



WERC Environmental Design Contest, College of Engineering



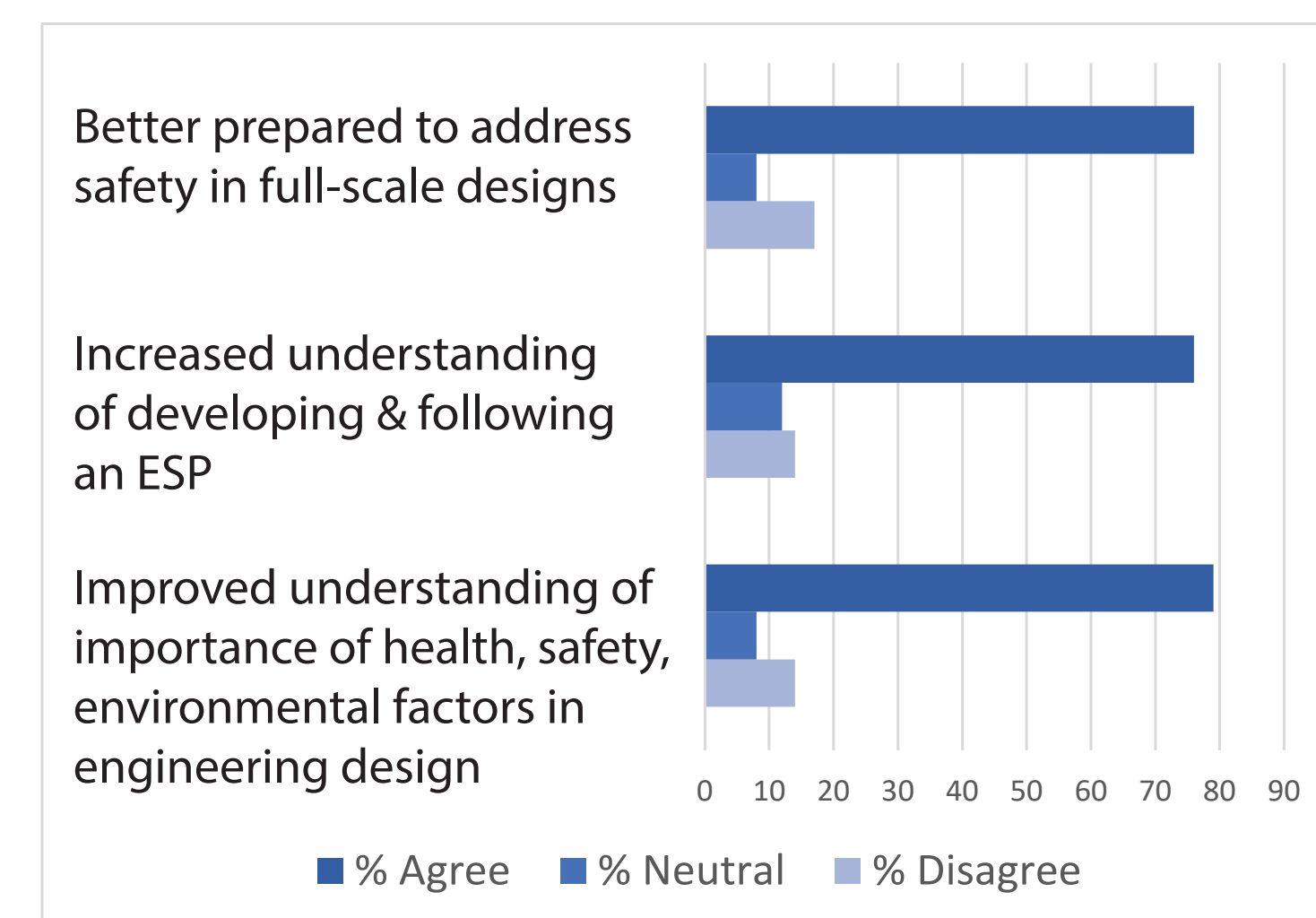
Using Capstone Projects to Instill a Safety Culture and Satisfy ABET Student Outcomes: The WERC Experience

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ADVANCING ABET OUTCOMES

ABET Student Outcome 2 can be challenging to demonstrate: "apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors."

WERC's 2026 post-contest survey indicates students generally agree that its structured safety reviews better prepare them to advance public health, safety, and environmental outcomes in the workplace.



EMPOWERING THE ENGINEERING WORKFORCE

Capstone projects that incorporate working prototypes are a key workforce development tool for achieving ABET Outcome 2, which emphasizes health, safety, and environmental considerations.

The WERC Environmental Design Contest demonstrates how moving from full-scale concepts to functional bench-scale models—when guided by structured safety reviews—deepens student understanding of hazard identification, mitigation, and real-world operations.


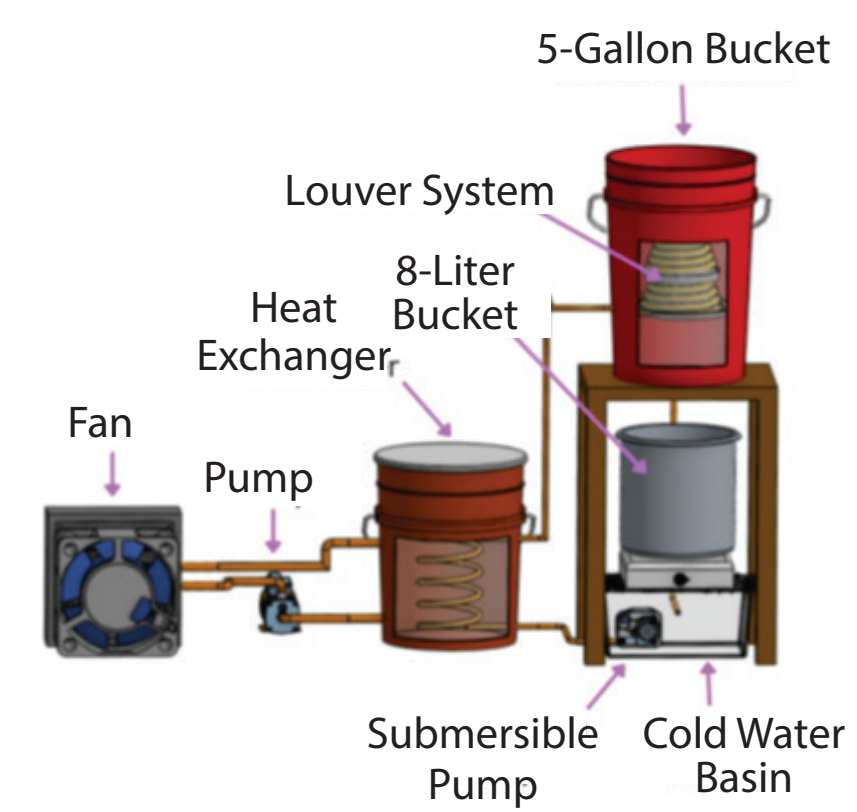

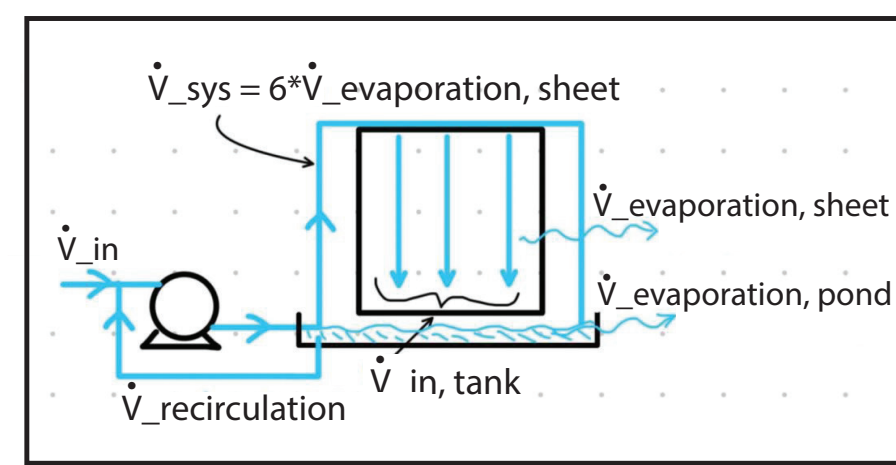

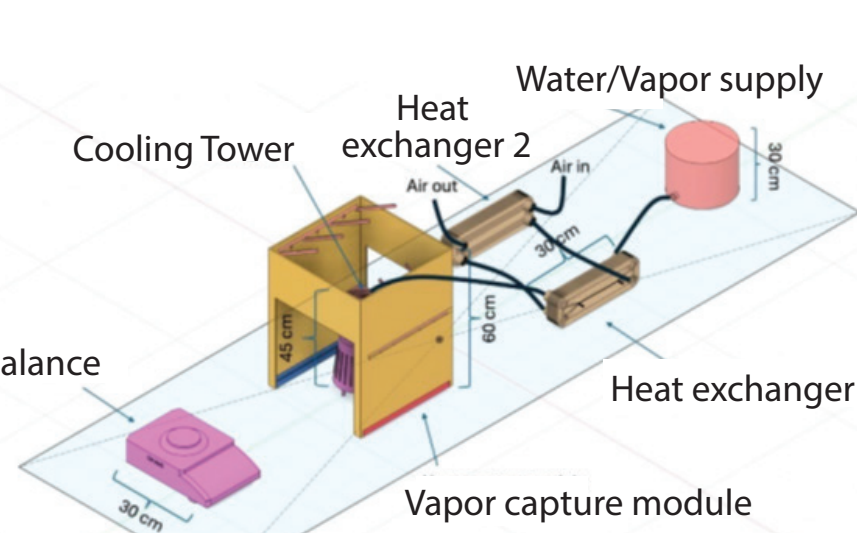

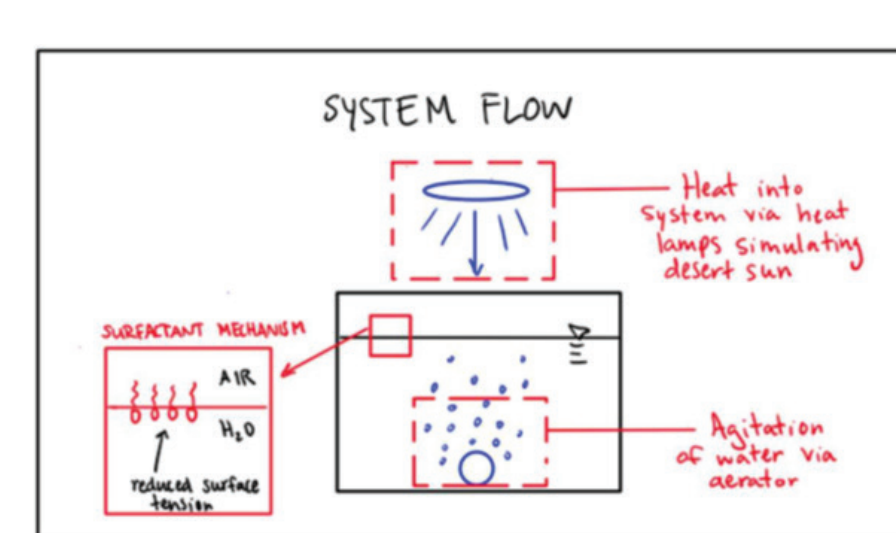
2026 team submissions show measurable improvements in safety integration and full-scale design quality. Four of the 21 submissions are highlighted below. Next Steps: Fully engage all team members in scheduled safety reviews.

GROWING SAFETY INSIGHT AND RISK JUDGEMENT

- Teams acquired deeper knowledge of hazards and mitigations
- Feedback loops with engineers guided final designs:
 - 30% Project Review
 - Experimental Safety Plan (ESP)
 - Final Report for the bench- and full-scale system
- Notable advanced approaches observed in 2 of the 4 teams:
 - Performing a full Hazard and Mitigation Analysis (MTU)
 - Developing comprehensive Emergency Action and HazCom Plans (BYU)



CASE STUDIES

Team	30% Project Review	ESP	Final Report	Team	30% Project Review	ESP	Final Report
Michigan Technological University <i>Recovering Water from Cooling Towers</i> 	Personal safety: Basic PPE, Oven mitts, gloves for splashes Lab-scale safety: Four-hour run time 	Personal safety, add: coolant gloves, cut-resistant gloves, burn/coolant treatment protocols Lab-scale safety: <ul style="list-style-type: none"> • Two 30-minute run times • Ethylene glycol SDS and labeling (6 unique components) • Coolant handling: storage, disposal, spills, cleanup, transfer, exposure, and vapors • Secondary containment 	Personal safety, add: Lab coats Lab-scale safety: ESP procedures Industrial-scale safety: <ul style="list-style-type: none"> • Detailed Risk Assessment: 11 scenarios addressed • Lockout/tagout, confined space protocols, hazard communication, PPE training, respirators, fall protection, lifting safety • Biofilm & leak prevention, diking, absorbents, emission reports, inspections Regulatory integration: <ul style="list-style-type: none"> • Cited OSHA, NRC, EAP 	Brigham Young University <i>Enhanced Evaporation of Produced Water</i> 	Safety: Not addressed in the team's 30% Project Review 	Personal safety: Basic PPE, buddy system, treatment for chemical contact Lab-scale safety: <ul style="list-style-type: none"> • Fire extinguisher, rinse-off station • Unattended overnight operation • Plastic box to isolate electrical parts from running water • Proper pump size to prevent overheating • Secondary liquid containment 	Personal safety: See ESP Lab-scale safety, add: Dust exposure hazard Industrial-scale safety: <ul style="list-style-type: none"> • Comprehensive Emergency Action Plan • Comprehensive Hazard Communication Plan • Workers: Eyewash, chemical showers, controlled access, lockout/tagout, liner inspections, NORM procedures • Planning/Construction: auto shutdown, level alarms, flowrate deviation and leak-detection sensors, berms (secondary containment), corrosion-resistant materials, HDPE/PVC liners Regulatory integration: <ul style="list-style-type: none"> • Cited NPDES, CWA, UIC, SDWA, NMED, OCD
University of Pennsylvania <i>Recovering Water from Cooling Towers</i> 	Personal safety: <ul style="list-style-type: none"> • Basic PPE, prevent burns (thermal insulation), training, securing vessels & tubing • U. Penn ESP training for entire team Lab-scale safety: <ul style="list-style-type: none"> • Isolate electrical from water, GFCIs 	Personal safety, add: <ul style="list-style-type: none"> • Safety glasses with side shields • Burn/cut treatment protocols Lab-scale safety, add: <ul style="list-style-type: none"> • Detailed safety protocols for two design options: • Boiling flask: heat, steam, electrical, burn/cut protocols • Ultrasonic humidifier: isolate electrical from water, run a few minutes to clear vapor from unit. Team selected this option. • Nonhazardous polymer coating for copper mesh 	Personal safety, add: <ul style="list-style-type: none"> • Shock risk: dry the connections, inspect cords Lab-scale safety, add: <ul style="list-style-type: none"> • Minor spills: shut off power, clean immediately, prevent w/ organized work area • Trip hazards: (route & secure cables) Industrial-scale safety: <ul style="list-style-type: none"> • Construction: lockout/tagout, crane lifts, hot-work permits, confined space, fall protection • Operation: electrical isolation, restricted work zones, confined space, elevated access/falls, hot water piping Regulatory integration: <ul style="list-style-type: none"> • Cited OSHA, NFPA, CAA/CWA, local permits 	Louisiana State University <i>Enhanced Evaporation of Produced Water</i> 	Environmental concerns only: <ul style="list-style-type: none"> • Design should be safe for environment and comply with EPA regulations. • Potential environmental harm from release of surfactants or their foams. Recommend liners and mesh nets 	Personal safety: Basic PPE Lab-scale safety: <ul style="list-style-type: none"> • Unattended overnight operation • Surge protector and secondary containment to isolate electrical equipment in proximity to liquid • Trip and snagging hazards: tape down cords & move equipment to table's center • High center of gravity: weigh down stand bases and tape to table 	Personal safety: See ESP Lab-scale safety, add: Mitigation of pinch and caught-between hazards Industrial-scale safety: <ul style="list-style-type: none"> • Mist prevention: surfactants and low-intensity aeration • Workers: PPE (gloves, splash protection), eye wash, non-slip surfaces, corrosive brine: secondary containment, leak mitigation, cleanup • Operations: sampling protocols, lockout/tagout procedures for pumps & aerators, emergency response plans for spills or equipment failures, secondary containment (berms), spill kits (absorbents) Regulatory integration: <ul style="list-style-type: none"> • Cited OCD, RRC, RCRA

Safety assessments, risk identification, and mitigation strategies become substantively developed as teams progress from 30% Project Review, to ESP for bench-scale apparatus, to full-scale design.