Strategic Opportunities in Chemical Safety Education: Report on the 2019 ACS Safety Summit

On March 1 and 2, 2019, a group of more than 30 invited stakeholders, consisting of subject matter experts as well as representatives of various American Chemical Society (ACS) units, (governance committees, technical divisions and staff), met at ACS headquarters to discuss strategic opportunities in **chemical safety education** in support of the Society's core values of *"Professionalism, Safety and Ethics"* . This report provides a summary of the work of this group. Complete meeting materials, including the agenda, a list of attendees, meeting presentations, and a compilation of chemical safety educational resources assembled to support meeting attendee discussions is available upon request to safety@acs.org.

Overview of the Summit

Participants were welcomed by Dr. Bonnie Charpentier and Dr. Peter Dorhout, current and immediate past ACS Presidents, of the Society. This was followed by several speakers reporting on emerging opportunities to support chemical safety education efforts at all levels (as described by one speaker, "*from K to gray*"). The speakers represented industry, faculty, academic staff and ACS staff. A connecting theme among the speakers was that technical and cultural safety competencies are intimately tied to each other. Speakers from industry explained the importance of inculcating safety awareness into new hires by example and developing safety competencies over the course of a chemist's professional development. The speakers reminded everyone that *"safety education has no final exam".*

The group then worked interactively to review the outcomes of the 2018 Summit relative to safety education topics and identify new opportunities based on four exploratory questions:

- What expectations do employers of chemists have for the safety competencies of the chemists they hire?
- What emerging safety knowledge, skills, and attitudes do chemistry educators believe should be included in a 21st Century chemistry education?
- What are the differences between safety training and education, and how does each support the development of the safety competencies professional chemists are expected to have?
- Within the current chemistry curriculum, how and where are chemists best educated in a safety culture ethos?

Three key themes emerged from the group discussions of these questions:

- Chemical safety instruction is an important opportunity to develop essential technical and professional skills that cut across the chemistry discipline. These skills include

critical thinking, chemical information literacy, and communication with a variety of audiences[1];
- Safety competencies (knowledge, skills, and culture) need to be consciously developed to support the ACS Core Values in the 21st Century chemistry enterprise[2]; and
- Development of chemical safety competencies is an ongoing opportunity for all chemists and should be approached with a "spiral" progressive education model within the curriculum[3].

It is encouraging to note that these themes are already reflected in ongoing ACS work, as described in the footnoted references. These discussions also included review of the educational thoughts from the 2018 summit. Subsequent discussions at the summit were able to connect to existing ACS safety education work as they explored specific opportunities.

The attendees broke into small working groups to develop *conceptual strategic plans* for six key opportunities identified in the broader discussions. The goals of these groups were to:
- define the opportunity as specifically as possible,
- identify stakeholders who would be interested in these opportunities,
- develop a timeline that progress on these ideas might be expected, and
- propose measurable indicators of progress on these opportunities.

The reports from the planning groups are provided in the next section.

The next day the program included a discussion, led by the ACS Presidents, about the importance of the ACS core value *"Diversity, Respect and Inclusion"* in building a safety culture within the ACS. The value of *"Respect"* was added to the ACS values statement in the latest ACS strategic plan. The ACS had recently joined with other scientific societies in creating the Societies on Sexual Harassment in STEMM[4].

The group discussed the role of ***diverse, respectful and inclusive culture*** in supporting a ***generative safety culture***[5] in the chemistry enterprise. This discussion did not result in any action items at the 2019 summit, but rather broadened the attendee's perspectives on the importance and interconnectedness of these values in the success of the chemistry enterprise.

[1] ACS Guidelines for Bachelor's Degree Programs
https://www.acs.org/content/dam/acsorg/about/governance/committees/training/2015-acs-guidelines-for-bachelors-degree-programs.pdf
[2] ACS Strategic Plan
https://www.acs.org/content/acs/en/about/strategicplan.html
[3] Chemical safety education for the 21st century — Fostering safety information competency in chemists
https://www.sciencedirect.com/science/article/pii/S1871553217300865
[4] American Chemical Society joins the Societies Consortium on Sexual Harassment in STEMM
https://www.acs.org/content/acs/en/pressroom/newsreleases/2019/february/acs-joins-the-societies-consortium-on-sexual-harassment-in-stemm.html
[5] See the Chapter 2 of National Academy report on *Safe Science* for further information generative safety cultures.
https://www.nap.edu/catalog/18706/safe-science-promoting-a-culture-of-safety-in-academic-chemical

Descriptions of Strategic Opportunities

Participants developed conceptual strategies for each of the six opportunities identified during the Summit. These strategies build upon the action steps related to safety education proposed at the 2018 Summit.

Group 1: Developing a rubric for creating and assessing safety case studies and lessons learned reports

This idea emerged in the discussion of safety education strategies and involves using interactive narrative scenarios to teach concepts of laboratory safety to a variety of audiences. Storytelling and narratives are powerful situational learning tools that leverage community experiences to build critical thinking while teaching concepts of chemical safety. This approach offers the learner an opportunity to practice both technical and professional skills while broadening safety competencies. Such case studies must be curated for quality and relevance.

To move such a curation and assessment process forward, this group discussed creating guidance documents to support this strategy, including:

- guidelines for writing case studies to be used as teaching tools,
- a rubric for assessing the case study strength,
- development of a network for peer review of the case studies and lessons learned,
- professional recognition for active learning and audience testing of the tools, and
- a feedback component for authors (such as user reviews).

A variety of ACS and external organizational partners who might be interested in supporting this effort were identified. Logistical details, such as where the rubric would be available and how long it would take to develop this program, were discussed.

Specific measures of success for this idea were identified, including:

- Indicators
  - Number of case study submissions and acceptance rate
  - Feedback from users about the case studies
  - Rubric scores
  - Number of attendees for webinars
  - Measures of how well the rubric works - reliability and validity
- Baseline
  - Various case studies currently exist, but there is no curation for chemical safety education purposes
- Goals
  - High quality clearinghouse of curated and peer-reviewed case studies

Group members: Scott Goode, Robin Izzo, Joan Esson, Jenny MacKellar, Jenny Bishoff, Sue Wiediger. Further work on this idea will be championed by the ***ACS Division of Chemical Education's Safety Committee, in partnership with the Committee on Chemical Safety.***

Group 2: Organizing a user-centered system for discovery and dissemination of case studies and lessons learned reports

This idea is to develop dissemination methods which make safety information available in ways that are personal, relevant, in context, applicable and accessible, focusing on case studies as resources for teaching and learning. Audiences for this work include chemistry professionals, decision-makers, students, and educators. This idea would leverage the work of Group 1 and develop technology tools that can help people find high quality case study information more efficiently than can be found using commercial search engines.

Many potential organizational partners were identified that may be interested in supporting and using such a resource. The group reported that it is difficult to estimate a timeline for such a project because a ***needs assessment*** for various audiences should be developed before work on supporting search strategies could begin. Such a needs assessment requires significant chemical information expertise combined with subject matter expertise provided by the chemical safety education community. Development of the partnerships necessary to support this work is underway and this momentum can be leveraged as the idea moves forward.

Metrics

Further indicators are expected to be identified in needs analysis and scoping.

- Usage (searching, downloads)
- Number of Contributions
- Social Media discussion
- Citations
- Feedback on events

Group members: George Athens, Scott Ayers, Leah McEwen, Kali Miller, Ken Roy. Further work on this idea will be championed by the ***Committee on Chemical Safety's Safety Advisory Panel.***

Group 3: Integrating Safety Science Instruction

The discussion in this group led to the idea of writing a white paper on the relationship between **safety training** and **safety education** and how these efforts can partner to provide more complete **safety instruction** for chemists. These two aspects of instruction have different goals and address different needs and are not mutually exclusive. For this reason, it is important that the role of each is well defined so that instructors in either domain can understand the expectations and needs of the students with whom they are working.

This group identified the need to move this idea forward as relatively urgent, because clarifying these issues would support many other projects currently underway. By working with key ACS partners, the group felt that such a white paper could be written in two years.

The indicators of success for this project are:

- Indicators – Progress through the phases of developing this white paper and use of the resulting document to inform other projects
- Baseline – There is currently a lack of clarity and shared understanding in key audiences

Group members: Jodi Wesemann, Dave Finster, Sammye Sigmann, Anna Dunn. Further work on this idea will be championed by the ***Committee on Chemical Safety's Communications Subcommittee.***

Group 4: Disseminating information to leaders in a variety of venues about the opportunities for professional development in safety competencies and instruction

Leaders within the chemistry community are identified as a distinct set of stakeholders who are an important target for ACS safety outreach efforts. Leaders include members and potential members of the ACS, chemists who assume administrative roles in their home institutions (i.e. chairs and deans), and members of the ACS governance. These stakeholders need to lead development of safety cultures in their areas of responsibilities and thus have specific needs around chemical safety education and training. This group explored how the ACS could provide resources to develop their safety culture leadership skills.

Potential ACS partners interested in this effort could include the Committee on Professional Training, the ACS Graduate and Postdoctoral Scholars Office, and the Society Committee on Education. Potential external partners identified for this effort are organizations focused on academic management issues (AAU, the APLU, the University of California Center for Laboratory Safety) as well as industrial partners who are reaching out to specific academic institutions on safety education issues.

The information developed for these audiences could be disseminated through a variety of media, including formal venues such ACS leadership courses, new faculty workshops, mock interviews at National Meetings, and the ChemIDP tool, as well as through more informal media such as podcasts, webinars and networking events. These venues could also include information about the other ACS Core Values, as these values reinforce each other.

Depending on the media chosen for dissemination, new information could be implemented in the 3- to 5-year time frame. The primary indicators of success for this effort would be the time required to develop the content for these materials and then how quickly they are able to be incorporated into the venues identified.

Group members: Richard Schwenz, Susan Shih, Anna Sitek, Mark Thomson, Terri Chambers. Further work on this idea will be championed by a partnership between ***ACS Education Division staff*** and the ***Committee on Chemical Safety.***

Group 5: Curating an "education toolbox" for a variety of audiences

To support the 2019 summit, the planning committee assembled a list of currently (or soon to be) available chemical safety education resources into a single table. While this is an important first step in providing access to these resources, this list must be curated carefully to be of maximum value to the chemistry education community. More specifically, because target audiences have both time constraints and different needs for safety resources, we need to leverage existing resources and use audience feedback to identify gaps in currently available resources to guide the development of new resources. Target audiences could include students in high school, undergraduate and graduate schools; chemists with training responsibilities; undergraduate pre-service science high school teachers, educators and administrators in high schools, and faculty and staff in higher education.

This group identified potential partners for this effort, including the AACT, NSTA and APLU. They also recognized that appropriate information should be delivered through a variety of media, ranging from guidance documents, structured teaching materials, videos, social media and workshops. It was suggested that current resources could be tabulated and validated in 2019; gaps and missing elements in the current resources could be identified in 2020 ; and an ongoing program for the maintenance of the toolboxes could be established in 2021.

Indicators of success for this set of toolboxes could be based on analysis of how often these resources are accessed and how patterns in this access change over time. These could be compared with current traffic levels on the ACS safety web pages. While traffic levels can serve as leading indicators, the workgroup also indicated that an important lagging indicator would be feedback from people who use these materials and their suggestions for opportunities to improve these resources.

Group members: Kendra Denlinger, Irene Cesa, Wendy Schatzberg, LaTrease Garrison, Dawn Mason. Further work on this idea will be championed by the ***Committee on Chemical Safety's Education Subcommittee.***

Group 6: Implementing a crowd sourced platform for peer sharing of safety expertise

As the chemistry enterprise is in constant flux, it is important to recognize that chemical safety tools and techniques are as well. For this reason, active channels of peer networking are an important tool for supporting a generative safety culture. An important challenge in establishing such a network, is the widely varying levels of time and expertise available to various safety education stakeholders across the chemistry enterprise. One example of a successful peer sharing around chemical safety issues is the Division of Chemical Health and Safety's DCHAS-L e-mail list. However, the nature and quantity of questions on this list is such that it is primarily full-time safety professionals who support a wide variety of laboratory work. People with part time safety responsibilities or responsibilities that are focused on one or several specific chemical processes can find the amount of traffic on DCHAS-L overwhelming and the guidance too technical.

For this reason, this work group began to envision electronic platforms that can support sharing of chemical safety expertise for other constituencies, such as high school teacher or graduate students in the research laboratory. The goal of this platform would be to empower specific communities within the chemistry enterprise to share questions, insights and experiences that are directly relevant to their working concerns.

With the two audiences named above in mind, this workgroup identified AACT and NSTA as outreach channels for high school teachers. Developing a national network of graduate student safety programs for research laboratories would also be useful. This group envisioned pilot efforts for these audiences that would seek to recruit 50 or so participants for a three-month trial period. The first month would be used to identify key safety questions for the audiences being recruited; the second month would involve discussion of these questions, and the third month would be used to summarize and memorialize the key learning points from the discussions.

This project is considered doable with IT tools currently available on the DCHAS web site and so it is hoped that these pilots could be completed in 2019 and 2020. Indicators of success would be the ability to launch and host these events and feedback from the participants.

Group members: Peter Reinhardt, Ochieng Aluoch, Ralph Stuart, Mary Beth Mulcahy, Dan Kuespert**.** Further work on this idea will be championed by the ***Division of Chemical Health and Safety*** through its outreach channels.

Summary

The 2019 ACS Chemical Safety Education Summit was an important opportunity for the ACS community to move several strategic goals forward:

- It demonstrated ongoing leadership support for the work of incorporating safety into the Society's programs. Both the current and immediate past ACS Presidents participated fully in both days of the meeting and the ACS Chief Executive Officer addressed the group about the importance of safety in his corporate experience as a chemical engineer;
- The 2019 meeting maintained the momentum of the 2018 ACS Safety Summit and built upon ACS projects that arose from that Summit as well as other ongoing ACS projects. One immediate deliverable from the 2019 Summit is the resource list of important chemical safety educational resources, organized by intended audience. This list is available at http://dchas.org/2019/03/11/education-resources/
- The summit was successful in describing strategic projects that can be acted on by collaborations both within the ACS and with external partners. It also identified ways of assessing progress in moving towards those goals, as the ACS continues to demonstrate its global leadership in supporting safety in the chemistry enterprise, from raw materials to lab to industry to consumer.

The next steps in this process will be to share this report with key stakeholders. The project champions mentioned above will begin work on these efforts in 2019 and the CCS will ask for progress reports from these groups at the 2020 spring ACS national meeting. We welcome interest in the work of this summit and any questions or comments you may have about it. These may be directed to safety@acs.org.

Written by Ralph Stuart, Chair, Committee on Chemical Safety, ralph@rstuartcih.org based on reports from the workgroups at the summit and reviewed by the 2019 Summit Planning Committee.