

# DESIGNING COLLABORATIVE VISUAL ANALYTICS TOOLS: FROM SUPPORTING EXPERTS TO ENGAGING THE PUBLIC



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University of British Columbia  
February 18, 2016 @ MSR

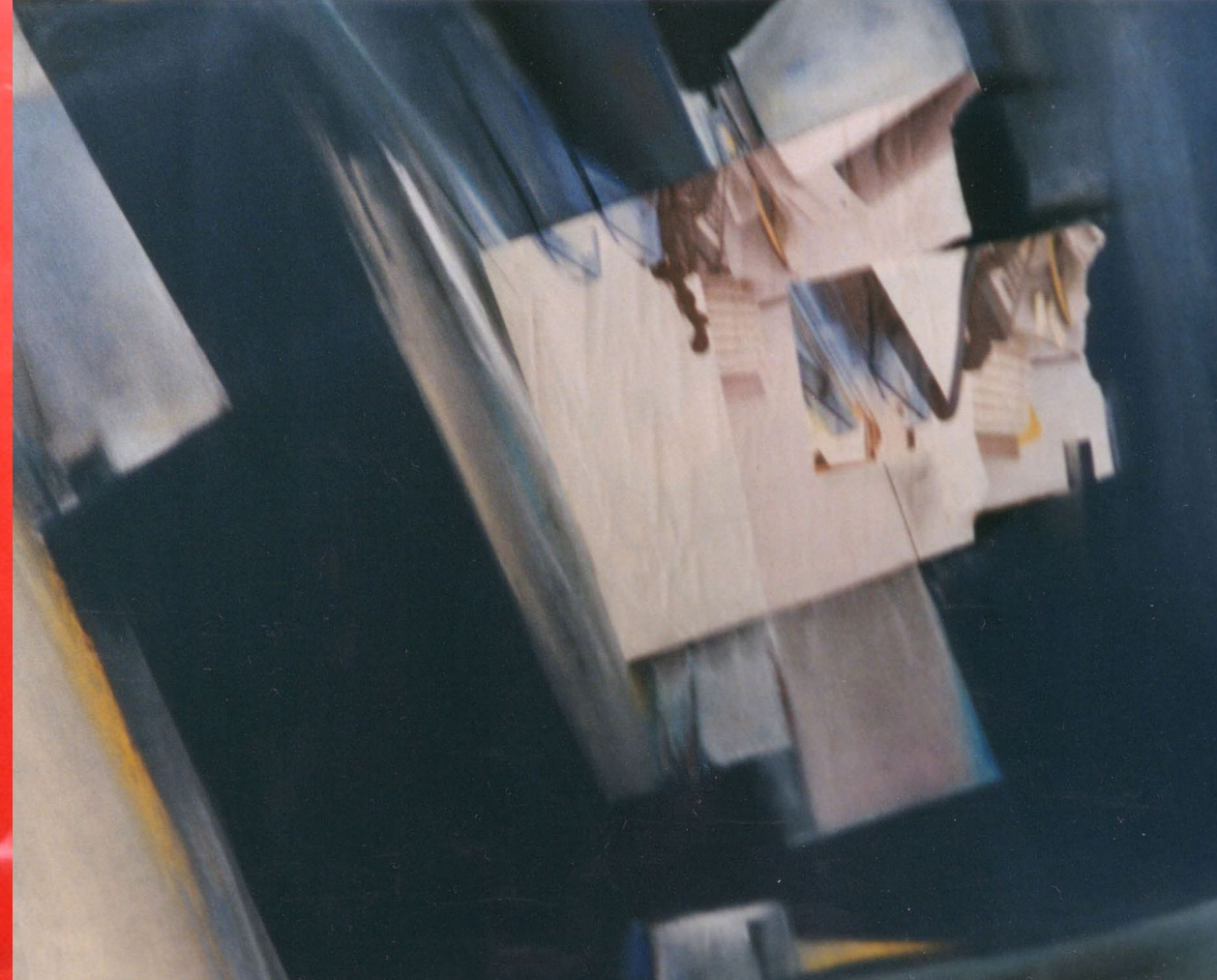




## INTERDISCIPLINARY BACKGROUND

- ▶ Electrical Engineering
- ▶ Fine Arts Background
- ▶ Computer Science





How can we combine fine arts and computer science?

How can art make CS reach beyond CS audiences?



### BIO

- ▶ I design, develop and evaluate novel visualization & interaction techniques to help people solve complex problems.
- ▶ Human-Computer Interaction (HCI)
- ▶ Collaborative Visual Analytics (CVA)
- ▶ Computer Supported Collaborative Work (CSCW)
- ▶ Visual Analytics (VA)



## DOMAINS

- ▶ Business Intelligence
- ▶ Intelligence Analysis
- ▶ Urban Planning
- ▶ Civil Engineering



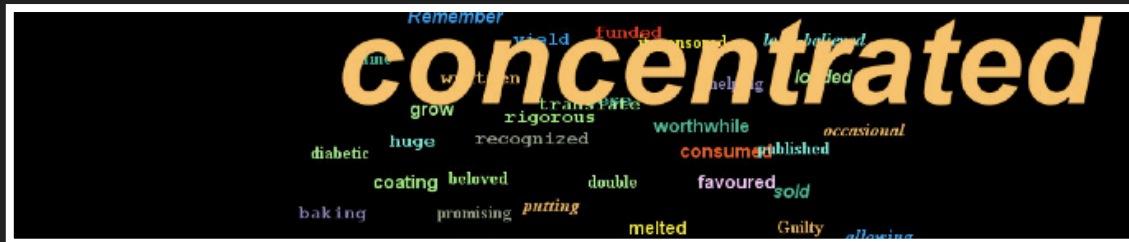
## MY RESEARCH APPROACH & METHODS

- ▶ Understanding the domain specific problems
- ▶ Designing visualization & interaction technologies
- ▶ Evaluating & analyzing the effect
- ▶ Ethnography
- ▶ Observational User Study
- ▶ Case Study
- ▶ System Building
- ▶ Qualitative & Quantitative Evaluation

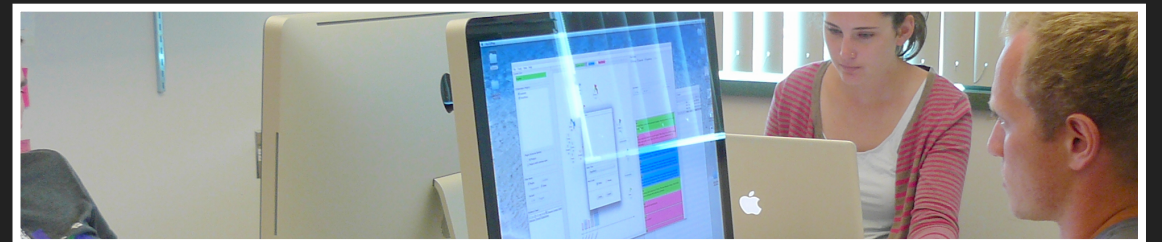


## WHO AM I & WHAT AM I DOING

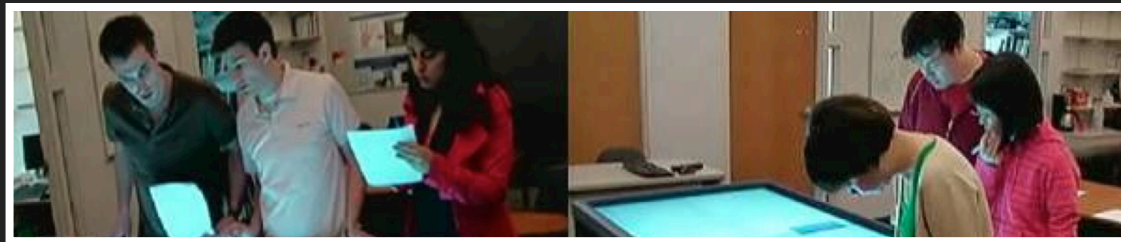
# MY MAIN RESEARCH CONTRIBUTIONS



MSc., ICCV 2010



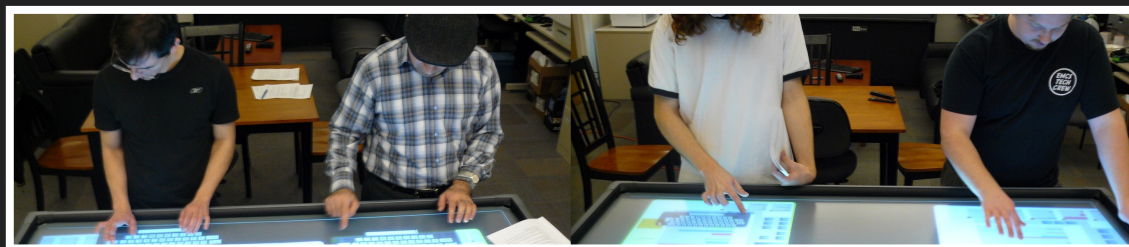
PhD, VAST 2014, **Best Paper Award**



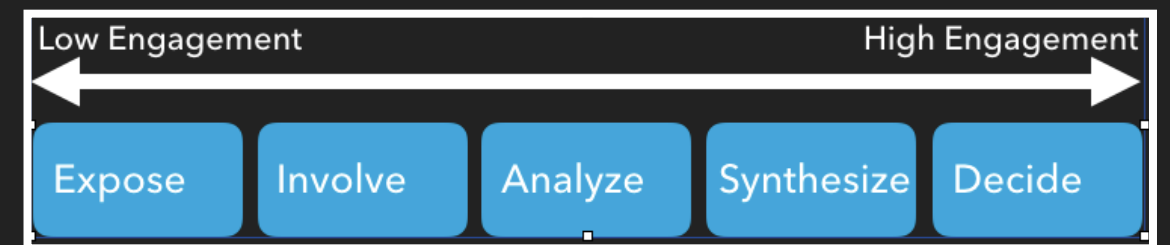
PhD, VAST 2010, InfoVis 2012



Postdoc, CSCW 2015, City Life



PhD, HICS 2013, ITS 2011



Postdoc, IEEE VIS 2015, Personal Vis



## OUTLINE OF THE TALK

- ▶ Collaborative Visual Analytics (CVA)
- ▶ A selection of my projects:
  - ▶ CLIP
  - ▶ Participatory Urban Design
- ▶ Contributions
- ▶ Vision & Future Directions



## WHY COLLABORATE VISUAL ANALYTICS (CVA)?

### ► Collaboration:

- Diverse backgrounds/expertise
- Quality of work
- Individual bias
- Task Load



### ► Visual Analytics:

- Visual representation & interactive exploration

## COLLABORATIVE VISUAL ANALYTICS: CHALLENGES

Users

Multiple backgrounds

Cognition

Foraging & sensemaking

Analysis results

Consensus, shared insight

Evaluation

Social interaction around data

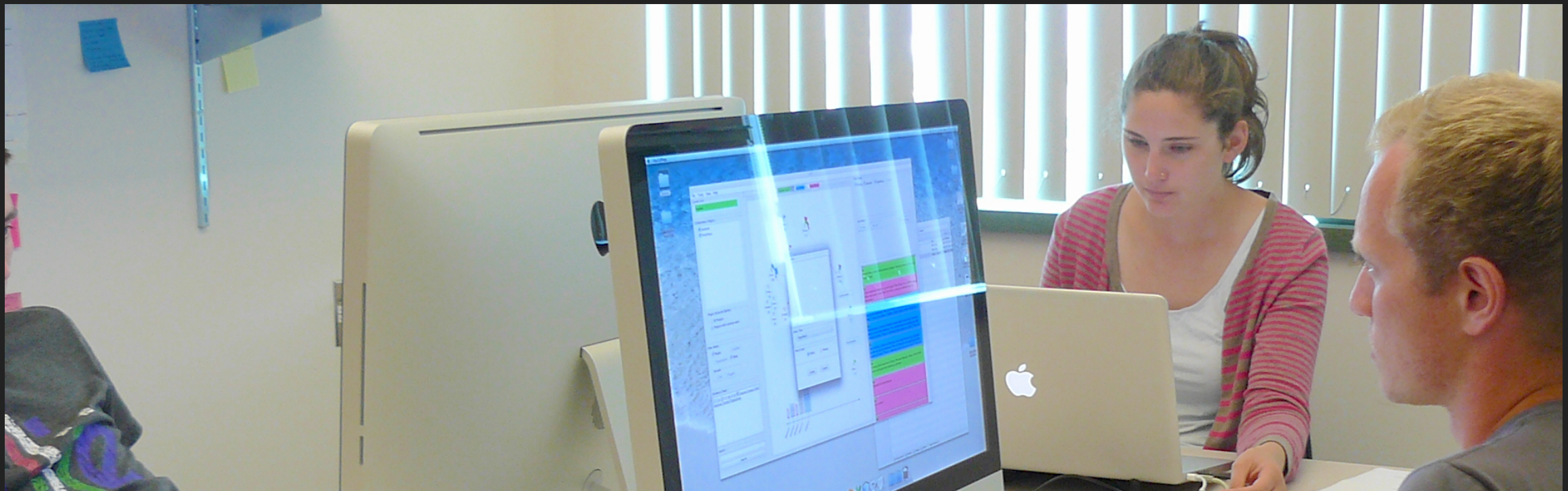
Visual representations

Multiple displays, novel I/O

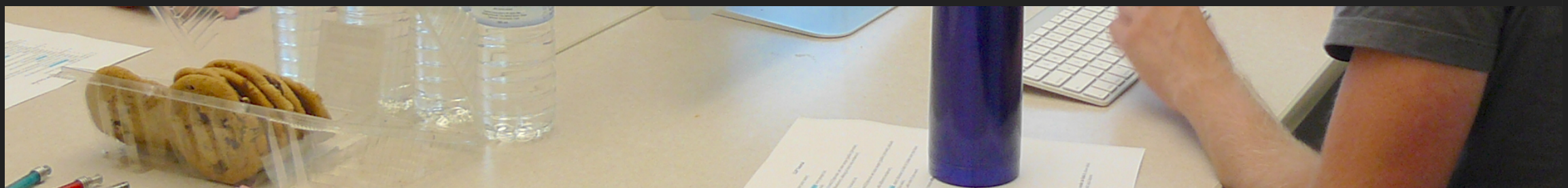
Isenberg et al., Infovis, 2012



## CLIP (COLLABORATIVE INTELLIGENT PAD)



CLIP is a collaborative thinking space that helps people to record, organize, and share their externalizations.



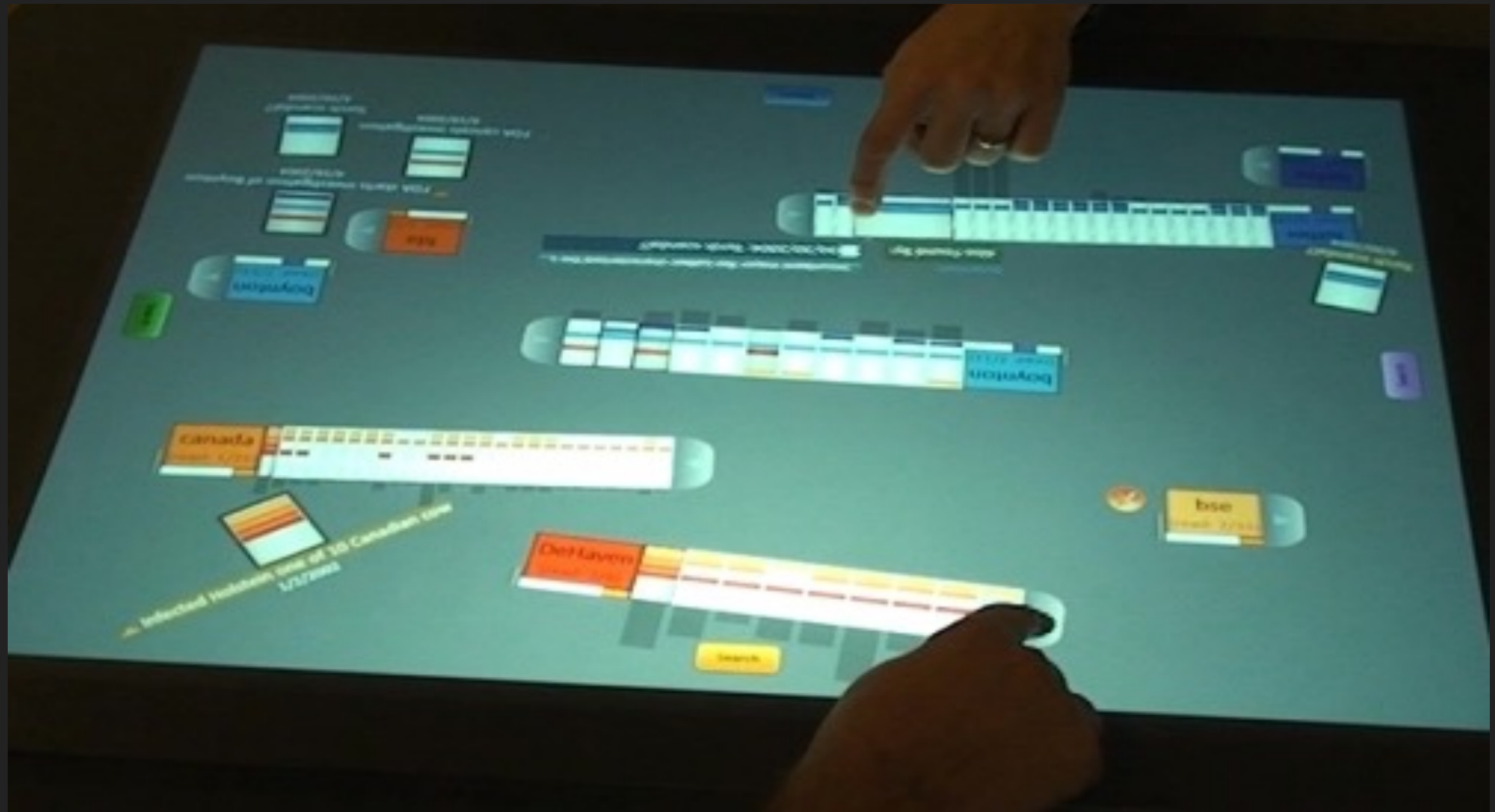
**Narges Mahyar** and **Melanie Tory**, “Supporting Communication and Coordination in Collaborative Sensemaking”, IEEE Transaction on Visualization and Computer Graphics (VAST 14), 2014. **[Best Paper Award]**

## RESEARCH PROBLEMS

- ▶ How to support collaborative sensemaking?
- ▶ How to support **externalizations**?
  - ▶ organize, record, and share findings, hypotheses, and evidence.
- ▶ Evaluate the effect on awareness, communication & coordination?



## CAMBIERA: FOR COLLOCATED VISUAL ANALYTICS OF DOCUMENT COLLECTIONS



Isenberg & Fisher, 2012

## CONTEXT

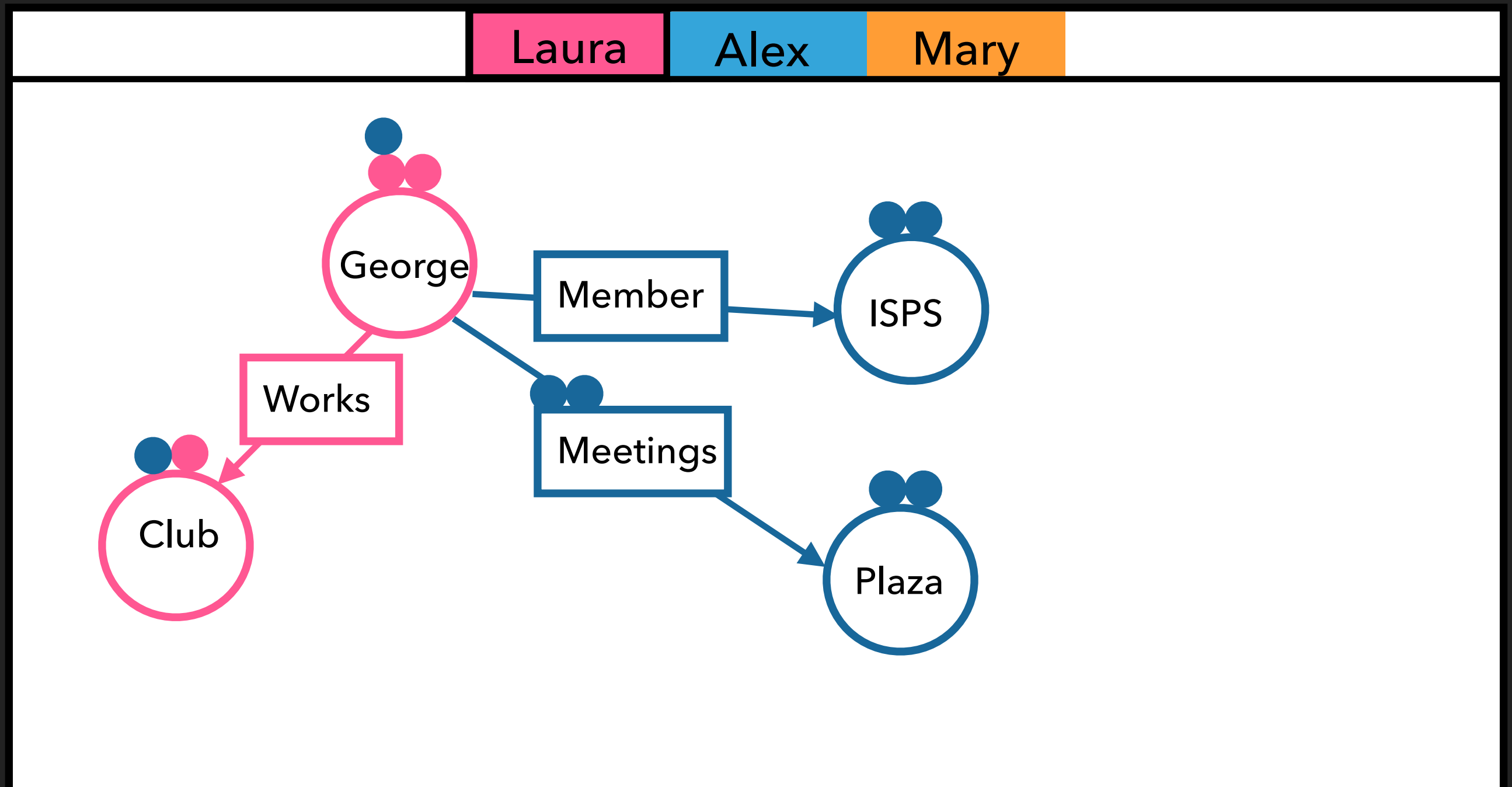
- ▶ Task: VAST 2006 challenge, a mystery task
- ▶ Dataset: 240 documents
- ▶ Setting: Collocated collaborative analysis



## LINKED COMMON WORK (LCW)

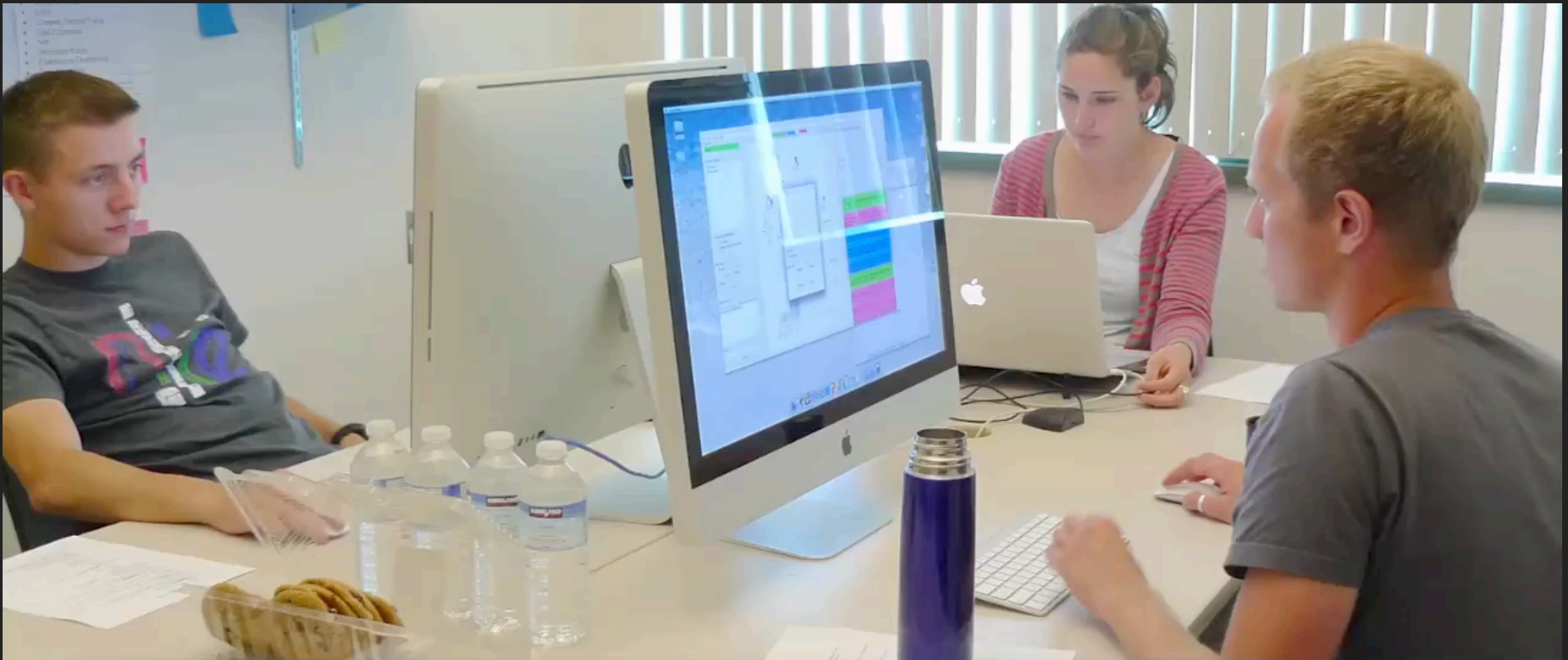
- ▶ **LCW**: automatically Identifying and visually representing similarities between collaborators' work
  - ▶ Partial merging
  - ▶ Full merging

## PARTIAL VS. FULL MERGING





## CLIP: VIDEO

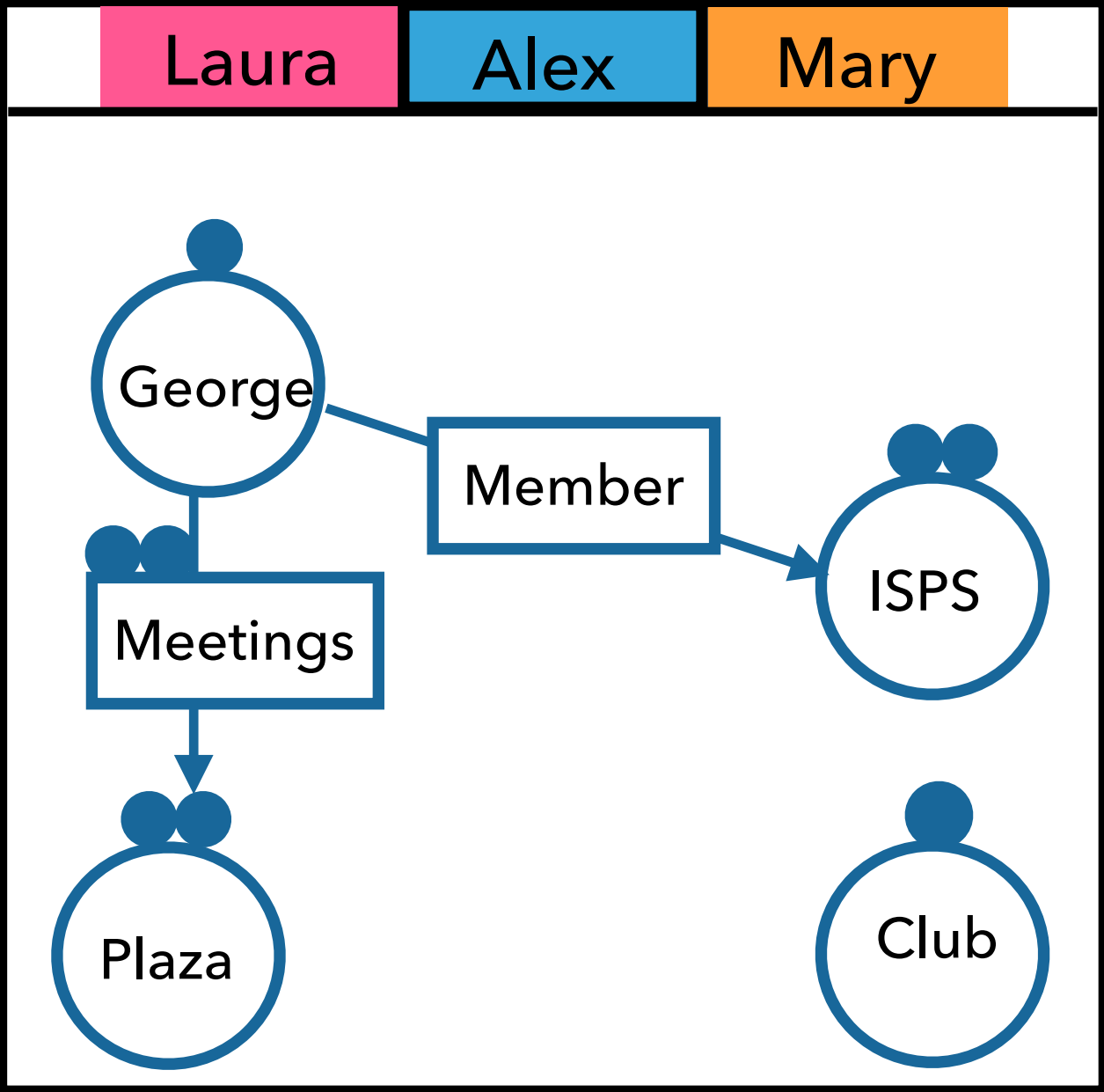
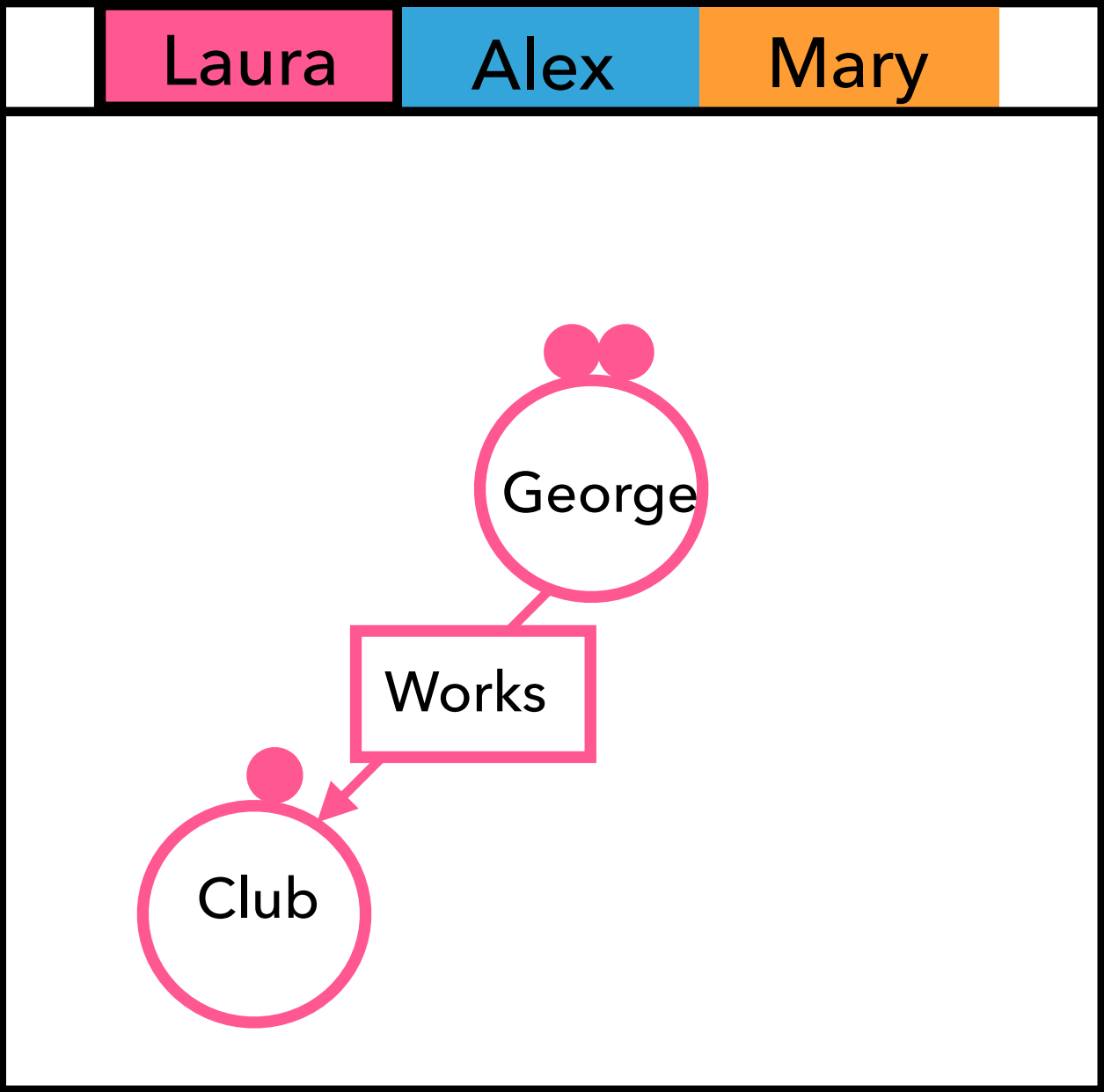


**CLIP: A Collaborative Visual Thinking Space to Support Joint Sensemaking**

## EVALUATION OF LINKED COMMON WORK (LCW)

- ▶ Experimental comparison of CLIP to a baseline tool
- ▶ Baseline tool: CLIP without LCW

# BASELINE TOOL





## USER STUDY & DATA GATHERING

- ▶ 16 groups of 3, 8 groups in each condition
  - ▶ Worked for 90 minutes
  - ▶ Used CLIP or Baseline
- ▶ Followed by semi-structured interview

## HYPOTHESES

- ▶ Linked Common Work will improve:
  - ▶ H1: Performance
  - ▶ H2: Communication
  - ▶ H3: Coordination
  - ▶ H4: Awareness

## METRICS AND ANALYSIS

- ▶ Performance
  - ▶ Scoring scheme (from Isenberg et al., 2012):
    - ▶ Positive points for finding and connecting relevant facts
    - ▶ Negative points for incorrect hypotheses
  - ▶ Number of key documents found (out of 10)



## METRICS AND ANALYSIS: DEVELOPING NEW METRICS

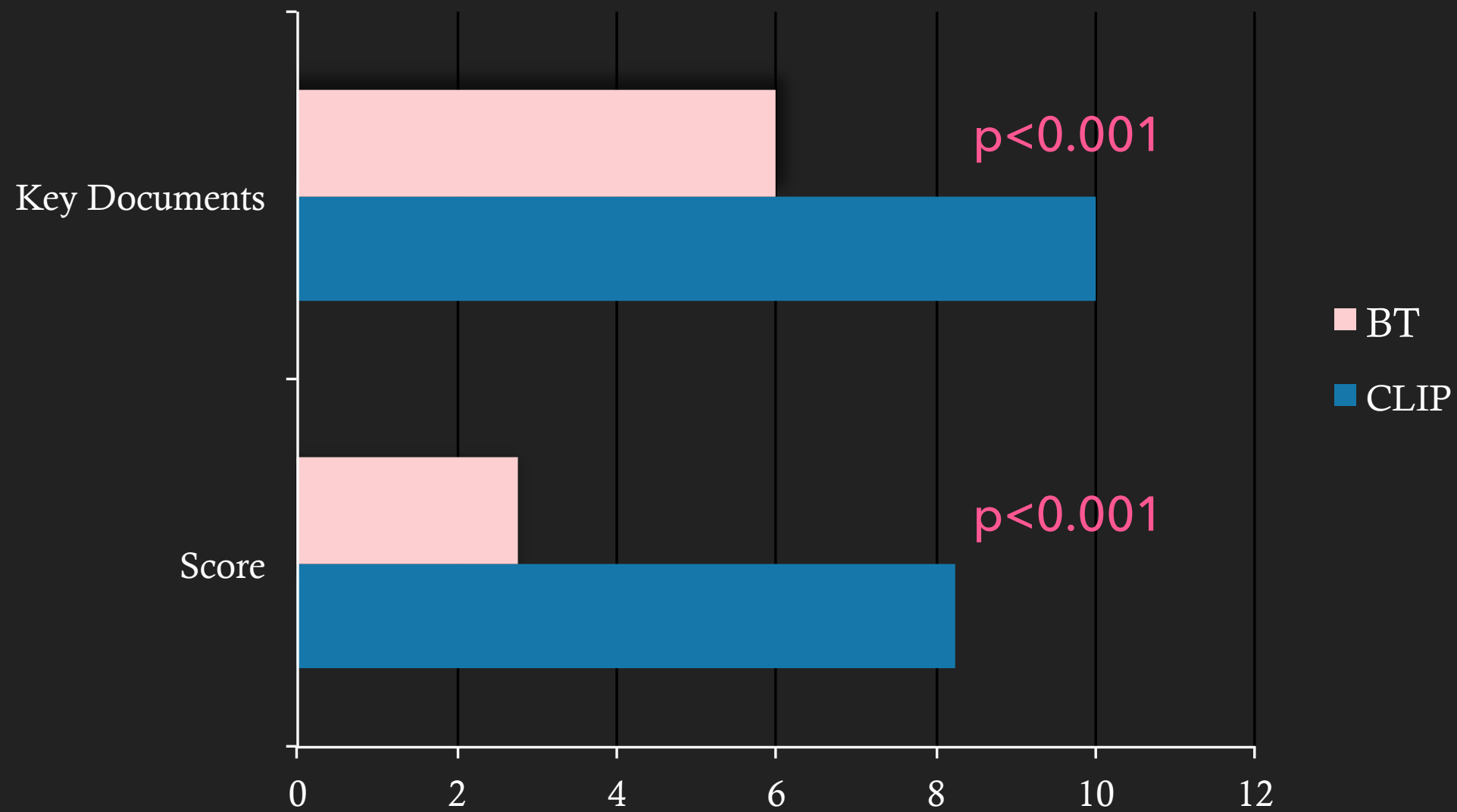
- ▶ Conversation analysis
  - ▶ Classified and counted statements of 7 different types
  - ▶ 2 coders, Krippendorff's  $\alpha = 0.91$
- ▶ Spent around **520 hours** on data analysis

## METRICS SCHEME

|    |                                    |
|----|------------------------------------|
| DH | Discussion / generating Hypotheses |
| RV | Referring to Visualization         |
| CO | Coordination                       |
| SA | Seeking Awareness                  |
| VF | Verbalizing Findings               |
| QF | Question about Findings            |
| RU | Related but uncategorized          |

# HYPOTHESES

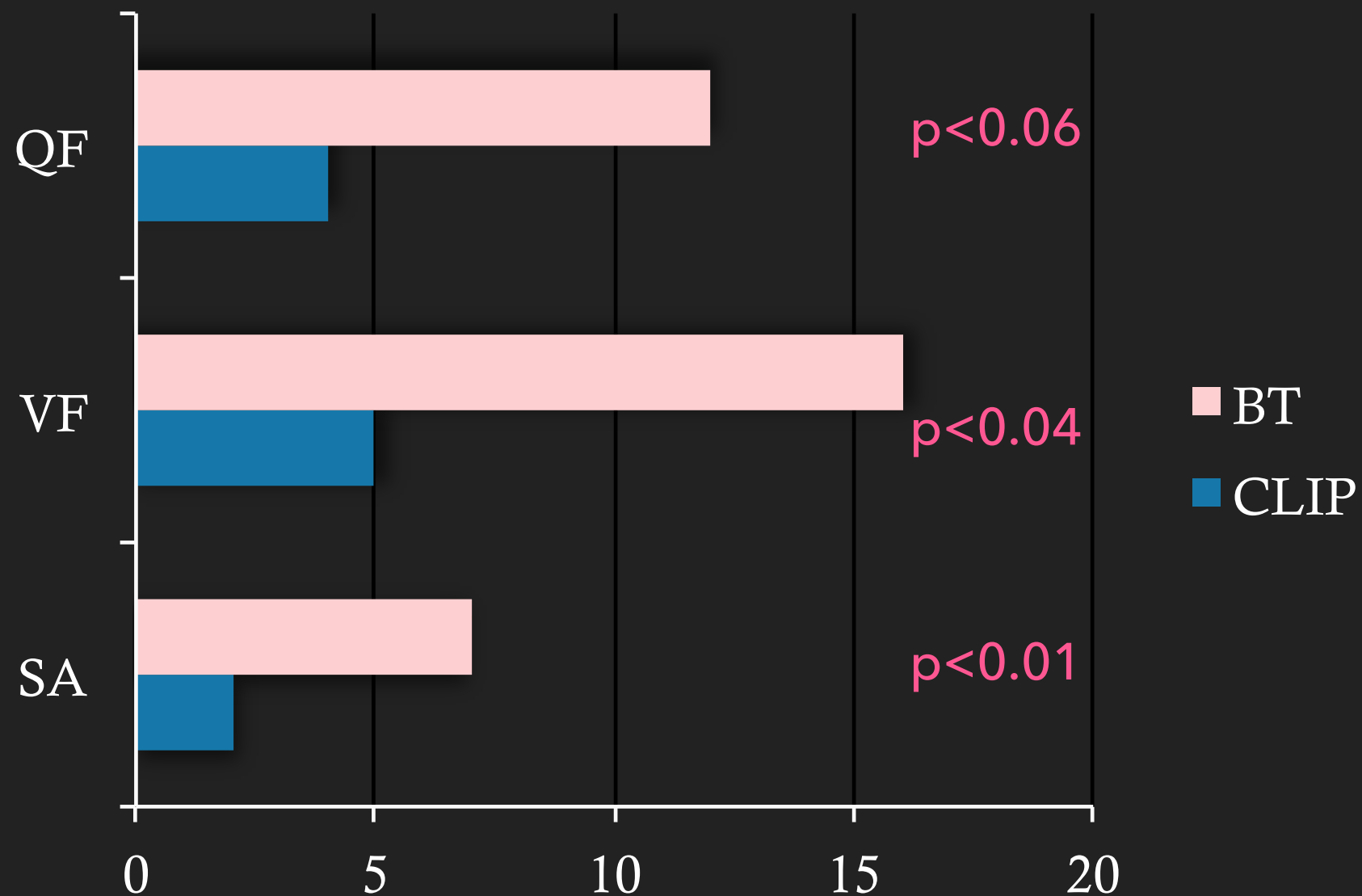
H1: Better performance





## HYPOTHESES

H4: Less reliance on verbal communications for awareness



## FUTURE APPLICATIONS OF THIS PROJECT

- ▶ LCW for different domains, e.g. co-authoring documents
- ▶ LCW for different collaborative settings, e.g. distributed software development

## PARTICIPATORY URBAN DESIGN



Ronald Kellett, Kellogg Booth, **Narges Mahyar**, “Collaborative Technology for Stakeholders Engagement in Urban Design”, Information Technology and City Life Workshop, CSCW 2015, March 2015.



## BEFORE I ARRIVED AT UBC: RESEARCH PROBLEM

- ▶ How to use visualization and collaboration technologies to increase public engagement?



## DEPLOYED VERSION

- ▶ Multi-touch tabletop



- ▶ Large-screen wall displays
- ▶ Visualization for sustainability metrics



## MY ROLE IN THIS PROJECT: NEW RESEARCH PROBLEMS

- ▶ What are the limitations of a single shared interactive display in supporting collaborative analysis scenario?
- ▶ What are the ways which we can design multi-display ecosystem to better support multi-users' interactions?

## MY ROLE IN THIS PROJECT: METHODS

- ▶ Observed the system in action
- ▶ Interviewed and closely worked with experts
- ▶ Led the design and mentored 2 students to develop new features
- ▶ Leading the evaluation: an observational study



## DESIGN OBJECTIVES

- ▶ Personal displays
  - ▶ Individual space to explore and customize data
- ▶ Visual history
  - ▶ Record and review session history
  - ▶ Tracking the session, understanding decision making

## INTEGRATING INDIVIDUAL DISPLAYS

- ▶ iPad 3D viewer app
  - ▶ Improve interactions with the 3D wall display
- ▶ iPad indicator app
  - ▶ Improve interactions with metrics
- ▶ iPad history app
  - ▶ Record and visually represent the interaction history

# SUPPORTING GROUP DYNAMICS





# INDIVIDUAL & GROUP DISCOVERY

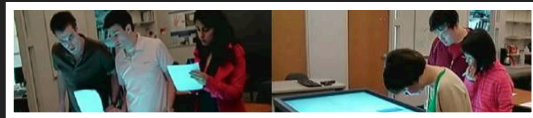




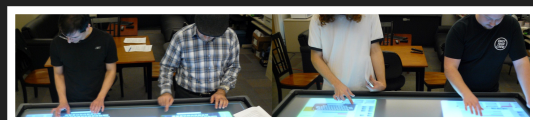
## FUTURE APPLICATIONS OF THIS PROJECT

- ▶ Use of multi-display eco-system for public engagement
- ▶ Evaluate the effects on:
  - ▶ learning
  - ▶ engagement
  - ▶ collaboration dynamics

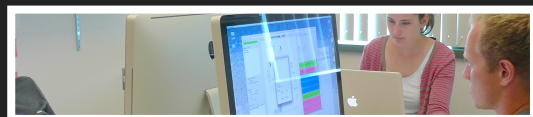
## MY MAIN RESEARCH CONTRIBUTIONS



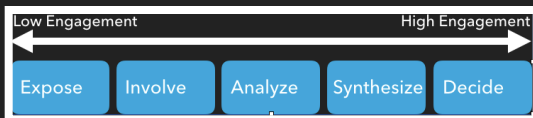
- ▶ Proposing a framework for CVA + role of note taking



- ▶ The effects of integrating record keeping into a CVA tool



- ▶ Introducing LCW method, new metrics for CVA



- ▶ Metrics for engagement



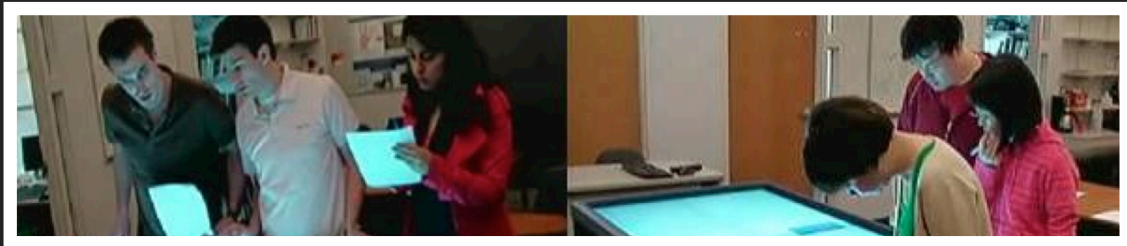
- ▶ Investigating a multi-display CVA tool for engagement

## VISION: TOWARDS MORE ENGAGING DESIGNS

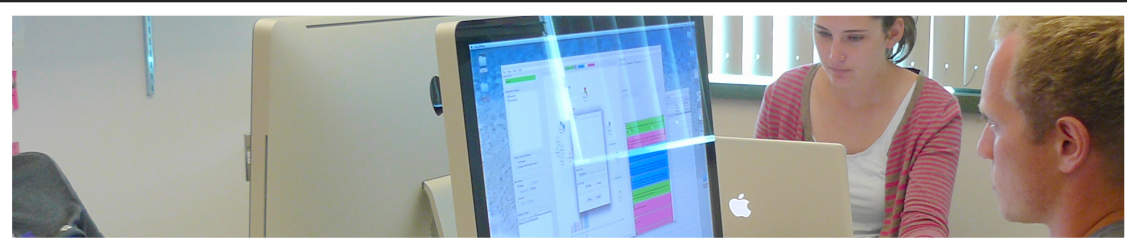
- ▶ Develop effective & **engaging** visualization techniques & collaboration technologies
- ▶ Develop theories about engagement
- ▶ Bring more design elements to CS
- ▶ Explore potentials of multi-touch surfaces for engaging novice users
- ▶ Revisit principles and guidelines for CSCW

## SHORT-TERM RESEARCH GOALS

- ▶ Collaborative note taking in different settings and domains



- ▶ LCW for different domains, e.g. co-authoring documents



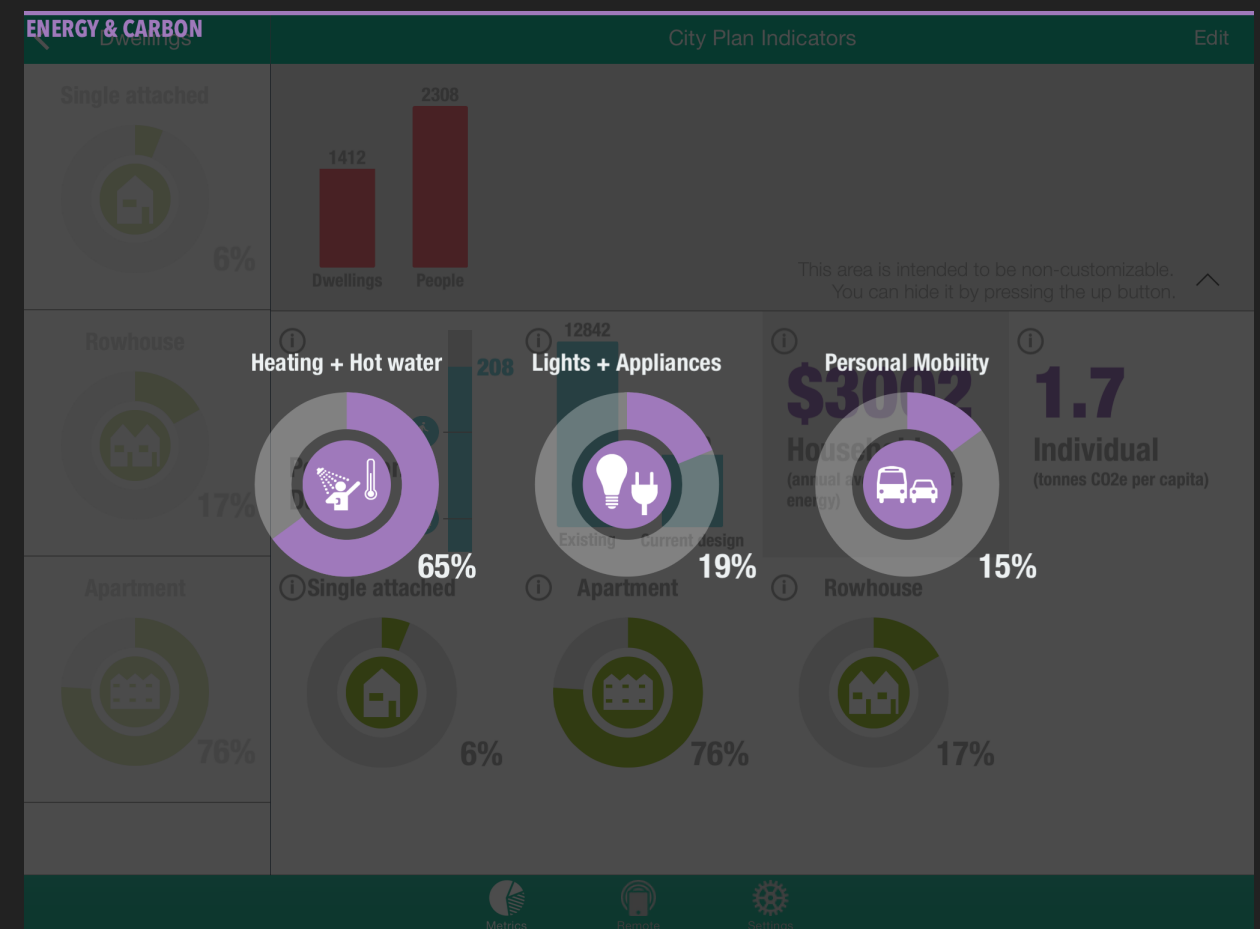
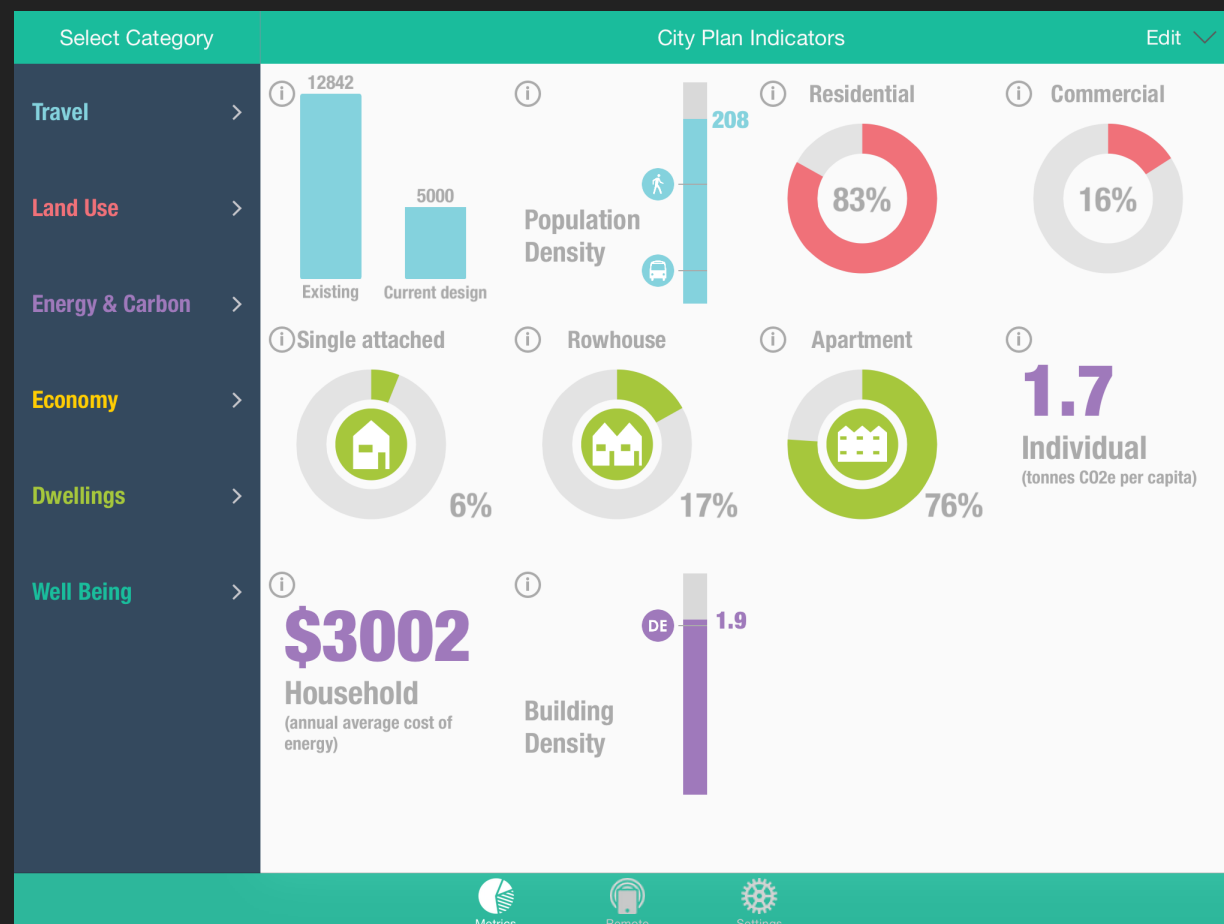
- ▶ Use of multi-display eco-system for public engagement





## SHORT-TERM RESEARCH GOALS

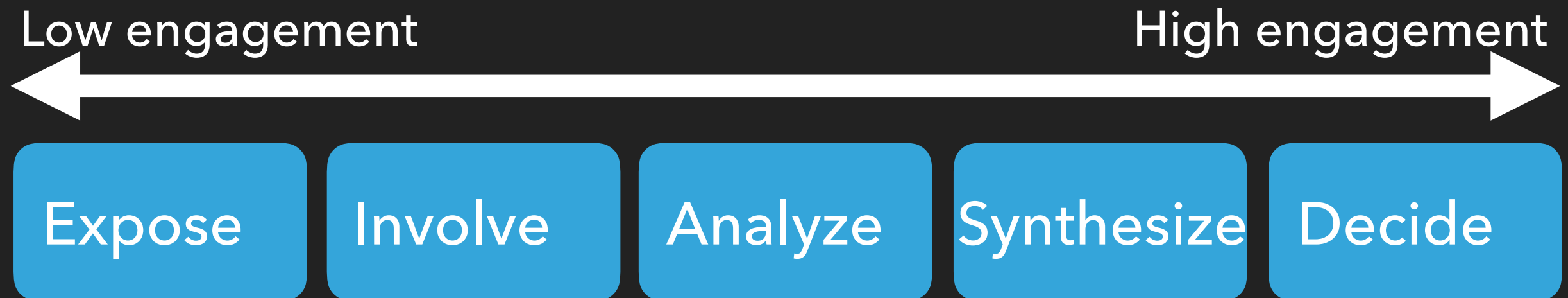
### ► Visualization design for public engagement



### ► Infographics & donut charts based on domain experts' suggestions

## SHORT-TERM RESEARCH GOALS

### ► Understanding user engagement

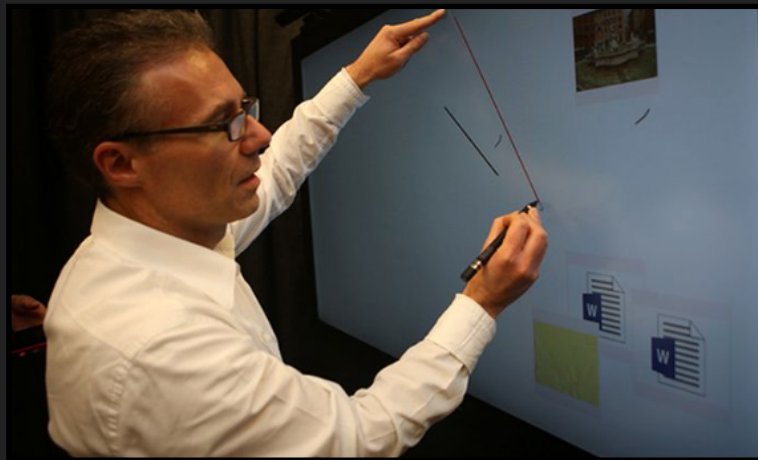


**Narges Mahyar**, Sung-Hee Kim, and Bum Chul Kwon, “Towards a Taxonomy for Evaluating User Engagement in Information Visualization“, *Workshop on Personal Visualization: Exploring Everyday Life*, IEEE VIS 2015, 4 pages, 2015.

## LONG-TERM RESEARCH GOALS

- ▶ Multimodal interaction for collaboration
- ▶ Evaluation methods for InfoVis & CSCW
- ▶ Visual storytelling
- ▶ Visualization for personal discovery, e.g. health data
- ▶ Bridging between computational/analytics & design/fine arts

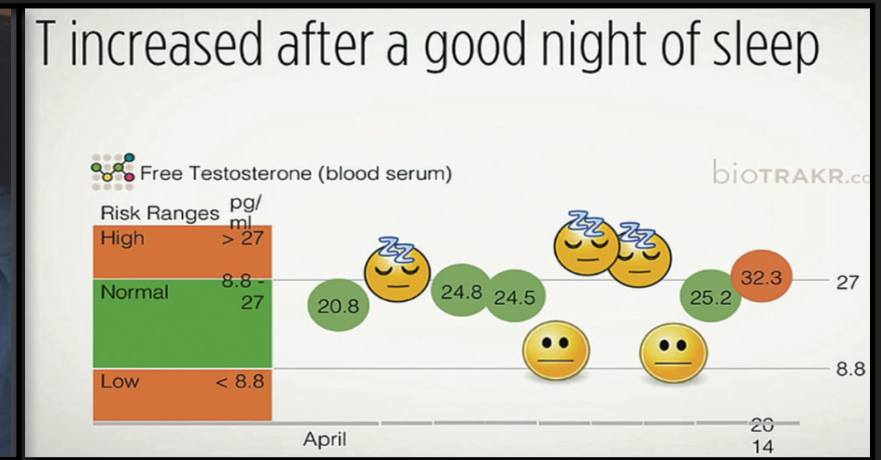
## INFOVIS & CSCW RESEARCH AT MSR



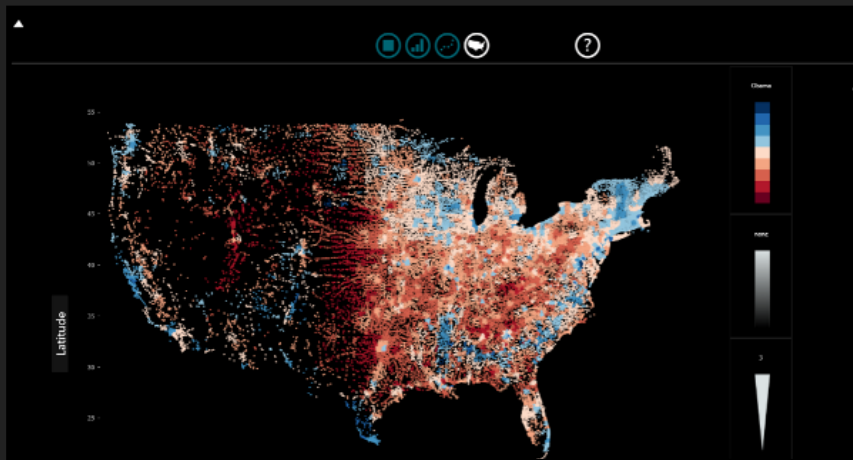
Society of Appliances



SketchStory



Self-tracking



SandDance



Designers' Designs



Bio Crystal



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# THANKS TO MANY







THANK YOU!

**NARGES MAHYAR**

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SLIDES, PAPERS, AND MORE:

[WWW.CS.UBC.CA/~NMAHYAR](http://WWW.CS.UBC.CA/~NMAHYAR)

**BACK UP SLIDES**



## OBSERVATIONAL STUDY



**Narges Mahyar**, Ali Sarvghad, and Melanie Tory, “Note Taking in Co-located Collaborative Visual analytics: Analysis of an Observational Study”, *Information Visualization*, vol. 11, no. 3, pp. 190-204, July 2012.

**Narges Mahyar**, Ali Sarvghad, and Melanie Tory, “A closer look at note taking in the co-located collaborative visual analytics process,” *IEEE VAST 2010*.



## COSPACES (COLLABORATIVE WORKSPACES)



**Narges Mahyar, Ali Sarvghad, and Melanie Tory**, “Observations of Record-Keeping in Co-located Collaborative Analysis”, *HICSS 2013*.

**Narges Mahyar, Ali Sarvghad, Melanie Tory and Tyler Weeres** “CoSpaces: Workspaces to Support Co-located Collaborative Visual Analytics,” *DEXIS 2011*, Nov 2011.