LARGE INTERACTIVE SURFACES
FOR COLLABORATIVELY EXPLORING & DRIVING MEANING FROM COMPLEX DATA

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University of British Columbia
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THE RADICAL PROMISE OF THE MULTI-TOUCH INTERFACE

Jeff Han, 2006
MULTI-TOUCH SURFACES (WALL DISPLAYS & TABLETOPS)

- Research centres
- Museums
- News
- Classrooms
WHO AM I & WHAT AM I DOING
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)
MY RESEARCH APPROACH

▸ Understanding the domain specific problems
▸ Designing visualization & interaction technologies
▸ Evaluating & analyzing the effect

METHODS

▸ Ethnography
▸ Observational User Study
▸ Case Study
▸ System Building
▸ Qualitative & Quantitative Evaluation
WHO AM I & WHAT AM I DOING

MY MAIN RESEARCH PROJECTS

MSc., ICCC 2010

PhD, VAST 2010, InfoVis 2012

PhD, HICS 2013, ITS 2011

PhD, VAST 2014, Best Paper Award

Postdoc, CSCW 2015, City Life

Postdoc, IEEE VIS 2015, Personal Vis
WHAT I WANT TO SHARE TODAY

- Overview
  - Design Challenges: Tabletops, CVA

- Projects:
  - Observational User Study
  - CoSpaces
  - Participatory Urban Design

- Contributions & Future Work
OVERVIEW: CVA
WHY COLLABORATE VISUAL ANALYTICS (CVA)?

- Collaboration:
  - Diverse backgrounds
  - Quality of work
  - Individual bias
  - Task Load

- Visual Analytics
  - Visual representation
  - Interactive exploration
DESIGNING FOR TABLETOPS: SOME CHALLENGES

- 1. Orientation
- 2. Fluid interactions
- 3. Territoriality: individual vs. group space
- 4. Changes in collaboration styles
- 5. Awareness
## Collaborative Visual Analytics: Challenges

<table>
<thead>
<tr>
<th>Users</th>
<th>Multiple backgrounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognition</td>
<td>Foraging &amp; sensemaking</td>
</tr>
<tr>
<td>Analysis results</td>
<td>Consensus, shared insight</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Social interaction around data</td>
</tr>
<tr>
<td>Visual representations</td>
<td>Multiple displays, novel I/O</td>
</tr>
</tbody>
</table>

Isenberg et al., Infovis, 2012
LET’S TALK ABOUT THE DESIGN PROCESS

1. Understand the problem (real problems!)
2. Design a tool (make lots of mistakes!)
3. Evaluate the tool (this is the hardest step!)
4. Reflect on the design (this is how you advance the field!)
OBSERVATIONAL USER STUDY


FINDING THE ISSUES: OBSERVATIONAL USER STUDY
USER STUDY

- Task: a business scenario (sales projection decisions)
- Dataset: sales of clothing items in 8 US states for 3 years
- Tool: a current tool from SAP
- Participants: 9 groups of 3
- Process: 90 min
- Observations: videos & interviews, analyzed participants’ notes
- Data analysis: qualitative evaluation methods
OVERVIEW | PROJECTS: USER STUDY, COSPACES, URBAN DESIGN | CONTRIBUTIONS & FW

QUANTITATIVE

- Numeric information
- Objective
- Limited

QUALITATIVE

- Non-numeric information
- Highly subjective
- Much harder to deal with, why? Why it's important?
HOW TO DO QUALITATIVE ANALYSIS WELL?

- Limit the bias:
  - More than one coders
  - Independent coding
  - Triangulation of mixed-methods
USER STUDY: CHALLENGES

- Task design and choosing the dataset
- Participants (number, real analysts, conditions)
- Motivation (e.g., incentives, prizes, etc.)
- Length of the study (break in the middle)
- Analyzing massive data (We spent nearly 2 months on analyzing gathered information)
COLLABORATIVE VISUAL ANALYTICS FRAMEWORK

- **Problem Definition**
  - Parse instructions
  - Pose question

- **Visualization**
  - Map data
  - Create visual artifact
  - Filter

- **Record keeping**

- **Dissemination**
  - Create report

- **Analysis**
  - Search
  - Mine visual artifact
  - Calculate value
  - Compare
Overview | Projects: User Study, COSPACES, Urban Design | Contributions & FW

Awareness Problems I Discovered in My Study

- Critical need to support Record Keeping activities
- Notetakers lost track of what others were doing
- Suggests: integrate notes within the application
COSPACES (COLLABORATIVE WORKSPACES)


DESIGN OBJECTIVES

- Orientation
- Fluid interactions
- Territoriality: individual vs. group space
- Changes in collaboration styles
- Awareness
- Visual Record Keeping (VRK)
VISUAL RECORD KEEPING (VRK)

- VRK in VA context:
  - Capturing analysis history & visually represent it
- Many researchers have mentioned the advantages of record-keeping/history in visualization.
- Speculations:
  - More important in collaborative task.
  - Improving communication & dissemination.
A business scenario:

- Find trends in the sales of most popular product lines
- Analyze the sales data and at the end prepare a report for your CEO
- Explains possible reasons for the sales anomalies

Dataset:

- Sale data, 8 US states, 3 years, 9 columns, 3273 rows
OVERVIEW | PROJECTS: USER STUDY, COSPACES, URBAN DESIGN | CONTRIBUTIONS & FW

COSPACES

[Graphical representation of Margin by Year showing data for 2002, 2001, and 2000.]
COSPACES: VIDEO
USER STUDY

- 10 groups of 2
- Two tasks: 20 and 40 minute sessions
- Follow up interview and questionnaire
- Captured video
- Logged history
- Two independent observers
1. SUPPORT FOR INDIVIDUAL VS. GROUP SPACE (TERRITORIALITY)

- Worksheet: work territory, either personal or shared
- Flexibility of use: panning, re-sizing, rotating
2. SUPPORT FOR CHANGES IN COLLABORATION STYLES

- All users performed part of the task individually and discussed their results at the end.
- Worksheet flexibility facilitated changes in collaboration styles.
3. SUPPORT FOR AWARENESS

- While pairs maintained awareness of each other work, Tabs were not used as much as we expected.

- 17/20 assessed Tabs as useful in their evaluation. (average: 4.95 out of 6.0, STDEV of 1.07)

- “...real time update of [the] other’s view was interesting, because [I] could keep [myself] updated all the time...”.

- “...being able to see others’ workspaces, [and] keep track of them in own workspace” was one of the most useful features of the system.
4. SUPPORT FOR VISUAL RECORD KEEPING

- Actions on History
  - Actions and Collaboration Styles
  - Actions and Analysis Phases
- Record-Keeping Behaviours
## ACTIONS ON HISTORY

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<thead>
<tr>
<th>Actions</th>
<th>Frequency</th>
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<tr>
<td>1. Reload a chart</td>
<td>155</td>
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<tr>
<td>2. Review history</td>
<td>128</td>
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<tr>
<td>3. Manual save</td>
<td>102</td>
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<tr>
<td>4. Delete</td>
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<tr>
<td>5. Note taking</td>
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<td>6. Review notes</td>
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<td>7. Use tabs</td>
<td>11</td>
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<tr>
<td>8. Copy local</td>
<td>4</td>
</tr>
<tr>
<td>9. Create external worksheet</td>
<td>3</td>
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</table>
ANALYSIS PHASES & INTENTIONS: RELOADING CHARTS

- Information Foraging:
  - Review exciting chart (50)
  - Reuse existing chart (39)

- Discussion:
  - Review exciting chart (62)
  - Reuse existing chart (4)
OVERVIEW | PROJECTS: USER STUDY, COSPACES, URBAN DESIGN | CONTRIBUTIONS & FW

ACTIONS & ANALYSIS PHASES

<table>
<thead>
<tr>
<th>Action</th>
<th>Info foraging</th>
<th>Discussion</th>
<th>Common in Both Phases</th>
<th>Foraging Phase</th>
<th>Actions in Information Phases</th>
<th>Total</th>
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<td>18.18%</td>
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</table>

39
VISUAL RECORD KEEPING BEHAVIOUR

Note Taking Behaviours

- Foraging: 18
- Manual Save: 8
- Note Taking: 8
- 23
- 19
- 9
- 11
- 20
- 12
- Both: 8
- 18

Analysis Phase Group
DISCUSSION

- Importance of Visual Record Keeping in CVA:
  - Gain awareness
  - Share work
  - Starting point for discussion

- VRK played an important role in all phases of analysis

- 2 different strategies for capturing findings:
  - chart-saving focused vs. note-focused
CONCLUSION

1. Support for individual vs. group space (territoriality)
2. Support for changes in collaboration styles
3. Support for awareness during loosely coupled work
4. Support for tracking history:
   - Inferred intention/s related to them
   - Relations to analysis phases & collaboration styles
DESIGN IMPLICATIONS

- Supporting multiple history views:
  - detailed, bookmarked, filtered, customized

- Support for sharing:
  - Direct & indirect (unobtrusive and non-icteruptive)

- Support for history management

- Support for note taking and reuse:
  - 2 of the prevalent record-epping actions
Q & A
PARTICIPATORY URBAN DESIGN

PARTICIPATORY URBAN DESIGN
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
Q & A

Johnny Appleseed
RESEARCH CONTRIBUTIONS

- Proposing a framework for CVA + role of note taking
- The effects of integrating record keeping into a CVA tool
- 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
OVERVIEW | PROJECTS: USER STUDY, COSPACES, URBAN DESIGN | CONTRIBUTIONS & FW

VISUALIZATION DESIGN FOR PUBLIC COMMUNITY PLANNING

- Infographics & donut charts based on domain experts’ suggestions
ENGAGEMENT IN INFOVIS

- Understanding user engagement

Low engagement
Expose  Involve  Analyze  Synthesize  Decide

High engagement

THANK YOU!

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