OBSERVATIONS OF RECORD-KEEPING IN CO-LOCATED COLLABORATIVE ANALYSIS

Narges Mahyar
Ali Sarvghad
Tyler Weeres
Melanie Tory

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Visual Record Keeping (VRK)

- VRK in VA context: Capturing analysis history & visually represent it.

- Many researchers have mentioned the advantages of record-keeping in visualization.

- Speculations:
  - More important in collaborative task.
  - Improving communication & dissemination.
Introduction

- Goal: study use of visual record-keeping in co-located collaborative setting on a tabletop, how people would use them, and what could be improved.

- CoSpaces: a system designed for co-located collaborative Visual Analytics on interactive tabletops.
Analytic Activities & Actions

- Action layer carries information regarding users’ analytic intention/s.

We identified actions on VRK:
  - inferred intention/s related to them.
  - relations to analysis phases & collaboration styles.
Remote Viewing
Facilitate Visual Analysis.

- Substantial table real state + Worksheet flexibility facilitated analysis.
Support changes in collaboration

- Supporting transient collaboration style
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
Findings

1. Actions on History
2. Actions and Collaboration Styles
3. Actions and Analysis Phases
   - Information foraging: gathered insight through visual exploration
   - Discussion: formed explanations and hypotheses around their finding
4. Record-Keeping Behaviours
5. Use of Tabs
## Findings: Actions on History

<table>
<thead>
<tr>
<th>Actions</th>
<th>Description</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reload a Chart</td>
<td>Reload a previously created chart from the history, either the local history or a collaborator’s history.</td>
<td>155</td>
</tr>
<tr>
<td>Review History</td>
<td>Review charts within the history, either the local history or a collaborator’s history.</td>
<td>128</td>
</tr>
<tr>
<td>Manual save</td>
<td>Manually save a chart into the history pane.</td>
<td>102</td>
</tr>
<tr>
<td>Delete</td>
<td>Delete a chart from the history pane.</td>
<td>99</td>
</tr>
<tr>
<td>Note Taking</td>
<td>Write down notes in the note pane.</td>
<td>77</td>
</tr>
<tr>
<td>Review Notes</td>
<td>Review note(s), add to a note, and/or reload a chart linked to a note.</td>
<td>30</td>
</tr>
<tr>
<td>View Current Chart</td>
<td>View the collaborator’s current visualization through tabs.</td>
<td>11</td>
</tr>
<tr>
<td>Copy Local</td>
<td>Copy a chart from a collaborator’s worksheet to the local Worksheet.</td>
<td>4</td>
</tr>
<tr>
<td>Create External</td>
<td>Creating a new Worksheet using a chart from the history.</td>
<td>3</td>
</tr>
</tbody>
</table>
Findings: Actions & Primary Intentions

<table>
<thead>
<tr>
<th>Action on History</th>
<th>Primary Intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reload Chart</td>
<td>Review Existing Chart</td>
</tr>
<tr>
<td></td>
<td>Reuse Existing Chart</td>
</tr>
<tr>
<td>Review History</td>
<td>Review Charts</td>
</tr>
<tr>
<td></td>
<td>Looking for a chart</td>
</tr>
<tr>
<td>Manual Save</td>
<td>Managing History</td>
</tr>
<tr>
<td>Delete</td>
<td>Managing History</td>
</tr>
<tr>
<td>Note Taking</td>
<td>Record Personal Finding/Insight</td>
</tr>
<tr>
<td></td>
<td>Record Discussion Outcome</td>
</tr>
<tr>
<td>Review Note</td>
<td>Reload a Chart Linked to a Note</td>
</tr>
<tr>
<td></td>
<td>Revisit all Notes</td>
</tr>
<tr>
<td></td>
<td>Use Notes to Support Discussion</td>
</tr>
<tr>
<td></td>
<td>Revisit a Note</td>
</tr>
<tr>
<td>View Current Chart</td>
<td>View Current Chart</td>
</tr>
<tr>
<td>Copy Local</td>
<td>Transfer a Chart between worksh...</td>
</tr>
<tr>
<td>Create External Worksheet</td>
<td>Comparison between charts</td>
</tr>
</tbody>
</table>
Findings: Analysis Phases & Intention

Eg. Reload a Chart:

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

- Discussion:
  - Review exciting chart (62)
  - Reuse existing chart (4)
Findings: Actions & Analysis Phases

Dominant actions in Information Foraging:
- Copy Local: 100.00%
- Manual Save: 99.02%
- Note Taking: 96.10%
- Delete: 88.89%

Common in both Phases:
- Review History: 32.81%
- Create External Worksheet: 33.33%
- Reload Chart: 42.58%
- Review Note: 70.00%
- View Current Chart: 81.82%

Dominant actions in Discussion:
- Copy Local: 18.18%
- Manual Save: 30.00%
- Note Taking: 57.42%
- Delete: 66.67%
- Review History: 67.19%
Findings: Actions & Collaboration styles

- Information Foraging: loosely-coupled
  - Goal: problem-solving.

- Discussion: tightly-coupled
  - Goal: decision-making.
Findings: Record-Keeping Behaviours

![Graph showing record-keeping behaviours]
Findings: Use of Tabs

- Our observations corroborated our speculated benefits of using tabs for providing awareness.

  “...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.”

- Information Foraging (15): mostly took place in the middle of the phase.

- Discussion (17): almost evenly distributed throughout the phase.
Discussion

- The importance of VRK in collocated collaborative setting. Recorded material facilitated collaboration:
  - Gain awareness
  - Share work
  - Starting point for discussion

- Record-keeping played an important role in both information foraging and discussion phases of collaborative work.

- Types of actions and the reasons for them differed between the phases.

- Two different strategies for capturing findings: chart-focused versus note-focused approaches.
Design Implication

1. Multiple History Views
   - Select different history views: detailed, bookmarked, filtered and customized views.

2. Support for Sharing
   - “Direct” and “Indirect” (remote, unobtrusive & non-interruptive)
   - Support for History Management
   - Customized view

3. Support for Note Taking & Reuse
   - Note taking and reuse are two of the prevalent record-keeping actions
Conclusion

- Nine actions on history & user intentions for each action.
- Actions and intentions varied depending on the analysis phase and collaboration style.
- Information foraging (Loosely Coupled):
  - Record findings, support individual analysis, and maintain awareness of others’ activities.
- Discussion (closely coupled):
  - Present past findings to collaborators and to record discussion results.
- Remote view of another workspace was useful in both situations, but for different purposes.
- Note taking and the link between a note and its related chart was very useful.
Generalizability & Future Work

- We expect actions and intentions would be repeated in other VA situations.
- Frequencies of actions & primary user intentions likely depend on system design and individuals.

Future Work:
- Investigate automatic recommendation of history.
- Linking notes based on their semantic relationships.
Thanks for your attention!

For more information please contact me at

nmahyar@cs.uvic.ca
Backup 1 - Implementation

- CoSpaces is a multi-touch application written in JAVA.
- Multi-touch for Java (MT4J) provides multi-touch functionality.
- Community Core Vision (CCV), TUIO.
- JFreeChart is used to create the graphical charts.
Participants performed two tasks.

20-minute introduction to the system and dataset,

Task 1, 20 minutes, learned how to use CoSpaces.

Task 2, 40 minutes, open-ended analytical question:

“Assume you are a financial analyst of a clothing company that sells clothing. Following is a list of the most popular product lines are: Dresses, Sweaters, Outerwear, Sweat-shirts, Dress shirts, Accessories. You will look at the first three items (underlined) and your team member will look at the rest. Analyze the sales data and at the end prepare a report for your CEO”
Two experimenters observed the study and recorded notes independently.

Recorded artifacts and notes.

Gathered video recordings of each session

Videotaped interview sessions and collected participants’ notes and reports.
Many groups used the on screen keyboard to take notes (total of 71 times, used by 8 out of 10 groups).

Participants mostly took notes while working individually.
Participants frequently saved, reused and manipulated recorded items.

Manually saved charts to the history 90 times.

Reloaded items from the history pane 146 times.

Reuse happened both during the analysis, when often working individually, and towards the end of the analysis session, when in a closer collaboration.
## Backup6 - Findings: Note Taking

<table>
<thead>
<tr>
<th>Group</th>
<th>Participant</th>
<th>Minutes of Time Stamp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P1</td>
<td>1 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>1 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29</td>
</tr>
<tr>
<td>2</td>
<td>P1</td>
<td>1 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>1 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29</td>
</tr>
<tr>
<td>7</td>
<td>P1</td>
<td>1 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29</td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>1 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29</td>
</tr>
</tbody>
</table>

- **Note Taking**
Example of tools (single user):

- **Tableau**: record visualization states and visually browse, search, filter and reuse them.

- **Vistrails**: scientific workflow, including data, visualizations, and the pipelines used to create the visualizations.
Backup 8- Contribution

- Providing various views of recorded material.
- Showing manually saved rather than automatically saved items by default.
- Enabling user to review collaborators’ work unobtrusively.
- Automatically recommending items related to a user’s analytical task.