

# Never Give Safety a Day Off - Cultivate Safety Across the Curriculum!

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**D**on't learn safety by accident. Chemical Process Industries (CPI) prioritize safety and so must universities. The CPI maintains a safety culture within its organizations beginning with leadership commitment and stakeholder input. Leadership sets expectations like "Safety First," then financially and organizationally supports the implementation. Stakeholders actively engage in identifying (sharing safety moments), eliminating (inherently safer design), and managing the risk (safety training). Likewise, our academic programs must prioritize and support safety *across the curriculum* to prepare our graduates for professional practice, ensuring seamless safety enculturation.

Pintar considered the three most common paths for incorporating Chemical Process Safety (CPS) into the chemical engineering curriculum: (1) a dedicated course; (2) integration into existing courses; and (3) a combination of the first two.<sup>[1]</sup> Like Pintar, we found reliance on one CPS course the least effective approach because students compartmentalize their learning and fail to make strong connections between CPS and engineering topics.

Creating a safety culture requires strategic change beyond creating a course or content. Borrego et al. suggest sustainable change requires a change agent, developing shared vision, enacting policy, developing curriculum and pedagogy, and developing reflective teachers.<sup>[2]</sup> While any one of these aspects can be used to create change, the more of these aspects used to create change, the more effective and sustainable the change. Northeastern University, with 36 faculty and 534 undergraduate students, and the University of Minnesota Duluth (UMD), with 11 faculty and 216 undergraduate students, have used all aspects of this framework to cultivate safety across their curricula.

UMD leadership was their change agent, building a safety culture around a unifying principle called "Conservation of Life" having the same gravitas as other pillars of chemical engineering such as conservation of mass and energy.<sup>[3]</sup> Similarly, several Northeastern faculty members committed to CPS integration and initiated the change. Both departments developed a shared vision by working with their industrial advisory boards (including CPS professionals), faculty, and, for Northeastern, students working in industry (Co-op). Concise CPS learning outcomes for both departments were developed with stakeholder input.

ABET AIChE program criteria support enacting policy by requiring curricula with "design, analysis, and control of processes, including the hazards associated with

these processes." Several chemical engineering programs responded to policy by adding a CPS-specific course. Others use AIChE's SChE Certificate program to build students' knowledge of important safety subjects. UMD found that relegating safety to one or two courses, or modular programming, failed to sustain a safety culture among the faculty and students. Accordingly, we advocate changing behavior by requiring safety learning outcomes in all chemical engineering course syllabi. Such an approach will hold faculty accountable for integrating safety within courses.

Northeastern leveraged change agents for developing curriculum and pedagogy. Two CPS-experienced faculty members helped the participating faculty develop the curriculum within the courses to meet the learning outcomes. Once implemented, Northeastern's learning outcomes analysis showed all students in all classes met or exceeded expectations in these areas. Analysis of learning methods at UMD showed that instructional methods of class discussions and in-class problem-solving were most effective, followed by homework assignments and projects around safety, with stand-alone SChE modules as least effective.

UMD and Northeastern University's chemical engineering departments elevated CPS to the same level of importance as the other pillars of the chemical engineering discipline. They showed that departments can sustain (NU-5 year data, UMD-10 year data) a safety culture by integrating CPS principles into the core courses across the curriculum.<sup>[4,5]</sup> The time is now for all chemical engineering programs to follow this lead and never give safety a day off.

## REFERENCES

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