

Closing the Gap Between Industry Needs and Academic Training Related to Process Safety Instruction

Hunter Flodman

University of Nebraska-Lincoln Department of Chemical and Biomolecular Engineering

Abstract

Industry hosted faculty workshops have played an important role in introducing chemical engineering faculty to process safety concepts. This paper explores the evolution of industry workshops for faculty over the past decade along with suggested strategies to meet process safety learning outcomes.

Keywords

Process Safety, Industry, Faculty Workshops

Introduction

Process safety deals with the prevention and control of incidents such as toxic releases, fires, or explosions that have the potential to cause serious injuries, property damage, and environmental impact. Process safety has been an important aspect of practicing chemical engineers since the discipline began. However, it was not until major process safety incidents, increased government regulation, and requirements from degree accrediting organizations that academia began to formally adopt the concept of process safety as a learning outcome. This outcome created a gap in knowledge for faculty members that did not have the experience of being a practicing engineer. Even for the faculty with practice experience, a perceived lack of resources existed from not having taken a process safety course or being exposed to process safety content as a student. Another challenge that arose was how and where to fulfill a newly required student outcome in an already packed curriculum or what to remove and replace to add process safety as a learning outcome.

The American Institute of Chemical Engineers (AIChE) Center for Chemical Process Safety (CCPS) has long been viewed as a leader in the field of process safety. The CCPS has provided a platform for industry and academia to share information and resources related to process safety. Chemical engineering faculty members that have been leaders in process safety instruction including Dan Crowl, Ron Willey, and Chip Howat began facilitating faculty workshops held at industrial sites as early as 1989 [1]. These workshops continue today. To date, over 800 faculty have attended industry led process safety faculty workshops from universities all over the world.

Faculty Workshops

Two years after the Chevron Richmond Refinery Fire on August 6, 2012, Chevron hosted a 3-day CCPS faculty workshop that included concepts of process safety culture, risk management, mechanical integrity, consequence modeling, and much more. Attending this workshop as a young faculty member provided exposure to new concepts and tools to start incorporating

process safety into courses that I taught including junior and senior level unit operations lab and process control. I was able to attend two more CCPS industry sponsored faculty workshops in 2016 hosted by Cargill and ADM. These workshops further solidified the importance and role of process safety in undergraduate instruction. My department chair attended the Cargill workshop with me. The experience provided enough activation energy in order to create a dedicated process safety course that would become part of the chemical engineering core curriculum at the University of Nebraska-Lincoln.

Faculty workshops provided tools, resources, and most importantly, insight into how industry addresses process safety. Every company that hosted a faculty workshop emphasized the importance of process safety as a core value for the company and the need to hire graduates with process safety knowledge. It also showed faculty that process safety had a significant science and engineering basis as well as a cultural and management basis. Each workshop had at least one faculty facilitator assigned. The role of the facilitator was to help faculty understand what industry was conveying, help faculty realize how and where the content can be used, and further connect faculty with additional process safety resources. The technical content itself was primarily controlled by the industry host. Different companies covered different content with a different depth, breadth, and style. Some of the content was presented with the goal of information transfer, which did not always correlate to faculty understanding how the material could be used or incorporated into courses. In 2019, Crowl, Willey, and Howat retired from facilitating CCPS faculty workshops, and Tracy Carter from Northeastern University and myself became facilitators.

Virtual Faculty Workshops

In 2020, the 3 day in-person workshop format was no longer feasible due to travel and site restrictions related to the COVID-19 pandemic. A new workshop format was created using video conferencing capabilities. The new virtual workshop format was an opportunity for change. The workshop content and presentations shifted from information transfer to how faculty can incorporate process safety content into the courses they teach. The workshop length changed from a 3-day workshop to a 2-day workshop. Breakout sessions were used for faculty networking and interaction using breakout rooms in Zoom. The workshop content presented by industry and facilitators was consistently structured around addressing the six process safety framework questions proposed by Crowl and Louvar [2]. These framework questions are:

1. What are the hazards?
2. What can go wrong and how?
3. How bad can it be?
4. How often can it happen?
5. What is the risk?
6. How is the risk controlled and managed?

The framework questions provided a clear road map to the logical thinking behind process safety concepts and techniques used in industry. Each industry workshop host would present a virtual tour of a process and then give a presentation on how each framework question was answered based on a hypothetical scenario involving the process.

These six framework questions can be taught in a dedicated process safety course. Concepts from one or more individual questions can also easily be added to any chemical engineering core course by making small changes to existing content, problems, and examples that are already taught. The “small changes method” for existing courses is something that can be utilized by all chemical engineering faculty regardless of experience or courses taught. It requires little effort, and faculty can start small and build their knowledge, comfort level, and understanding over time. For example, a professor teaching a material and energy balance course can have students identify hazards associated within certain chemicals and processes to address framework question 1. A fluids class can use equations and concepts already covered to produce a source model to calculate the quantity of material released from a leaking vessel or pipeline to address framework question 3. Fluid mechanics can also be used to model the flow of fluid through a pressure relief device which addresses framework question 6. Many more examples exist. Suggestions of framework questions to incorporate into chemical engineering courses are shown below in Table 1.

Table 1. Suggestions of framework questions to incorporate into chemical engineering courses.

Framework Question	Courses
1. What are the hazards?	All but best to start early in the curriculum
2. What can go wrong and how?	All
3. How bad can it be?	Fluids, Transport, Thermodynamics, Reactors, Lab, Design
4. How often can it happen?	Design, Lab, Process Safety
5. What is the risk?	
6. How is the risk controlled and managed?	Fluids, Transport, Reactors, Design, Lab, Process Safety

In-Person Workshops Return

After experiencing the success of the virtual workshops, industry sponsors and faculty alike continue to embrace the structure of workshops built around answering the six process safety framework questions post pandemic. In-person workshops with this structure continue in the United States and have also been hosted in Spain and Germany in the past two years. Virtual workshops continue to be held to further reach international audiences. The idea of making small changes to incorporate process safety into any chemical engineering course remains a cornerstone of the workshop with multiple breakout sessions designed to show faculty that this method can be done with relatively little effort while satisfying ABET outcomes. Furthermore, this can be done without department permission or making changes to the four-year plan. It is my opinion that process safety should be a core chemical engineering course, but I also believe the more students are exposed to process safety concepts, the better equipped they will be to have a successful career in industry, academia, government, or any other career path they choose to follow.

Workshop Impacts

In 2021, 145 faculty that attended industry sponsored CCPS faculty workshops between 2016 and 2020 responded to an online survey via email invitation. When asked if attending the workshop prompted them to add process safety content into a course they teach, 87% responded

yes. When asked if workshop content was added to a course they taught, 91% responded yes. Eighty eight percent indicated they had recommended attending a faculty workshop to a colleague. This data, collected at least one year after workshop attendance, shows the effectiveness of inspiring and training faculty to add process safety content into their courses. It also shows that workshop content is frequently incorporated into courses taught by faculty attendees.

Future Workshops

Although there will most likely always be a need for introductory process safety workshops hosted by industry, it's likely that more advanced workshops will be needed for those who teach dedicated process safety undergraduate or graduate courses. Workshops could be created that focus in-depth on answering one of the six process safety framework questions. These workshops are not yet offered but have interest among multiple companies that typically host process safety workshops.

Summary

Faculty workshops have not only introduced hundreds of engineering faculty to process safety concepts but also provide a mechanism to close the gap between industry practice and educational instruction at universities. With a seemingly growing number of faculty members without industry experience, industry hosted workshops may be as close as some faculty come to experiencing process safety firsthand in an industrial setting. These workshops provide valuable insights into what students will be expected to know and do post-graduation while showing faculty how to integrate content into courses.

References

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Hunter Flodman

Hunter Flodman is an associate professor of practice in the Department of Chemical and Biomolecular Engineering at the University of Nebraska-Lincoln. He teaches junior and senior level chemical engineering laboratory courses and a freshman introduction to chemical engineering course. He is a CCPS staff consultant and facilitates faculty workshops focused on process safety hosted by CCPS member companies.