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University Of California Electronic Lab Notebook Initiative

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The day of the isolated lab notebook is over.

Collaboration is the key to Scientific Research in the future.

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Why Go Digital?

- Increase worker productivity
- Systems integration synergy
- Fill gaps in safety compliance around student training procedures in handling hazardous substances
- Build history of hazardous procedures and related adverse events
- Chemical purchasing and archiving capability
- Facilitate knowledge exchange
- Long term storage and retrieval of data
- Secure intellectual property record

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How are ELN's Structured?

- Essentially, organized workspaces ("data dumps")
- Most types of files can be added
  - Text, spreadsheet, PowerPoint, pdf, image, specialty file types
- Can be shared
- Entries are time-stamped
- Cross-signing is typical
- Can be converted to other file formats

Stakeholder Categories

- PI's
- Students
- Lab Safety Infrastructure
- UC Intellectual Property Office
- Archiving Infrastructure
- Purchasing Infrastructure

Stakeholder Interests – PI's

- Increase student productivity
- Permanent archiving of data, including raw machine output
  - Safe storage of data
  - Project continuity
  - Digital capture of observations
- Purchasing control
- Productivity checkpoint
- Fraud checkpoint
- Safety checkpoint

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Stakeholder Interests – Grad Students

- Increased productivity
- Permanent archiving of data, including raw machine output
  - Safe storage of data
- Link to instrumentation
- Digital capture of observations
- No duplication of written protocols
- Mimic of industrial systems
- Home access?

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Stakeholder Interests – Undergraduates

- Digital and safe storage of data, including raw machine output
- Digital capture of observations
- No duplication of written protocols
- Increased consistency of grading
- Home/device access
- Portfolio building capability

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Benefits to Undergraduate Lab Instruction

- Consistent formatting of experiments
- Highlights safety protocols via field-selective data entry
- Secure history of lab operation
- Clearer expectations of record-keeping performance
- Harmonization among TA's and Instructors
- Improved organization of protocols, observations and results
- Greater clarity of records
- Permanence of records
- Convenience of use
- More reflective of private sector practices
- Portfolio Construction

Instructional ELN Capabilities

- Intuitive Interface
- Web browser-based or secure UC campus-based system
- Local cloud storage of data
- Data security
  - E-signing and witnessing
- Administrative control at Professorial level
- Flexibility across disciplines
  - Fields customizable by researcher/student
  - Template creation by researcher/student
- Multiple drawing application compatibility or dedicated application
- File import flexibility
- Data exportable to print and electronic formats
- Links EHS systems
- Links to purchasing infrastructure
- Links to major instrumentation
- Links to searchable structure/reaction Db's

UCSD ELN Project 2013 - ?

- Transition UCSD Chemistry teaching labs from paper ⟹ digital
  - Optimize hardware, software and pedagogical parameters
  - Assess student satisfaction
  - Assess effect on learning outcomes
  - Establish the digital culture
- Transition research labs

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Five ELN Demo Studies Undertaken in the Past 6 Quarters

- Upper division chemistry lab courses of 30 – 100 students
- Four commercial software systems used
- Looking for pitfalls, assessing student satisfaction and learning outcomes
  - Pre- and post-instruction survey format
- Identify key concerns/complaints

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Key Information We Are Seeking

- What is the best way to integrate ELN's in undergraduate teaching labs in Chemistry?
  - Software characteristics and capabilities
  - Hardware characteristics and capabilities
  - ***Lab Infrastructure***
- Is there really a better learning outcome for students if ELN's are used instead of paper notebooks?

Methodology

- A series of small pilots to test various hardware, software and laboratory configurations
  - Small lab sizes (<100)
- Assess student satisfaction quantitatively
  - Pre- and post-course surveys (pseudo-mandatory)
- Assess student LO's anecdotally (at first)
- Assess TA satisfaction anecdotally

Key Survey Questions

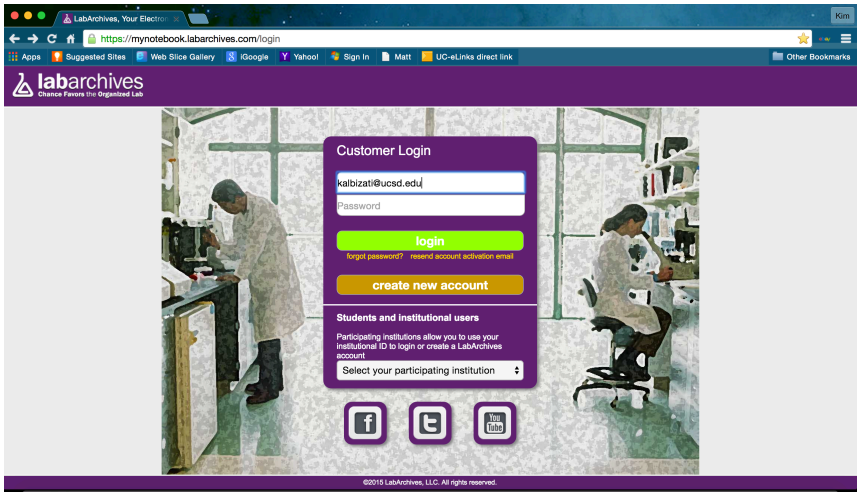
- "How enthusiastic are you about the prospect of using an electronic lab notebook in your next chemistry lab course?"
  - Very enthusiastic
  - Enthusiastic
  - Not enthusiastic
  - Opposed to using ELN's in labs
  - Don't care
- "How did the use of an ELN affect your learning experience in this lab?"
  - Improved the learning experience
  - Detracted from the learning experience
  - No difference

Pilot #5 – Fall 2014
Chem 143A – Organic Chemistry Lab

- Hardware supplied by ACMS
  - WORKSTATIONS in Lab (WYSE, monitors, keyboards, mice)
  - Students hardware out-of-lab
- Lab Archives software (entirely web-based)
- Protocol – 15 sections – all paper

  5 sections – all electronic
- 116 students

Lab Archives



- Located in Carlsbad
- Web-based system
- Can be locally served
- Two variations
  - Professional Edition - research
  - Classroom Edition – teaching
- Simple, intuitive feel
- ***Has professor and TA interfaces***
- Student entry into the system is easy
- Capabilities similar to other systems
- UCSD has site license
- Otherwise, $15/quarter/semester (1GB storage)

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Workstation Setup in York Hall 1246

Pilot #5 – Fall 2014
10th Week Survey Results (n = 116)

- "How enthusiastic are you about the prospect of using an electronic lab notebook in your next chemistry lab course?"
  - Very enthusiastic - 33%
  - Enthusiastic - 47%
  - Not enthusiastic - 3%
  - Opposed to using ELN's in labs - 3%
  - Don't care - 14%
- "How did the use of an ELN affect your learning experience in this lab?"
  - Improved the learning experience - 57%
  - Detracted from the learning experience - 6%
  - No difference - 37%

Pilot #5 – Fall 2014
10th Week Survey Results (n = 116)

- "In your next lab class, if you had a choice of using a paper-based lab notebook or an ELN, which would you prefer?"
  - Paper - 11%
  - Electronic - 89%

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Conclusions So far

- It is more than just the software package
  - Lab Hardware
  - Lab Peripheral Infrastructure
  - Course Construction Detail
- Software must be robust
  - Web-based
  - No Plug-ins
  - Intuitive
  - Free of issues
- Students are willing to pay for ELN access
  - At least as much as a paper notebook costs

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Acknowledgments

- Valerie Polichar – Integrated Digital Infrastructure (IDI)
- Wade Blomgren, Sean Osterthaler and Adam Tilghman - ACMS

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Questions?

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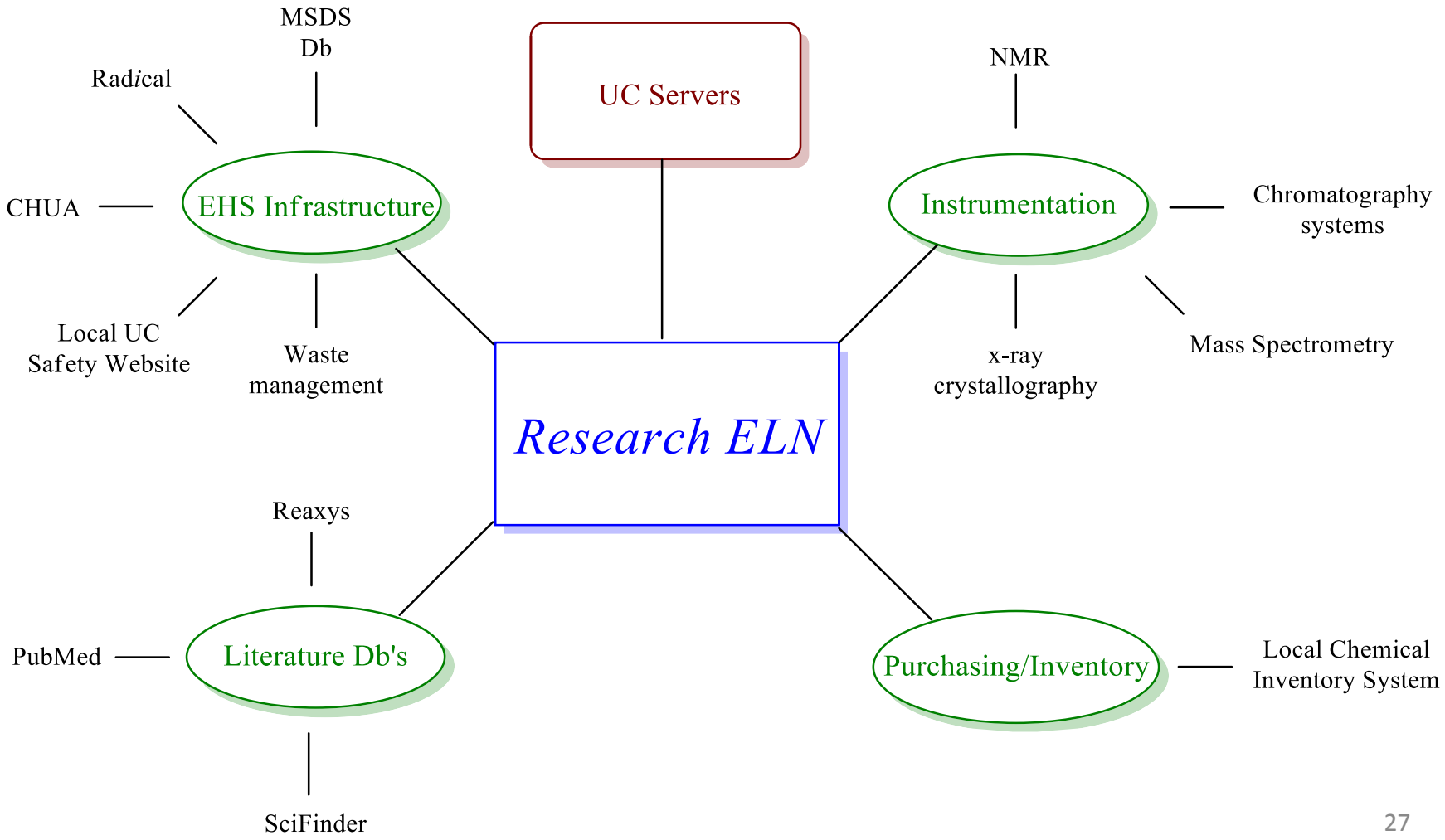
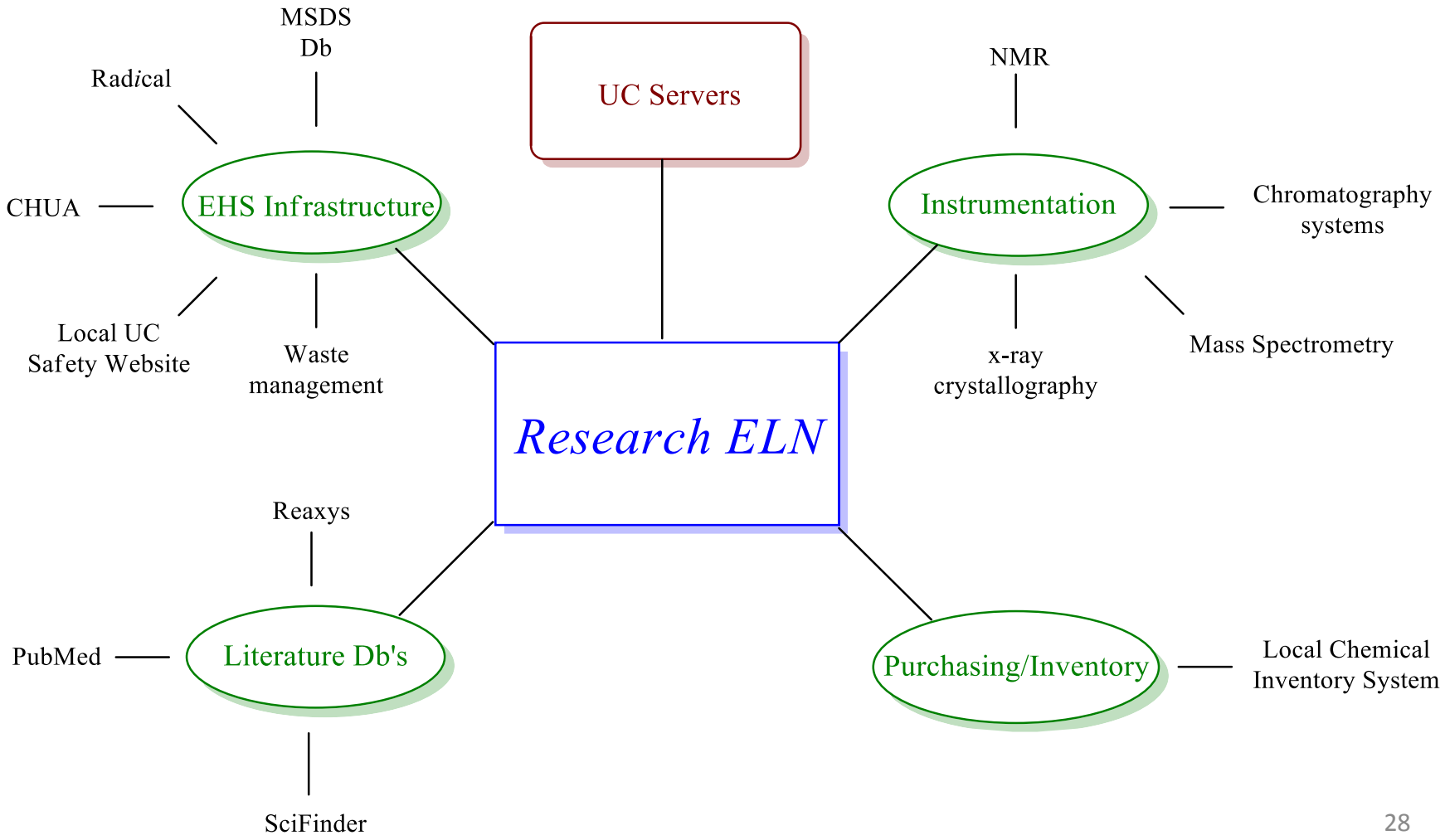
Current ELN Solutions

- Documents with embedded chemical structures and equations
  - First generation attempts at an ELN
- Enterprise solutions of specialized software companies
  - ca. 30 commercial solutions and several freeware solutions
- Highly specialized custom-designed programs
  - Most industrial ELN's in are this category

High Level Research ELN Architecture



High Level Instructional ELN Architecture



Project Communication and Rollout

- Advisory Team
  - One faculty member from each of the 10 campuses to keep faculty informed of progress and obtain feedback, concerns and advice
- Initial communication to UC Departments of Chemistry in March
- Regular updates to Departments through Advisory Team members
- KA to present to Departments in early stages??
- Rollout strategy depends on the desired level of conformity

Campus Advisors/Champions

- UCB
  - Anne Baranger
- UCD
  - Mark Kurth
- UCI
  - Kimberly Edwards
- UCLA
  - Pat Harran
- UCM
  - Jason Hein
- UCR
  - pending
- UCSB
  - pending
- UCSC
  - Ted Holman
- UCSD
  - Kim Albizati
- UCSF
  - pending

Pilot #1 – Winter 2013
Chem 143AH – Honors Organic Chemistry Lab

- Hardware supplied by students
  - PC – web-based
  - Apple – downloaded onto laptops
- iLabber system (Accelrys)
  - Required plugins
- Protocol – first half of the course – paper
  second half – electronic
- 56 students

Pilot #1 – Winter 2013
10th Week Survey Results (n = 56)

- "How enthusiastic are you about the prospect of using an electronic lab notebook in your next chemistry lab course?"
  - Very enthusiastic - 14%
  - Enthusiastic - 36%
  - Not enthusiastic - 14%
  - Opposed to using ELN's in labs - 13%
  - Don't care - 22%
- "How did the use of an ELN affect your learning experience in this lab?"
  - Improved the learning experience - 36%
  - Detracted from the learning experience - 18%
  - No difference - 46%

Pilot #3 – Fall 2013
Chem 143AH – Honors Organic Chemistry Lab

- Hardware supplied by ACMS (Wyse Netbooks)
  - WYSE Netbooks in Lab
  - NSB 2303A Computer lab for out-of-lab work
- E-Notebook (CambridgeSoft)
- Protocol – lab entirely performed in ELN
- 71 students

Pilot #3 – Fall 2013
10th Week Survey Results (n = 71)

- "How enthusiastic are you about the prospect of using an electronic lab notebook in your next chemistry lab course?"
  - Very enthusiastic - 7%
  - Enthusiastic - 38%
  - Not enthusiastic - 23%
  - Opposed to using ELN's in labs - 7%
  - Don't care - 25%
- "How did the use of an ELN affect your learning experience in this lab?"
  - Improved the learning experience - 38%
  - Detracted from the learning experience - 23%
  - No difference - 39%

Research ELN Capabilities

- Intuitive Interface
- Web browser-based or secure UC campus-based system
- Local cloud storage of data
- Data security
  - E-signing and witnessing
- Administrative control at Professorial level
- Flexibility across disciplines
  - Fields customizable by researcher/student
  - Template creation by researcher/student
- Multiple drawing application compatibility or dedicated application
- File import flexibility
- Data exportable to print and electronic formats
- Links to EHS Systems
- Links to purchasing infrastructure
- Links to major instrumentation
- Links to searchable structure/reaction Db's

Main Concerns Cited by Students (post-lab)

- Excessive scrolling required
- Portability of notebook in the lab
- Difficult to work with chemical structures and equations
- Loss of data
- Contamination of hardware
- Counter space