# Paper Assignments / Three Case Studies

September 19, 2018



## Today

Assigning paper presentations

Requirements for

- Reading comments / questions
- Paper presentations / discussion leading

3 Case Studies



## Questions/Comments

For each paper discussion class, you will need to come up with **two** questions or comments per paper

Questions should be designed to **stimulate discussion**



## Questions/Comments

Good questions/comments:

- Comment on a important strength or weakness
- Relate the research to general issues in the field
- Relate the research to other papers discussed in the course
- Propose interesting potential avenues for future work

## Questions / Comments

Post your questions/comments on the discussion forum on UMLearn by **7:59pm the day before class**

Late questions/comments will not be accepted or graded



## Questions / Comments

Marking

- Each **set** of questions will be marked on a 5-point scale:
  - 1=poor (C), 2=fair (B), 3=good (B+), 4=very good (A), 5=exceptional (A+)
- No written feedback provided



## Paper Presentations

This will consist of:

- Presenting a short ***critical summary*** of the paper
- Leading the discussion



## Critical Summary: Expectations

Your critical summary should be 10-15 mins long

Your summary should cover the following:

- What is the motivation?
- What are the contributions?
- What are the strengths and weaknesses?

## Discussion Leading

For the remaining 25-30 mins, you will lead our discussion

- Beforehand
  - Review the questions / comments posted on UMLearn
  - Organize them
- During
  - Lead us through important points, themes, etc. in the questions / comments
  - Involve the whole class

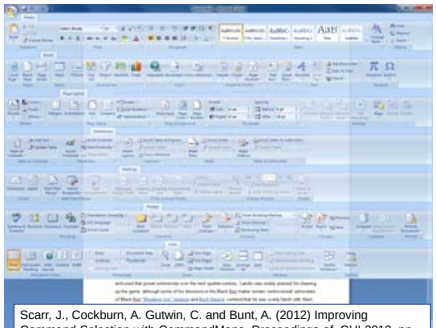


## Case Studies

1. A controlled quantitative experiment
2. A purely qualitative study
3. An example "systems" paper



## Case Study 1: CommandMaps



Scarr, J., Cockburn, A. Gutwin, C. and Bunt, A. (2012) Improving Command Selection with CommandMaps, Proceedings of CHI 2012, pp. 257-266



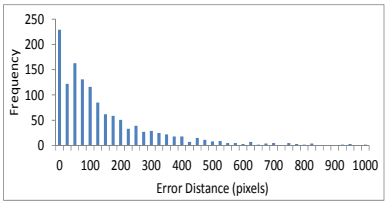
## Experiment 1: Testing Spatial Memory

12 experienced Word users asked to indicate "familiar commands"

Participants shown blank toolbar

Asked to "select" each familiar command

## Experiment 1 Results




Median errors was 92 pixels (2.5 cms)



## Experiment 2

18 participants

3 x 2 factorial design

Factors:

- Interface: menu, ribbons, CommandMap
- Parent: same, different



## Hypotheses

**$H_1$:** Users can select commands faster using CommandMaps than when using Ribbons and menus.

**$H_2$:** CommandMaps are faster than the Ribbon for tasks requiring switching between different parent tabs.

**$H_3$:** Subjectively, users will prefer CommandMaps.



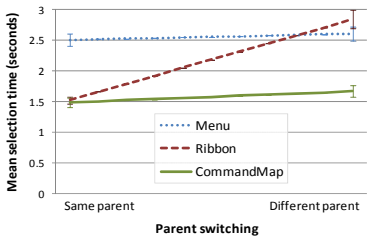
## Experiment 2: Results

Results analyzed using ANOVA

Things to look for in the paper:

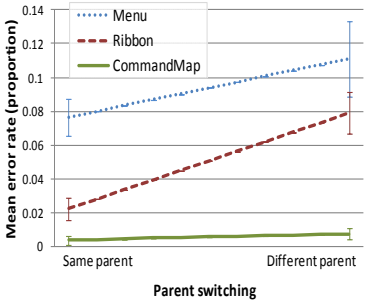
- Which main effects were found?
- Which post-hoc comparisons were significant
- Which interaction effects were found?
- What was the nature of these interaction effects?

## Experiment 2 Results: Time



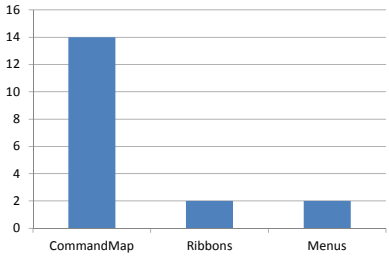



## Experiment 2: Errors



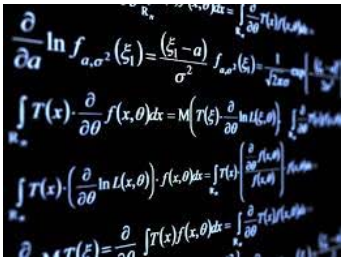



## Preference



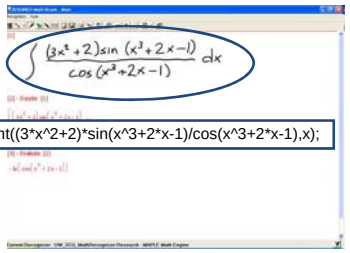



## Case Study 2: Mathematicians



https://commons.wikimedia.org/wiki/File:Pure-mathematics-formul%C3%A6-blackboard.jpg

## Pen-Math




MathBrush



## Taking a Step Back

How do mathematicians work?

- What are their goals?
- What characterizes their workflow?
- How do tools such as Computer Algebra Systems (CAS) integrate into their existing work practices?



## Related Work: Evaluating Tools for Mathematics

Laboratory evaluations of general feature sets

- Impact of media on problem-solving performance (e.g., Oviatt et al. 2006)
- Expression entry (e.g., Anthony et al. 2005)
- Expression entry + problem-solving in pen-math systems (LaViola 2007, Labahn et al. 2008)

CAS use in educational settings

(e.g., Artigue 2002, Leinback et al. 2002, Pierce et al. 2004, Ruthven 2002)



## What About Professional Use?

How do tools like CAS support mathematical problem solving in a professional setting?

Our focus: university researchers

- No longer learning basic math principles
  - Instead, seeking to gain new insight
- Problems largely ill-defined

## Study Overview

Goal:

- Understand the work practices, artifacts and tool use of professional mathematicians in a research setting

Qualitative data collection + analysis:

- Interviews + photographs of working materials and environments

9 participants in total



## Study Design

Semi-structured interviews

Interviews took place in each participant's primary workspace

9 theoretical researchers at a university

- Work largely symbolic in nature
- 3 professors, 3 postdocs, 3 graduate students
- 8 males, 1 female

Data collection: audio recordings + digital photographs



## Interview Topics

Asked participants to walk me through things they had worked on recently

As they did, I would probe for further detail on:

- Goals
- Aspects of their workflow
- Which tools they used, when, and for what reasons
- Any tool/media preferences



## Data

Interviews ranged from 30 mins – 1 hr

One failed audio recording

- Immediately made detailed notes, asked participant to confirm

First step: transcribe audio

- Approximately 70 pages of transcripts

## Data Analysis

Affinity diagrams for interview statements

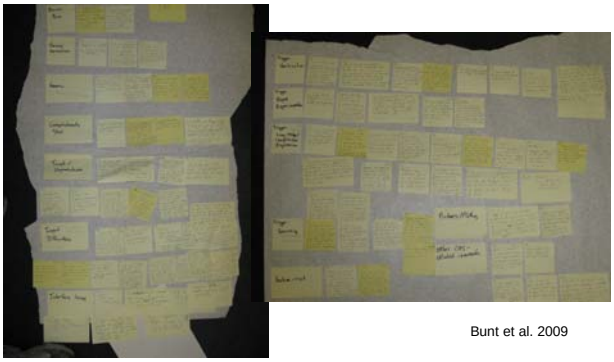
"Thematic" analysis of work artifacts

Timeline of work artifacts

Documents progression from initial ideas to final solutions

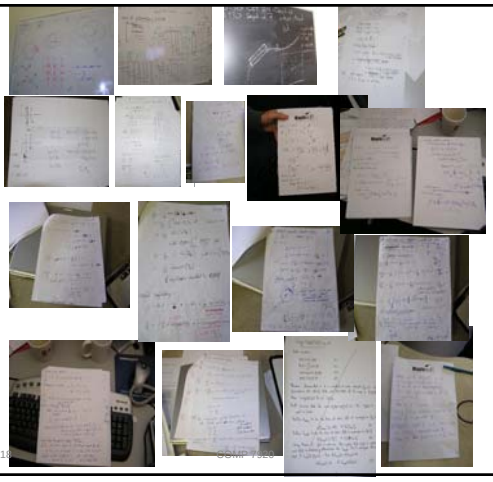


## Affinity Diagram Examples



Bunt et al. 2009







## Findings: Overview

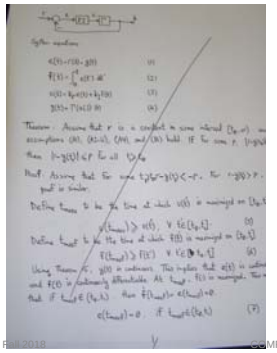
Goal/product of work

Work processes

Roles of CAS and other computational tools

Open issues

## Goal/Product of Work: Mathematical Narrative



- Highly structured document
- Transforms entities from an initial form to a more desirable form
- Dual purpose:
  - Communicates
  - Argues correctness



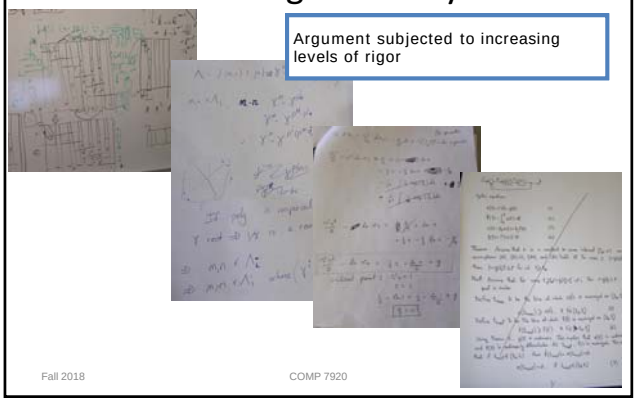
## Work Processes

Data suggests that creating this narrative involves a number of phases:

- Ideation
- Execution
- Formalization
- Dissemination



## Evolving Formality



Argument subjected to increasing levels of rigor



## Computational Tools

Typesetting software

- LaTeX
- Dissemination
- Some use in the formalization process

CAS

- Maple
- More limited role in problem solving than anticipated

## CAS: Primary Uses

Long, tedious expressions

> *"If I have some horrible expression that I don't like, some large amount of tedious computation, integrate this or reduce this giant mess to something useful, then sometimes I'll stick it in Maple to see if it can solve the problem for me."*

Verifying hand-derived work



## CAS: Other Uses

Sophisticated searching

> *"It's a matter of just testing all possible solutions to see if they are solutions or not. And the algorithms are really the fastest way I can test that."*

Experimentation in the Ideation phase

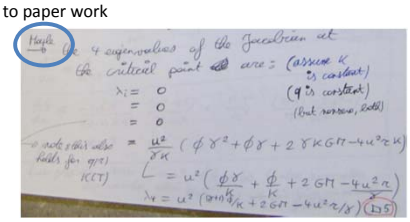
- Rapid manipulation
- Plotting



## CAS and Workflow

Typical CAS usage:

- Work on paper
- Switch to CAS when needed
- Return to paper work






## Open Issues

1. Need for insight and transparency
2. Need for free-form 2D representational forms
3. Transcription problems
4. Need to collaborate

## Need for Insight and Transparency

Hand-derived work provides better insight, facilitates pattern detection, and keeps skills sharp

> *"Computers are great for running through large amounts of examples, but you don't get the same insights. Whereas if you did something by hand, sometimes you just get more insight and can figure out the general pattern."*
>
> *"Sometimes [...] it is a good exercise for me to try to do it as much by hand as possible because then I exercise certain parts of my grade 12 calculus class and keep those fresh."*



## Need for Insight and Transparency

Lack of transparency leads to issues with trust and predictability

> *"I tend to not trust the results from the symbolic toolbox [...] Although it is very infrequent that the results are incorrect."*
>
> *"Whenever you do something in Maple, you'd like to be able to re-produce it by hand."*
>
> *"Sometimes the computer algebra, it skips steps, or you can't see, or in the end you have to go back..."*

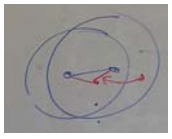


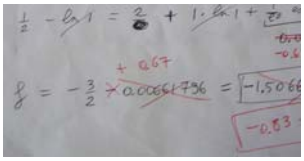
## Need for Free-Form 2D Representational Forms

Narratives consist of prose, diagrams, symbols

Additional affordances of pen/paper:

- Physical space
- In-place manipulations







## Contrast to Maple

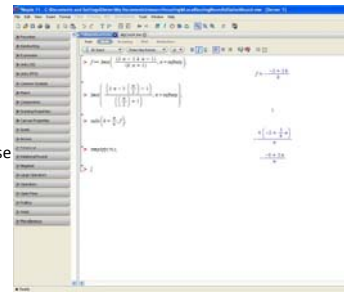
Strict input/output style dialogue

Level of formalism is not flexible

- Cannot be adjusted to suit current problem-solving phase

Pen/paper:

- allows formalism to evolve within the same medium



## Transcription Problems

CAS use requires transcription from physical media to form it can manipulate

Issues:

- Reduction in dimensionality
- Very little error checking, errors difficult to diagnose
  - *"I'll type in an expression, I'll have spent an hour trying to figure out what it means and what the results are, and then I realize I've made an error typing."*



## Transcription Problems

Surprising very few negative comments concerning syntax requirements

Potential reasons:

- Initial learning investment
- Restricted symbols sets
- Macros



## Lack of Support for Collaboration

Mathematical problem solving is highly collaborative

Whiteboards primary medium

Paper also used



## Reflecting on the Paper

What makes this paper an HCI contribution?

What aspects of the study, analysis, presentation, etc. did reviewers appreciate?

What are the limitations?

## Case Study 3: Switter

General research methodology

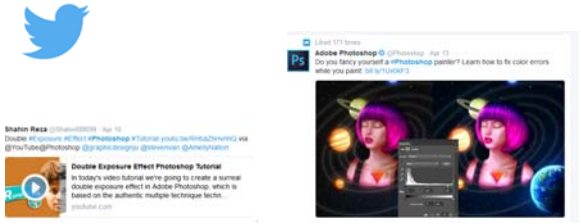
- Exploratory study
- Prototype design / implementation addressing a subset of challenges / issues raised in study
- Limited field deployment



expert designers continually seek to learn new things

even after 10 years of experience











## Challenges

Volume of content

Assessing utility difficult

# Switter

Supporting Exploration of Software Learning Materials on Social Media



## Field Study

Deployed Switter to 9 design practitioners

Used at least once per day over 7 days

"Wizard of Oz" content population (~30 tweets/day)

Data collection

Logs, journal entries, semi-structured interviews

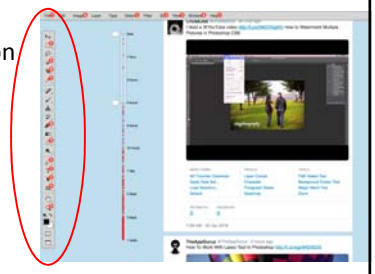


## Findings

Exploration based on popularity

Addressing known weaknesses

Command comparisons

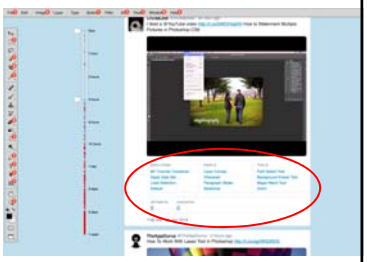




## Findings

Quickly assess the content

unexpected/ unknown use-cases



## Discussion

Wizard-of-oz components

Missing features

Choice of evaluation method