

Stories of Chemical Safety in the 20th (and 21st) Century

Ralph Stuart, CIH, CCHO
Chemical Hygiene Officer
Keene State College
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Keene
STATE COLLEGE

Wisdom to make a difference.

A 20th Century Family History with Chemistry

- 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.
- My father graduated with an agricultural degree from Cornell in 1951; he spent 5 years working in Cornell's 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.



A Lesson in Lab Safety

- Two years as a lab tech at Cornell
- My first lab task at Cornell was cleaning out someone else's lab leftovers, including chemicals in the hood
- After three years as a lab tech in an industrial hygiene lab at UVM, I began the UVM lab safety program field: 24 years in EHS at UVM, then 3 at Cornell and now 3 years at Keene State in Keene, NH



Why Share Stories?

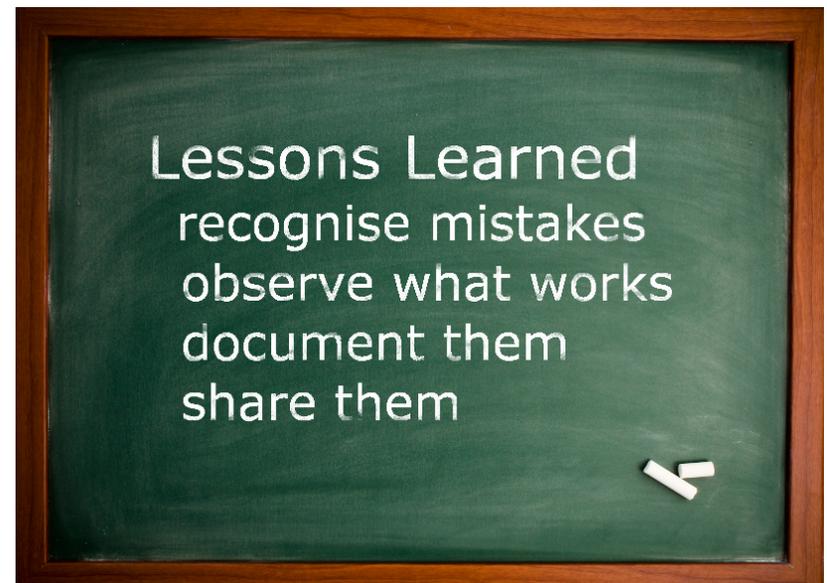
A page of history is worth a pound of logic.

- Oliver Wendell Holmes

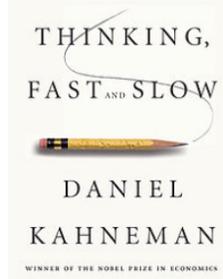
History doesn't repeat itself, but it does rhyme.

- Mark Twain

By Sharing Lessons Learned in the Lab, we can help others make good lab safety decisions



The Psychology of the Decision-Making Process



	Fast Mental System	Slow Mental System
What it does	The continuous stream of thoughts Instinct	Mental activities that allow solving complex problems Literacy
Adjectives	Automatic, fast, effortless	Slow, effortful
Solves questions like	<ul style="list-style-type: none"> • $2 + 2 = ?$ • What was the Russian Revolution? • Read words on a billboard Safety Stories Science	<ul style="list-style-type: none"> • $17 * 24 = ?$ • Tell someone your phone number
The sound I imagine	Constant buzzing of a bee	Strenuous groaning of a weight lifter

Warning: The Challenge of Stories

- On the day of the Deepwater Horizon explosion (*a process safety event*), the company held a ceremony on the rig celebrating 7 years without a lost time accident (*a measurement of personal safety*).
- Personal stories may not connect to system stories and vice versa
- Safety Culture is how we use stories to connect **Personal Experiences** and **Process Safety**



The Radium Story

- Pierre and Marie Curie jointly discovered **radium** in 1898 and shared the 1903 Nobel Prize for this achievement.
- After winning a second Nobel, Marie died in 1934 of aplastic anemia from radiation exposures in her lab
- Marie's notebooks are still too radioactive to handle safely without Personal Protective Equipment



The Radium Girls of New Jersey

- The **Radium Girls** contracted radiation poisoning from painting watch dials at the United States Radium factory in Orange, New Jersey in the 1910's.
- The women, who had been told the paint was harmless, ingested **radium** by licking their paintbrushes to sharpen them; some also painted their fingernails and teeth with the glowing substance.
- As a result, many suffered from anemia, and bone fractures of the jaw, a condition also known as "radium jaw".



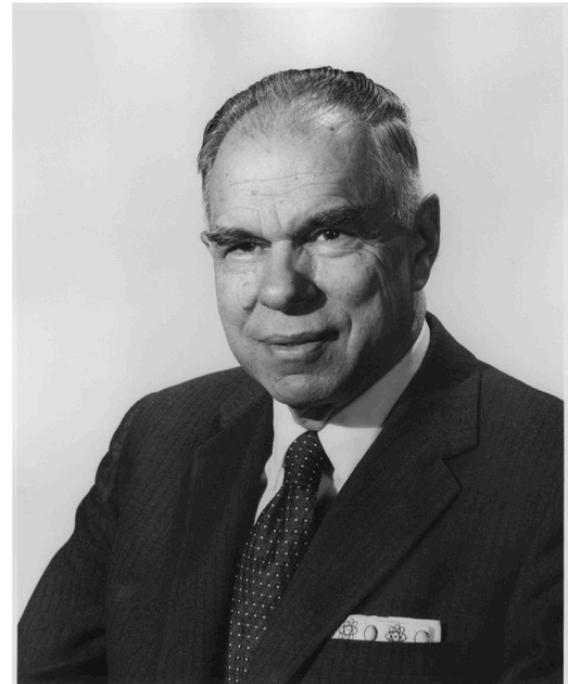
Dr. Alice Hamilton

- Dr. Hamilton joined an investigation into the Radium Girls working conditions
- Her approach to addressing the issue was to start with moral persuasion of the factory owners, but she met a dead end there.
- She goes to Joseph Pulitzer of the NY World to publicize the issue in order to get action.



The Plutonium Story: Glenn Seaborg

- Discovered plutonium and received the 1951 Nobel Prize for this work
- He led the lab group that purified **plutonium** for the Manhattan Project in Chicago
- While he worked in college, he became aware of the health problems associated with radium exposures through the press that Dr. Hamilton generated.



Glenn Seaborg, Journal Entry

Wednesday, January 5, 1944

As I was making the rounds of the laboratory rooms this morning, I was suddenly struck by a disturbing vision. I pictured in my mind the expanding scale of work with solutions containing plutonium that will soon result from the large quantities of plutonium to be received from Clinton Laboratories.

I visualized beakers of plutonium solution throughout the laboratory rooms, and it struck me forcibly for the first time that ***plutonium handling will no longer be confined to microquantities manipulated by specially trained experts.***

Recalling the health problems incurred by workers in the radium dial painting industry, I realized clearly that similar hazards face those of us working with alpha-particle-emitting plutonium-239.



Dr. Seaborg's guidelines for handling plutonium

To protect workers in the plutonium lab, Dr. Seaborg proposed these laboratory safety practices:

- Put linoleum on all floors.
- Paint or varnish walls and ceilings.
- Remove steam coils from windows and seal all windows
- Provide a cleaning crew to mop every laboratory and wipe down every laboratory bench twice a day.
- No laboratory unit should have more than four workers.
- Every effort should be made to develop adequate methods for monitoring the air.
- Such dangerous practices as eating in the labs must be stopped.

This list is the origin of many of today's lab safety practices



The Result

In the 1990's a retrospective health study of the Manhattan Project workers showed that those who worked in the plutonium labs lived slightly longer and healthier lives than the peers in the Project.

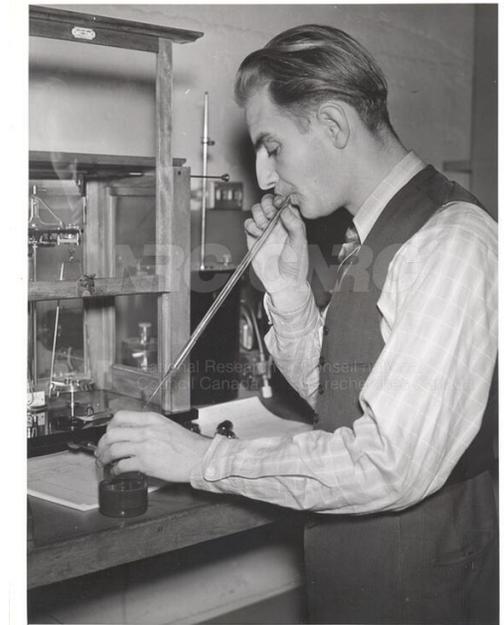
Dr. Seaborg's awareness of Environmental Health and Safety concerns was an important reason for this.



Another Side of the Story

Meanwhile, back in the plutonium lab in California:

- We were working with **hot concentrated perchloric acid**... concentrated solutions of **plutonium**, which were beautifully colored. We had no rubber gloves and worked on wooden lab benches. There was one death – a grad student who was doing dry chemistry breathed plutonium dust. He died in a month...
- Dr. Connick would check our hands with a Geiger counter. (If contaminated,) we dipped our hands in **chromic acid cleaning solution**. We felt nothing, but when we put them under the tap, the heat of dilution was murder...
- We mouth-pipetted plutonium solutions, but we never got a plug.



What are Oxidizers?



Oxidizers are chemicals that can react with organics to cause a fire.

Preparation of
Anhydrous Nitric Acid

A New Lab Safety Challenge: Biological Sciences in 2017

International Genetically Engineered Machines



Hynes Convention Center, November 9 - 13, Boston



Competition

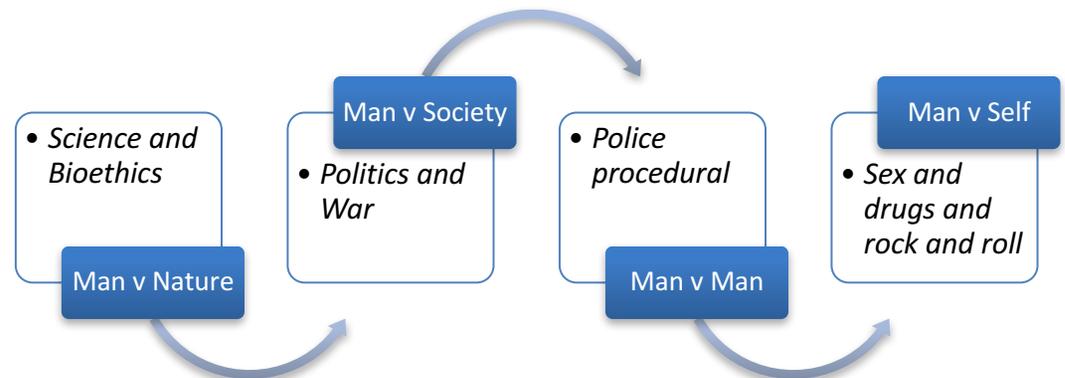
The iGEM competition is an annual, world wide, synthetic biology event aimed at undergraduate university students, as well as high school and graduate students. Multidisciplinary teams work all summer long to build genetically engineered systems using **standard biological parts** called BioBricks. iGEM teams work inside and outside the lab, creating sophisticated projects that strive to create a positive contribution to their communities and the world.



In 2017, 311 high school, undergrad and grad iGEM student teams from around the world will compete for sNA recognition at the Boston Convention Center

A 21st Century Alice Hamilton?

- Orphan Black is a Canadian [science fiction television series](#) starring [Tatiana Maslany](#) as several identical people who are [clones](#). The series raises issues about the [moral](#) and [ethical](#) implications of [human cloning](#), and its effect on issues of personal [identity](#).
- The show provides 50 hours of content, which use the 4 forms of narrative conflict pretty evenly.
- 300,000 people saw the finale; most of them new to science.



Today's Challenge: Developing Microstories

You always look both ways before you cross the street, even if you've crossed the same street safely 100 times before; take the same approach with your lab experiments.

- Timothy C. Gallagher, chair of the chemistry department, University of Bristol, UK quoted in the ACS Safety Zone blog

