Detected Geometry



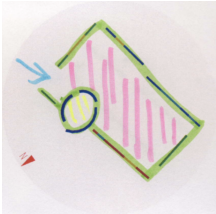
Designer's Intention

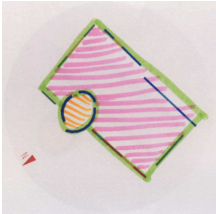


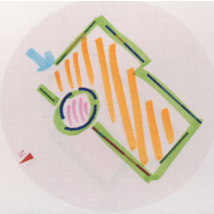
Favor Collinearity



Favor Skew Lines



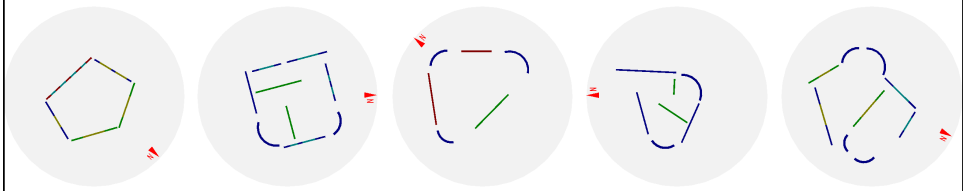




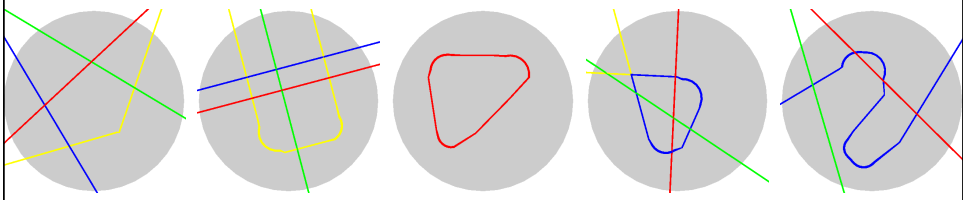
Other Users' Interpretations

Linking Elements to Form Chains

- If A→B and B→A are best matches for tangent, then the walls are joined into a chain



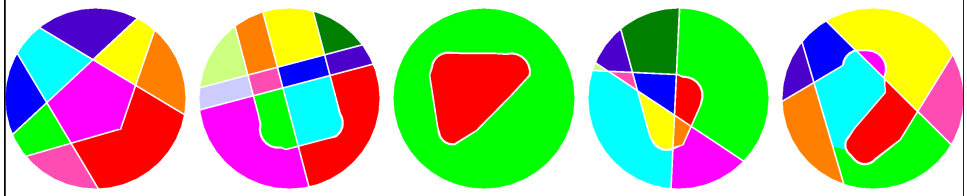
Detected Geometry



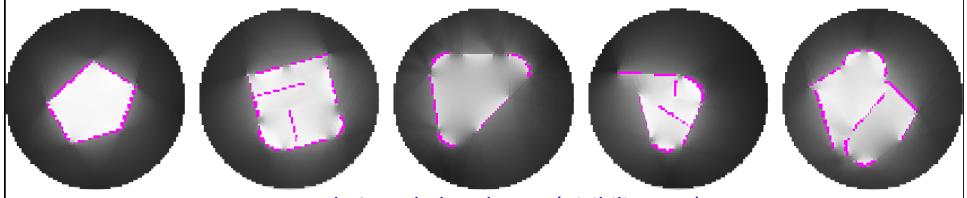
Wall Chains, Extended to Infinity

Halfspace Zones & Enclosure

- Further subdivided using GraphCuts (if needed)



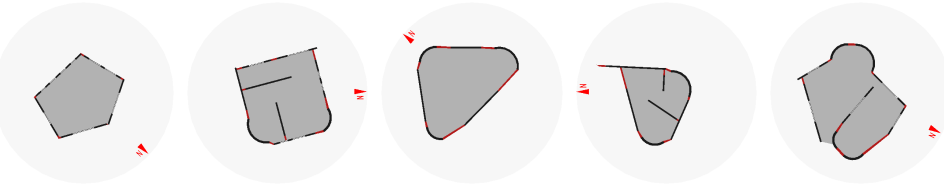
Halfspace Zones



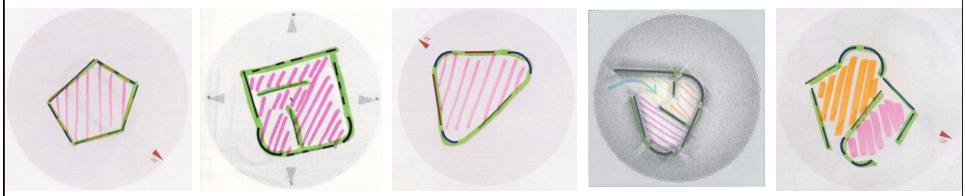
Densely Sampled Enclosure (Visibility Test)

Interior/Exterior Enclosure Threshold

- Unfortunately, there is no universal threshold
- Varies design-to-design, and *within-a-design*



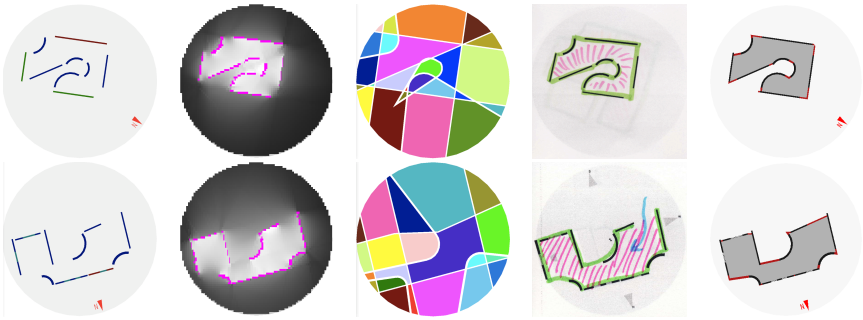
Automatic Interior/Exterior Determination & Final Floorplan



Compare to Designer's Intention

Interior/Exterior Optimization

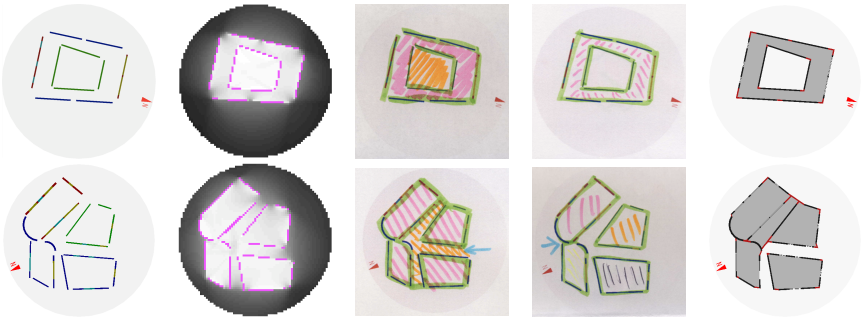
- Analyze histogram of point-sampled enclosure values
- Maximize usage of lengths of real wall elements
- Minimize length of inferred (added) walls
- Minimize area assigned in opposition of simple threshold metric



Complex Boundaries & Varying Gaps

Interior/Exterior Optimization

- Analyze histogram of point-sampled enclosure values
- Maximize usage of lengths of real wall elements
- Minimize length of inferred (added) walls
- Minimize area assigned in opposition of simple threshold metric
- (Courtyard option) Minimize total enclosed area



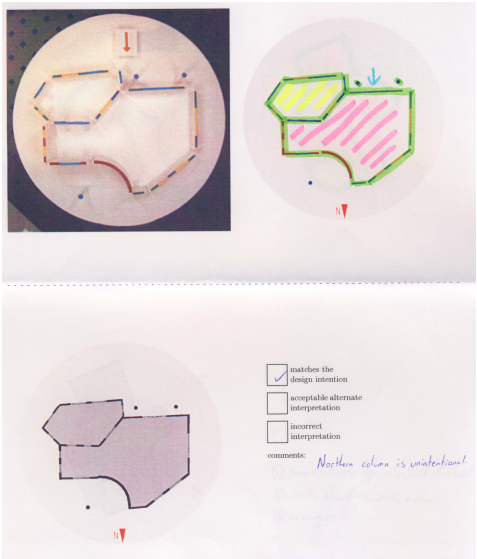
Open Courtyards & Multiple Buildings

Our Goals in Conducting User Studies

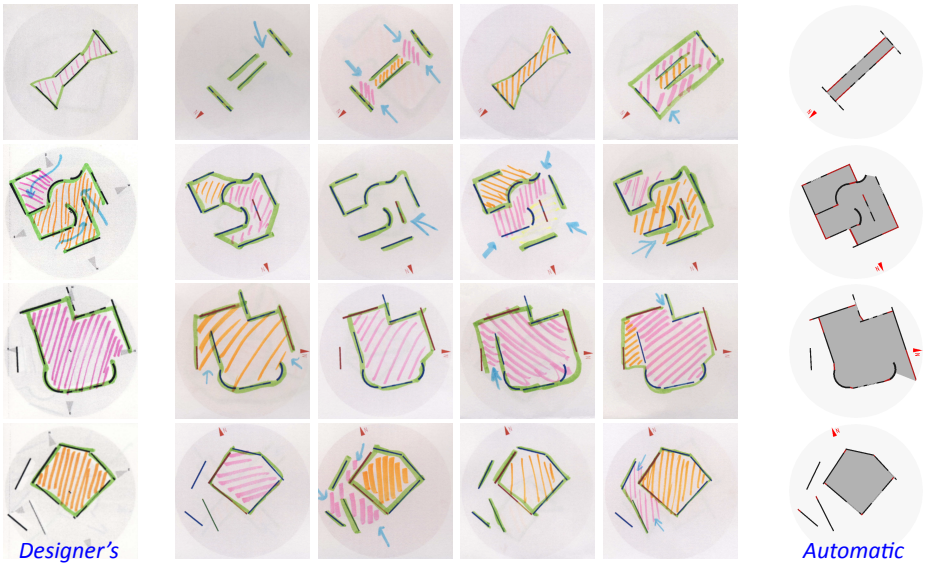
- Understand range of designs possible
- Improve physical sketching user interface
- Improve algorithm for sketch recognition of interior/exterior space
  - Learn common human interpretation "rules"
  - Quantify design ambiguity
- Measure effectiveness of *Virtual Heliodon* as an architectural daylighting design tool

User Study 1: Open-Ended Design

- 30 participants (15 architects)
- 20 mins of sketching
- 329 unique designs (154 by architects)
- After design session:
- Designer annotates each design
- Then, we reveal our automatic interpretation



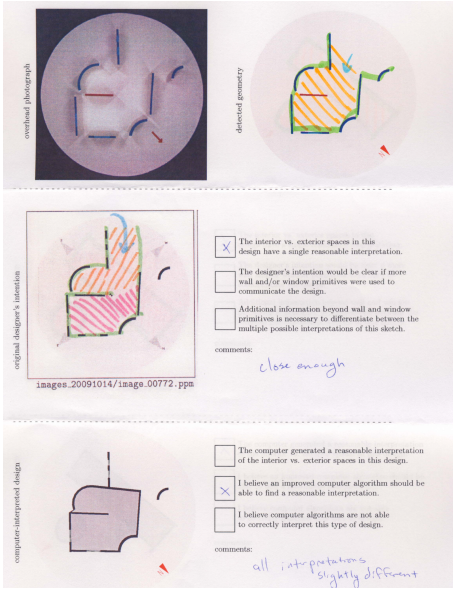
Identify/Quantify Ambiguous Designs



Designer's Annotation *Re-Interpretation by Other Users* *Automatic Interpretation*

User Study 2: Re-Interpretation

- 114 designs from Study 1
  - All ambiguous designs included
  - Some clear designs (as controls)
- 15 participants
- Re-interpreted by another user
  - 3-6 new annotations for each
  - 346 total (124 by architects)
- Then compare to original designer's annotation
- And finally, to our automatic interpretation



Re-Interpretation Results

matches the original designer's intention

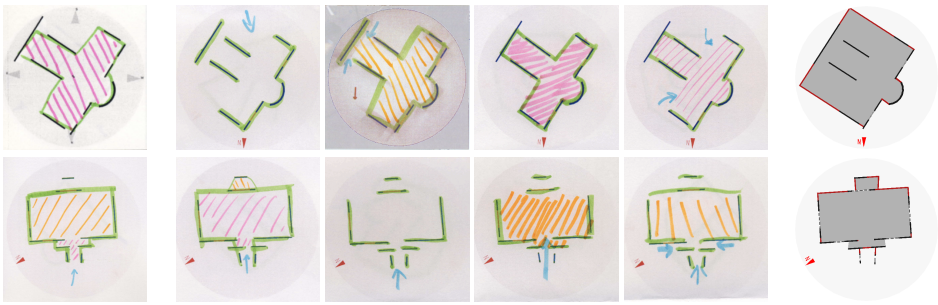
	correct		mostly correct		incorrect		total
clear	155	78%	17	9%	26	13%	198
ambiguous	74	56%	35	27%	22	17%	131
total	229	70%	52	15%	48	15%	329

multiple interpretations possible

- No correlation found between background (architecture/arts/none) & interpretation accuracy
- We will continue to improve the robustness of our software

Domain-Specific Knowledge Required

- Standard vocabulary of architectural forms (e.g., cruciform, portico, etc.)



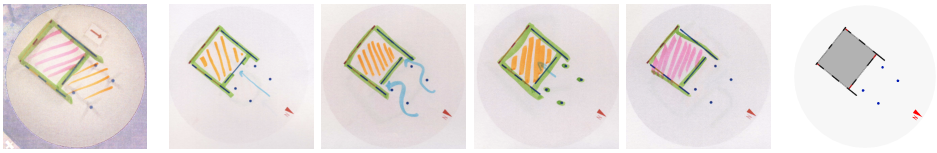
Designer's Annotation *Re-Interpretation by Other Participants* *Automatic Interpretation*

Future Work

- Improve/robustify interpretation algorithm
  - Detect symmetry & repetition
  - Multi-zone interiors & circulation paths
- Incorporate domain-specific knowledge
- Enhance user interface
  - Additional tokens, more complex element shapes
  - Alternative to sketching in plan:
    sketch (double height, multi-floor) vertical sections
- Apply to pen-based sketch interpretation

Thanks!

- Yu Sheng, Ted Yapo, & Andrew Dolce
- Our user study volunteer participants
- Funding from NSF & IBM



Designer's Annotation *Re-Interpretation by Other Participants* *Automatic Interpretation*