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Full Circle

Years in industry informs Al Weimer's work in fuels

By Todd Neff

It seems the stuff of fantasy: Take sunlight, add lawn clippings, get green gasoline.

It is, in fact, the stuff of Al Weimer's University of Colorado laboratory, and the product of a process with intellectual roots reaching back to the stuff in super-hard drill bits made by a chemical giant in Midland, Michigan. To understand what drill bits have to do with a most promising form of renewable energy, one must first know a bit about Al Weimer.

Weimer, 55, (Ph.D. '80) is most prominently executive director of the CU-led Colorado Center for Biorefining and Biofuels, or C2B2, a key part of the Colorado Renewable Energy Collaboratory unifying CU, Colorado State University, The Colorado School of Mines and the National Renewable Energy Laboratory in renewable-energy research. C2B2 has a $2 million annual budget, most of which goes to researchers at the various institutions aiming, ultimately, to garner fuel from non-food plants, wood waste, algae or other photosynthesizing sources.

Also a CU professor of chemical and biological engineering, Weimer leads "Team Weimer," a group of 10 Ph.D. students and three postdoctoral researchers, in efforts having yielded two technology startups and the School of Engineering and Applied Science's 2005 Faculty Research Award, among other distinctions.

Catty corner to the 2005 plaque hangs, on Weimer's Discovery Learning Center office wall, the Dow Excellence in Science Award, 1995. It was awarded to one researcher in the 60,000-person chemical giant that year.

Many career academics have smatterings of industry experience; few have 16 years of it, or have risen so far in commerce before making the transition.

Given the gravelly voice and stocky build, one is unsurprised to learn Weimer was the son of a steelworker with an eighth-grade education in Youngstown, Ohio. His father lost his job in the late 1960s, and Weimer remembers his dad delivering newspapers at 5 a.m., driving the morning school bus, sleeping a few hours, driving the afternoon school bus, and then working as a security guard into the night. Weimer's 80-hour works weeks pay a sort of homage to such a work ethic.

"You work with Al and you can expect to get e-mails at 4:30 in the morning at least two, three times a week," said Ryan Gill, C2B2 Managing Director and chemical and biological engineering professor.

Al Weimer earned his degree in chemical engineering from the University of Cincinnati in 1976. He came to CU that year and would earn his Ph.D. in chemical engineering in 1980. He was into energy, in particular coal gasification with fluidized bed reactors, which create chemistry-stoking cauldron of solid particles and gases.

"I had no intention of becoming a faculty member. It never crossed my mind," Weimer said.

At Dow Chemical he continued his fluidized bed work, in particular Fischer-Tropsch processes best known for having kept the German war machine running on synthetic fuel. In Dow's case, the goal was to convert the synthesis gas coming from the fluidized bed – a mixture of hydrogen and carbon monoxide – into alcohols, gasoline additives and other marketable liquids. In the process, Weimer learned how to run industrial-grade process equipment, build and run pilot plants, and to take economics seriously.

"In industry, cost is a big factor, whereas most academics don't have a clue or even care what the cost is," Weimer said.

But he kept a toe in academia, through successive leadership roles in the American Institute of Chemical Engineers and, in his spare time, publishing a peer-reviewed journal article or two a year.

He landed in a Dow scientific group synthesizing super-hard metals by focusing laser beams on gaseous precursors. Weimer told the scientists it would never be economical and could never scale to industrial dimensions. But the product was superb, and they fashioned a graphite tube, heated it to 2,000 degrees Celsius (3,632 F; a temperature at which "steel is a glowing puddle on the floor," as Weimer put it), and found that flowing powder through the tube at high speed, they could get similar results.

Political battles and pilot projects followed, and Weimer prevailed. The rapid carbothermal reduction process now makes the ultra-fine tungsten carbide used to form drill bits for printed circuit board drilling and other high-end cutting tool applications around the world.

The awards poured in. But by 1996, Weimer was concerned with the lack of emphasis on innovation at his employer, and, to no small extent, the U.S. chemical writ large. While applying for a teaching position at the University of Cincinnati, he stopped by CU to round up recommendation letters. They asked him to stay.

Weimer promptly took to applying his industrial and technical expertise, whose essence was particle chemistry in withering heat. He sat in on a talk by CU chemistry and biochemistry professor Steven George, a pioneer in creating ultra-thin films using a process called atomic layer deposition, and suggested applying ALD to particles. In 2001, they spun off a company called ALD NanoSolutions, which, based on CU-developed intellectual property, is developing coatings for everything from space hardware to next-generation batteries. P. Michael Masterson (M.S. 1978), who helped finance the venture, is CEO; Karen Buechler, a former postdoctoral researcher in Weimer's lab, serves as president.

Weimer's career had come full circle geographically; thematically, it was work with NREL that brought him back to his roots in energy. Beginning with a small Department of Energy grant, Weimer and his team eventually developed a system of mirrors to focus sunlight on a cauldron combining zinc and water. It split the water and produced hydrogen. More recent research using atomic-layer deposition has lowered the temperature required to split water to make hydrogen from about 1,600 degrees Celsius to about 1,000 degrees, low enough that standard materials no longer melt into glowing puddles on the floor.

For an encore, they focused sunlight on grass clippings and fallen leaves – known more formally as source-separated green waste. The output was synthesis gas, the same stuff coming off Fischer-Tropsch processes Weimer had honed as a CU Ph.D. student more than 25 years earlier and from which one can make green gasoline, green diesel, green natural gas and so on.

Unlike competing processes, Weimer says, the sun-cooked green fuels are synthesized hot enough (1,200 C) that there's no tar to deal with; what's more, he says, there's no need to burn part of your input biomass to cook up green fuel, which amounts to a 30-percent loss.

In 2006, Masterson stepped in again, founding Copernican Energy with Weimer and his graduating Ph.D. student Christopher Perkins. Weimer says the technique can make a gallon of green gasoline for less than $3.00. The work goes on at CU, Team Weimer having won a three-year, $1 million federal grant to continue refining the process.

"The path to solar thermal hydrogen goes through biomass," Weimer said. "You can use biomass to make syngas through solar, start making liquid fuels and then, eventually, the hydrogen market comes along."

Beyond enabling innovation, Weimer's years in industry has helped students and colleagues understand the need for speed and the ability to scale the technologies they hope to bring to market, said Carl Koval, a CU chemistry and biochemistry professor and executive director of the CU Renewable & Sustainable Energy Initiative. He said Weimer's understanding of how to position intellectual property has also brought major benefits to the university, as has his ability to speak the language of industry.

With C2B2 in particular, "Al could explain the research to these companies and what the value was to them, and that was one of the main reasons they were able to recruit companies into that center." Koval said. "That would've never happened with a pure academic. They wouldn't have known what to say."