GEORGE BURNET
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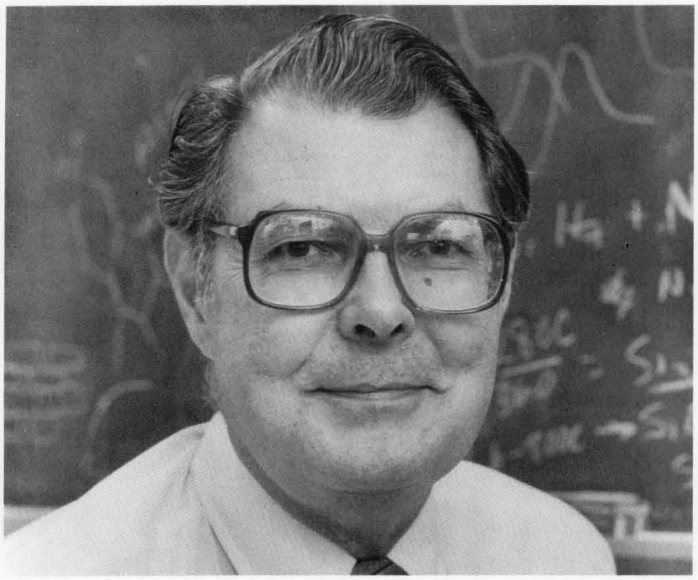

To demonstrate the danger of powdered materials in the vicinity of a flame, a high school chemistry teacher blew some flour dust into a coffee can heated with a candle. The resulting explosion blew the can lid into the air—and piqued the interest of at least one student in that central Iowa classroom. To that student, George Burnet, the demonstration conveyed the excitement he could find in a career in chemistry.

But instead, George seemed destined for engineering. His father, grandfather, great-grandfather, and great-great-grandfather were all civil engineers named George. George V didn't break the tradition entirely; he combined his interests and chose chemical engineering. One of his six children, son George VI, became a mechanical engineer.

College confirmed his decision. "When I got to O.R. Sweeney's senior industrial chemistry class at Iowa State, I was really hooked," George recalls. "His lectures convinced students that chemical engineers could do anything."

Other chemical engineering faculty also influenced the young engineering student. From the University of Minnesota, department head Sweeney had attracted B.F. Ruth who developed the department's unit operations course, became known as the father of filtration theory, and ultimately supervised George's MS program.

World War II interrupted George's education after two years into which he had packed three-fourths of the required courses plus ROTC training. George entered the chemical warfare service, went through the officer training program, was commissioned in the field artillery, and served overseas in the China Burma India theater. He returned to Iowa State in 1947 to finish his undergraduate work, earn the MS in 1949, and complete his PhD with L.K. Arnold in 1951. By that time he and his wife Betty, whom he had married before going overseas, had three children in their two-bedroom apartment in the temporary student housing erected for returning servicemen and their families.

They were happy to move to Terre Haute, Indiana, where George had accepted a position in Commercial Solvents Corporation's central engineering division. But five years later, when B.F. Ruth's death opened a vacancy on Iowa State's chemical engineering faculty, George returned as associate professor in charge of the unit operations course Ruth had taught. He also accepted a half-time appointment at the Ames Laboratory. "That proved to be a very attractive arrangement," George recalls, "because it involved work at an outstanding research facility (almost like an industrial research environment) coupled with teaching at a major university."

RESEARCH

George's research at Ames Lab centered around high-temperature processing. In the early years he

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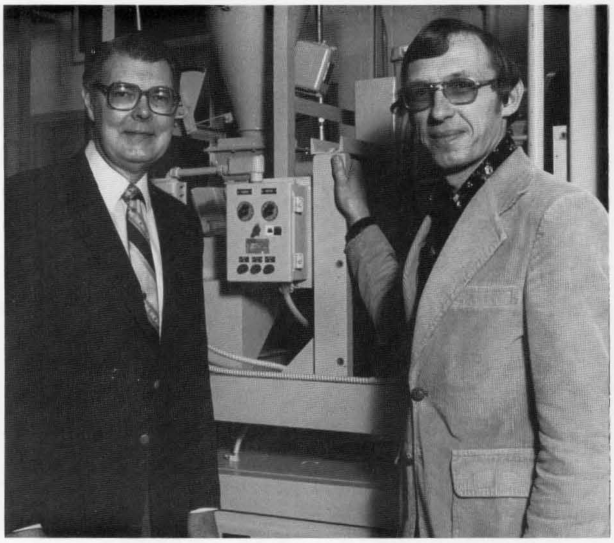
studied the fundamental properties of liquid metal systems and their applications in heat transfer and separation phenomena—areas of particular interest to the Atomic Energy Commission which managed the Ames Lab at that time. George and his group studied ways to purify and use metals until the time that support for such work related to nuclear energy declined.

When the national labs began to look at energy more broadly under the new Department of Energy, George's interest turned to extremely pure, single crystals of metals as large as three inches in diameter and twelve to fifteen inches long. "We translated the skill we had in high-temperature systems to techniques for growing these very large single crystals for use in instruments and for measuring properties of materials," George recalls. "We were successful enough that the process became routine, and Ames Lab created a Materials Research Center that consolidated a number of activities such as this."

George then began looking for a new problem to solve. Because of the oil crisis in the early 1970s, fossil energy, including efficient use of coal, was a candidate. While serving on graduate research committees in civil engineering, George had learned about research to characterize fly ash and determine its fundamental properties and reactions. In particular, the civil engineering group studied the use of this by-product of powdered coal combustion for soil stabilization. "But from a chemical engineering standpoint, I could see it as a raw material for processing rather than for use in construction," George recalls.

Fly ash typically contains 35% alumina, 20-24% iron oxide, and 1-1.5% titania, plus silica. "An ore with a composition like that would be an attractive raw material to mine," George says, "and millions of tons of this waste product with a high and uniform quality are readily available in fixed locations." Their search for ways to "mine" fly ash economically led to the Ames lime-soda sinter process and to the HiChlor process.

The lime-soda sinter process heats fly ash in the presence of lime and a small amount of sodium carbonate to convert the alumina into soluble calcium and sodium aluminates and the silica into an insoluble dicalcium silicate. Using a very dilute sodium carbonate solution to adjust pH, the research-



George and his long-time associate Mike Murtha developed this pilot plant size model of the Ames lime-soda sinter process

ers learned they could extract 90% of the alumina in very pure form, leaving a residue of dicalcium silicate. "Portland cement is tricalcium silicate, so you simply add more limestone, heat—and you have Portland cement," George points out. "You've used everything," he adds. "There's nothing left but the squeal!"

The HiChlor process uses high temperature to treat metal oxide with chlorine in the presence of carbon to get a stream of gaseous metal chlorides mixed with carbon oxides. "The carbon acts as an oxygen getter and removes oxygen from the reaction system so you get a mixture of metal chlorides," George explains. "You condense and separate these metal chlorides and get metals in the form of halides."

By the late 1980s, George and his group had thoroughly investigated both processes and patented some aspects of them. "When people begin looking for new capacity in the production of alumina, these processes using indigenous raw materials are going to be quite attractive," George predicts. Environmental concerns may help fulfill his prediction.

TEACHING

Along with his research activities, George taught both undergraduate and graduate unit operations, as well as transport phenomena. And when Morton

Smutz (chemical engineering's successor to G.L. Bridger, who replaced Sweeney) became an associate director at Ames Lab in 1961, George replaced him as department head. The appointment also made him Chief of the Ames Lab's Chemical Engineering Division with its five research groups.

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So for the next seventeen years he taught one section of the introductory materials and energy balance course to sophomores and one section of the plant design course to seniors. "This served a good purpose," George says. "I got to know students coming in and could assess changes in their preparation, and I was also able to see firsthand how these and other engineering courses changed over those years."

George ventured into new territory when Iowa State's chemical and nuclear engineering departments merged. "We occupied the same building; the chair of nuclear engineering, Glenn Murphy, had reached age sixty-five, and back then that meant compulsory relinquishment of administrative duties," George says. "So he took over the Engineering Education Projects Office, and I became head of the Chemical Engineering and Nuclear Engineering Department." George's work at Ames Lab had introduced him to nuclear power, but he admits he was "far from a nuclear engineer."

Iowa State's nuclear engineering program, like most of the programs throughout the country at that time, offered only a graduate degree. Most of the undergraduate programs that did exist had emerged from advanced-degree programs whose faculty came from nuclear science disciplines such as physics and metallurgy. So not only were there too few BS degree graduates to meet industry's demand, but also the graduates there were had learned little about processes. George changed that at Iowa State. "We had a lab that looked a lot like a chemical engineering unit operations lab where students learned heat transfer, fluid flow, and process control," he says. The program was accredited for the full term the first time it was evaluated.

Eventually, chemical and nuclear engineering separated, and a nuclear engineer again headed the nuclear engineering department. Since Murphy had recently died, the Engineering Education Projects Office (EEPO) needed a new director, and George took it on. "I thought of EEPO as a small ASEE," he says, "doing many of the things right here in our college that ASEE does nationally: things such as enrichment of teaching, pedagogical development of faculty, new teaching materials, foundation support for experimental programs, new ideas, and innovations in the area of engineering education."

EXTENSION, OUTREACH, AND SERVICE

Continuing education was one area that George developed in EEPO. "As we began to work on improving teaching, we found good resources on campus as well as outstanding individuals off campus who had good, new ideas and perspectives on ways to teach engineering," George says. At the same time, distance-learning technologies evolved. "Over the years it has become almost a way of life to bring in satellite-transmitted short courses and conferences taught by some of the leading investigators in the country," he says. "It has also led to my interest in the broader aspects of continuing education and bit-by-bit to my present assignments in the college."

That present assignment—associate dean for outreach and external affairs—precludes most research activity. Until going to an associate position at Ames Lab two years ago, George had maintained an active research program there, supervising twenty doctoral and nearly fifty master's students, in addition to his teaching and administration.

All of the above was in addition to George's other activities. "I can still recall the telephone conversation in the early 1960s when George Bankoff, then chairman of the AIChE Education and Accreditation Committee, asked me if I would be an ad hoc visitor for what was then ECPD." Burnet's accreditation experience at the time had been limited to one visit at ISU. "George Bankoff persuaded me that this would be a useful thing to do, and I'm very glad that he did," George says. "He also arranged for me to go on a learning evaluation assignment with Jim Knudsen as team chairman, and I couldn't have had a better mentor-tutor. All this convinced me that accreditation activities offered a good way to use my discretionary time. I could see so many really good things resulting from this work." Among them were appointments to the ECPD (later ABET) Engineering Education and Accreditation Committee and later to the chairmanship of that committee and to the Board of Directors as an AIChE representative and as a member of the executive committee.

In 1965, shortly after O.R. Sweeney died, George invited Eric Walker, shown here, to give the first Sweeney Lecture at Iowa State.

"That involvement has been a very satisfying and important part of my professional life, largely because of the association it provided with outstanding individuals in AIChE," George notes. "Much the same thing could be said for my ASEE experience with its strong interdisciplinary exposure and ideas that were important to my work."

Ray Fahien, a colleague and friend in his early years at Iowa State, sparked George's interest in ASEE. "Ray said I should join, and I'm glad I did," George says. His first national meeting was at the University of Kentucky. The president was Eric Walker, who later was one of the founders of NAE and president of Penn State. "With people like Ray Fahien and Eric Walker to admire, I soon became active in ASEE," George recalls. That activity included serving as national president in 1976.

Another result of his ASEE activity was an invitation to serve on an eighteen-member commission established by the National Science Board to look at precollege education in math, science, and technology. Over a period of two years the commission held hearings around the country, listening to experts' opinions about ways to strengthen precollege education, visiting model programs, and writing a report, "Educating Americans for the 21st Century," to accompany the Department of Education's report, "A Nation at Risk." That report, which came out first, dealt with broad aspects of precollege education. Its extensive media and public attention set the stage for the second report, which George remembers as more focused, more action-oriented, and more specific in the kind of remedies it proposed.

One of the programs that grew out of those recommendations was NSF's Science and Engineering Education Directorate, with its commitment to precollege and undergraduate education. George served on the advisory committee for that new directorate for two years.

HONORS AND AWARDS

George's activities have garnered honors and awards too numerous to list. He was named Anson Marston Distinguished Professor at Iowa State; he was elected a Fellow in AIChE, AAAS, and the Iowa Academy of Science, and a Charter Fellow in ASEE and ABET; he won AIChE's Founders Award, ASEE's Lamme Medal and Collins Award, and ABET's Linton E. Grinter Distinguished Service Award.

George has also served on many awards committees to provide others with the recognition they deserve. "Recognition of achievement is important under all circumstances, whether in your family or your profession," he asserts. "Serving on awards committees is another activity that has so many benefits," he adds. "Just like ASEE and accreditation—the doer soon becomes the benefactor, and not just in terms of personal satisfaction. I benefit from reading about achievements, accomplishments, what others have done, and how they've done it. I've learned a lot just from seeing what other people do and working to emulate them."

Emulate *them*? The citation on George's AIChE Founders Award describes a career others might only dream of: "For being an outstanding teacher and leader in engineering education, influencing education both nationally and internationally, leading an outstanding department of chemical engineering in the production of graduates who have been major contributors to progress in industry and in education, and for his research work in applying chemistry, pyrometallurgy, and coal waste utilization"

George Burnet has had a career to make all his engineering forebears, as well as that high school chemistry teacher, proud. ❐