



**Electronic Laboratory Notebooks:
*A Foundation for Scientific Knowledge
Management***

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Agenda

- Why paper notebooks?
- What is knowledge management?
- How do paper notebooks prevent knowledge sharing?
- What is an ELN?
- How does the ELN help knowledge transfer?
- ELN benefits

Webster Defines Science as...

1 : the state of knowing : knowledge as distinguished from ignorance or misunderstanding

*2 a : a department of systematized knowledge as an object of study
b : something that may be studied or learned like systematized knowledge*

*3 a : knowledge or a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method
b : such knowledge or such a system of knowledge concerned with the physical world and its phenomena*

... as a Knowledge Discipline

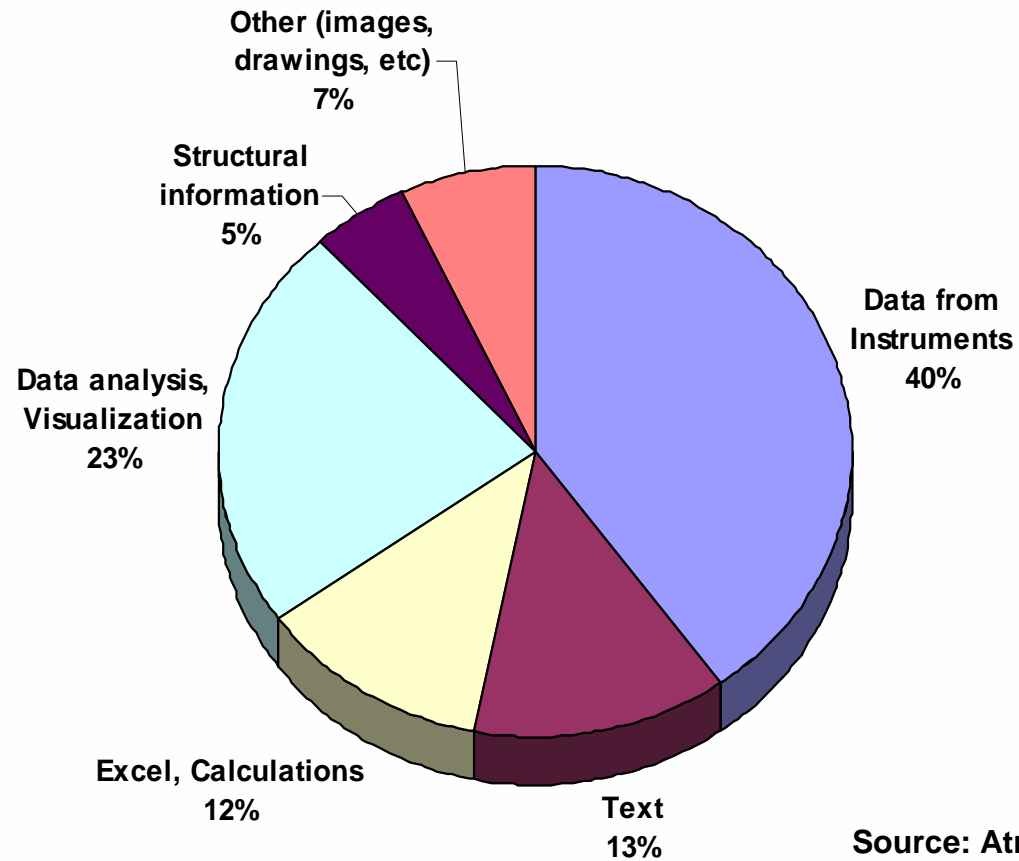


Why a Notebook?

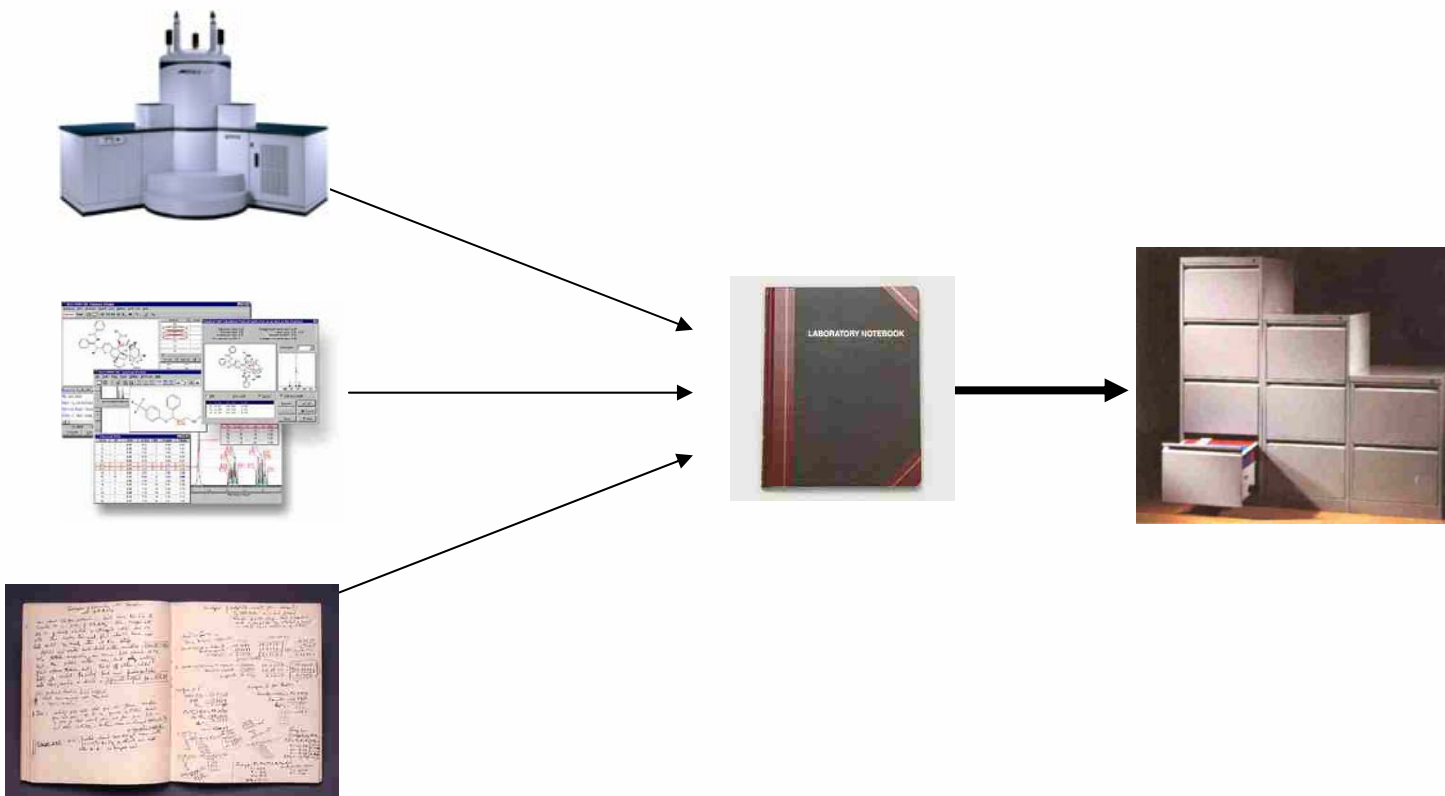
Why a Laboratory Notebook?

- It is a complete record of why experiments were initiated and how they performed
- Central repository to collect data from unrelated sources to collate them into contextual relevance
- It encourages sound thinking and a scientific process
- It allows for sharing of information
- It is required for patents and/or regulatory compliance

Notebooks Contain a Variety of Content



Critical Experimental Information is Buried in Filing Cabinets



Billions of Dollars of Research Are Lost Every Year

Shortcomings of a Laboratory Notebook

- Poor communicator**
 - Ideas and experiences are lost
 - Failed experiments are destined to be repeated

- Often illegible**

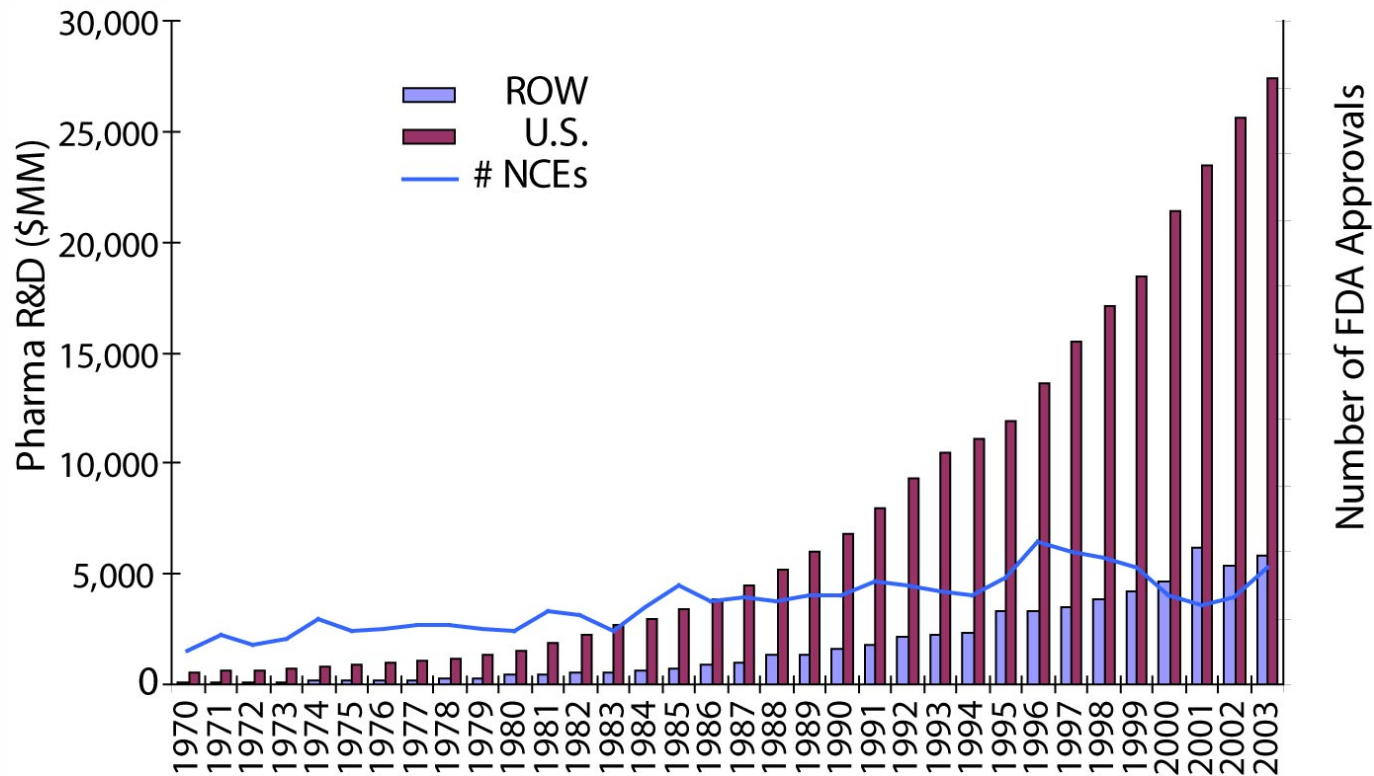
- Traps company knowledge capital in a filing cabinet**

- Expensive to manage and maintain**

- Cannot easily re-purpose or re-analyze data**

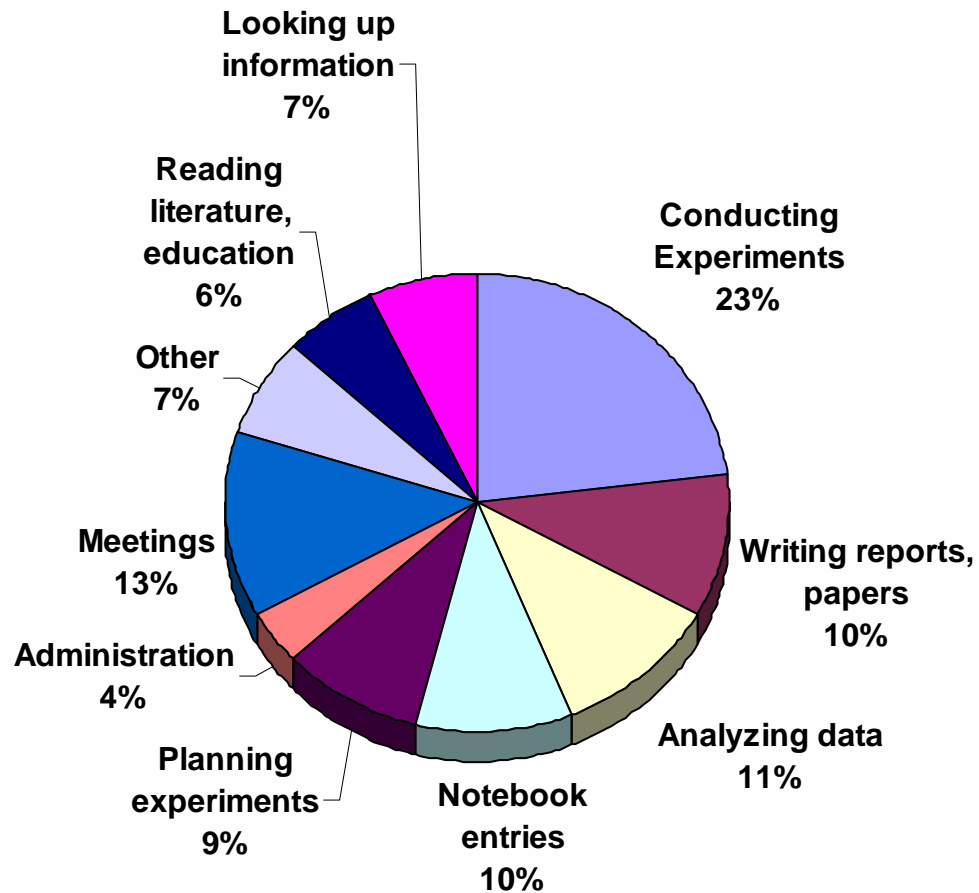
- Barrier to team building**

Pharma R&D Efficiency Must Improve to Justify Increasing Expenditures



PhRMA Member R&D Spending and Number of FDA Approvals (PhRMA 2004)

20-40% of Scientific Resources are Wasted on Non-Productive Activities



Typical Scientist Time (Source: Atrium Research)



What is Knowledge Management?

Knowledge Management....

- ❑ **IS NOT a technology that manages knowledge**
 - ❑ Knowledge is not a thing that can be managed!
- ❑ **IS NOT collecting every piece of data and information**
- ❑ **IS a discipline that involves people and processes**
- ❑ **IS a cultural migration to sharing, reusing and creating knowledge**
- ❑ **Fosters improvements in efficiency by faster decision making, idea generation and problem solving**

Two Generally Accepted Types of Knowledge

Explicit

- ❑ Knowledge that can be easily written down and transferred
- ❑ Is formal, such as the specific steps of an experiment or sequence

Tacit

- ❑ Knowledge that is difficult to put into written form
- ❑ Experience knowledge – skills gathered from years of practice
- ❑ Contains philosophies and viewpoints

Knowledge Transitions

Tacit to Tacit – This is the sharing of tacit knowledge directly with another

- ❑ For example, a new post-graduate works as an intern at a pharmaceutical company observing senior chemists perform their work. They pick up tips and tricks that were learned from the years of experience of the elder scientist
- ❑ A team of researchers meets in a conference room to discuss a new idea

Tacit to Explicit – Creation of easily expressed knowledge from experiences and lessons learned

- ❑ An experienced researcher writes into their notebook the way they designed an experiment noting tips they have learn from previous work

Knowledge Transitions

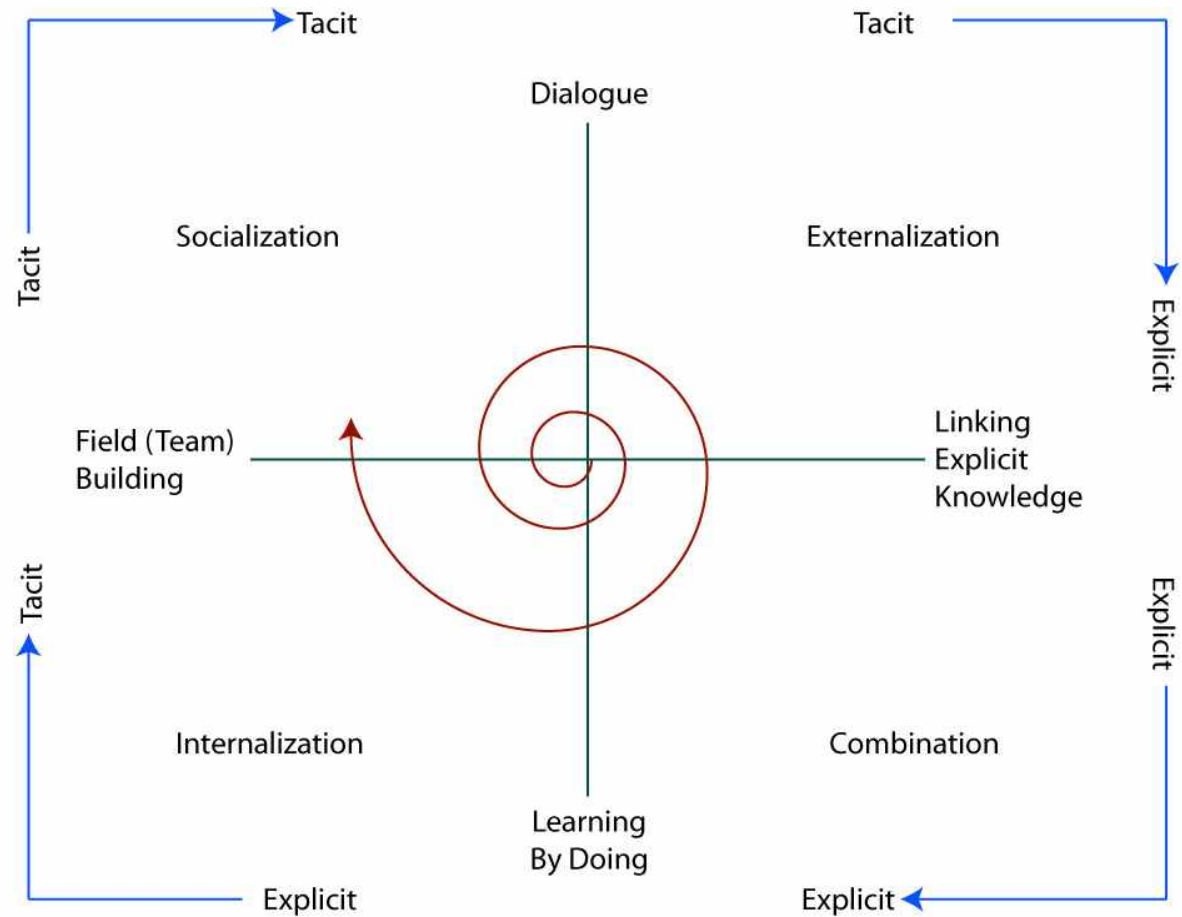
Explicit to Explicit – This is combining explicit knowledge to develop a new understanding

- ❑ For example, gathering analytical data from a number of different sources in a notebook, analyzing it, and coming to new conclusions that are then recorded in the notebook

Explicit to Tacit – As new explicit knowledge is shared, others begin to internalize it. They use it to broaden their own tacit knowledge

- ❑ For example, reading outside proteomics research to develop ideas for the design of a new molecular entity

Nonaka's Knowledge Spiral



Nonaka, Takeuci *The Knowledge Creating Company*, Oxford Press

Two Types of KM Strategies

Codification

- ❑ Collection, storage, and organization of explicit knowledge
- ❑ Example enabling technologies: ECM, Document Management, SDMS

Collaboration

- ❑ Sharing and utilization of experiences, lessons learned, ideas, etc – tacit knowledge
- ❑ Example enabling technologies: Expert locators, discussion groups, chat rooms, whiteboards, even the water cooler!

The most successful projects balance the two

How Can Technology be Applied to KM?

- ❑ **Process enabler – not a solution!**
 - ❑ If a culture doesn't change, technology won't help
- ❑ **Repository of explicit knowledge**
 - ❑ Not everything!
 - ❑ Improved efficiencies through not reinventing the wheel
 - ❑ Not destined to repeat failed experiments
- ❑ **Can help to enforce a common ontology**
 - ❑ Has to be created in the first place!
- ❑ **Can assist in capturing tacit>explicit knowledge**
- ❑ **Collaborative tools bring users closer together**
 - ❑ Expert locators
 - ❑ Experience sharing, idea forums, discussion groups

Why Have So Many Knowledge Management Initiatives Failed?

Over reliance on technology

- ❑ KM is NOT an IT problem!

Cultural resistance to change

- ❑ What's in it for me?

Poor strategy, planning and execution

- ❑ Let's store everything and do it today!

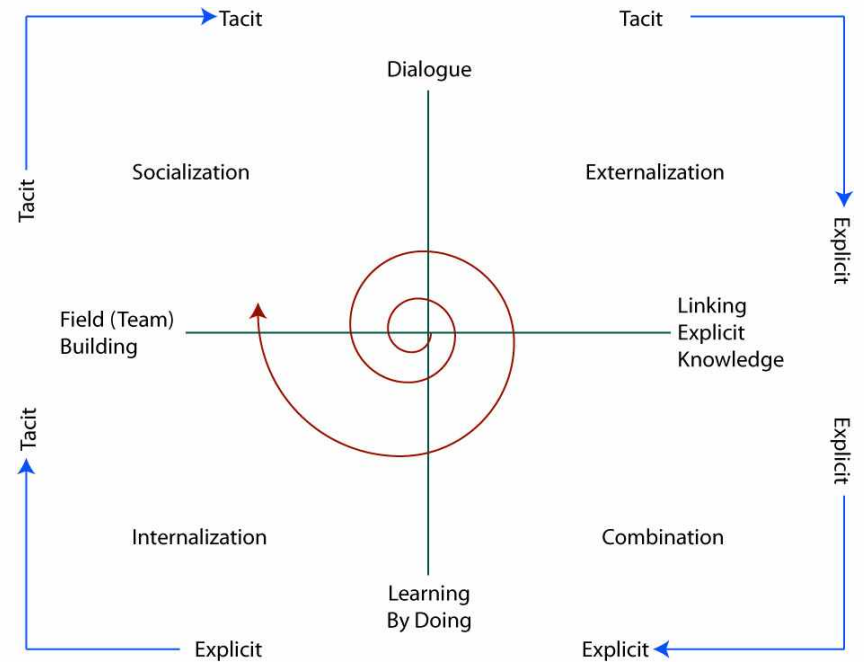
Lack of leadership

- ❑ Management does not set a clear vision



How do Paper Notebooks Prevent Knowledge Sharing?

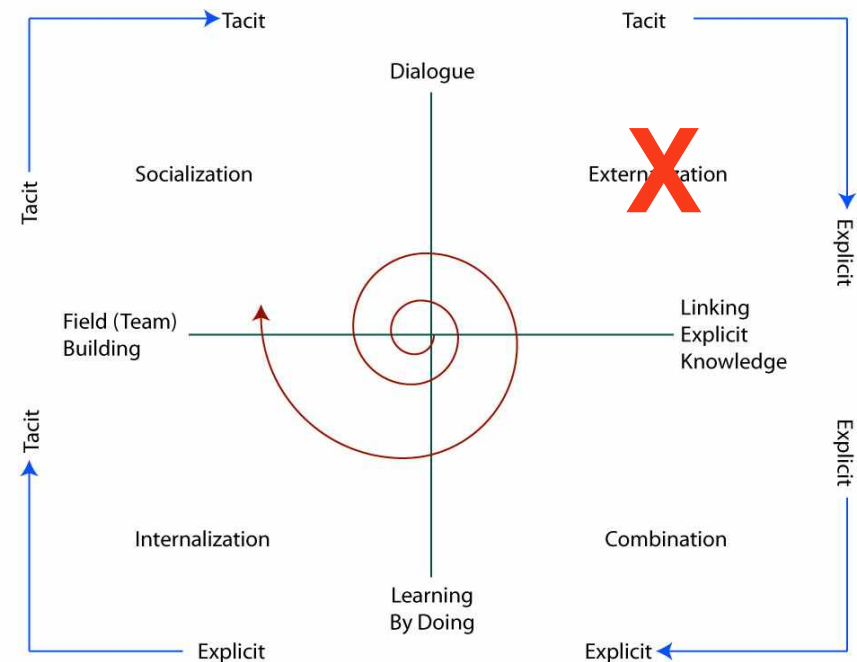
Paper Notebooks Obstruct the Knowledge Spiral



Paper Notebooks Obstruct the Knowledge Spiral

Tacit knowledge is not transformed to explicit

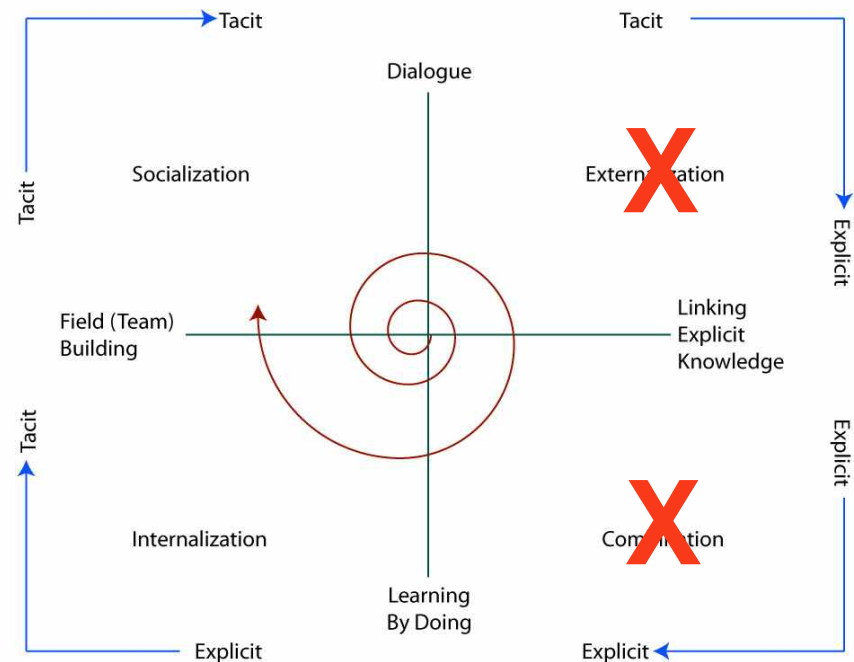
- ❑ Often illegible handwriting
- ❑ No automation to enforce a process of capture
- ❑ Why bother to write that, no one will see it anyway!



Paper Notebooks Obstruct the Knowledge Spiral

Explicit knowledge that was gained is lost

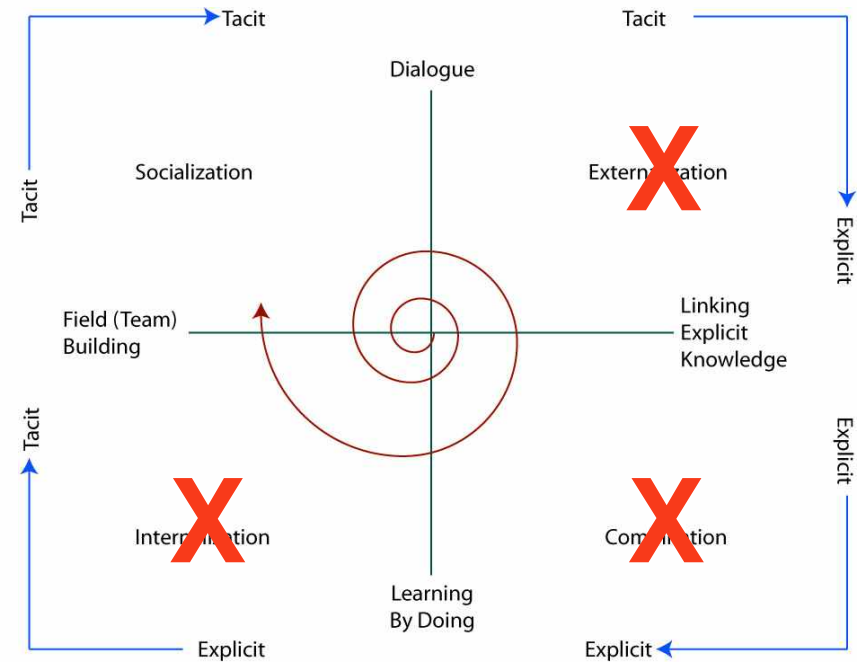
- ❑ Knowledge locked away in filing cabinets
- ❑ Not searchable
- ❑ Not readable
- ❑ Failed experiments are destined to be repeated



Paper Notebooks Obstruct the Knowledge Spiral

Explicit knowledge is not shared for tacit knowledge creation

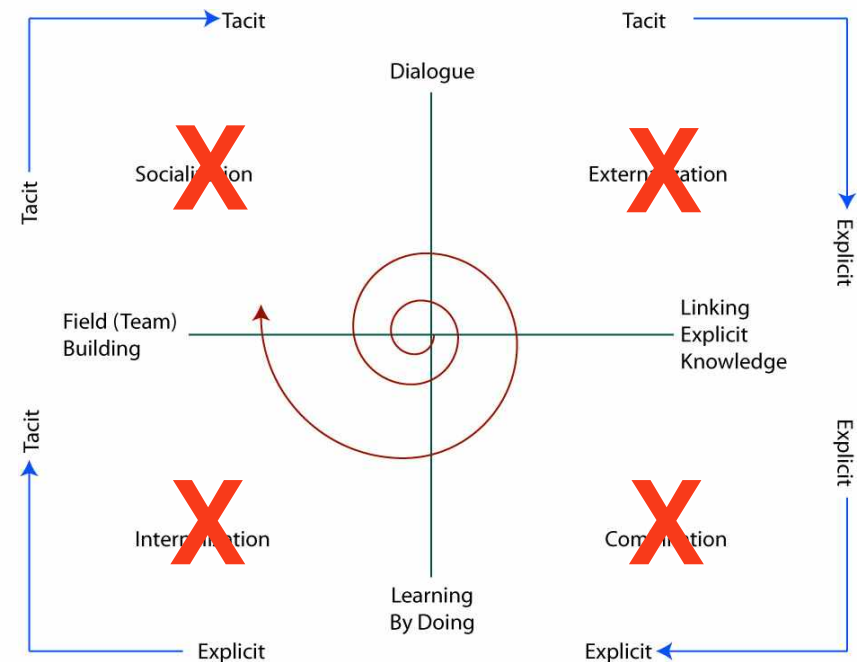
- ❑ Can't internalize what you don't know about
- ❑ Must be readable and searchable



Paper Notebooks Obstruct the Knowledge Spiral

Communication barriers restrict socialization

- ❑ Who is the expert on a subject?
- ❑ Who else is working on the same project?
- ❑ Who did this before?



The Result?

- “Don’t know about what you don’t know”**
 - Duplications
 - Repeated failures

- Lost experiences**

- Wasted resources**

- More meetings!**

- Slower idea creation and decisions**

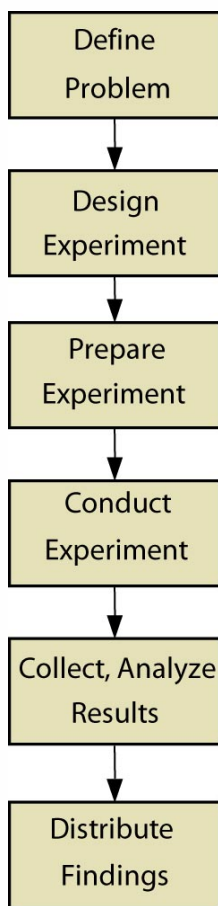


What is an Electronic Laboratory Notebook?

An ELN....

- IS NOT just a digital version of a paper notebook**
- IS a tool for securing intellectual property**
- IS a knowledge repository that allows for collaboration and sharing of explicit and tacit knowledge**
- Provides tools to improve the efficiency of resources**
- Meets legal and regulatory requirements**

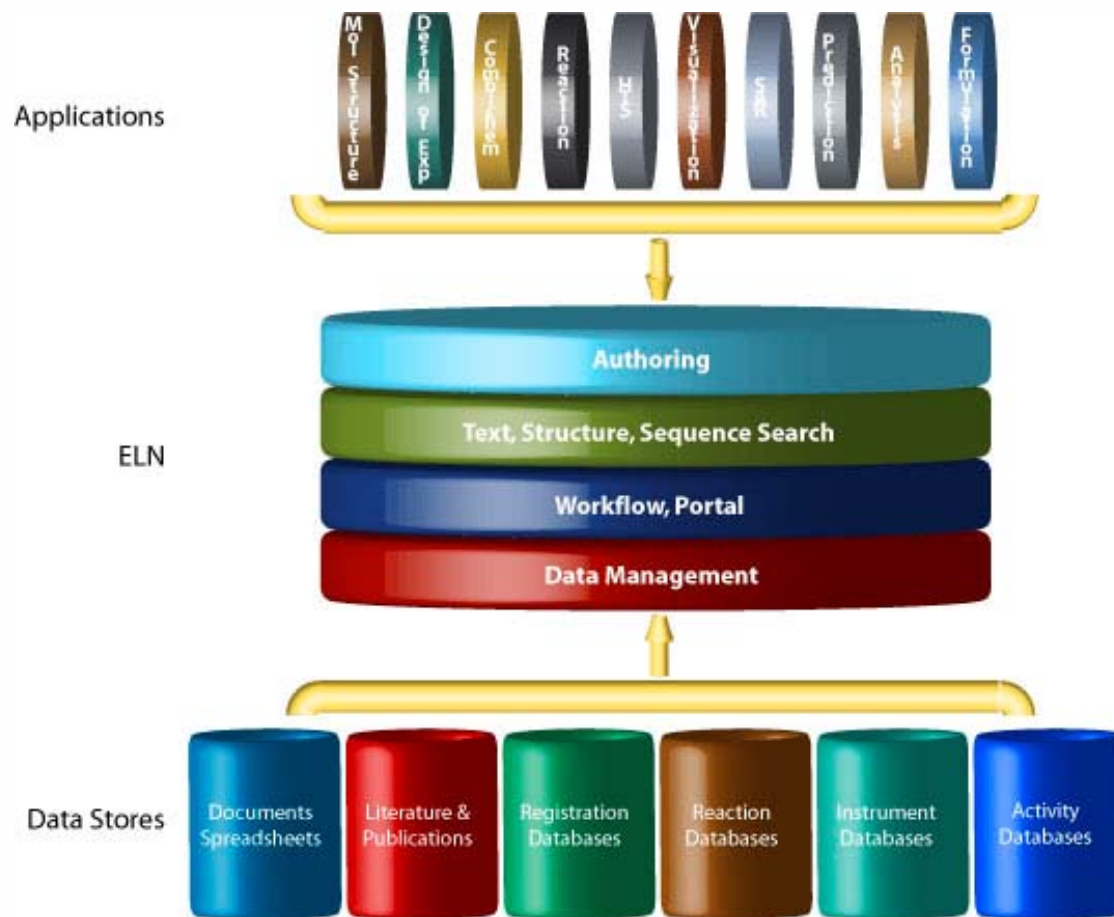
Requirements of an ELN



Scientific Workflow
Source: Myers 2000

- Supports the scientific workflow
- Permits entry of structured data
- Permits entry of unstructured data
- Allows for annotations
- Is secure and has an audit trail
- Digital signatures for data authentication
- Has authenticated e-signatures
- Is searchable and provides collaborative workspaces

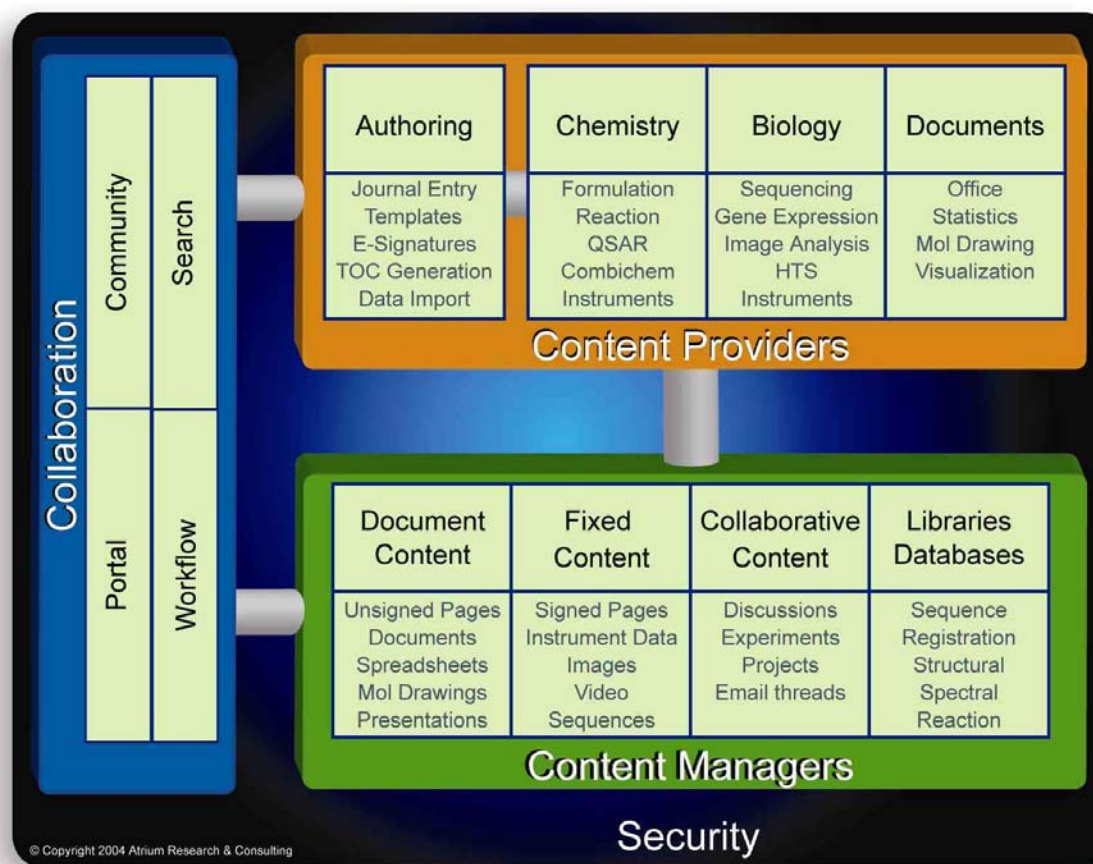
An ELN as a Content Aggregator and Tool for Collaboration



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An Enterprise View of an ELN

Synonymous with eR&D, Collaborative R&D, Digital R&D, etc.



Two Types of ELNs

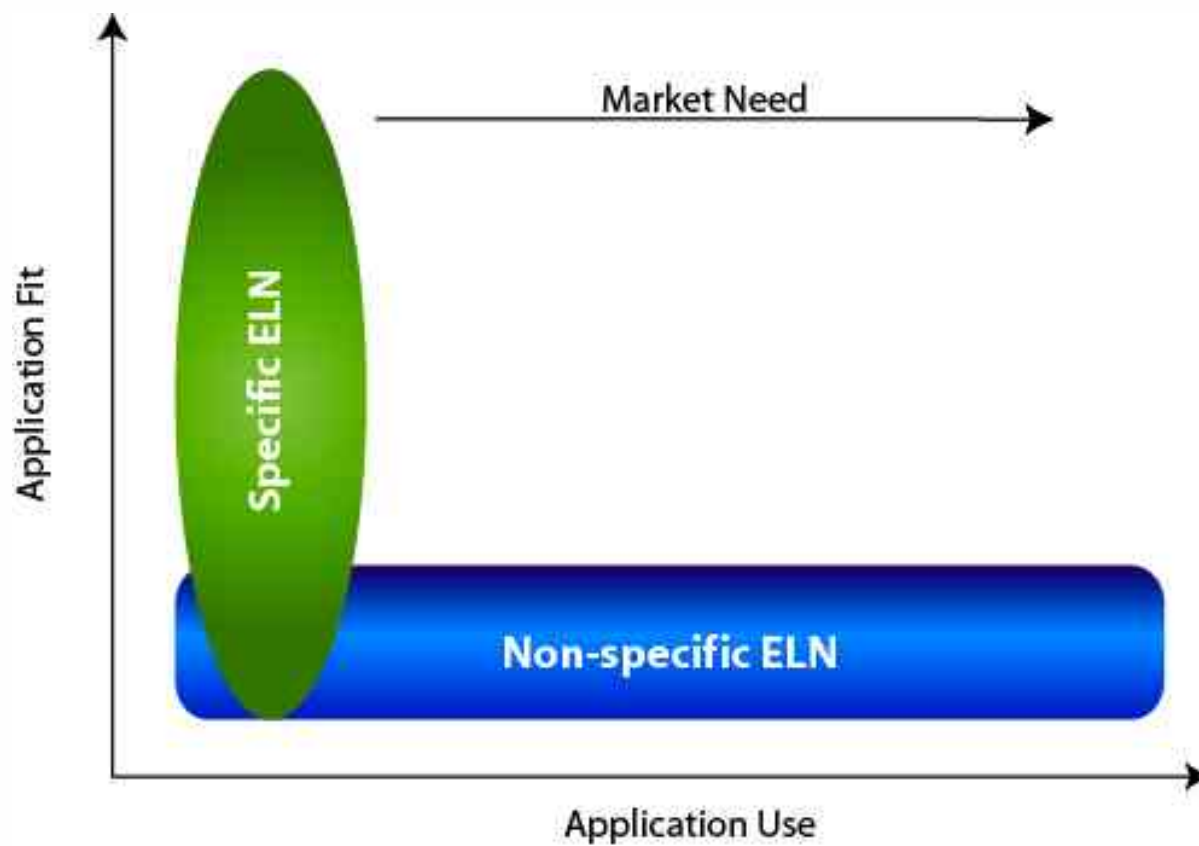
Non-specific

- ❑ Designed for multiple markets
- ❑ Generic authoring tool
- ❑ Focused primarily on intellectual property protection and patent support
- ❑ Personal, workgroup, or enterprise

Specific

- ❑ Designed for a single market
- ❑ Feature rich for one or two application areas (i.e. synthetic chemistry)
- ❑ Focused on improving efficiencies in niche area
- ❑ Targeted at enterprise, primarily life sciences

Vertical vs. Horizontal Fit

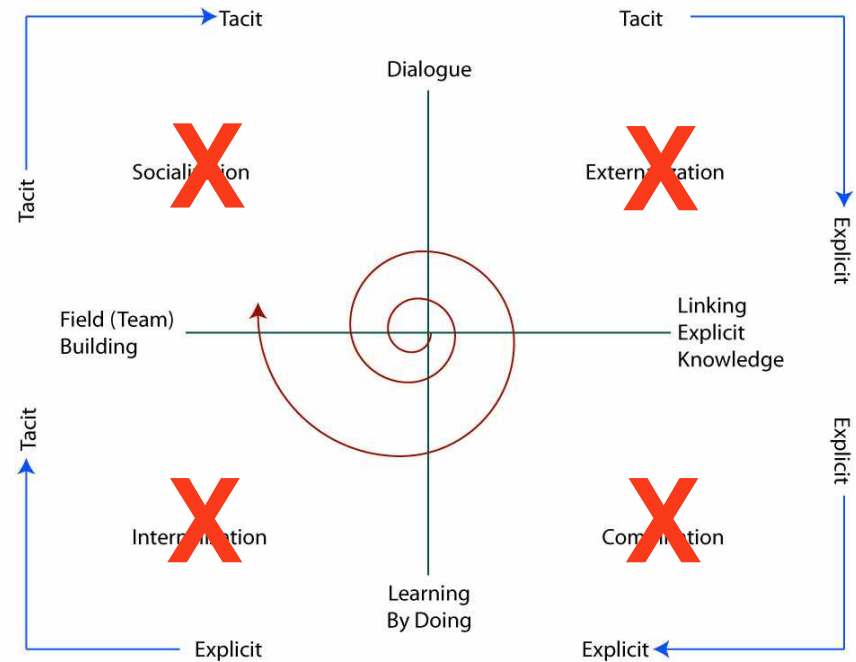


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How Does the ELN Help Knowledge Transfer?

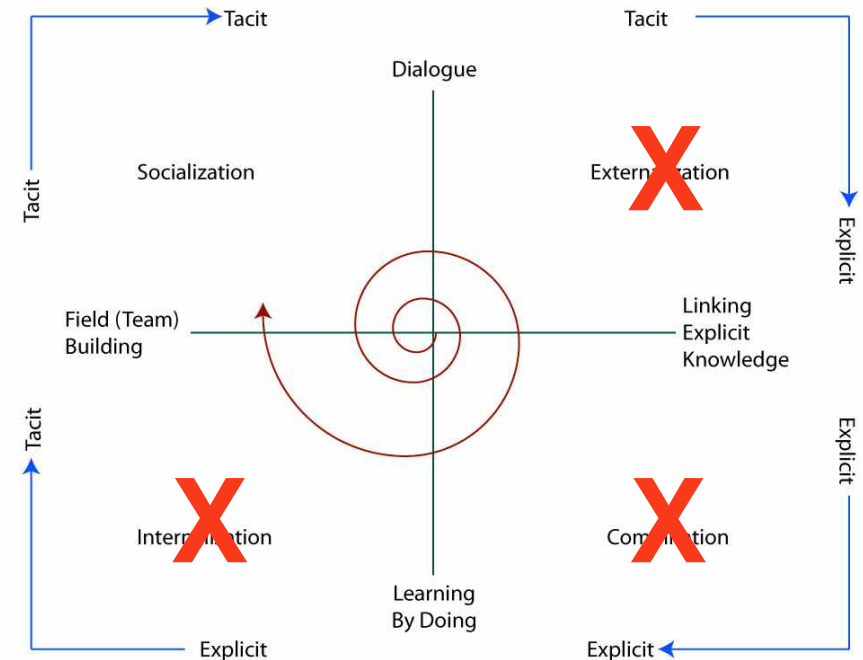
Paper Notebooks Obstruct the Knowledge Spiral



ELNs Assist the Knowledge Spiral

Collaboration supports socialization

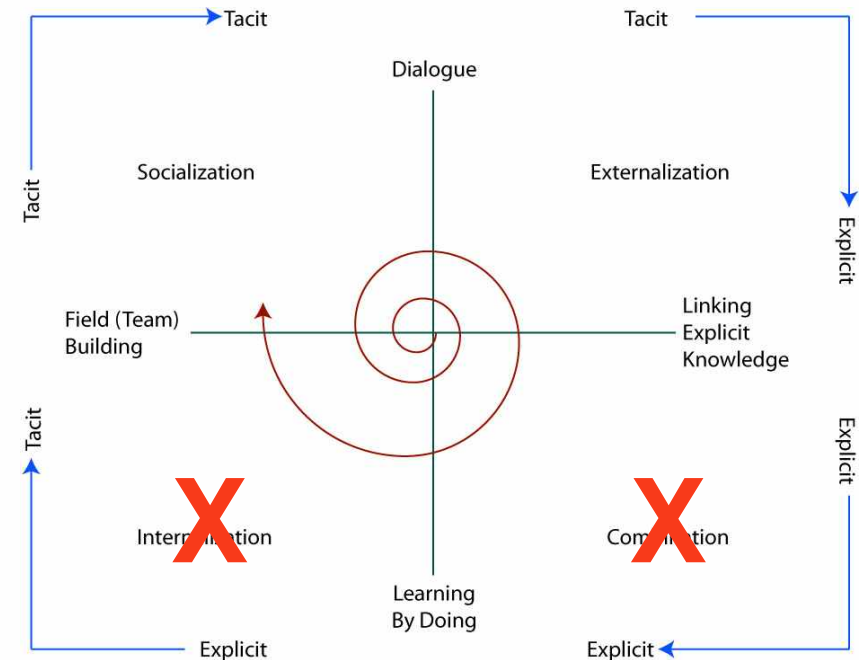
- ❑ Finding experts
- ❑ Discussion groups
- ❑ Collaborative workspaces
- ❑ Searching



ELNs Assist the Knowledge Spiral

Tacit knowledge > Explicit knowledge is recorded

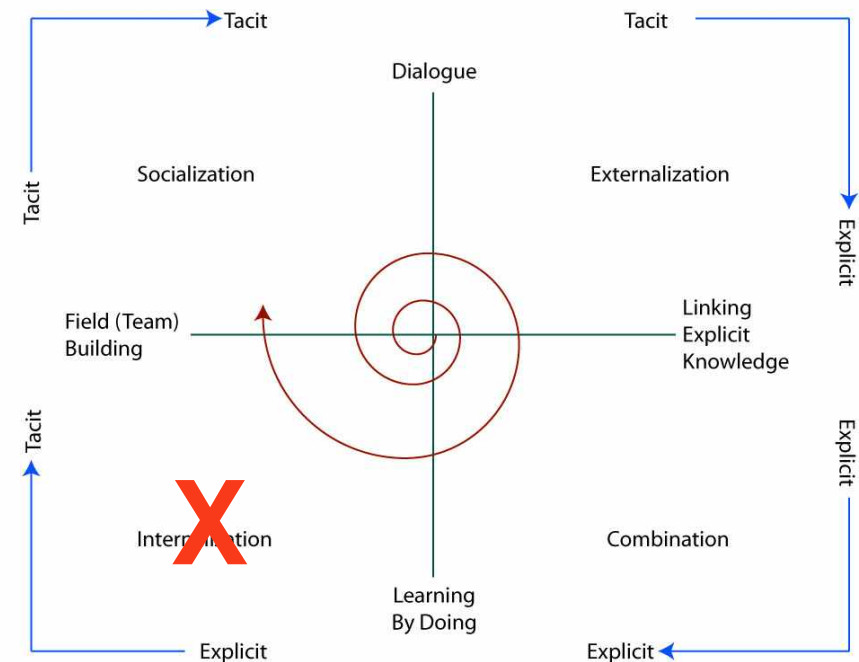
- ❑ Lessons learned
- ❑ Observations
- ❑ Tips, tricks
- ❑ Now readable, searchable and contextual



ELNs Assist the Knowledge Spiral

Explicit knowledge can now be combined

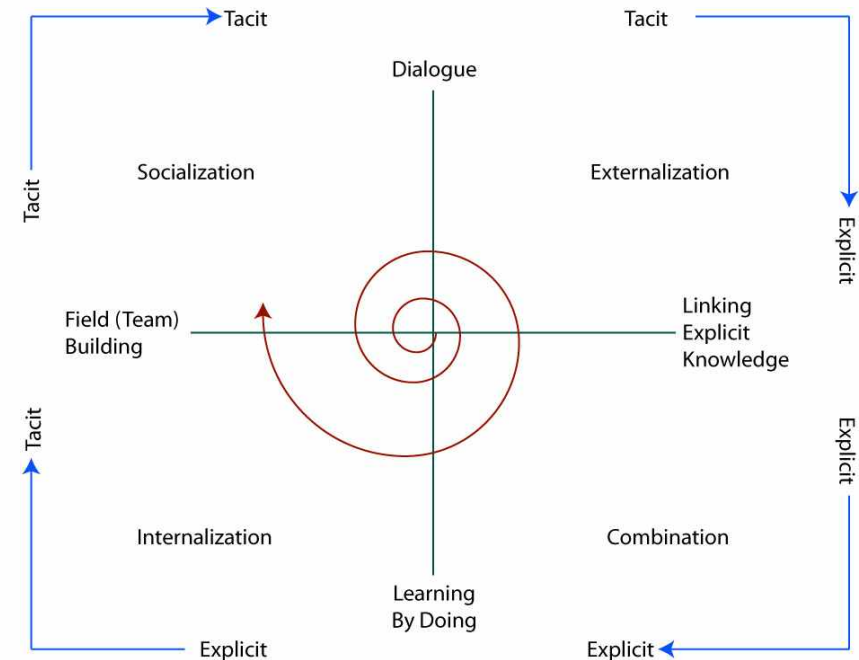
- ❑ Searching and finding information of interest
- ❑ Can now combine outside with internal research



ELNs Assist the Knowledge Spiral

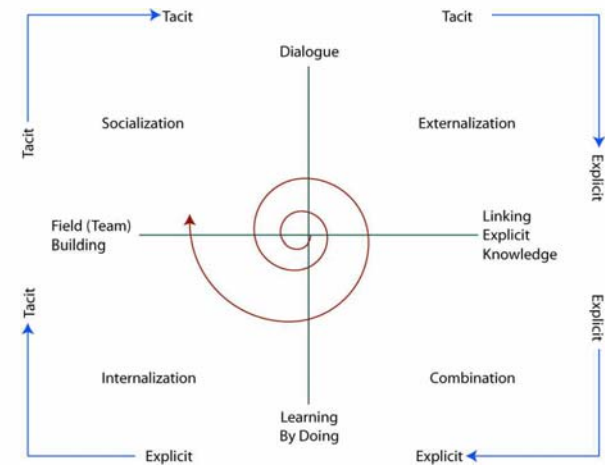
Tacit knowledge is gained from explicit repository

- ❑ Learning from successes and failures for experiment design
- ❑ Insight into problem solving



An ELN to Support a Knowledge Management Strategy

- ❑ **Must be seen as a culture change**
 - ❑ No more “my data is my data”
- ❑ **Must provide direct benefits for the end user to increase adoption**
 - ❑ Must not have multiple data entry points
- ❑ **Must have the support of senior management**
- ❑ **Must be balanced between codification and collaboration**



Benefits of an ELN

- Improved effectiveness
- Improved data quality
- Creation of an institutional memory
- Improved IP protection
- Improved compliance

Summary

- KM is about people and processes, not technology
- Knowledge is a process
- Paper notebooks impede the creation of new knowledge
- A well-designed ELN is a foundation for a knowledge management strategy



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