

Investigating Multi-Touch and Pen Gestures for Diagram Editing on Interactive Surfaces

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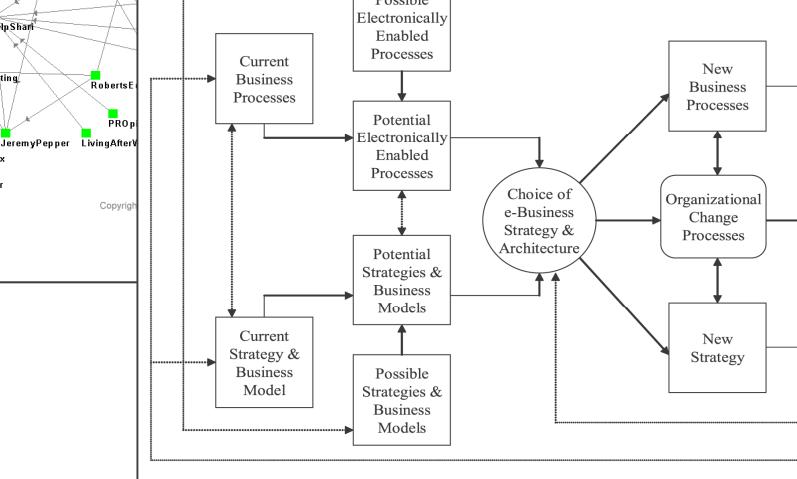
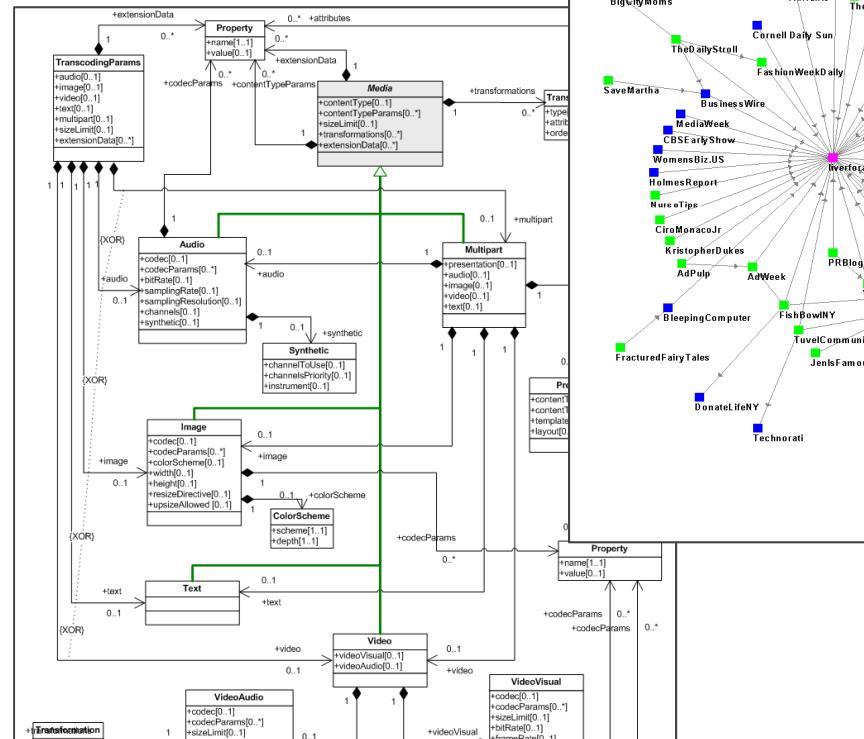
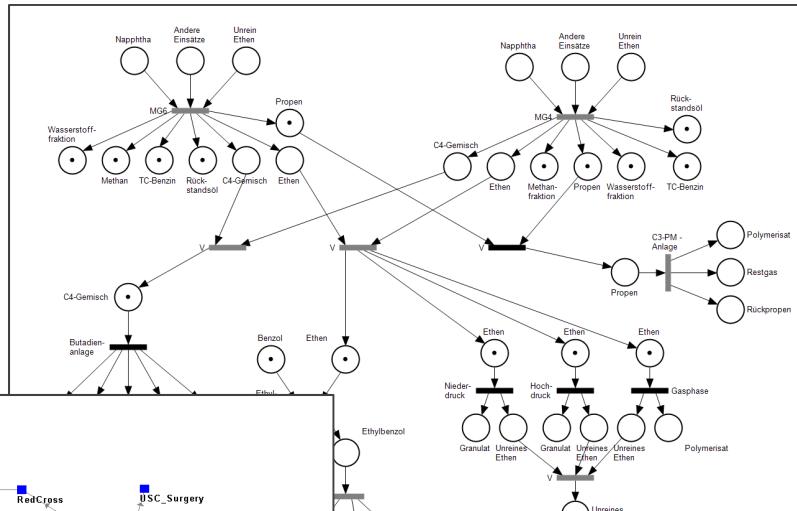
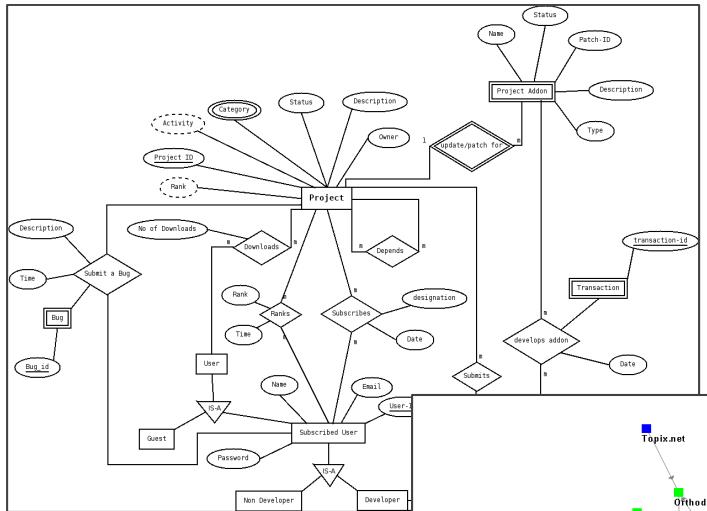
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Outline

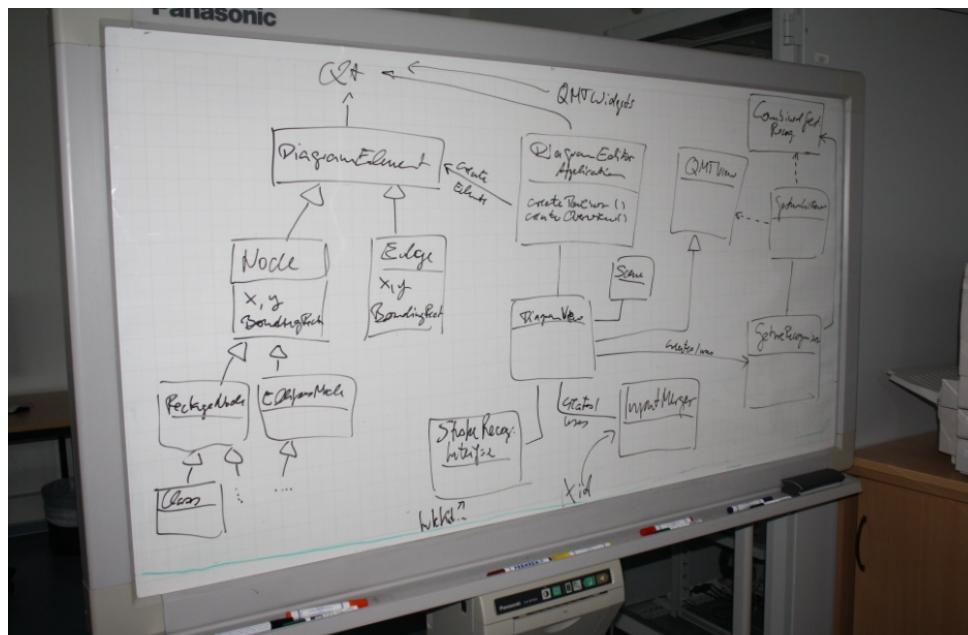
- Motivation
- Design of the pilot study
- Results
- Observations & Discussion
- Conclusion & Future Work

Motivation



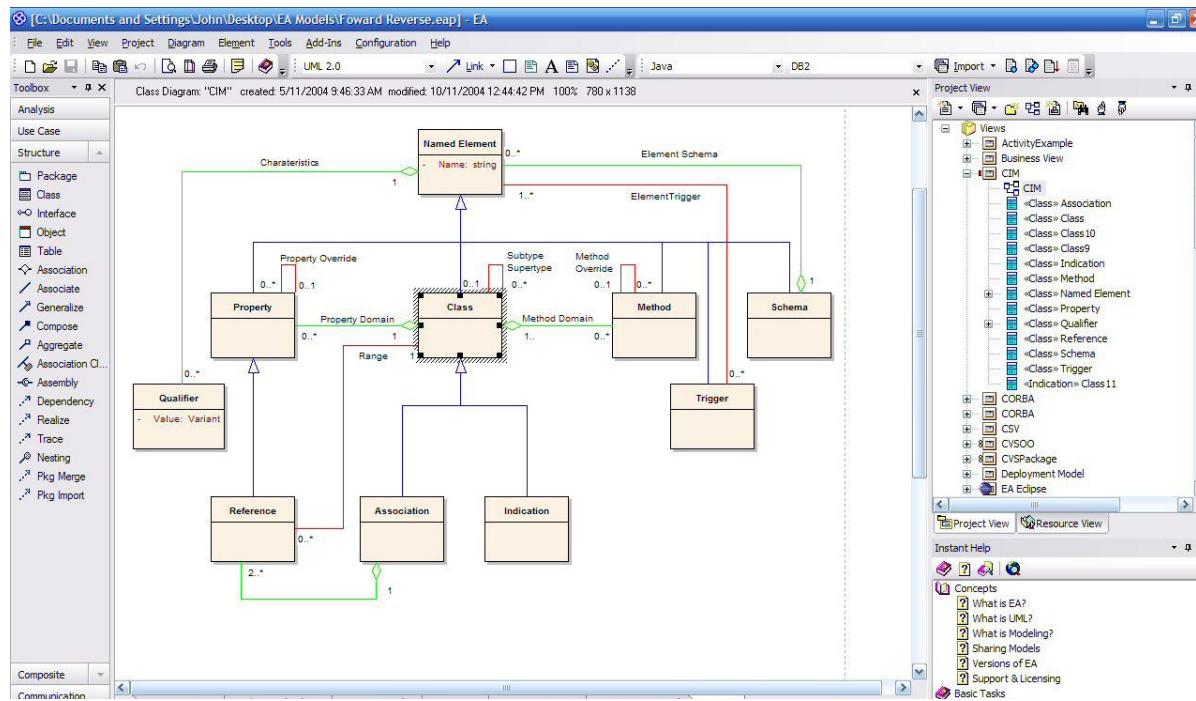
Motivation – Creation of Diagrams

- Diagram Sketching:
 - On whiteboards, flip charts or paper
 - Content has to be remodeled in digital tools
- Applications for electronic whiteboards or Tablet PCs
[Damm et al. 2000], [Chen et al. 2003], [Grundy et al. 2007]
 - Ad-hoc sketching + additional digital features



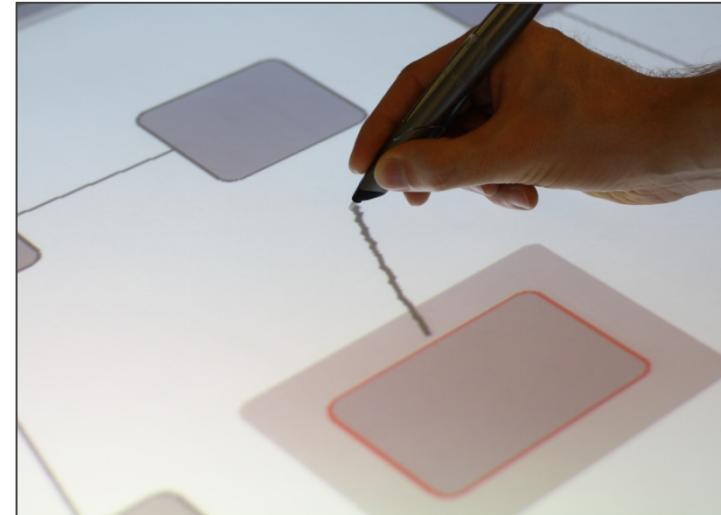
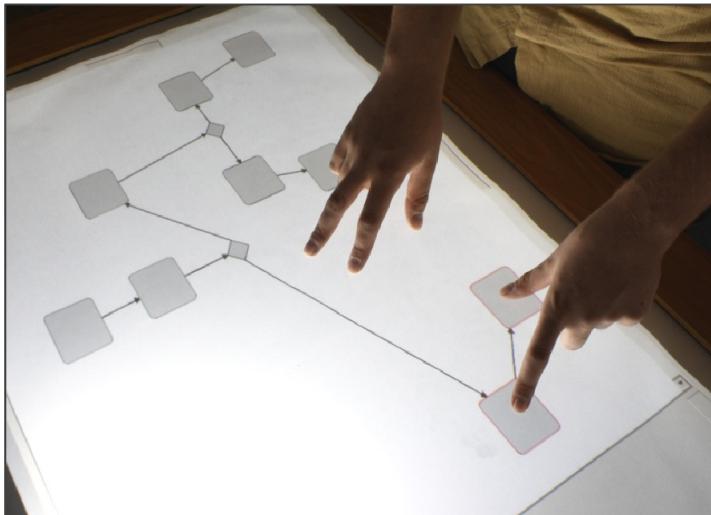
Motivation – Creation of Diagrams

- Structural Diagram Editors:
 - Point & click, dragging elements from toolbar...
 - Diagrams conform to semantic rules
 - Often conceived as inflexible and constrictive [Damm et al. 2000], [Grundy et al. 2007]



Our Approach

- Combination of multi-touch and pen gestures on interactive surfaces for diagram editing



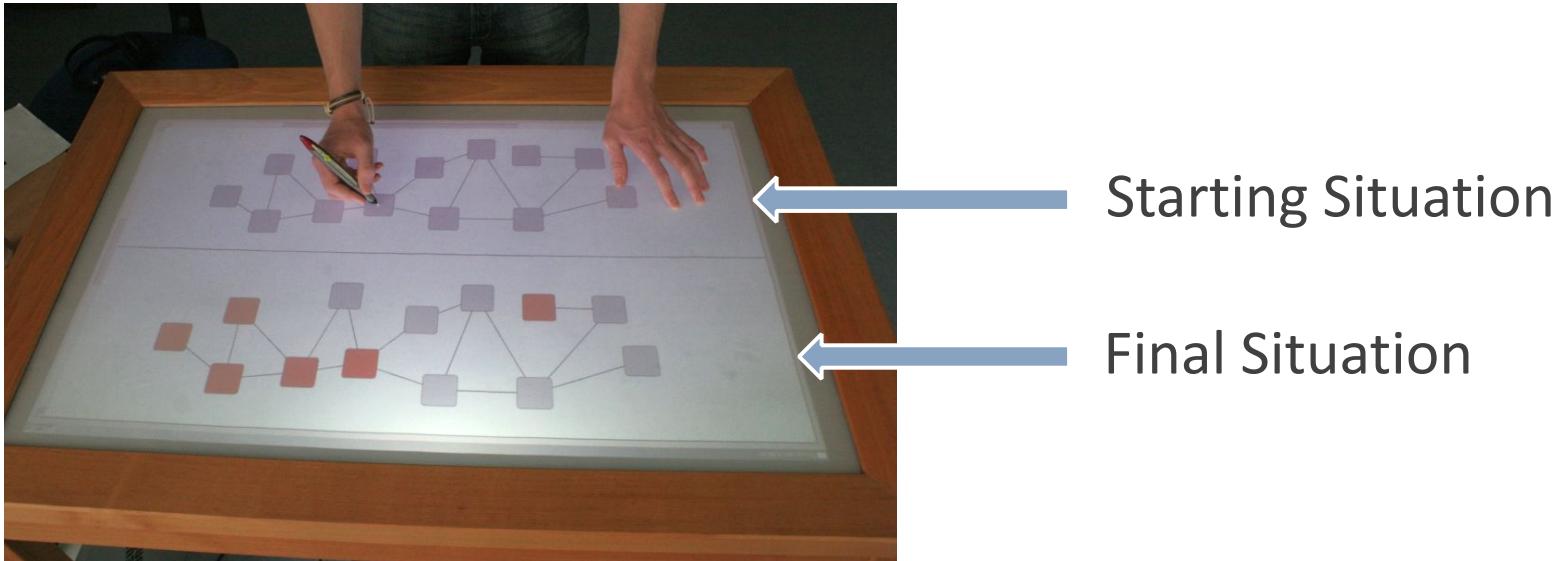
Our Approach

- As a starting point:
 - User-centered design approach to develop basic gesture set for further research
- Pilot study to elicit gestures from users
 - Similar to design as applied by [Epps et al. 2006] and [Wobbrock et al. 2009]
 - Considering
 - touch interaction (*structural editing*),
 - pen input (*diagram sketching*),
 - combination of both
 - No unambiguous user-defined gesture set without conflicts

Questions to clarify

- Will there be a high level of agreement between users?
- For which tasks will bimanual interaction be preferred?
- What is the nature of the performed gestures?
- Will gestures be distinguishable for all tasks?
- Will the pen be used in combination with the non-dominant hand?

Method



- Participants performed gestures in the lower area
 - Conditions: One-handed,
Two-handed,
Pen (supported by hand if necessary)
 - Free choice of interaction technique to start with
 - Suitability questionnaire after each task

Method

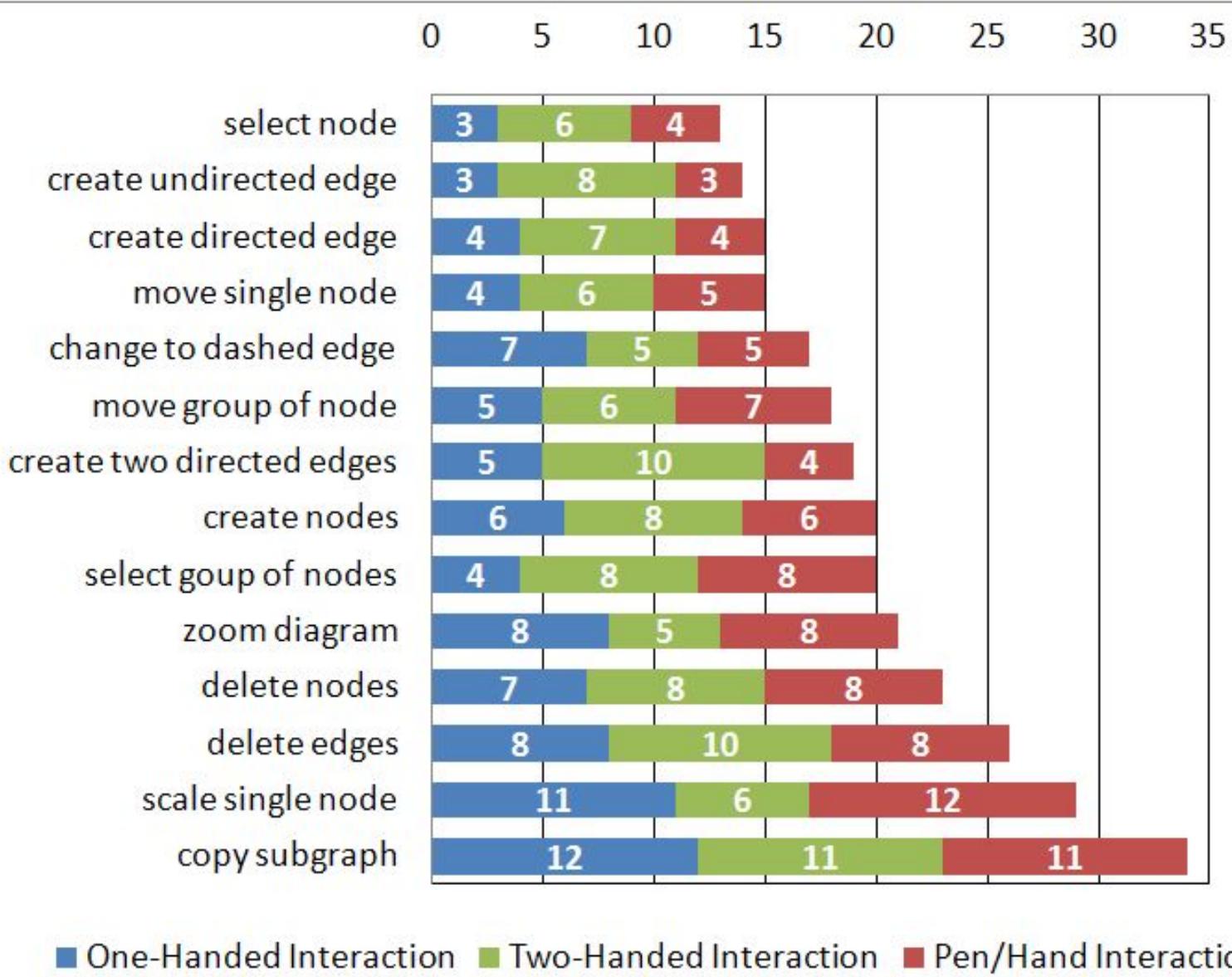
- 14 basic diagram editing tasks
 - Create and delete nodes/edges, copy sub-graph...
- 17 Participants
 - Solid background in software engineering
 - Knowledge of modeling tools
 - Within-subjects design
- Apparatus
 - Tabletop display (1280x800)
 - Capturing of the gestures by video, tabletop vision system, taking notes
 - Pens with IR source



Results – Gesture Analysis

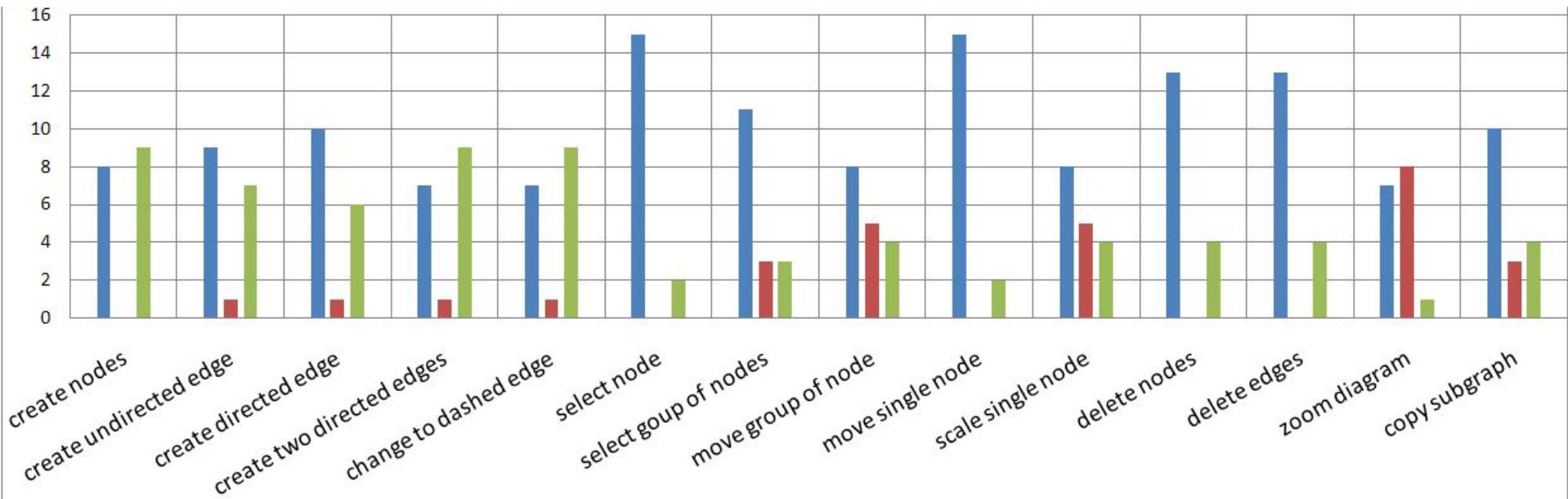
- 658 gestures recorded
- 26 abbreviations to group equal or very similar gestures
 - discrete and continuous actions
 - sequential and parallel actions
 - pen-only gestures and pen gestures supported by hand
- Amount of gestures for each task show level of agreement

Results – Gesture Analysis



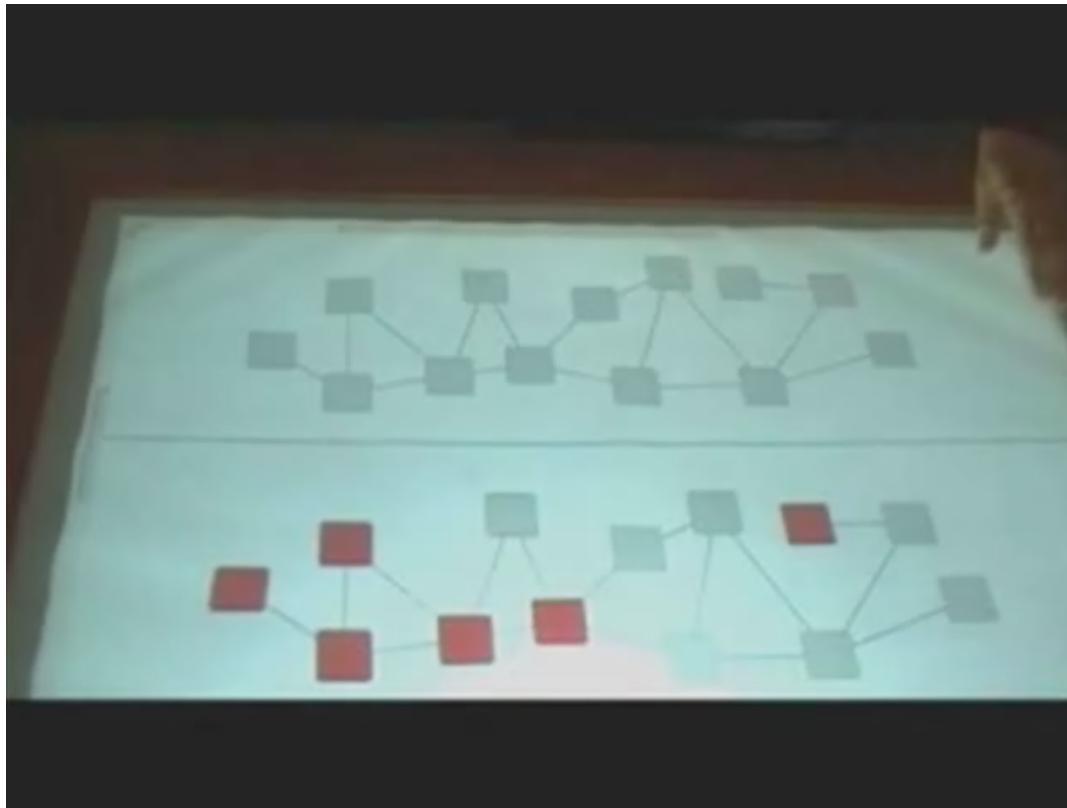
Results – First Choice of Interaction

- One-handed interaction: 141 cases (59%)
- Pen/hand interaction: 68 cases (29%)
- Two-handed interaction: 28 cases (12%)



Results – User Observations

- Diagram sketching & structural diagram editing
 - both applied where possible
- Desktop metaphor very dominant
 - especially for abstract tasks



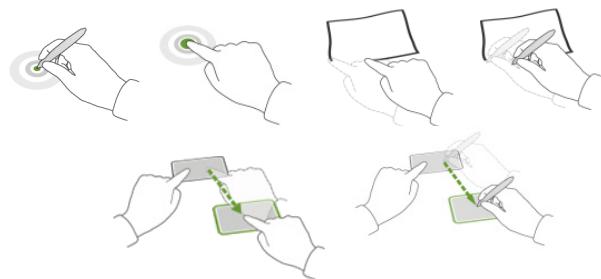
Results – The Gesture Set

- Consideration of
 - First choice data
 - Suitability questionnaire
 - Structural editing / Sketching
 - ⇒ more than one top candidate for each task
- Examples

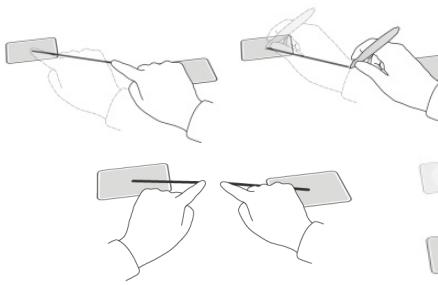


Create node

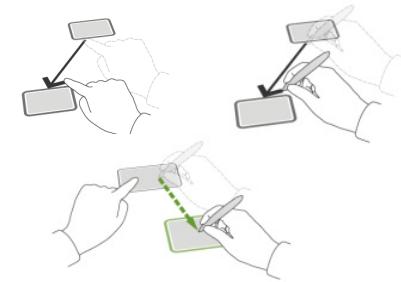
Results – The Gesture Set



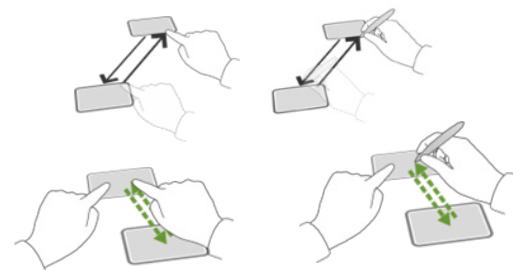
Create node



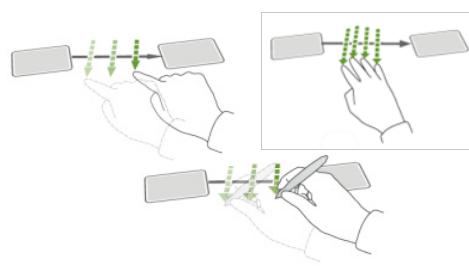
Create undirected edge



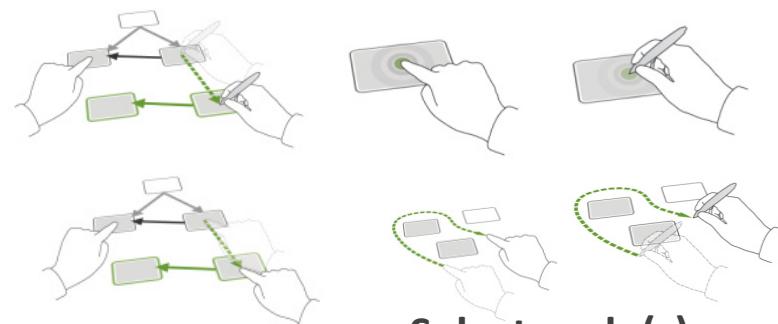
Create directed edge



Create two directed edges

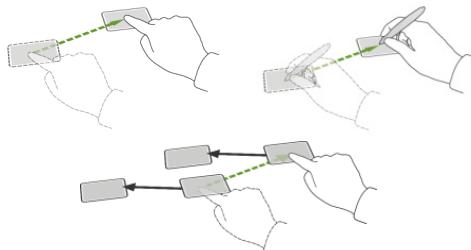


Change type of edge

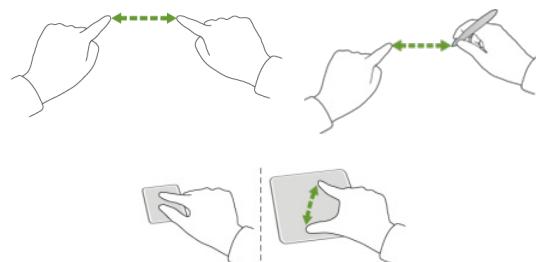


Select node(s)

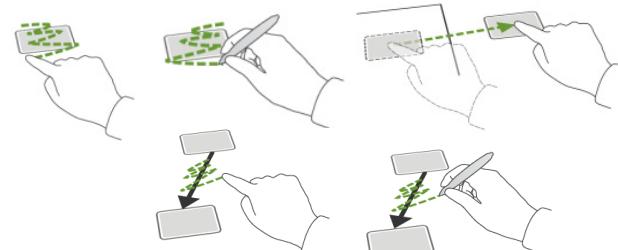
Copy sub-graph



Move node(s)



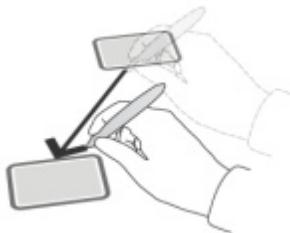
Scaling & Zooming



Delete nodes & edges

Observations & Discussion

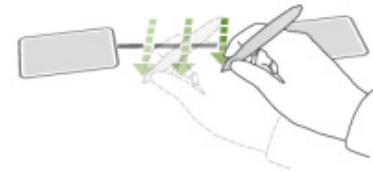
- 2 Categories of “sketching gestures”



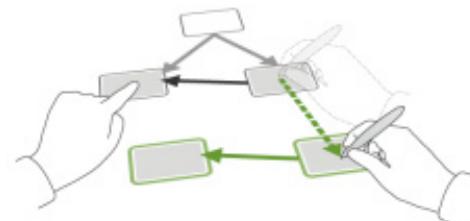
Physical gestures



Metaphorical gestures



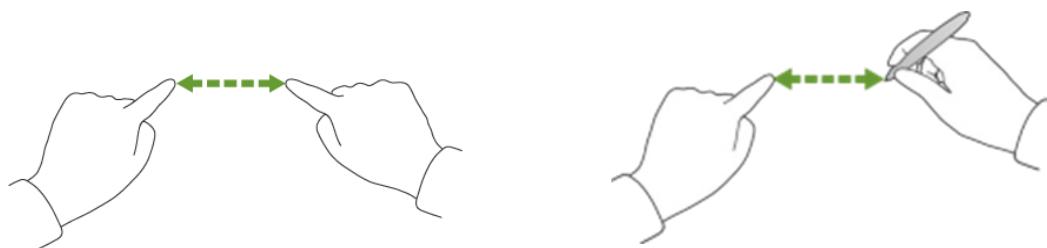
- Ambiguities
 - Conflicts mainly in abstract tasks
 - Users try to solve ambiguity by including context
 - ⇒ Contextual help and disambiguation for simple but powerful gestures



Abstract gestures

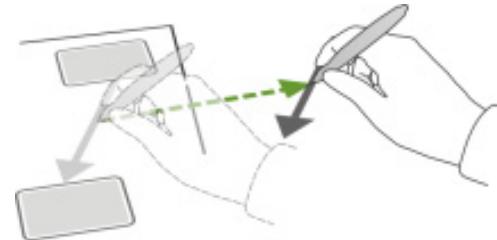
Observations & Discussion

- Pen and Hand Interaction
 - Non-dominant hand in combination with pen hardly used (only 12 %)
 - Exceptions:
 - scaling and zooming tasks
 - non-dominant hand used for mode switches
 - ⇒ Participants not used to combine both
 - Hardly distinction between fingers and pen

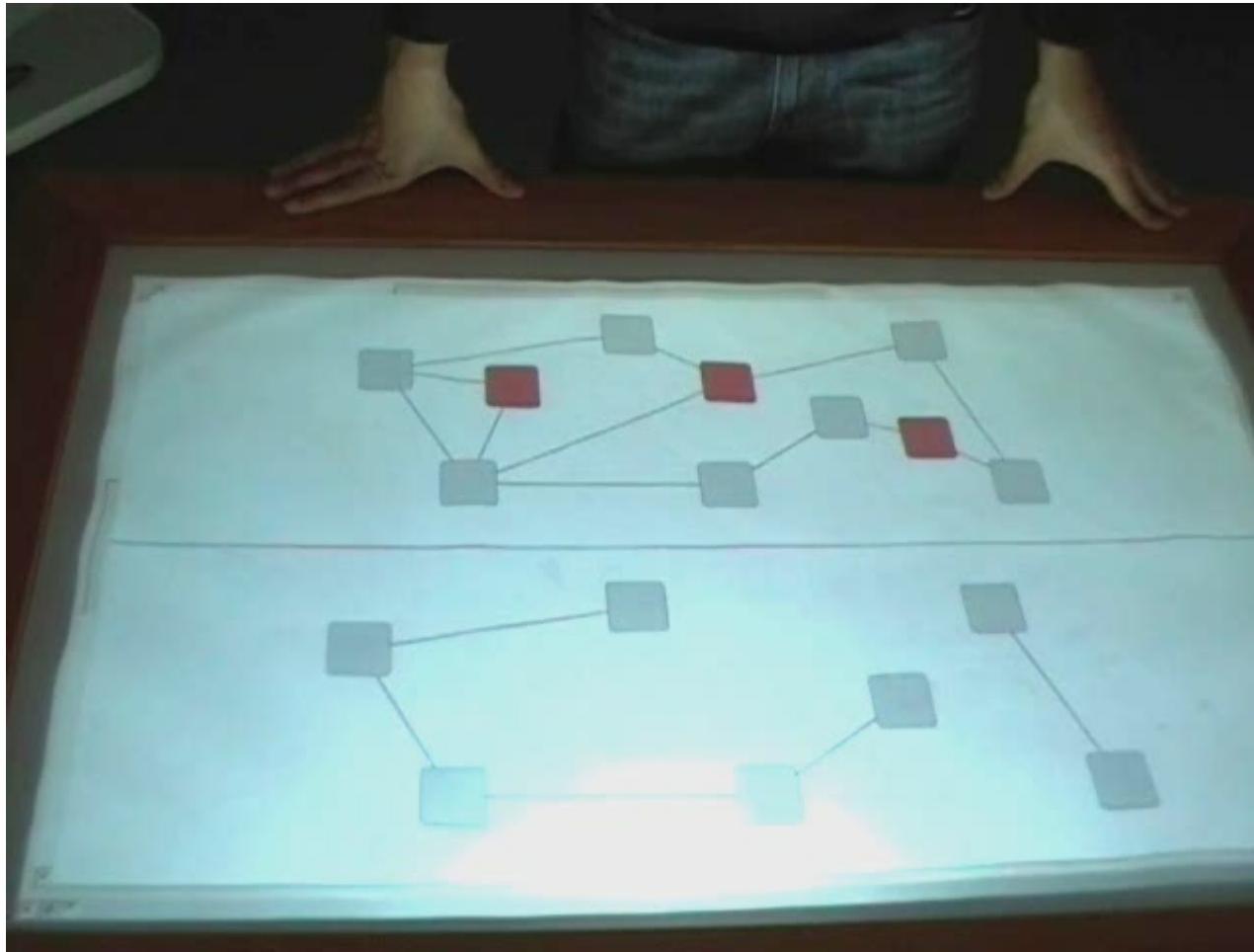


Observations & Discussion

- Unexpected gestures
 - Symbol drawn on background
 - Dragging to off-screen
 - Unrecognizable gestures (flipping hands, grappling...)



Observations & Discussion



Observations & Discussion

- Unexpected gestures
 - Symbol drawn on background
 - Dragging to off-screen
 - Unrecognizable gestures (flipping hands, grappling...)

Conclusion & Future Work

- Contribution of a basic set of user-defined gestures for node-link diagram editing on interactive surfaces
- Pilot study to elicit hand and pen gestures from users
- Findings:
 - Requirement to equally support *diagram sketching* and *structural diagram editing*
 - Preference of simple gestures with disambiguation
 - Dominance of one-hand and pen-only interaction
 - Unusual gestures
- Next steps
 - Resolving conflicts + implementing the gesture set
 - Follow-up evaluation of the gesture set
 - Further developing and extending the gesture set

Thank you.

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References

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