Electronic Lab Notebooks

From paper to screen, keeping track of your research
The amount of scientific data doubles every three years, but scientists mostly still rely on paper notebooks to keep track of their experiments, much like Marie Currie did 100 years ago.

However, today most of generated data is digital and more than 80% of it becomes untraceable, stored on some computer.

Introducing ELNs – a modern way to organize your scientific data and safely store it all in one place.
In this presentation you will learn:

- History of Electronic Lab Notebooks, ELNs
- How ELNs function and their features
- ELNs that are best suited for the research environment
- ELNs in clinical research and clinical data
ELNs aids reproducibility

• “I need to find raw data from an experiment I performed years ago but do not recall exactly where I stored that information.”
• “I want to replicate an experiment from a colleague, and need some additional information, but that person has already left our organization.”
• “I cannot use the data needed to continue a group project, because the person who holds the specific data set went on holidays without a full handover, or unexpectedly took ill.”

The electronic lab notebook provides the missing infrastructure for data recording, retrieval and integrity.
What is ELN?

- Electronic Lab Notebook (or ELN) is a digital version of the traditional lab notebook
- ELN is a software program designed to help you:
  - Plan
  - Track
  - Manage
  - Record
  - Analyze your experiments digitally
Why do you need an Electronic Notebook?

1. ELN can be designed specifically for the type of research you are doing.
2. Data can be stored centrally and accessible by other members of your team.
3. No more cutting and pasting results activity into your paper notebook.
4. ELN creates greater efficiency and produces a more historically accurate data management system.
5. ELN leads to reduced mistakes and lowered total research costs and time.

Why should you switch to ELNs?
When did ELNs begin?

• 206th National Meeting of the American Chemical Society in August, 1993, an entire day of the conference was dedicated to talking about "electronic notebooks" and ELNs.

• “These are all things you could never do with a paper notebook. The beauty is I can not only search the notebook but also use it to initiate searches of other databases.” - Dr. Reymond E. Dessy – Virginia Tech, 1980’s

Dessy even predicted the future of the electronic notebook when he described the portable aspects:

“Laptop and palmtop PCs that can dock with a mother computer to discharge research results are available, and wireless communication linkages exist between truly portable computers and a host.”

• First ELN came in 1997 - Kodak ELN, implemented as a collection of Lotus Notes databases and applications

• In 1998 one of the first ELN web-based versions - Virtual Notebook Environment
Where are we today?

- OVERSATURATED ELNs Market
- Scientific Community RESISTANCE to ELNs
- ELN usage and barriers to adoption

History of ELNs

Overcome the barriers

Example: Searching and Backup procedures

Scenario 1: Trying to search for some work/data 6 months later

Scenario 2: What would happen if your lab was set on fire and you lost everything in there

Scenario 3: If you were indisposed for a while how would your supervisor/research group access your work

ELNs Advantages

- Easy to search, copy and archive
- Templates, scientists don’t have to rewrite protocols
- Researchers can link experiments to specific samples or files
- Share information easily with other lab members and collaborators
- Facilitating reproducibility
- Supervisors can monitor the activity of their teams remotely
Free versions, BUT limited:

- Number of users
- Data storage
- File size

- Network interruptions could temporarily restrict access to data
What do researchers think and want?

• “Our department was looking for something simple to use, cheap, and with ability to backup on the cloud and share notes/files.” (Hani Ebrahimi, postdoc at NIH, 2017)

• “Will NIH or NSF be making a rule or recommendation? The gov't makes rules about software in other fields, they may insist on something that integrates with, for example, grants.gov.” - (Dany S. Adams, scientist at Ion Diagnostics LLC, 2015)

• “The discussion about all these softwares / apps should be about how reliable are they in terms of privacy if you use their server. It's common sense that you want to have the data on a cloud.” – (Ioannis V. Pavlidis, Assistant Professor at University of Crete, 2013)
To find a software solution that suits your needs:

1. Get information – Online resources
2. Calculate Costs
3. Understand Legal issues
4. Evaluate Stability
5. Run on mobile devices
6. Software integration
7. Test-driving
8. Try Generic platforms
9. Commit to change

*Nature, 2018*
FEATURES

USER EXPERIENCE
• Graphical user interface
• Intuitiveness
• Support (on-line support, available manuals and video tutorials)

ABILITY AND FLEXIBILITY
• Multi-device compatibility
• Working with different operating systems and browsers
• Cloud
• Real-time collaboration
• Instrument integration and open APIs

BUSINESS MODEL AND PRICING
• Licensing model
• Free version (yes or no)
• Cost efficiency
The **Electronic Lab Notebook Matrix**, collated by Harvard Medical School in Boston, Massachusetts, lists the details of more than 50 features for 27 ELNs.

How to pick an ELN: FEATURES

https://datamanagement.hms.harvard.edu/electronic-lab-notebooks

- **Interactivity**
- **Support for research documentation**
- **Adaptability to Lab workflows**
- **Storage**
- **Hosting**
- **Support**
- **Security**
- **Other**
Find a solution that fits your needs

1. Data Creation & Retrieval

2. Data Storage: PUBLIC SOLUTION VS OWN SERVER

3. TEAM WORK: balance between sharing information in a collaborative environment and protecting your data
   - Team administration
   - Sharing and Communication
   - Data Integrity Safeguards

4. Lab Inventory Management
Regulations and Legal Aspects

ELNs in Clinical Research

GLP Compliance, FDA 21 CFR Part 11, ISO certification
1. **Security**: ELN must be able to archive, securely store, protect and extract the data and notes you create.

2. **Confidentiality**: Lab notebook software must employ procedures that keep all stored records protected from unauthorized parties.

3. **Authenticity**: Multi-level authentication processes, secure user identification, electronic signatures, and a migration plan.

4. **Integrity**: Restricted management rights, a full audit trail (version control, timestamps), secure data transfer, and organizationally defined controls on data availability, data retention, and data deletion.

**Good Laboratory Practices (GLP): How data should be stored, secured and managed**
Title 21 CFR Part 11 of the Code of Federal Regulations

Your ELN must do the following:

1. Your data must be digitally recorded using a closed system that restricts access, and ensuring that only authorized personnel can access your records.

2. Your digital lab book must also be able to create readable copies of your notes at any time (ex. pdf format). These copies must also be archived for future retrieval.

3. FDA also mandates that electronic notes have an audit trail with time stamps, which cannot be edit or deleted.

4. FDA is also very specific about how electronic signatures should be instituted to prevent fraudulent use. For witnessing documents, it is required to securely record who is witnessing and at which date and time, in a manner that wouldn’t allow a signer to easily repudiate the signed record as not being genuine.
ISO standards

- ISO 9001 (general quality management)
- ISO 15189 (medical and diagnostic laboratories)
- ISO 17025 (testing and calibration laboratories)

ELNs must:

1. Allow users to assign a title to documents.
2. Automatically create a timestamp for date creation and modification.
3. Assign a unique ID to each document.
4. Ensure that editing a document can only happen by one authorized person.
5. Add serial page numbers when printing the digital notes.
6. Identify the authors of each document.
7. Have a full audit trail recording the nature, the date/time and author of changes.
8. Make it possible to invalidate documents.
9. List all documents in a master list.
10. Review and revise processes and SOPs based on the latest guidelines.
HIPAA Compliance and Electronic Lab Notebooks

HIPAA: Health Insurance Portability and Accountability Act governs how personal health information (PHI) should be handled by healthcare providers and businesses they collaborate with.
A study conducted in 2016 by the University of Southampton, UK, identified 72 active products (S. Kanza et al. J. Cheminformatics 9, 31; 2017)

Over 100 ELNs available to researchers - Research Insights, April 2018

https://www.limswiki.org/index.php/ELN_vendor

- Benchling
- elabFTW
- BIOVIA Notebook
- eLabJournal
- Hivebench
- IDBS E-WorkBook
- LabArchives
- LabCollector
- Labfolder
- Labguru

- Labii
- Labstep
- LabWare
- Mbook
- OpenLab PerkinElmer Signals Notebook
- RSpace
- Scilligence
- sciNote
Something to note when choosing an ELN at Rockefeller University

When choosing an ELN to use here at Rockefeller University be aware of the IT Department’s guidance regarding software and software support

http://it.rockefeller.edu/support
SciNote is a top-rated platform for researchers in academia or industry, who need electronic lab notebook, inventory management and project management functionalities.

RSpace links to open data repositories

Open Science is directly encouraged by Hivebench. Hivebench makes it simple to directly export and share your data to Mendeley Data.
• Used in life sciences, chemistry, physics
• Free for academic users and offers unlimited storage capacity
• A limited file upload size (10MB initially, extended up to max 25MB).
• Strong on protocol and resource management and sharing
• API for automation of data collection.
SciNote (Slovenia, USA)

**PROS:**
- Intuitive and easy to use
- Flexible workflows, experiment and protocol setup
- Inventory management and MS Office integration
- Export all data in a readable format and API
- Automatically generates reports & manuscript drafts
- Free account option

**CONS:**
- No option for drawing molecules
RSpace (Scotland)

PROS:
• Possible archive management, built-in metrics, and analytics
• Can connect to the eCAT sample tracking system
• Supports chemical structures
• Free to use
• Many integrations

CONS:
• Not open source
• GUI could use improvements

RSpace ELN as a good option for a system with total research data management (RDM) integration
With Hivebench, researchers can:

- Keep track of experiments, results and data in the lab
- Use your own structured protocols or import and adapt from a protocols library
- Easily prepare data and results to share with collaborators and the world
- Share and collaborate
- Set-up and maintain groups
- Access to data after project ends

Data Notebook: Hivebench
Capture data and results in the lab

Data Repository
Hivebench is integrated with Mendeley Data (if you want)

Pros:
- Plate designer
- Free account with 10 GB of storage space

Cons:
- Creating protocols is very rigid
- No possibility to create tables
- The free account is limited to 10 users
- iOS version only
ELNs
Commercial Solution

labarchives
Chance Favors the Organized Lab

labfolder

Free Edition:
• Create and manage notebooks
• Unlimited notebooks
• 25 MB storage

Free (with capacity limitations) for academic users
• User-friendly
• Self-contained cloud service
• Molecular Biology bias
• CRISPR tools
It is easy to upload a photo snapped from a cellphone so there are often entries that wouldn’t normally go into a standard hand written lab book.

PROS:
• Pubmed references entry editor
• Interface with GraphPad Prism

CONS:
• Graphical user interface needs improvements
• Quite complicated, additional training necessary
• Not a lot of storage space in the free version
• Not open source
Labfolder (Germany)

PROS:
- Sketching
- Free account for smaller teams and free mobile app
- Integration with Mendeley

CONS:
- Not very intuitive
- Unflattering structured design
- The free version is limited to 3 team members
Benchling (USA)

PROS:
• Very user-friendly and quick to set up
• Useful DNA tools (CRISPR guide and primer design)
• Templates for sequence mapping and sharing
• Free account with 10 GB of storage space

CONS:
• The free account is tied to a single user
• Report structure is not flexible
Final Tips

So, what will we keep in mind?

1. Electronic research notebook software implementation takes time, commitment and adaptability.
2. Don’t try and do everything.
3. Good planning from the outset......
4. What will happen to my data if I stop using the software?
5. An electronic research notebook is only as good as it’s user!

REMEMBER: ELNs ARE COFFEE-PROOF
For more information on Data Management please contact the following staff at the Rita and Frits Markus Library

1. Matthew Covey - University Librarian
   mcovey@rockefeller.edu
   x8909
2. Rie Goto – Assistant University Librarian
   rgoto@rockefeller.edu
   x8980
3. Ilaria Ceglia – Science Informationist
   ilariac@rockefeller.edu
   x8944