Parsing the Chemical Risk Assessment Process for the Laboratory

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Keene STATE COLLEGE

Wisdom to make a difference.

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Why Risk Assessment?

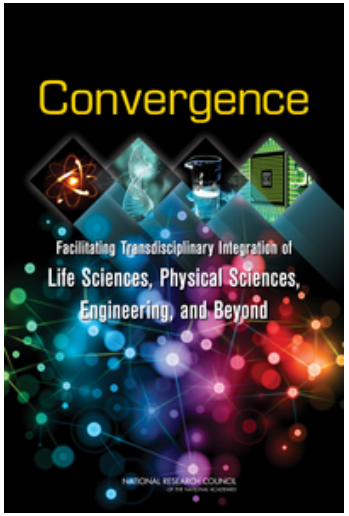
- My grandfather graduated from high school in **1919**, before the periodic table was used as a teaching tool; he spent 30 years in the Niagara Falls chemical industry as a research lab tech. He brought home CCl_4 to do laundry with.
- My father graduated with an agricultural degree from Cornell in **1951**; he spent 5 years working in Cornell's labs and orchards testing pesticides in the 1950's.
- I graduated with an engineering degree from Cornell in **1979**; in the 1980's I spent 5 years as an academic lab tech conducting environmental chemical analyses.

The Chemical Safety Tradition: Rules Based Safety

- **Caveat emptor**: Chemistry textbooks and laboratory manuals provide a overview of **generic rules**, usually followed by *"see the MSDS for further instructions"*.

The Continuing Evolution of Science

Lab science in the 21st Century is an emerging complex system which highly values converging knowledge.



Changing Science, Changing Learning Styles

Science Paradigms

- Thousand years ago:
  science was **empirical**
  describing natural phenomena
- Last few hundred years:
  theoretical branch
  using models, generalizations
- Last few decades:
  a **computational** branch
  simulating complex phenomena
- Today: **data exploration** (eScience)
  unify theory, experiment, and simulation
  - Data captured by instruments or generated by simulator
  - Processed by software
  - Information/knowledge stored in computer
  - Scientist analyzes database/files using data management and statistics

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{4\pi G\rho}{3} - K\frac{c^2}{a^2}$$

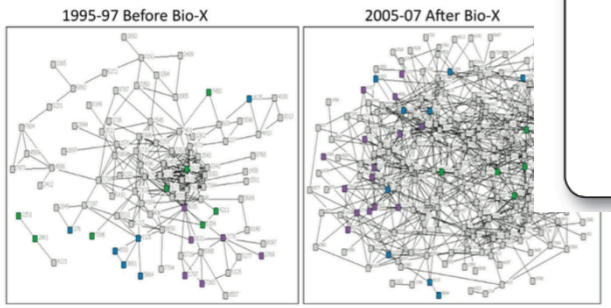
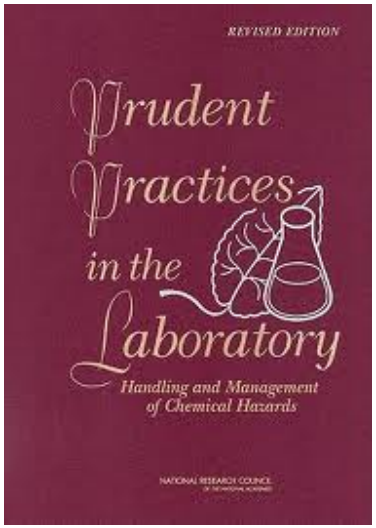


FIGURE 4-2 The web of faculty interactions created by Bio-X. The network of faculty interactions across Stanford has expanded since the establishment of the Bio-X program. The resulting network reportedly appeals to technology com-

The Limits of the Chemical Safety Tradition

- Reports by the **National Research Council, the Chemical Safety Board** and the **NFPA** after specific laboratory safety incidents found the rules-based approach to chemical safety education and information inadequate.



A Cultural Watershed: The 2011 Report from CSB

Dartmouth

UCLA

Texas Tech

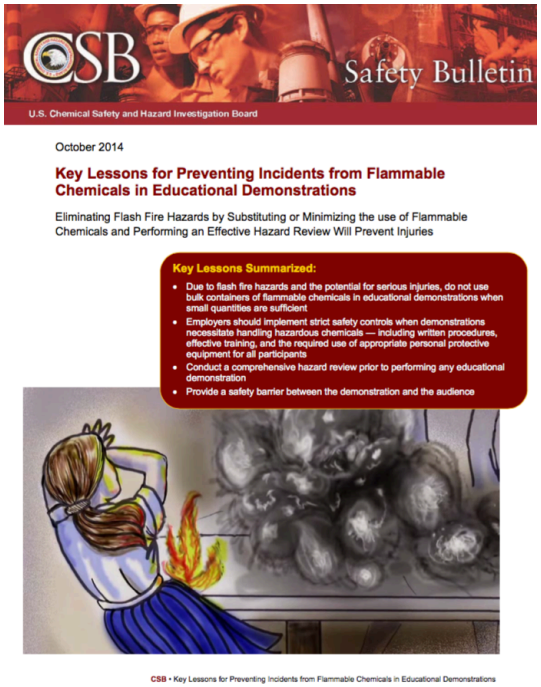
Concerns about Research Lab Safety

Another Emerging Issue: Safety in the Chemistry Classroom

Demonstration methanol fires in high schools and public settings:

1. New York City, January 2014
2. Reno, Nevada, September 2014
3. Denver, Colorado, September 2014
4. Raymond, Illinois, October, 2014
5. Chicago, November, 2014
6. Tallahassee, Florida, May 2015
7. Washington, DC, October 30, 2015

18 incidents alcohol-fueled fires from educational demos injured at least 72 people since 2011

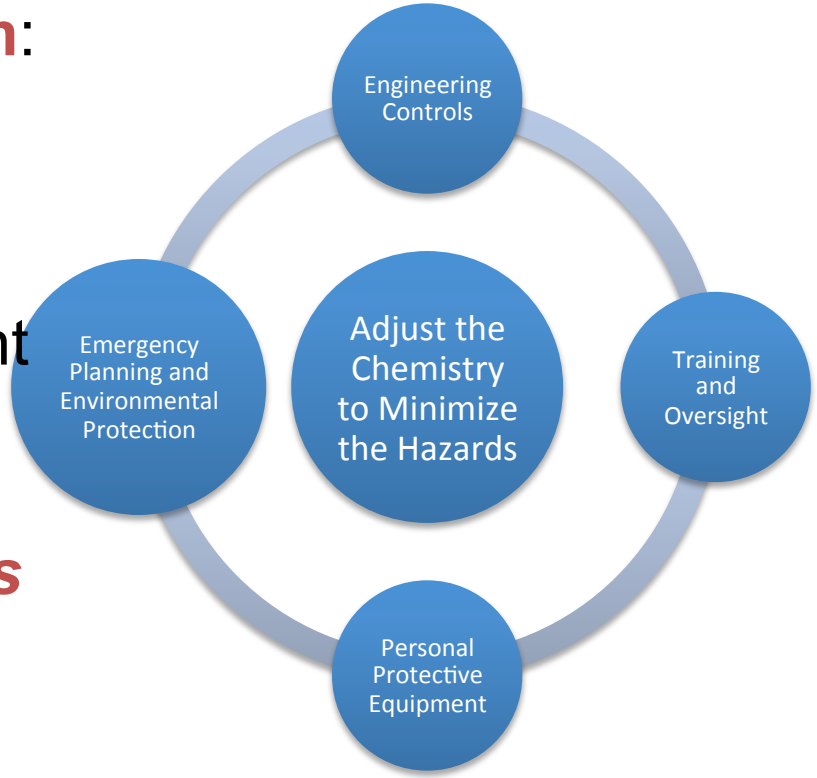


Safe Chemical Use requires a System, not a Solution

Managing chemical hazards in the lab integrating 5 strategies into a **system**:

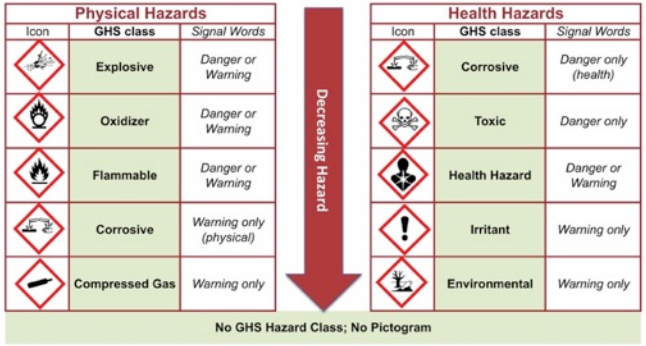
1. Hazard Reduction
2. Engineering Controls
3. Training and Oversight
4. Personal Protective Equipment
5. Emergency Planning and Environmental Protection

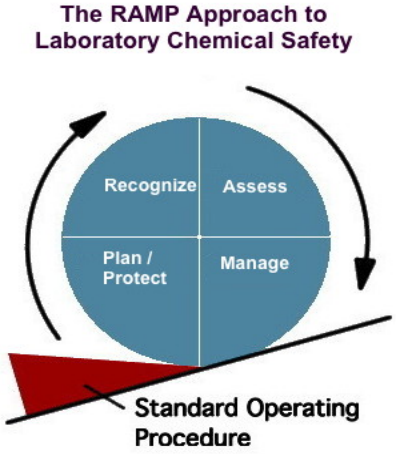
Organizing such a system requires conscious thought and documented planning. This skill involves education rather than training.



Emerging Risk Assessment Educational Tools

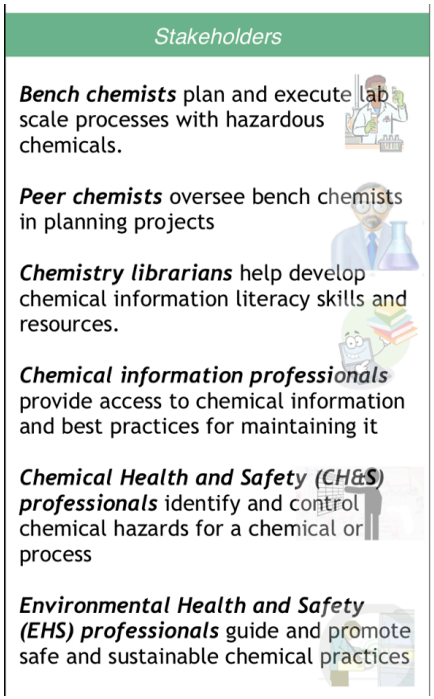
- The logic for developing the system is described in emerging tools available since 2010.
  - The **Globally Harmonized System**
  - The RAMP paradigm from **Laboratory Safety for Chemistry Students** (Hill and Finster)
  - ***Identifying and Evaluating Hazards in Research Laboratories*** from the ACS





Using Information in the Lab Risk Assessment Process

- To support safe science while protecting research, safety information must be ***scalable, transferable*** and ***sustainable***.
- These goals entail describing the safety use case using ***ontology*** and ***curation*** tools and applying the logic developed established by the CH&S community to the use of these tools.

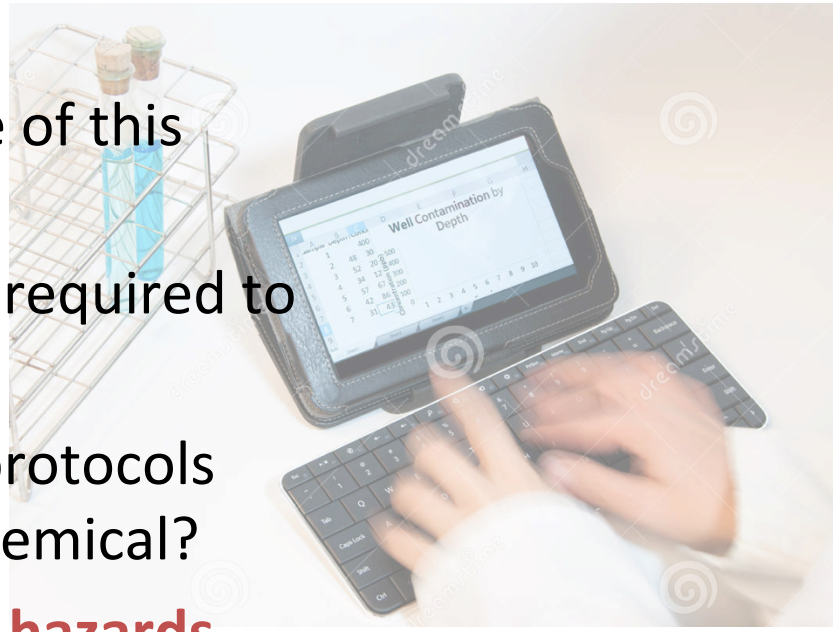


Laboratory Use Cases to Consider

- **Teaching laboratory setting:** short term use of specific chemical concentrations in procedures with expected outcomes; close oversight of inexperienced lab workers by experienced personnel can be assumed.
- **Research laboratory setting:** evolving use of chemicals with uncertain process outcomes for lengths of time determined by results of work; diverse group of lab workers with loose supervision by experienced personnel.
- **Service laboratory setting:** long term use of specific chemicals in similar processes with reproducible outcomes on an long term basis.

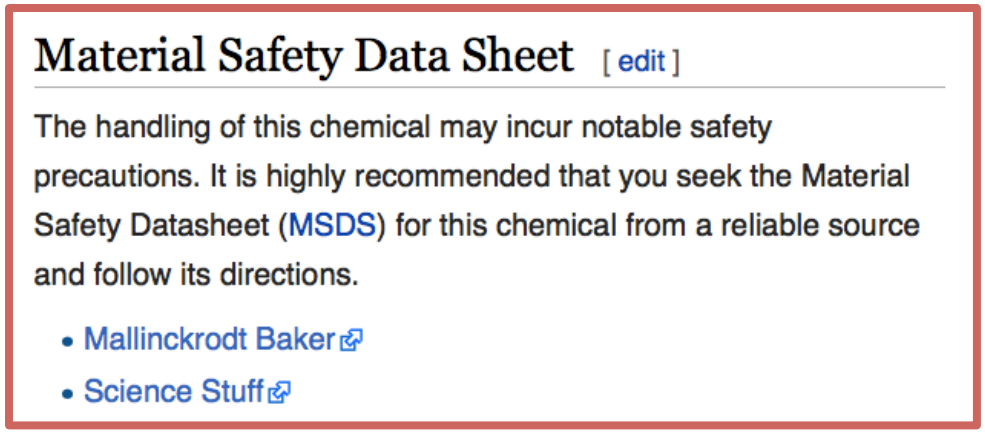
Sample Lab Safety Questions

- Does the use of this chemical require the use of a fume hood or other local **ventilation** system?
- What **PPE** is appropriate for the use of this chemical?
- What **waste disposal protocols** are required to legally dispose of this chemical?
- Are **unusual emergency response** protocols necessary for work involving this chemical?
- Are the **specific chemical reactivity hazards** associated with the use of this chemical that all users should be aware of?



The Current Context of Chemical Safety Information

- **Caveat emptor**: Chemistry textbooks and laboratory manuals provide a overview of generic rules, followed by "see the MSDS".
- For example, Wikipedia provides links to random MSDS sources with no evidence of why that source is selected; some sources are kaput, many are dated



Material Safety Data Sheet [edit]

The handling of this chemical may incur notable safety precautions. It is highly recommended that you seek the Material Safety Datasheet (MSDS) for this chemical from a reliable source and follow its directions.

- Mallinckrodt Baker
- Science Stuff

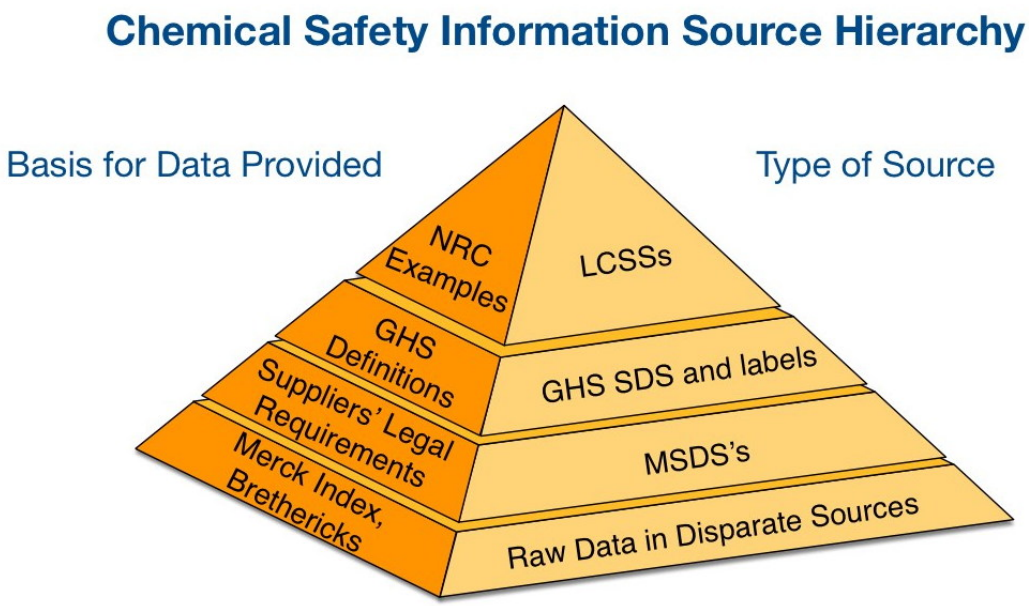
The Structure of Chemical Safety Information

1990's

2000's

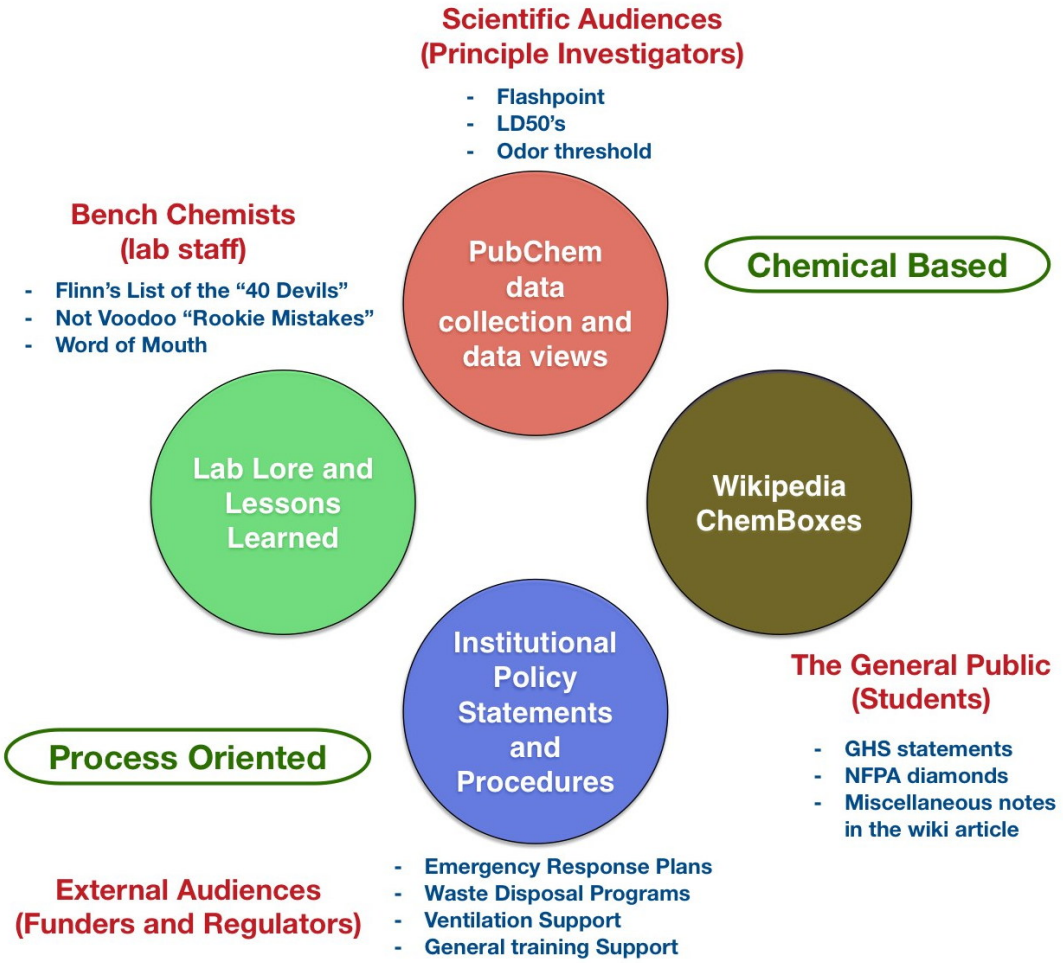
1980's

1970's



Increasingly well-defined; also increasing voluminous

Less Structured Chemical Safety Information

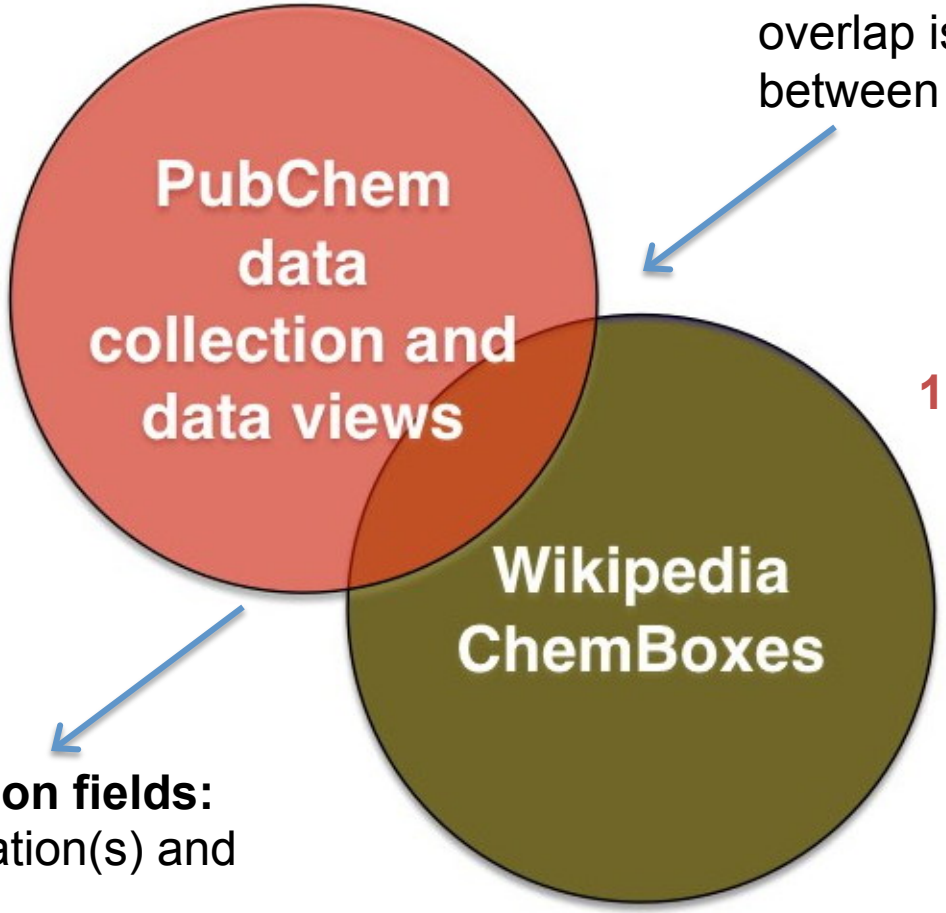


Looking for Structure in the Electronic Data

- How large is the PubChem chem safety information universe?
- How high quality is it (including consistency & provenance information)?

Millions of chemicals; 3500 with GHS info

How much overlap is there between the two?



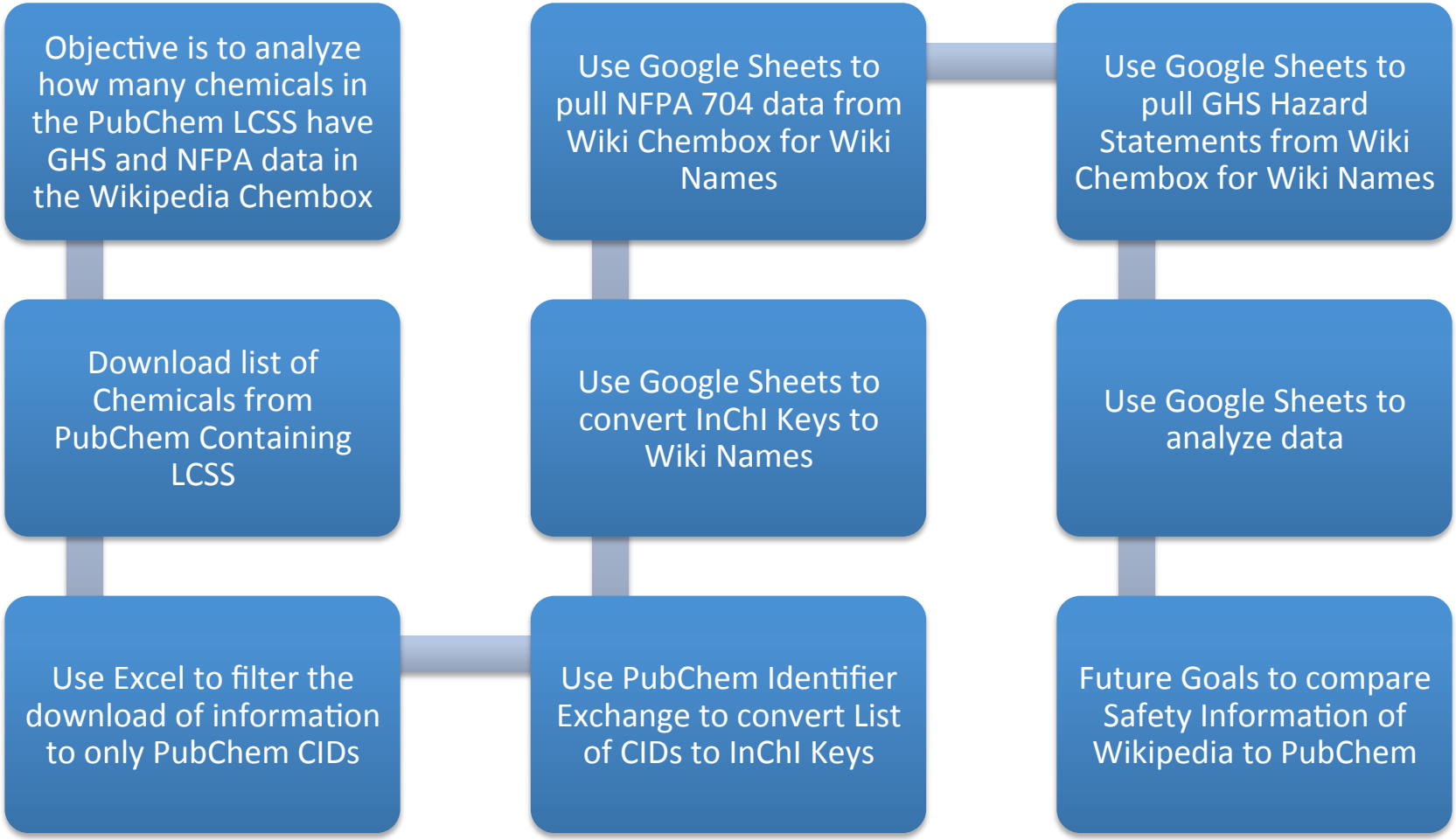
10,000 Chemboxes

- How large is the Wikipedia chem safety information universe?
- How high quality is it?

Key safety information fields:

- GHS class designation(s) and signal word
- NFPA diamond information

Project Overview



The Early Statistics

- PubChem has an LCSS view for about 3500 (2000 more to come soon) chemicals; Wikipedia has Chemboxes for about 10,000 chemicals
- Of those in the PubChem LCSS collection, about 30% have an entry in Wikipedia
- 4% of the Pubchem collection has GHS information; 12% of the PubChem collection have NFPA diamond information

	Not in Wikipedia	In Wikipedia	GHS Hazard Statement	NFPA 704	Total
n	2441	1038	157	431	3486
%	70.02%	29.78%	4.50%	12.36%	

Conclusions

- Risk assessment is an **information process** and provides a significant educational opportunity for concurrently teaching safety and information literacy.
- Safety information is currently **not well organized** for lab use
- Understanding **how to organize safety information** requires envisioning who and how this information will be used.
- Leveraging this opportunity will require **collaboration** between **EHS**, **chemical information** professionals and **chemical educators**.