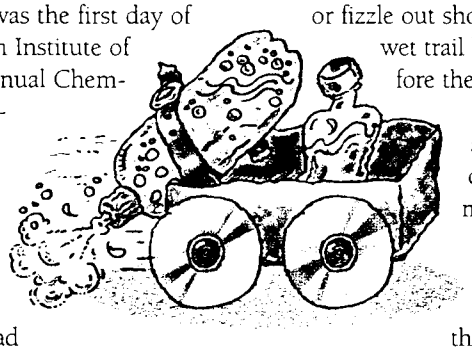
√Shaw
√Stark
Stephen
Badger

Nancy K. McGuire

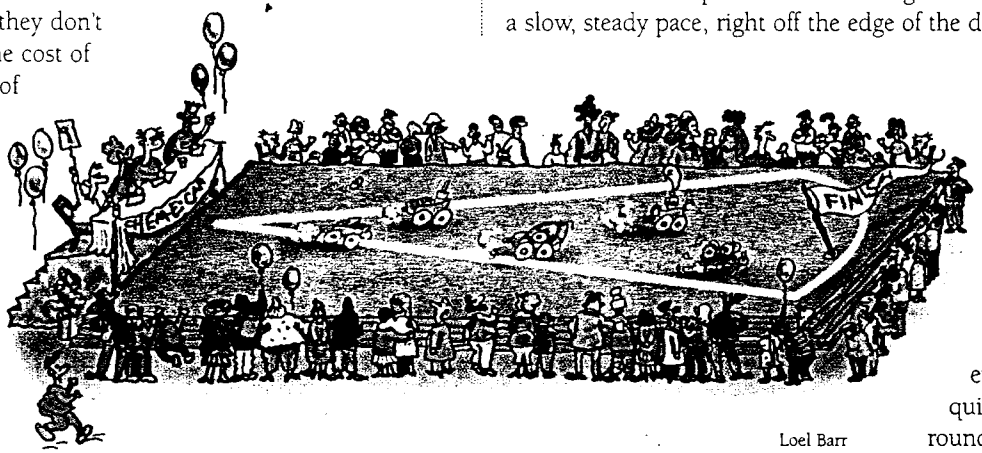
Chemical cars: Baking soda rockets and geriatric turtles

We shivered as the wind cut through our too-thin jackets, and the air only got colder as the sun began to set. Los Angeles wasn't supposed to be this cold, even in November, and this wasn't exactly the Indy 500, but we couldn't tear ourselves away from the spectacle. More than 100 hardy souls braved the unseasonable weather on the sundeck of the Westin Bonaventure Hotel last November 12. It was the first day of the 2000 Annual Meeting of the American Institute of Chemical Engineers (AIChE). The first annual Chem-E-Car Competition was pretty good entertainment for downtown Los Angeles on a Sunday night.



Twelve teams of undergraduate chemical engineering students tried their hands at designing, building, and running shoe-box–sized vehicles powered solely by chemical reactions. Each team had 2 min to introduce their school, describe their vehicle, and start their car. They had an additional 2 min for their cars to carry a standard load as close to the finish line as possible, then stop. Each car was judged on the basis of successful completion of this task and the creativity of the design (see box, "Contest rules"). Speed was used as a tie-breaking factor.

All the cars had a distinctly do-it-yourself look, possibly because of the size and cost requirements. Construction materials consisted of items normally found in a standard chemistry stockroom, with a little assistance from the metal shop. Compact discs seemed to be a popular choice for wheels; because they are often received as junk mail inserts, they don't add anything to the cost of the vehicle. None of the cars had much ballast, except for the standard payload, and some of the lighter cars had trouble staying on course in the gusty wind.



Loel Barr

Half of the entries, including the one from the University of Michigan (winner of the 1999 pilot competition), relied on the tried-and-true formula of baking soda and vinegar, environmentally benign ingredients that are available from a local supermarket. These "rocket" cars tended to take off quickly, then either sail off the edge of the sundeck and down the steps or fizzle out short of the finish line. In addition, they left a wet trail behind them that had to be mopped up before the next entry could start.

The South Dakota School of Mines added a paddle wheel to their baking soda car, a feature that let them control its speed more easily. The car moved slowly, stopping 47 ft, 3 in. short of the finish line in the first round. (Even though the contest specifications were posted in metric units, the distances were measured in feet and inches, probably because that's the kind of tape measure the judges had on hand.) The University of Tulsa team would have won the first round (2.5 ft short) with their piston-driven baking soda car, except they had forgotten to add their payload and were disqualified.

Three cars used fuel cells. These cars tended to be slow and steady, but they either stopped far short of the finish line or didn't stop at all (until they took a tumble down the steps surrounding the deck). The University of Nevada, Reno, used magnesium and H_2SO_4 to generate hydrogen gas for their fuel cell. Their entry, the Geriatric Turtle, won this year's poster contest but lived up to its name during the race. It maintained a slow, steady pace, right off the edge of the deck.

Brigham Young University used sugar, $KClO_4$, and magnesium metal. Their car produced a lot of smoke, a brief burst of energy, and a quick fizzle. First-round distance: 23 ft

Contest rules

Preliminary competitions were held at regional conferences, but competition at the regional level was not a prerequisite for entry in the national competition. Each AIChE student chapter was limited to one entry in the national competition. Posters were on display immediately before the competition to show how each car worked and how it conformed to safety and environmental standards.

To keep things interesting, contestants were informed of the required load (0–500 mL water) and distance (15–30 m) just 1 hour before the competition began. However, each car was given two tries to complete the task, so if you got it wrong the first time, you could try again. This year's competition used a 19.8-m (65-ft) course, and each car carried 375 mL of water.

After each run, two judges (volunteer AIChE members) measured the distance from the car's stopping place to the arc-shaped finish line. If the car stopped short of the line, that distance was subtracted from the optimum score. If it ran over the line, a 10-ft penalty was added to the distance from the finish line to where the car went out of bounds, and that number was subtracted from the optimum score. If a car ran off the steps of the sundeck, it was disqualified from that round.

The second round started 10 min after the end of the first round. The cars competed in order of their first-round rankings, lowest first. If your car competed early in the first round and did well in the rankings, you had plenty of time to refine your strategy for the second round. If not, you really had to hurry.

To make things tougher still, the cars had to run exclusively on power generated by a chemical reaction; commercial batteries were prohibited. No remote controls, mechanical brakes, or mechanical or electronic timing devices for stopping the reaction were allowed. The car had to fit inside a $32 \times 20 \times 12$ cm^3 box, but it could be disassembled to meet this requirement. The cost of the car components and chemicals had to be less than $500. Not only that, but students were responsible for safely transporting the chemicals from the point of purchase to the competition site and for safely disposing of them afterwards. Hazardous chemical protocols had to be reported and described on the poster. Also, the cars had to be capable of safe operation inside a building, even though the contest was held outdoors.

General Mills, which sponsored the competition, awarded trophies for the top three teams and cash prizes of $2000 for first place, $1000 for second place, and $500 for third place. The competition was run on the same sort of honor system used at science fairs. Faculty and graduate students could act only as sounding boards, not as active team participants. Teams had to have students from more than one class, and multidisciplinary teams were encouraged. Each team had to have at least five participants.

The complete list of contest rules is posted on the AIChE Web site (www.aiche.org/students/competition/c3car.htm; accessed Nov 2000).

short. Colorado School of Mines, running on KNO_3, sugar, and sulfur, won the first round. The fuel mixture for this car was ignited using a model rocket fuse attached to an electronic detonator.

The University of Akron team came up with a lead–acid battery with a timer brake based on thiosulfate, which consumed the H_2SO_4 and eventually stopped the lead–acid reaction. In the first round, their 2000 ChemCar stopped 21 ft, 1 in. short of the finish line.

Two teams were not able to get their cars to function in the second round, and one car couldn't run on the increasingly wet concrete surface, despite the best efforts of the towel teams to mop up. Some teams that had stopped far short of the finish line in the first round overadjusted for the second round, sending their cars hurtling into the crowd of bystanders. (No one was injured, "hurtling" being a relative term here.)

In the end, the University of Akron came through, stopping a mere 3 in. short of the finish line. The crowd went wild, then hurried inside to the warmth of the hotel lobby and the free food at the opening reception for the main meeting.

Nancy K. McGuire is associate editor of Chemical Innovation.

Chemical Innovation wins recognition

Chemical Innovation has won two awards in the Society for Technical Communication's 2000–2001 Washington, DC, chapter competition, in the categories of "technical publication" and "technical art". The winning entries (our August, September, and October 2000 issues) will go on to compete at the international level this year.

The STC sponsors the technical publications competition "to determine, recognize, and encourage excellence in communication through printed media. The [competition] honors technical writers and editors who set the standards for published technical communication." The technical art competition "recognizes significant accomplishment in visually communicating technical concepts. This competition evaluates the work of communicators who use the tools and techniques of the visual artist and the graphic artist" (www.stc-va.org/fcomp.htm; accessed Jan 2001).

Many thanks to all the ACS staffers who help us put the magazine together every month. (You'll find all of our names on page 2 of every issue.) We are very pleased to receive this recognition from our peers.

— The Editors