

Looking Back at the 2021 Inaugural ChemE Cube Competition

Ashley Smith-Schoettker ■ Keith Joseph ■ Ignasi Palou-Rivera ■ RAPID Manufacturing Institute®

At the 2021 AIChE Annual Meeting in Boston, MA, the RAPID Manufacturing Institute held the inaugural ChemE Cube™ competition, an undergraduate student competition that challenges teams to design, build, and operate a process in a one-foot cube.

The problem chosen for the inaugural competition was “Modular On-Demand Water Purification for Developing Countries.” Water is essential for human life and not everyone in the world is fortunate enough to have direct access to clean water. Limited access to clean water is a constant problem in the developing world. According to the United Nations (1) and other sources (2), an average household uses approximately 14–22 L of water per day. The competition problem focused specifically on drinking water, as it requires the highest purity and is the most basic need.

The competing teams were tasked with creating a modular, on-demand surface water treatment mini-plant that could fit inside a one-foot cube, purify at least 25 L of surface water per day, and meet relevant drinking water standards (e.g., the U.S. Environmental Protection Agency’s national primary drinking water standard and others). Cubes were supplied with only DC current to replicate the use of off-grid power sources such as solar or wind power. The first-of-a-kind prototypes were required to have material costs of \$1,500 or less. Minimizing the manufacturing and operational costs of the cube will be key in ensuring its economic sustainability along the value chain (e.g., a small-scale factory being able to turn a profit selling cubes, or a cube owner being able to achieve a reasonable payback time by offering on-demand clean water to customers).

The inaugural competition took place over half a day. The teams checked in with a multi-point safety inspection. Upon passing, the teams became eligible to compete in the onsite competition elements: The Pitch and The Duels (3). The five teams completed each element concurrently to optimize the time allotted for the competition. The pitch allowed each team to delve into the marketability of their product and garner the buy-in of the judges. In the duels, teams faced off in head-to-head matchups to efficiently produce clean water. Duels were judged on the following criteria: energy consumption, weight, and time to produce 90 mL of clean water.

The Univ. of Delaware’s team won the first-place award and the team from North Carolina State Univ. (NC SU) was the runner-up based on the total points accumulated from the duels, the pitch, and the ad they were tasked with creat-

ing to “sell” their cube. RAPID presented three additional awards: Most Resourceful Award to Univ. of Delaware for the highest cube score to total cost ratio; Entrepreneur Award to NSCU for receiving the most investment dollars from the pitch judges; and RAPID Award to Missouri S&T for integrating modular chemical process intensification (MCPI) concepts into their design and pitch.

After a successful inaugural competition, the RAPID team is evaluating how to continue the momentum in the coming years. RAPID staff, members, and ChemE Cube volunteers have contributed many interesting suggestions (e.g., a drone for unobstructed aerial shots of the duel action) and ideas on how to maximize the impact of ChemE Cube and gain exposure for these talented and hard-working student teams. New “problems” that would fit within the constraints of the ChemE Cube competition and address the societal challenges of sustainable development, environmental and energy justice, and increased resilience are being considered. For example, can we develop a competition in which students must develop a direct air capture device (capturing CO₂ from air) or an energy storage device?

Visit www.aiche.org/chemecube for news on the competition and to complete the team interest form.

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1. **United Nations**, “The Human Right to Water and Sanitation,” Media Brief, www.un.org/waterforlifedecade/pdf/human_right_to_water_and_sanitation_media_brief.pdf (2011).
2. **Mayo Clinic**, “Water: How Much Should You Drink Every Day?” www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/water/art-20044256 (Sept. 6, 2017).
3. **Smith-Schoettker, A.**, “A Next-Generation Competition Prepares Students to Tackle Today’s Challenges,” *Chemical Engineering Progress*, 117 (10), p. 20 (Oct. 2021).



▲ Students at the inaugural ChemE Cube Competition demonstrate the function of their one-foot cube modular water treatment plant. Source: Kevin Trimmer.