

***Connecting Professionalism, Safety & Ethics:
Opportunities & Challenges***

Understanding the Dimensions of Risk

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20th Century Risk Assessment

$$\text{Chemical Risk} = \text{Hazard} * \text{Exposure}$$

What elements are missing from this equation?

Important missing elements (among others):

Who assumes the risk and who benefits from the risk?



Monument to the X-ray and Radium Martyrs of All Nations, Hamburg, Germany



Marie Curie statue at the Radium Institute, Warsaw

20th Century Chemical Ethics

- In 1964, in a *Journal of Chemical Education* article, Dr. Livingston states: “*Legal requirements... are outside the competence of our committee... Certainly if **humanitarian and ethical requirements** are met, there are not likely to be any issues that will require legal action.*”
- This approach to chemical safety relies on chemical and ethical **intuition** rather than **critical thinking**.



H.K. Livingston,
first CCS chair in 1963, newly
moved to Wayne State
University after 13 years at
DuPont

Despite the intrinsic interest of these unusual compounds, this laboratory has provisionally discontinued all experimental work requiring the preparation or use of the dibromides or their hydrolysis products.

There is no *a priori* reason to believe that these particular compounds are more dangerous to man than several related substances widely used as industrial chemicals; however, of the three laboratory workers who have used the dibromides and bromohydrin VII, two later developed similar pulmonary disorders which contributed to their subsequent deaths. The third has exhibited minor skin sensitivity reactions.

DEPARTMENT OF CHEMISTRY
UNIVERSITY OF CALIFORNIA
LOS ANGELES 24, CALIFORNIA

S. WINSTEIN

RECEIVED FEBRUARY 23, 1961

Thinking Critically about Ethics

Academic Ethics

Mission: educate citizens and/or entrants to the profession

Decisions made: content covered and students' grades

Values:
doing your own work while demonstrating theory

Response to Problems:
described in syllabus

Thinking Critically about Ethics

Academic Ethics	Science Ethics
Mission: educate citizens and/or entrants to the profession	Mission: develop new technical tools based on emerging information and understanding
Decisions made: content covered and students' grades	Decisions made: To publish or not to publish
Values: doing your own work while demonstrating theory	Values: scientific misconduct (identified by the NSF as fabrication, falsification, and plagiarism)
Response to Problems: described in syllabus	Response to Problems: peer review of specific cases

Thinking Critically about Ethics

Academic Ethics	Science Ethics	Professional Ethics
Mission: educate citizens and/or entrants to the profession	Mission: develop new technical tools based on emerging information and understanding	Mission: use technical tools to contribute to the general welfare in specific situations
Decisions made: content covered and students' grades	Decisions made: To publish or not to publish	Decisions made: recommendations to clients
Values: doing your own work while demonstrating theory	Values: avoid scientific misconduct (identified by the NSF as fabrication, falsification, and plagiarism)	Values: autonomy of others; non-maleficence; beneficence; justice; truth-telling; promise-keeping
Response to Problems: described in syllabus	Response to Problems: peer review of specific cases	Response to Problems: professional codes of ethics

What is the Safety Connection?

Systems Thinking for Safety:
Ten Principles

A White Paper

Moving towards Safety-II

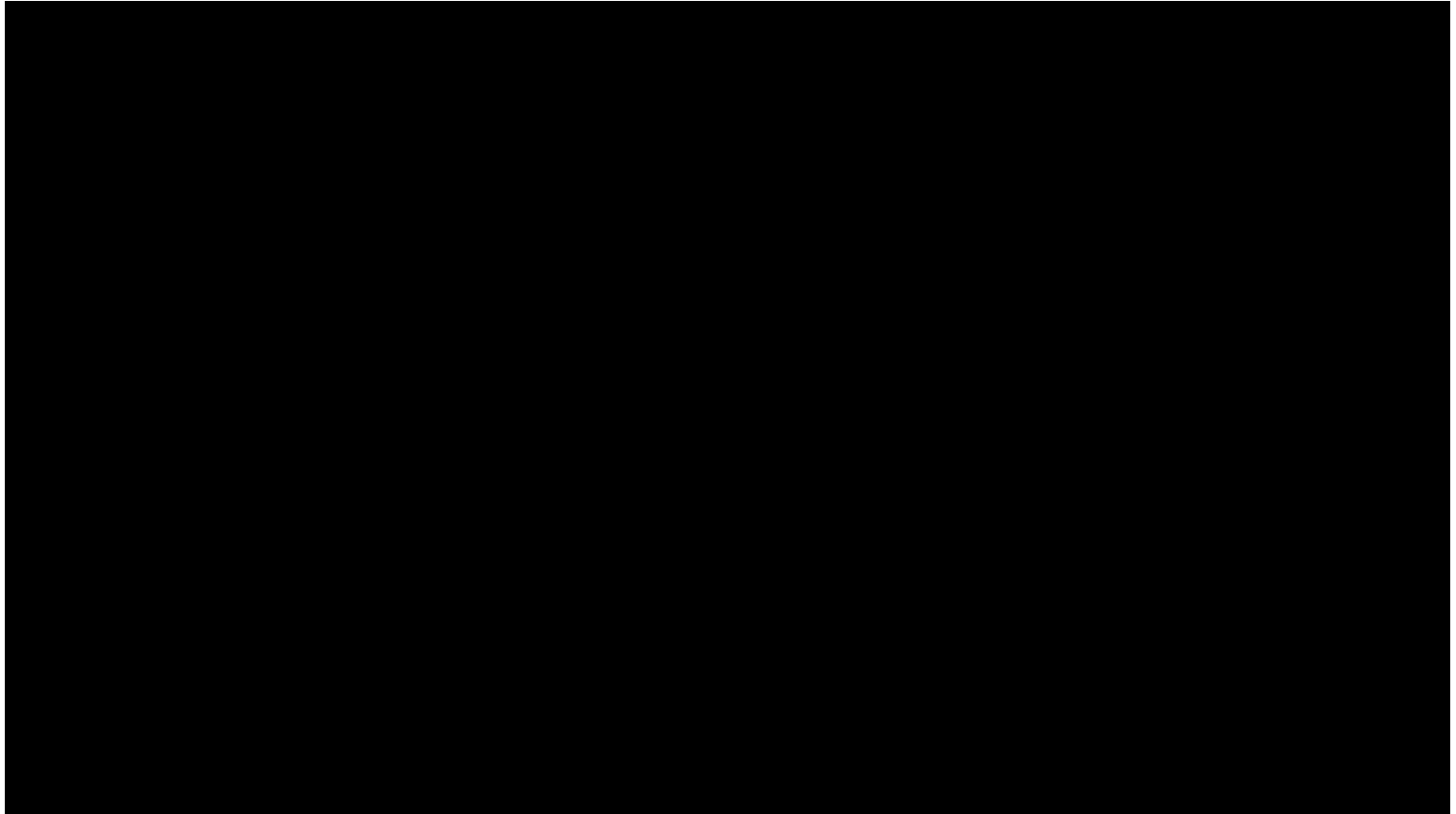
August 2014 – European
Organisation for the Safety of
Air Navigation

Systems Thinking for Safety: Ten Principles
A White Paper
Moving towards Safety-II

DNM Safety



21st Century Safety Culture Education



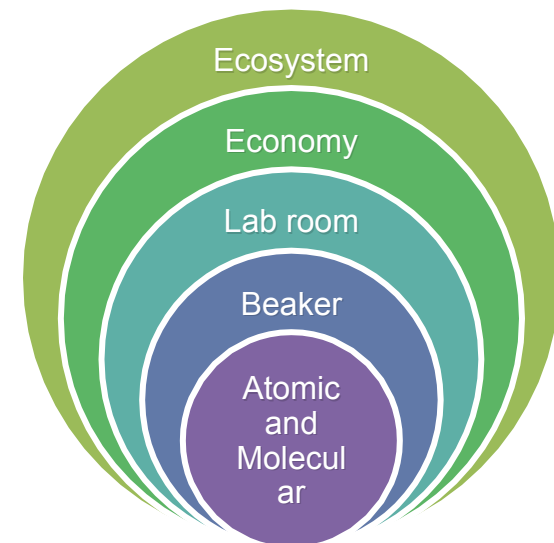
John Warner's parallel puzzle

- When his young son died of cancer, John asked himself if he knew whether his work could have led to the disease.
- or -
- Asking the question in reverse: “Given a PhD in chemistry, how do I make a carcinogenic dye?”
- Out of that rose his work on Green Chemistry



Key themes from the SAP Green Chemistry discussion

- A *systems approach* to address these chemical concerns in the environment includes many *scales*, *stakeholders* and *sciences*
 - *Stakeholders* need to think at the molecular, beaker, lab, community and global *scales* in an iterative fashion
 - This *system* model encompasses both lab safety and sustainability
- *Collaboration* skills apply to both Green Chemistry and Lab Safety





The Impact of a Change in Perspective: The Green Duality

Bench Level Aspects

Institutional Aspects



2. ATOM ECONOMY

Reduce waste at the molecular level by maximizing the number of atoms from all reagents that are incorporated into the final product. Use atom economy to evaluate reaction efficiency.

7. USE OF RENEWABLE FEEDSTOCKS

Use chemicals which are made from renewable (i.e. plant-based) sources, rather than equivalent chemicals originating from petrochemical sources.

3. LESS HAZARDOUS CHEMICAL SYNTHESIS

Design chemical reactions and synthetic routes to be as safe as possible. Consider the hazards of all substances handled during the reaction, including waste.

4. DESIGNING SAFER CHEMICALS

Minimize toxicity directly by molecular design. Predict and evaluate aspects such as physical properties, toxicity, and environmental fate throughout the design process.

5. SAFER SOLVENTS & AUXILIARIES

Choose the safest solvent available for any given step. Minimize the total amount of solvents and auxiliary substances used, as these make up a large percentage of the total waste created.

8. REDUCE DERIVATIVES

Minimize the use of temporary derivatives such as protecting groups. Avoid derivatives to reduce reaction steps, resources required, and waste created.

1. WASTE PREVENTION

Prioritize the prevention of waste, rather than cleaning up and treating waste after it has been created. Plan ahead to minimize waste at every step.

12. SAFER CHEMISTRY FOR ACCIDENT PREVENTION

Choose and develop chemical procedures that are safer and inherently minimize the risk of accidents. Know the possible risks and assess them beforehand.

10. DESIGN FOR DEGRADATION

Design chemicals that degrade and can be discarded easily. Ensure that both chemicals and their degradation products are not toxic, bioaccumulative, or environmentally persistent.

11. REAL-TIME POLLUTION PREVENTION

Monitor chemical reactions in real-time as they occur to prevent the formation and release of any potentially hazardous and polluting substances.

9. CATALYSIS

Use catalytic instead of stoichiometric reagents in reactions. Choose catalysts to help increase selectivity, minimize waste, and reduce reaction times and energy demands.

6. DESIGN FOR ENERGY EFFICIENCY

Choose the least energy-intensive chemical route. Avoid heating and cooling, as well as pressurized and vacuum conditions (i.e. ambient temperature & pressure are optimal).



Dr.
Christopher
Weber,
Clemson
EHS



Green Duality: perspective and scale



Bench



Institution



Flammable Storage



Chemical Storage



Compliance



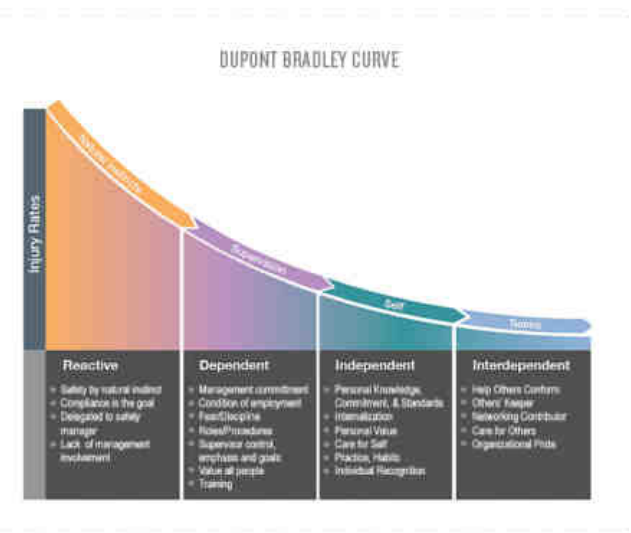
Why Do Ethical Challenges Arise?

Organizational Responses to Surprises

My Experiences:

- 1) **Bully culture:** deny the event and repress questions
- 2) **Bureaucratic culture:** blame the individual and train everyone else
- 3) **Resilient culture:** repent and throw (a few) new resources at the problem
- 4) **Generative culture:** review the event and incorporate changes from Lessons Learned

An organization can house all of these cultures at the same time.



Recognizing Safety Partnerships that Support Just, Generative Cultures

1. Texas Tech University and the Chemical Safety Board
2. The University of Minnesota Departments of Chemistry, Chemical Engineering and Environmental Health and Safety
3. The University of Bristol College of Chemistry and Environmental Health and Safety



Texas Tech University
Laboratory Explosion



UNIVERSITY HEALTH & SAFETY UNIVERSITY OF MINNESOTA Driven to Discover

Dangers of Peroxide Formers—Explosion at UMN



Incident:
A large explosion occurred while a UMS Environmental Health and Safety Technician was processing organic waste from a laboratory cleanup. The technician was in the process of combining flammable solvent waste into a "bulking drum", which is a standard practice at our facility. Upon disposal of an emptied glass bottle into a hg cart for recycling, a large detonation occurred in the cart. The shockwave from the detonation was large enough to tip the cart in half (Figure 1), blow open the doors in the room, cause damage to adjacent rooms, and shake the windows in the facility. The technician survived the blast without major injuries.

Figure 1: Damaged cart and glass fragmentation from the detonation.



WORKING
ALONE
IN THE
LAB?

...WHAT IF?

Remember We're in This Together

