Constructing an Affirmative Safety Culture in Educational and Research Laboratories

Part 2 of a two-part series

by Kenneth C. Hover and Michael J. Schneider

Part 1 of this series discussed safety hazards and responses in civil engineering and construction management laboratories.[1] Meeting our responsibility to protect students in academic teaching and research laboratories also provides the opportunity to instill habits and attitudes about safety that students can carry to the professional workplace. We teach students how to solve technical problems in the design office and on the jobsite, and we should likewise teach them to recognize risks and hazards and how to take steps to protect themselves[*] and the people for whom they will soon be responsible. We know that our students want to be successful and make positive contributions to society. Herein, we explore why and how the academic community may make progress toward these goals.

Culturing Safety

Fatalities and serious injuries in university laboratories (and the ensuing legal actions) have demonstrated the need to radically change academia's approach to laboratory safety from what we call "rule-and-reminder-based programs" to changing "the way faculty, staff, and students work and think."[2] The incidents that precipitated this concern are discussed in multiple landmark documents calling for safer academic laboratories, including those prepared by the American Chemical Society (ACS),[3] the National Research Council (NRC),[4] and the Association of Public and Land-Grant Universities (APLU).[5] Among what NRC calls a "broad range of responses" in academia is Stanford's comprehensive review and recommendation to create "a culture where our scientists don't think about safety as a compliance issue or a set of guidelines distinct from their research activities, but as a fundamental value embedded in everything they do."[6] Stanford's strategic safety plan calls for moving "away from an era when safety was important but adjunct to missions, goals, or objectives and toward safety and environmental protection being integrated into all processes."[2]

A central theme of the cited reports (and the subject of a rapidly growing literature) is the need to establish a "safety culture," a term that has seen increasing use since it was introduced to the nuclear power industry after the Chernobyl disaster in 1986.[7] The need for an effective "safety culture" in the nonnuclear, industrial context was identified by the U.S. Occupational Safety and Health Administration (OSHA) in 1989 and updated in 2015.[5,8] In popular usage, the term "safety culture" has achieved buzzword status, resulting in vague interpretations. But more specifically, the U.S. Nuclear Regulatory Commission (USNRC) defines "safety culture" as "an organization's collective commitment, by leaders and individuals, to emphasize safety as an overriding priority to competing goals and other considerations to ensure protection of people and the environment."[9] Sorenson[7] and Hudson[10] contend, however, that the word "culture" merely applies to

[*]Many of us crave adventure and challenge. Many of us want to "live on the edge" and "walk on the wild side," and some are drawn to "extreme" sports, hobbies, and careers where personal risk is unavoidable. But regardless of the pursuit, the goal every day is to come home from the job or activity with all body parts intact.

Practicing safety in the lab at Cornell University. From left: Yvonne Yang, Isabella Cardenas-Garcia, Luke Small, and Iratxe Lopez de Subijana Esteban

From left: David Palmer, Michael Suarez, and Sarah Freiheit

the collective mindset of an organization in regard to safety (or anything else). Thus, an organization's so-called "safety culture" could in reality be either supportive or unsupportive of employee safety (for example, an organization's "safety culture" could consider safety to have a lower or higher priority than economy or productivity).

Fittingly, the USNRC describes a "good" safety culture as "a reflection of the values, which are shared throughout all levels of an organization, and which are based upon the belief that safety is important, and it is everyone's responsibility."[9] Olewski and Snakard[11] express the same idea in the laboratory context by saying that "a paradigm shift is needed to stop seeing laboratory operations (including teaching, research, and service) and safe laboratory work practices as two different activities and simply embrace a single concept of safe laboratory operations as the only way to work." But just adopting, pronouncing, mandating, or hyping a "safety culture" is not enough. Organizational leaders must take safety from the posters to the people. On page 12 in Reference 5, APLU defines the core institutional values that are foundational to a culture of safety. According to the APLU report,[5] each institution must recognize that:

- **Safety is everyone's responsibility.** Each institution should commit to providing a campus environment that supports the health and safety practices of its community (faculty, students, staff, and visitors) and empowers the community to be responsible for the safety of others. A safe campus environment is a right of employment for all categories of employees. A safe campus learning environment is a right of all involved in education and research;
- **Good science is safe science.** Safety is a critical component of scholarly excellence and responsible conduct of research; and
- **Safety training and safety education are essential elements of research and education.** They instill a culture of safety in the next generation of researchers and future faculty, and they are important for our students' career development and employability.

The APLU report[5] also notes that an improved culture of safety is necessary to truly reduce risk throughout the academic enterprise. Further, it should be accepted that diverse methods and flexible approaches will be used to develop strong cultures of safety throughout the academic world, as each institution will have to develop a culture that is unique to its situation.

While the function of creating and maintaining a safety culture is slowly gaining ground in educational institutions,[11] it has rapidly become a fundamental attribute in global industry, including the construction sector. Developing a positive or affirmative safety culture has gained and continues to receive significant attention as "a key and necessary element to further eliminating safety related accidents, reducing risk and lowering incident rates."[11] But college students who find themselves on construction sites may be unprepared for employers' expectations for overall safety-oriented behavior on the jobsite, regardless of whether the students are visitors or employees of the contractors, designers, suppliers, or owners. The wide variations in safety training, enforcement, policy, and locally implemented safety culture within and among educational and research institutions (refer to Reference 6) not only puts students at risk in the laboratory but can also leave some students and recent graduates unaccustomed to the depth of commitment to safety required when transitioning from campus to jobsite.

Prodding educators to close this gap, Olewski and Snakard[11] point out that although "Academia and Industry are too often in competition to demonstrate who is smarter,… it is now time for academic institutions to learn from industry and incorporate the elements of process safety management into the daily practices of teaching and research labs." ACS declares that "Academic administrators, faculties, and staff members have ethical responsibilities to care for their students' safety and to instill a strong, positive awareness about safety. They need to teach students the safety skills they need to work in laboratories **on campus and in the workplace** [emphasis added]. In a strong safety culture, students will acquire the skills to recognize hazards, to assess the risk of exposures to those hazards, to minimize the risk of exposures to hazards, and to be prepared to respond to laboratory emergencies."[3]

But in an entirely other and controversial way, the gap between safety cultures in the lab and in industry may be closing. An incident in a university lab was the subject of the first investigation of an academic research laboratory by a nonregulatory government organization that typically focuses on industrial incidents, and charges of involuntary manslaughter have been brought against a faculty member.[4] Regarding changing societal expectations, Gibbs[2] notes that "attitudes at large have also shifted, placing a greater emphasis on safety and lowering the tolerance for mistakes or injuries on campuses," to which we add: "and on construction sites." Advancing safety requires an **affirmative safety culture**, in which all members of an organization understand and are committed to the importance of safety in their organization and to themselves, and they recognize that responsibility for safety is shared by all.

Suggestions for Progress

In-depth reports already cited in this article[2-5] contain powerful strategies for developing an effective safety culture in university laboratories, to which we add the following suggestions for better preparing our students for career-long engagement in safety in industry and in their personal lives:

- **Develop a group commitment to safety**

An effective, affirmative safety culture cannot be restricted to only one lab, course, or instructor in a department, or only one semester. With the full "no-exceptions" support of the entire staff, faculty, and department heads (backed up by deans), the entire teaching and research team must define and then enforce laboratory safety standards. Contrary to time-honored academic individualism, safety must be the ONE THING upon which we can all agree. "Commitment" is key to establishing an affirmative safety culture. That is, administrators, faculty, and students must be committed to establishing and enforcing the primacy of laboratory safety, regardless of time and budget constraints or the accumulation of other commitments and promises. While it is "trendy" nowadays to offer the excuse of being "overcommitted" for failure to meet an obligation, we argue that, while we are often "overpromised," there is no such thing as overcommitted. That is, one is either "bound or obligated to a person or thing, as by pledge or assurance," or one is not. Instead of saying "I am overcommitted," it would be more accurate to say, "I abandoned my commitment to that task."

- **Know your responsibilities**

Faculty and staff need to know the policies and standards.

Our review of the Cornell University safety manual brought the stark reminder that "Principal Investigators, faculty, and laboratory supervisors are responsible for laboratory safety in their research or teaching laboratories."[12] Direct responsibility is clearly borne by faculty and lab supervisors, and it is indirectly borne by the health and safety division of the university and the framers of university safety policy. An informal chat with a legal staffer once brought the revelation that in the case of an accident and consequent lawsuit, the university would defend a faculty member if it were demonstrated that university safety policies had been enforced. Otherwise, the faculty member would be exercising his or her academic freedom and individuality while up a dark creek without either a paddle or a concrete canoe!

- **Remember that personal protective equipment (PPE) is the last line of defense[11]**

The first line of defense is deciding whether to take on the project or perform the experiment; the second line is identifying the risks involved. The third is to "engineer" controls, procedures, instruments, or equipment that will eliminate or reduce risk of an incident. The fourth is to train all participants in how to safely perform the work AND how to respond in the case of an incident. The last line of defense is to assume that an incident can occur, so plan for it and provide personal protection. Far more effective than protective gear, however, is to think the experiment through to predict and avoid an incident in the first place.

- **Learn and teach hazard identification**

Involve the students in risk assessment in advance of executing any experiment or demonstration. What dangers can they identify? Where are the pinch-points? Are there toxic or corrosive chemicals? What will happen when the specimen fails while under test? Which way might it fall? Have an open discussion drawing on common sense, engineering principles, and imagination to get the students to understand that they need to open their eyes and brains to hazard identification and

mitigation. Continue this discussion by identifying things that all lab participants can do to reduce the chances of an accident. When the students understand the risks, they are more likely to suggest ways of reducing those risks and will be more willing to wear their PPE for the duration of the operation.

This process has an important carryover to industry: we want our students to be able to walk onto a jobsite and identify hazards, assess measures taken to mitigate those hazards, and know when coworkers are properly and improperly protected. The goal is not memorization of safety rules, even if they come from OSHA. We want to develop professionals who recognize that public safety rules are required minimum standards (just like building code requirements) and to be alert to the need for either better protection or changing operations to eliminate risks not previously identified.

Construction in the future will incorporate new materials, processes, equipment, and skills—all generating new hazards and risks that will be mitigated only by the ability to recognize and identify hazards and to imagine new solutions. Let's get our students involved in that process now.

- **Classify structures and concrete materials labs as construction sites**

Mandate that the wearing of PPE and attention to safety requirements always pertains. This is not an exaggeration or a training simulation—the risks are real (refer to the first article)! Admittedly, the duration of exposure to hazards in the laboratory is generally shorter than for full-time construction workers. However, in some research projects, students are working essentially full-time with every bit of the intensity of exposure as in the work world.

As pointed out repeatedly by Olewski and Snakard,[11] it's not the "volume" of risk—it's the intensity, and students and researchers are often intensely involved in the work and making measurements that put them physically closer to a danger point than any construction worker would be. This being the case, it is irresponsible to require less protection for our students than would be required if they were exposed to the same risk on a construction site. Therefore, wearing of PPE cannot be discretionary, and it must not be "just for show" when important visitors or research sponsors visit. We need to get the students into the habit of understanding that when you walk "onto the site," you wear safety equipment: "This lab has a dress code!"

In university labs, the required safety equipment will commonly vary depending on what specific experiment or demonstration is being conducted on that day. It is then up to supervisors and instructors to define any conditions under which the baseline safety requirements need to be augmented or may be relaxed. On a typical construction site, however, there is a basic set of PPE that must be worn by everybody on the site at all times. For example, it is not uncommon in a university laboratory to have a rule that says hard hats must be worn when the overhead crane is in use. Such a conditional rule would be rare indeed on a construction site, where the requirement to wear a hard hat is not conditional. The mandated culture on most modern construction sites is that all workers, supervisors, and visitors on the site wear hard hats, eye protection, gloves, and protective footwear for as long as they are on that site.

At the initial enforcement of such standards, students and faculty will surely complain. They will want to wear shorts, short-sleeve shirts, flip-flops, and sandals. Many will declare that hard hats are hot and uncomfortable, protective eyewear won't stay on or "doesn't fit over my glasses," and that hearing protection is uncomfortable. Others will complain that gloves make it difficult to do smaller-scale work. Yet others will declare that respirators or surgical masks are hot and uncomfortable and make it hard to talk. Ask any construction professional: they have heard (and voiced) these and other complaints, and none of them justify unsafe behavior on a construction site. Since the construction site is where we, as faculty members, are sending these people, we and our students should stop whining and get over it!

- **Be mutually responsible**

It helps to build the safety culture when we recognize our mutual responsibility for our mutual safety. We all win only if we all go home safe at the end of lab, with all body parts intact. Our students are responsible not only for their own safety but for the safety of their colleagues. Expect each person present to enforce the policies and to remind one another (and the instructors) of risks, vulnerabilities, and failure to follow agreed-upon procedures. Laboratory supervisors and faculty members should not be the only people looking after the safety needs of our community. Students must realize that they really are their sisters' and brothers' keepers. Everyone in the lab needs to be concerned for the safety and welfare of everyone else in the lab, every day. We therefore need to create an Incident and Injury Free (IIF) environment that applies to all parties involved in the laboratory (refer to the text box). We all have to agree that NO injury is acceptable.

- **Expand the content of safety briefings**

The common recitation of hazards and safety provisions before a lab activity is typically an unimaginative, rote exercise, eliciting an eyes-glazed-over response from the students. We can get the students into the game by involving them in risk assessment as noted previously, and by pointing out that safety provisions are reasoned, rational responses to the hazards associated with the task at hand (not just bureaucratic rules). Just as we introduce our students to building codes and standards, we should introduce them to safety regulations such as those published by OSHA or other industrial/governmental standards. This shows that safety issues are not merely of local university or laboratory concern, but are in fact generic, global concerns (with generic, global solutions). Just like we ask our students to solve complicated and realistic design problems, we can also ask our students to solve complicated and realistic construction-safety problems.

- **Train for response to unintended incidents**

We often lecture on accident prevention, but we rarely tell students what to do in the event of an emergency. When do you use an eyewash? When do you not use an eyewash? What types of incidents are likely to require medical care? Should we call 911, or is there an on-campus emergency number? Who makes the call? Who makes the critical, early decisions? What do we do if the lab supervisor is injured? What incidents will require evacuation from the lab? You've probably had dozens of fire, tornado, or earthquake drills that required you to move from your office or classroom to a safer place—don't forget your lab.

- **Conduct a root-cause analysis**

When there is a laboratory safety incident or near-miss, we need to perform the same kind of root-cause analysis as would be performed by professionals in the field. In the process, we may find that the root cause of the incident occurred well before the students even arrived in the laboratory. Consider also the educational value of staging a laboratory incident and challenging student teams to perform their own root-cause analysis. This could become a creative and exciting exercise that introduces students to very real and practical concepts, perhaps with a forensic, failure-analysis component.

- **Develop incentives and disincentives**

Consider awarding bonus points to vigilant students who identify safety hazards. Alternatively, consider assessing penalty points for those who fail to comply with stated policies, perhaps after an initial warning. Other options include establishing a departmental policy for lab access for students who continue to ignore safety requirements or establishing a lab-safety award for the student (or students) who demonstrates the most effective attention to his/her own safety and the safety of his/her coworkers.

- **Help your favorite organization become a key contributor**

We note that the word "safety" does not appear in the list of "Topics in Concrete" on the ACI website as of this writing. Nevertheless, ACI has a high-profile involvement with students via student membership, student chapters, webinars, and student competitions; through its highly effective Faculty Network; and through its integration with the construction

Create an Incident and Injury-Free™ Environment

An incident and injury-free (IIF™) environment should be an objective for all parties involved in the laboratory. IIF is a personal and organizational commitment that creates an environment free of any injury. This requires building and maintaining a culture that keeps people safe all day, every day. For those of us within an IIF culture, absolutely no injury is acceptable—whether it happens to our fellow students, to us, or to members of our families. To accomplish this, we:

- Accept personal responsibility for our own and others' safety;
- Share knowledge, best practices, tools, and resources;
- Invest in each other's learning and development;
- Take action—always and immediately;
- Expect similar commitment from our laboratory partners; and
- Honor people who live safe and healthy lives.

IIF is achieved through personal adherence to three key principles:

- Respect—I respect myself, my coworkers, and our families; and so I must respect the mission to be safe—always;
- Commitment—I commit to total safety for myself and others; and I am committed to speaking up when I see an unsafe situation, even if it means stopping work; and
- Relationships—I am sincere in building personal relationships with my peers, and I take responsibility for my actions and the actions of my coworkers.

For an IIF culture to exist, we must distinguish between priorities and values. Priorities change, sometimes more than once in the course of a normal day in the laboratory. Values, however, are constant and are held high in the minds of the group. It is paramount that our students, as future stakeholders in the construction industry, establish safety as a value while still in school.

Note: IIF and Incident and Injury-Free are registered trademarks of JMJ Associates, LLC. For more information on their programs, visit **www.jmj.com**.

community at all levels. The Institute can therefore provide a very effective forum for communication on construction safety. For example, discussions could start within ACI's Faculty Network, and network members could connect with contractors to exchange best practices about lab safety policies and report accidents and near misses. There might be a "Hot Topic" session that would allow contractors to inform designers and students of safety implications for both new construction and for repair and rehabilitation or to inform faculty and students about jobsite expectations. The network should strive to learn what contractors want academics to teach about safety. And since we are in this together, we should apply Ken's policy, which has always been to teach at the university that which is most effectively learned and taught at school, suggesting that employers should teach that which is most effectively learned in the workplace.

ACI could also tighten safety requirements associated with student competition projects—not just at conventions but back home in the labs. We could take the lead from ASCE and AISC on safety requirements for concrete canoe and steel bridge competitions. And ACI could be more circumspect in publishing construction images that show unsafe practices, thus avoiding the unintentional promotion or endorsement of such practices.

Sharing Security

It is a given that we want our laboratories to continue to be spaces for the exciting and safe exploration of the principles upon which our theory and practice is based. But in doing so we also want our students to develop a construction safety consciousness that makes them alert but not frightened, responding not merely reacting, and thinking about hazard mitigation and not merely memorizing rules. We want our summer interns, co-ops, and recent graduates to WANT TO BE AND STAY SAFE, prepared to become young professionals who are an asset and not a liability to themselves or others. Shortly after graduation, many of our students will themselves become responsible for the safety of their coworkers.

We can use programs of laboratory safety as a training ground for how those future professionals will approach that responsibility, to include how they will identify risks and how they will identify means to reduce those risks to acceptable levels. We can show them how to respond when individuals knowingly or unknowingly fail to comply with safety policies. Let's make sure that the college laboratory is the first place that students have learned how to protect themselves and others.

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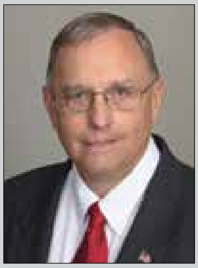
Selected for reader interest by the editors.

ACI Honorary Member **Kenneth C. Hover** is Professor and Weiss Presidential Fellow at Cornell University, Ithaca, NY. He served as ACI President in 2010-2011. He is a member of ACI Committees 301, Specifications for Structural Concrete; 305, Hot Weather Concreting; and 306, Cold Weather Concreting; and ACI Subcommittee 318-A, General, Concrete, and Construction. He was an Army Combat Engineer Officer, Project Engineer and Project Manager for Dugan & Meyers Construction, and a Partner and Manager for THP structural engineers before coming to Cornell.



Michael J. Schneider, FACI, is Senior Vice President and Chief People Officer at Baker Concrete Construction, Inc., Monroe, OH. Schneider served as ACI President in 2016-2017. He is Chair of the ACI Foundation and a member of the Concrete Research Council, as well as ACI Committees 132, Responsibility in Concrete Construction; 134, Concrete Constructability; and S801, Student Competitions; and Joint ACI-ASCC Committee 117, Tolerances. He has been active in the American Society of Concrete Contractors and served as its President during 2005 and 2006.