

# PaperCP: Explore the Integration of Physical and Digital Media for Active Learning

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# A Question

How many of you attended the  
HCIL Symposium last year ?



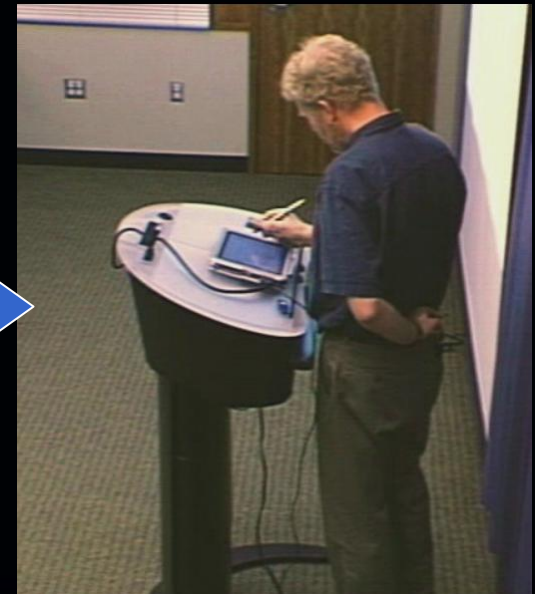
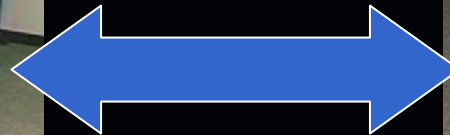
# Two-Way Communication in Active Learning

- Involve students in activities for learning



# Fully Digital System for Active Learning

- **Classroom Presenter** [Anderson,'04]
  - Data transfer, archive and display
  - Reading and writing experience, tangibility, display size, cost



# Gap Between Paper and Computers

**Paper**



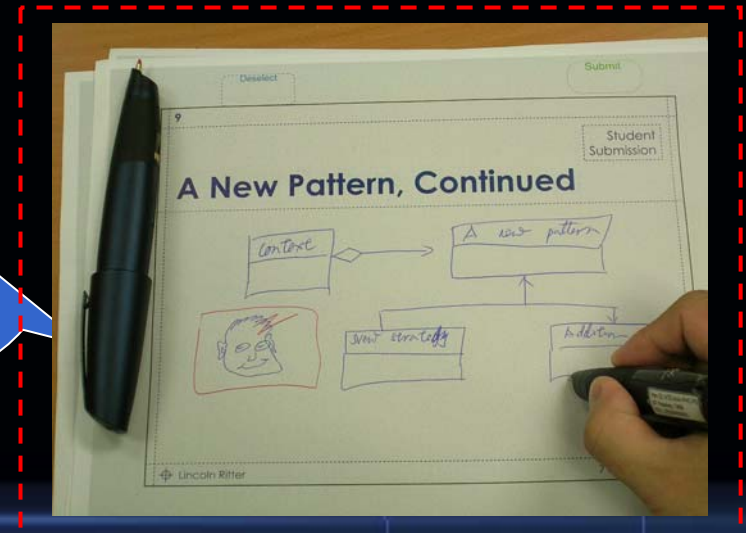
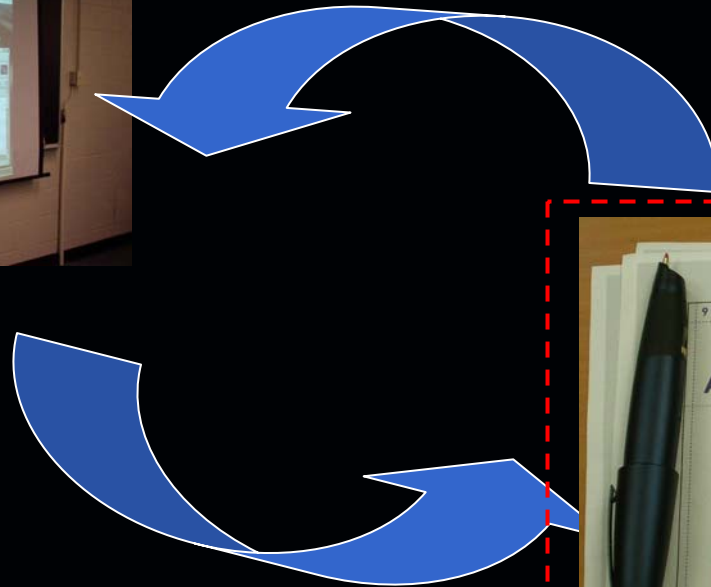
**Computer**

# Our Solution



# PaperCP: Integrate Paper and Computers

- A paper-based Interface built on the Classroom Presenter digital infrastructure



# PaperCP in Action (1)

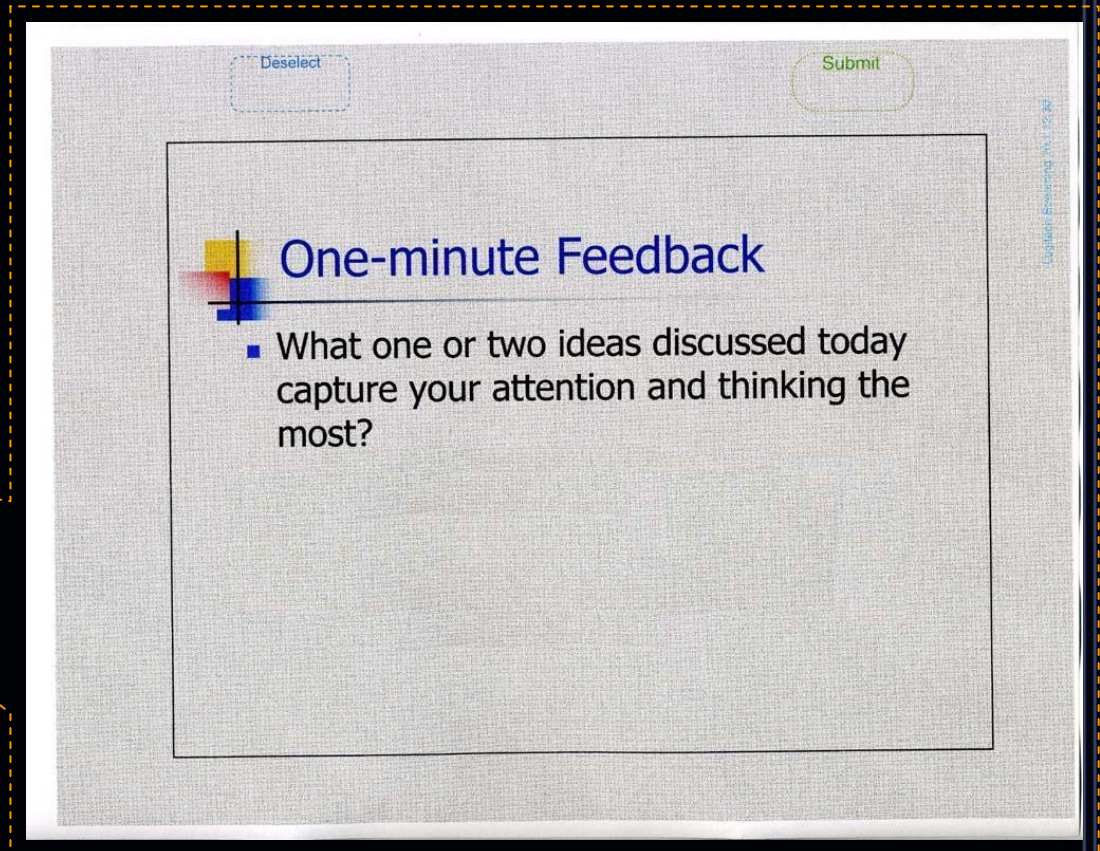
- Printed slides are handed out to students



instructor



student



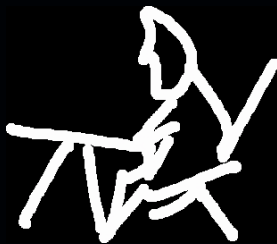


# PaperCP in Action (2)

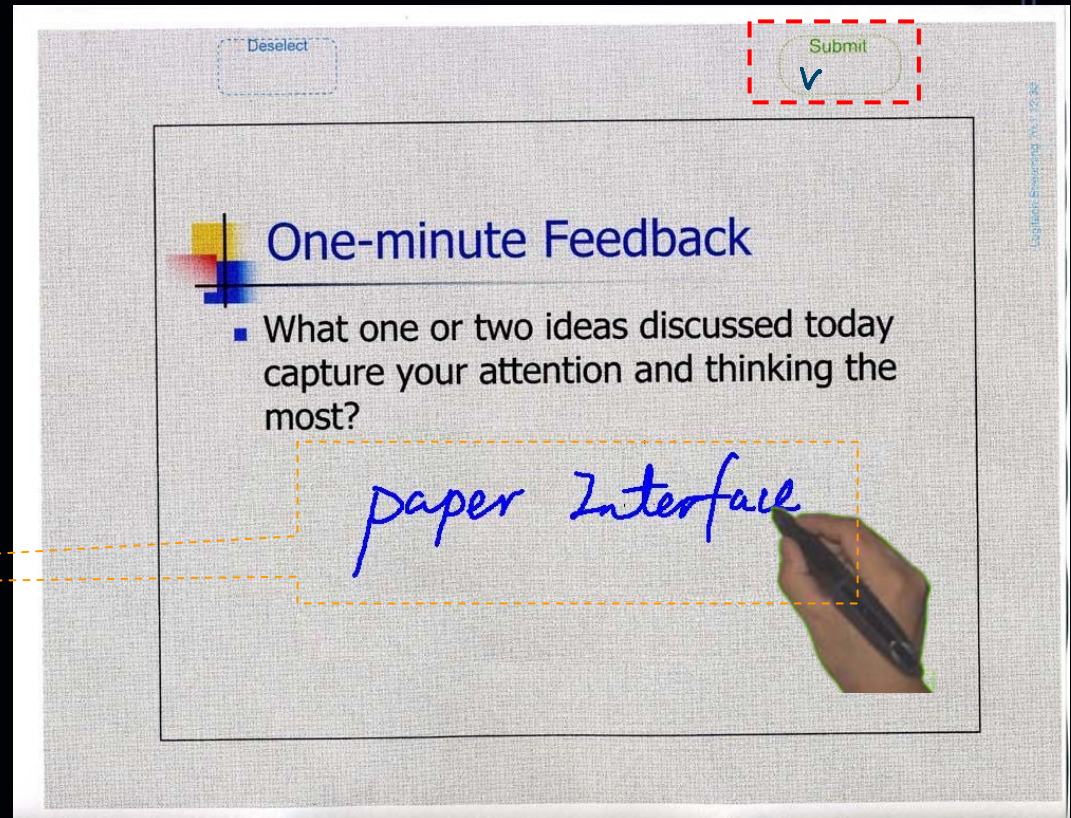
- Responses are submitted from **paper**



instructor

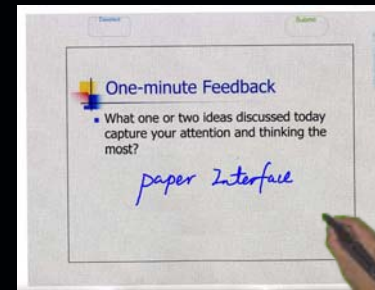
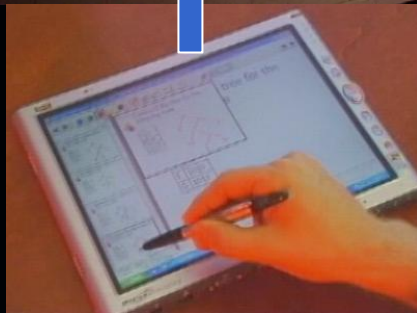
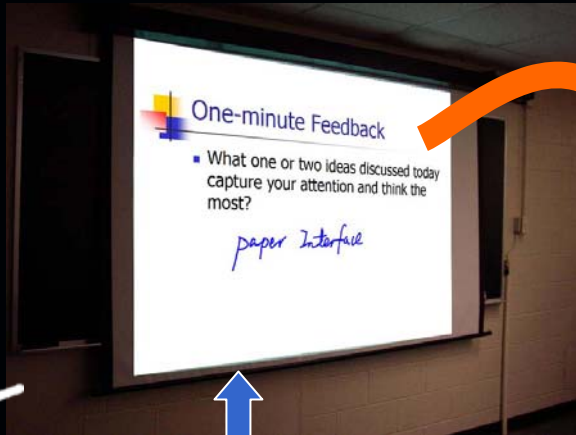
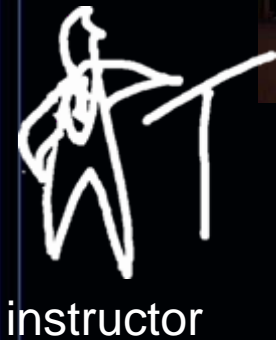


student



# PaperCP in Action (3)

- Submissions are reviewed and discussed



student

# Previous Work

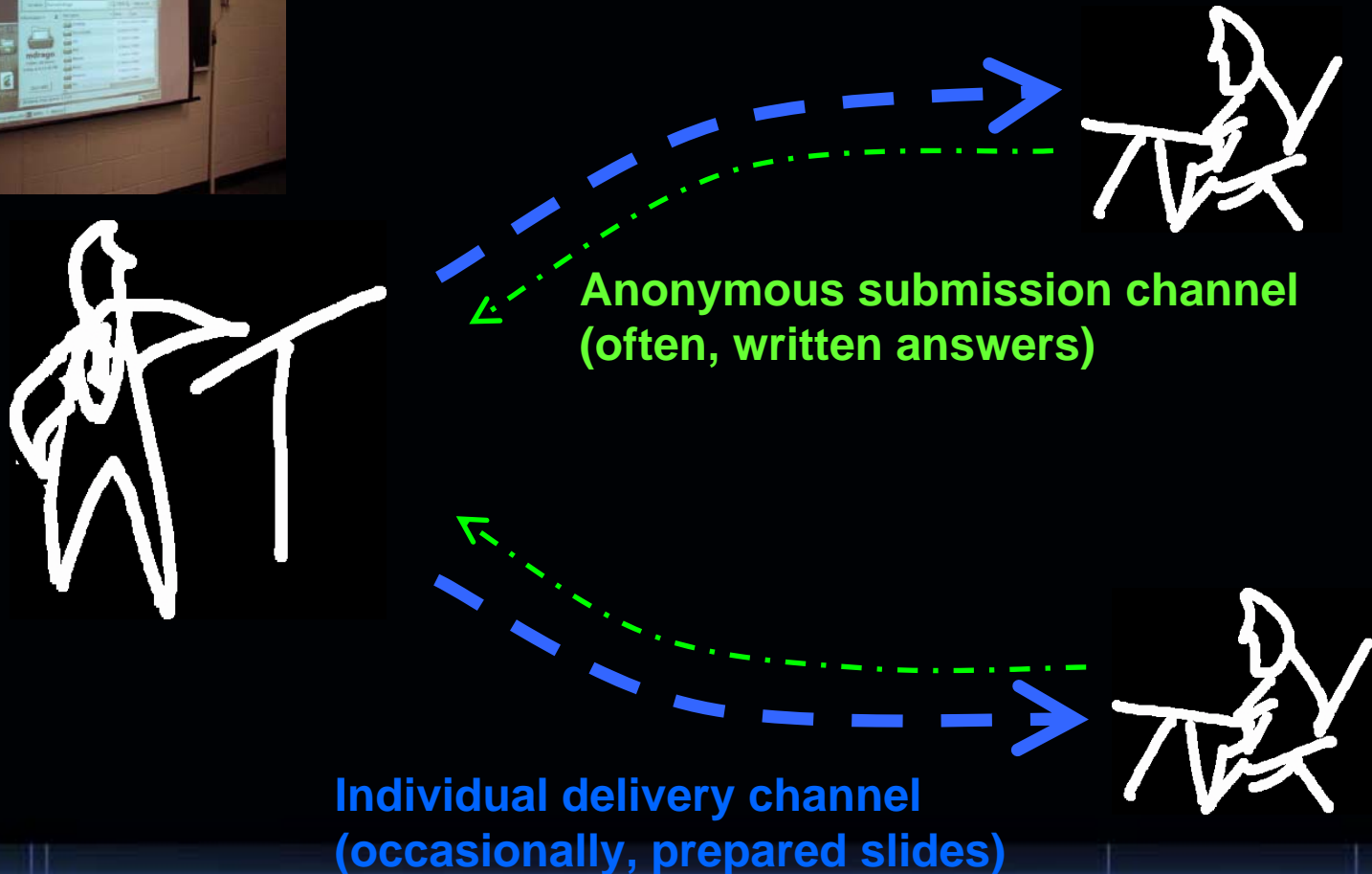
- **Computer-supported Learning/Teaching**
  - Classroom 2000 [Abowd,'00], LiveNotes [Kam,'05], Classroom Presenter [Anderson,'04]
- **Paper-Computer Integration**
  - PADD [Guimbretière,'03], PapierCraft [Liao,'05]
  - PaperPoint [Signer,'05], Palette [Nelson,'99]
  - DigitalDesk [Wellner,'93], PaperWindows [Holman,'05]

# Building Blocks

# Communication Model of Active Learning



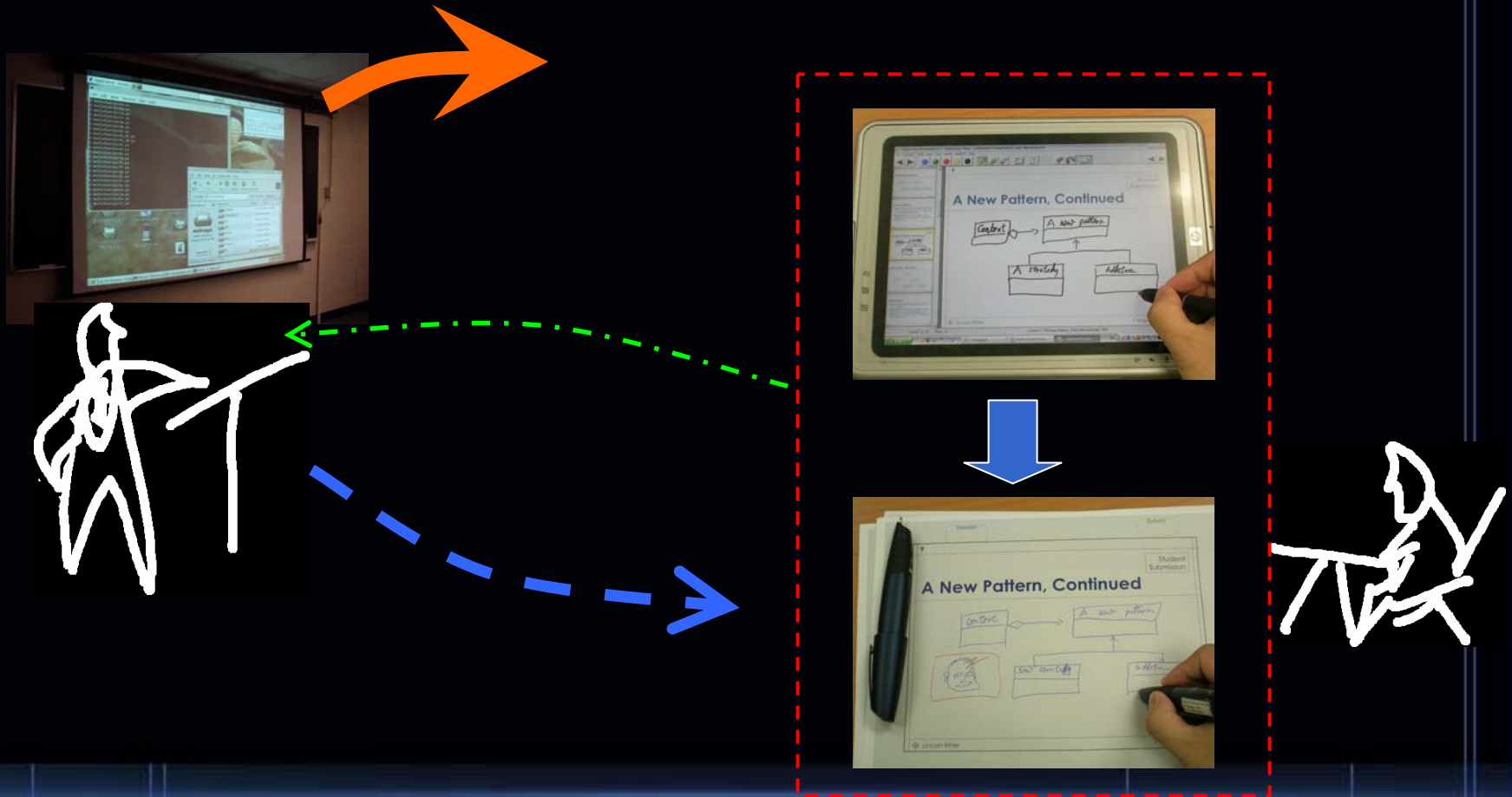
**Shared delivery channel**  
(often, slides + annotation + submission)





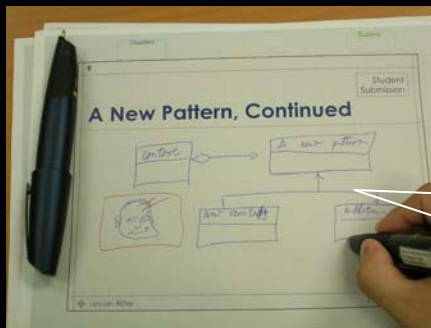
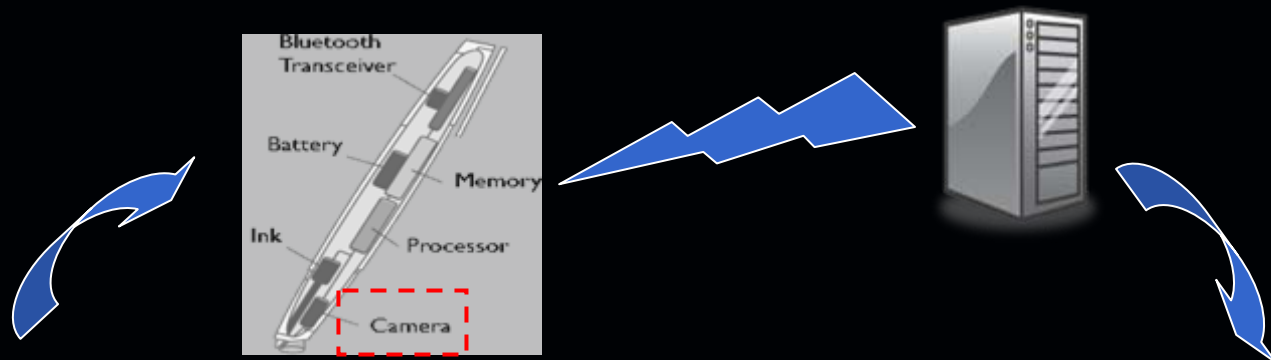
# Model Implementation in PaperCP

- Paper interface for students
- Computer interface for the instructor

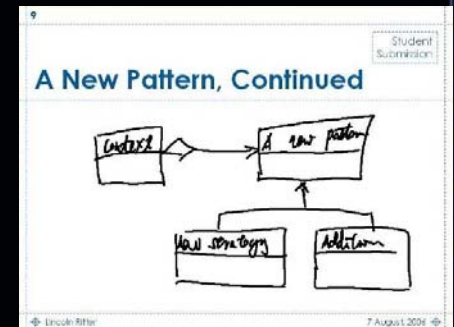


# Challenges(1): Physical-Digital Mapping

- Anoto pen traces handwriting in real time
- PADD links digital & physical documents



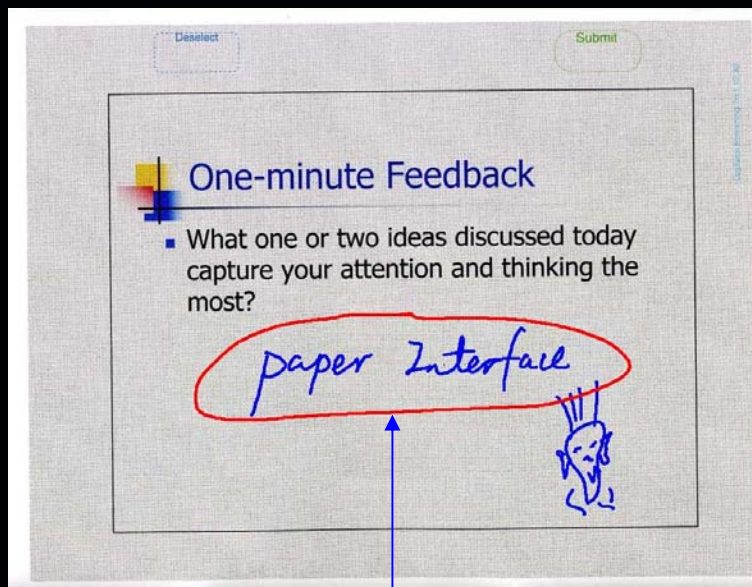
Anoto [Anoto, 2002]



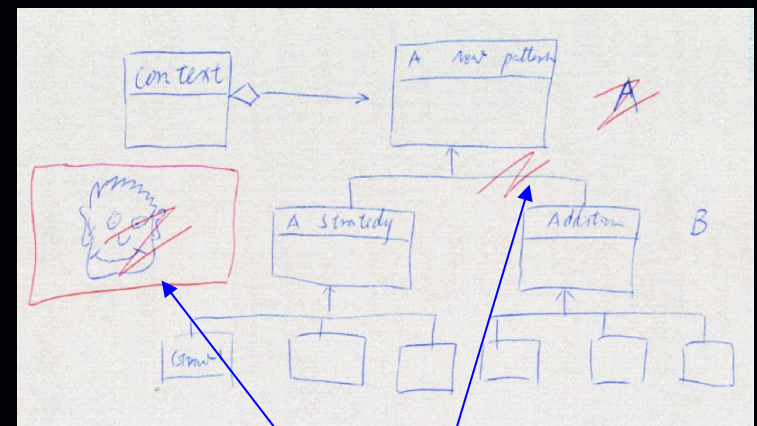
PADD [Guimbreti re, '03]

# Challenges (2): Weak Feedback on Paper

- Use ink as feedback
- Issue commands by drawing



Selective submission gesture



Deleting gestures

# Preliminary Experiments

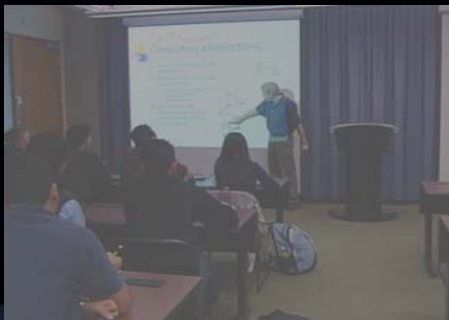
# Testing in A Real World

- Deployed in a realistic Software Engineering class at Univ. of Washington
- Eight students + one instructor
- Within-subject setting comparing the Tablet PC and paper interface



# Results: Feasibility and Usability

- The paper interface is feasible
  - Work well with the digital infrastructure
- The paper interface is usable
  - Well integrated with Active Learning
  - Comparable to the Tablet PC interface in supporting student submission



# Results: Lessons

- Physical arrangement
  - One-slide-per-page layout is not good
  - Unstapled pages are not good
- Efficiency
  - Printing needs speed-up
  - Pen switching is annoying
- Feedback
  - More real time feedback is needed

# Future Work

- Improve print layout
- Enhance real time pen-top feedback
- Mix paper and computer interfaces
- More rounds of experiments

# Take-away Messages

- PaperCP is a paper-based interface to support 2-way communication in Active Learning, combining the merits of physical and digital media
- Preliminary experiment has shown PaperCP's feasibility and usability, as well as challenges such like printout layout and feedback
- More information
  - <http://www.cs.umd.edu/{~liaomay,~francois}>

# Acknowledgement

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- All volunteer participants



# Thank you! Any questions?

