Supporting Communication and Coordination in Collaborative Sensemaking

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Design and evaluation of CLIP

**Externalization support**
- Helping analysts to record, organize, and share findings, hypotheses, and evidence

**Collaborative awareness support**
- Keeping track of collaborators’ activities and findings
Context

- Domain: Intelligence analysis
- Setting: Collocated collaborative analysis
- Task: VAST 2006 challenge
Jigsaw’s Tablet View

Bradel et al., 2011
Collaborative Brushing & Linking

- Cambiera (Isenberg and Fisher, 2012): supported information foraging

- Extend this concept:
  - sensemaking loop
  - externalizations
Linked Common Work (LCW)

- **LCW**: automatically identifying and visually representing similarities between collaborators’ externalizations.

  - Partial merging
  - Full merging
Linking Externalizations

- shared understanding for effective collaboration (Clark & Brennan, 1999)
- learning from others’ findings (Chen et al., 2011)
- common shared view is more useful (Balakrishnan et al., 2008)
- collaborators wanted a shared note space (Bradel et al., 2013)
- merging collaborators’ work provides common ground (Bernnan et al., 2006)
Thought it was a big meth lab.

It was NOT Tom Sullivan. I am sure it was the captain of the ship that had the incident with the apples. Suspected to be part of Provenzano Luminoso.

Thought it was a big meth lab.

Owner of local FFE farm.

Trucks are there in the middle of the night. Found a broken bottle of George Prado's farms. It burned. Smelled like flower garden. There was water there.

President of Paraguay, fights against shining future.

4 children hospitalized with E. coli.

Killed, he was the leader of that shining future, killed by Paraguayan forces.

Wrote a story about trucks between Argentina and the International Monetary Fund (based in Washington).

Has huge interests in building the casino.
Evaluation of LCW

- Dataset and Scenario: VAST 2006 Challenge
- Experimental comparison of CLIP to a baseline tool
- Baseline tool: CLIP without LCW
Baseline Tool
Participants:
- 16 groups of 3, 8 groups in each condition
- Students, average age 28, 28 males + 20 females

Worked for 90 minutes
- Analyzed a digital document set
- Used CLIP or Baseline to record findings, hypotheses, evidence

Followed by semi-structured interview
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)

Conversation analysis (based on coding transcribed instances of conversation)
- Classified and counted statements of 7 different types
- 2 coders, Krippendorff’s alpha = 0.91
- Spent around 520 Hours on data analysis
Coding Scheme

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH</td>
<td>Discussion / generating Hypotheses</td>
</tr>
<tr>
<td>RV</td>
<td>Referring to Visualization</td>
</tr>
<tr>
<td>CO</td>
<td>Coordination</td>
</tr>
<tr>
<td>SA</td>
<td>Seeking Awareness</td>
</tr>
<tr>
<td>VF</td>
<td>Verbalizing Findings</td>
</tr>
<tr>
<td>QF</td>
<td>Question about Findings</td>
</tr>
<tr>
<td>RU</td>
<td>Related but uncategorized</td>
</tr>
</tbody>
</table>

14
Hypotheses (Informal version)

H1: better performance

Key Documents

Score

p<0.001

p<0.001
H2: more discussion of hypotheses and greater use of the visualization in discussion
H3: coordination at a more detailed level

\[ p < 0.01 \]
H4: less reliance on verbal communication for awareness

- QF: p < 0.06
- VF: p < 0.01
- SA: p < 0.04
Qualitative Results

✿ CLIP group:

“[Full merging] made it faster because we knew what everyone was looking at. We could go on the same direction or do something else...it helped us to collaborate more closely.”

✿ Baseline group:

“I couldn’t read my stuff when others were telling me what they read, it was grabbing my focus.”
Contributions

- Design and evaluation of CLIP
- Linked Common Work
- Set of Metrics

Thanks to SAP, GRAND & NSERC for funding this research.
Key Message

デザイナーサンエヴァレーションオブアービアルサインキングスペースフォーコロケーションビルコラボレーションインテリジェンスアナリシス。

・Linking collaborators’ externalizations and showing their common work facilitates collaboration.
Sensemaking loop

Information foraging loop

(Pirolli & Card, 2005)
Collaborative Sensemaking

- Supporting **communication** and **coordination**
  - Record, organize and share findings
  - Awareness
  - Individual access
  - Encourage close collaboration in case of common work
LCW Model

![Diagram of the LCW Model]

- **Investigation** leads to **Externalization** which then leads to **Awareness**.
- **Awareness** facilitates **Discussion** leading to new ideas.
- **Recording** captures the information from **Investigation**.
- **Coordination** directs new actions.
- **Initiates new** QH Formulation leads back to **Investigation**.
- **Leads to new** discussions.

The LCW model emphasizes the iterative process of investigation, externalization, awareness, discussion, and coordination.
Future Work

- Scalability to larger datasets and tasks
- Field studies with professional analysts
- Other settings: LCW for shared screens, distributed work, etc.
- Does LCW lead to group-think?
<table>
<thead>
<tr>
<th>People</th>
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<tbody>
<tr>
<td>Aaron Porter</td>
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<tr>
<td>Aaron Ramos</td>
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<tr>
<td>Aaron Richards</td>
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<tr>
<td>Abel Barajas</td>
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<td>Abilene</td>
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<td>Adolph</td>
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<td>Alaska</td>
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<td>A. Board</td>
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<td>A. Technology</td>
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<tr>
<td>ACS</td>
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<td>Ad Hoc Committee</td>
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<th>Date:</th>
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<td>2012 Jan 04</td>
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<tr>
<th>Add Evidence</th>
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<tbody>
<tr>
<td>Apple Exports</td>
</tr>
<tr>
<td>Dangerous Chemicals</td>
</tr>
<tr>
<td>Missile silo</td>
</tr>
<tr>
<td>South American Terrorist Organizations</td>
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</tbody>
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<table>
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<tr>
<th>Add Note:</th>
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<tbody>
<tr>
<td>He is involved with a terrorist organization.</td>
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<table>
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<tr>
<th>Select Image</th>
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<td>Hypothesis</td>
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<td>Public</td>
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<td>Private</td>
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</table>
He is involved with a terrorist organization.

Happened at Adolph, is there a connection with apple accident?
He is involved with a terrorist organization.

Happened at Adolph, is there a connection with apple accident?
He is suspicious!
He is involved with a terrorist organization.

Happened at Adolph, is there a connection with apple accident?

He is suspicious!