DECAGON DEVICES

▲ Decagon team stand in the atrium of the new Hopkins Court building.

Decagon's first product was improvised in 1963 by Dr. Gaylon Campbell, then working as an undergraduate in a Soil Physics lab.

A Frustrating Challenge

Tired of painstakingly calibrating fragile thermocouples with a series of salt solutions only to break them before he could measure a single soil sample, Campbell wondered, "Why can't I keep the thermocouple fixed and bring the salt solutions to the thermocouple instead of the other way around?"

A Visionary Solution

Suddenly inspired, he saw the revolving cylinder of a six-shooter in his mind, with each solution-filled chamber rotating under the thermocouple to be read. After rummaging around in the lab, he found an old brass permeameter, repurposed it, and the thermocouple psychrometer sample changer was born.

Water Potential Defined

A thermocouple psychrometer is a sensor built to measure water potential. Water potential is one of the most fundamental measurements in the study of soil. Like voltage measures energy in electricity, water potential measures the energy of water.

More than just Gravity

Water in soil is acted on by many forces. Obviously, gravity is one of these forces. But if gravity were the only force acting on water, all soil above the water table would be dry.

Powerful Forces of Nature

Water in soil is also moved and held in gravity-defying ways by powerful adhesive and cohesive forces. Water potential quantifies these forces.

A Virtually Impossible Measurement

Water potential measurements are not just important to soil scientists. They are also important

Water Potential, Human Potential

A growing company built by uncommon people.

to plant and animal scientists. But until the 1950s, most researchers thought it was virtually impossible to measure water potential outside a very wet zone.

A Virtually Impossible Solution

Water activity was first accurately measured using a thermocouple psychrometer by D.C. Spanner in 1951. Although Spanner proved it could be done, his method was so difficult—he made his own wire out of bismuth antimony—that others struggled to repeat it.

Better...But Still Difficult

Eventually, researchers found viable, commercially available wire. This made the measurements possible, but still amazingly difficult. It took up to a week to equilibrate the samples, and thermocouples were easily contaminated or broken.

The Secret of Success

Then came Dr. Campbell and his "six shooter" idea. With his prototype sample changer, measurements that had been almost impossible to make became suddenly trivial.

Publication and Propagation

Dr. Campbell published details of the improved thermocouple psychrometer in 1966. By 1979, he had developed a useful thermocouple psychrometer sample changer and had several of them built.

Birth of a Business

Decagon was actually founded by Dr. Campbell's high school aged daughters as a way of earning money for college. They turned selling sample changers into an after school business that eventually grew from its 120 square foot basement space to the current 33,000 square foot building with attached soccer field and in-house slot car track.

Discovering Human Potential

Starting with the Campbell sisters, Decagon has always had improbable employees. It is a company willing to hire a person of ability regardless of resume. Like many small companies, it has been blessed by nepotism and has been fortunate in the contributions of its friends.

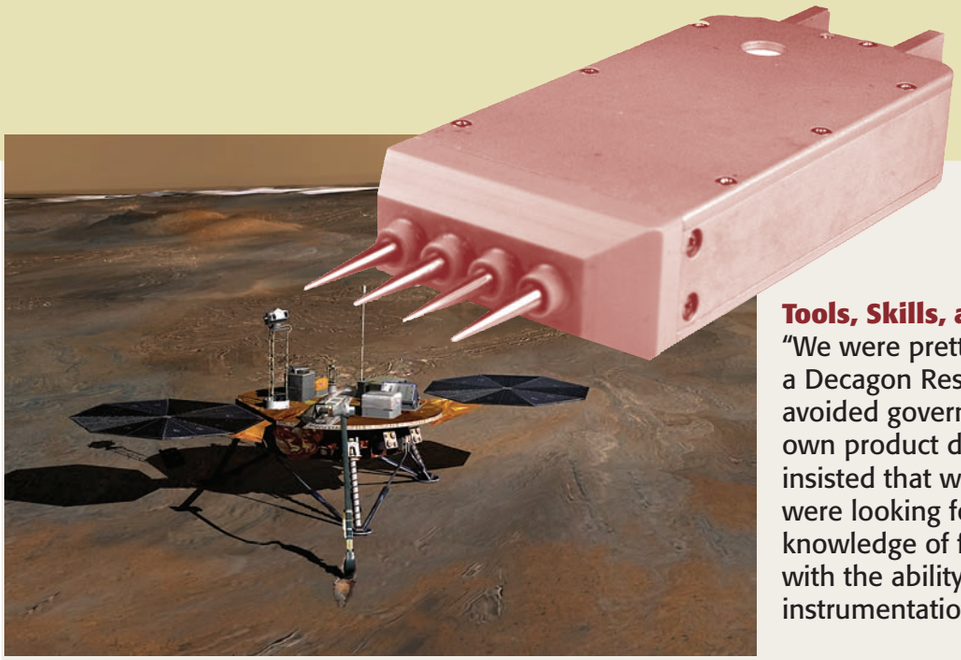
▲ Though Decagon was started by high school aged sisters, the foundations of the company were actually laid by soil scientist Dr. Gaylon Campbell (pictured with wife Judy) and first President and CEO Joseph Harris.

Investing in People Makes the Difference

Decagon today makes sensors that measure many attributes of the world—from transpiration in leaves to thermal conductivity of drilling mud, from the safety of shelf-stable cookies to the permeability of raincoats. But we exist not so much in the quality and breadth of our sensors and instruments as in the ingenuity, determination, creativity, and skill of our past and present employees. They make us believe that this may not be the last time we'll have to move. ■

Knowledge from a dif

With the Mars Lander, our who is done, how things



On August 4, 2007, the Phoenix Mars Lander blasted off from Kennedy Space Center. Next May, Phoenix will—hopefully—set its feet down firmly on the northern polar region of Mars. Soon after that, Phoenix's robotic arm will push four short, fat probes into the Martian regolith and, if all goes well, find quantitative answers to some of our oldest questions about Mars. Those four probes and the instrument that runs them were designed and built by Decagon's engineering team.

But we're Earth Scientists

Decagon never planned to get involved in planetary science. Over the years, earth science has proved enough of a challenge. But when a mothballed Mars Lander was revived, phoenix-style, and given another shot at the Red Planet, NASA's Jet Propulsion Laboratory (JPL) decided to replace one of the instruments on the lander's robotic arm. After seeing Decagon's KD-2 Thermal Conductivity Probe, JPL asked if Decagon had ever thought of putting a thermal needle on a spacecraft.

▲ NASA's Phoenix Mars Lander launched successfully Saturday morning August 4, 2007 at 5:26 AM EDT from Cape Canaveral Air force Station, Florida

Tools, Skills, and Curiosity

"We were pretty reluctant," says Dr. Colin Campbell, a Decagon Research Scientist. "We've always avoided government contracts in favor of doing our own product development, but the guys at JPL insisted that we were just the group of people they were looking for—a company that combined a knowledge of fundamental soils measurements with the ability to design and build instrumentation."

Undaunted by Complexity

In the end Decagon accepted the challenge and hired Dr. Douglas Cobos to head the Thermal and Electrical Conductivity Probe (TECP) design project. Figuring out the complex science of making thermal conductivity measurements on Mars turned out to be the easiest part of the project. The toughest challenges came from having to fit in with JPL's specifications. Because the TECP replaced another instrument, Decagon engineers soon discovered that everything about the TECP's design—from location and orientation to communications protocol—had been inconveniently predefined by the location and protocols of the previous instrument.

Tough Angle

The TECP's orientation on the robotic arm meant that its probe needles would be pushed into Martian soil at an angle. Decagon's KD-2 Thermal Conductivity probes are long,

a different planet … Mars.

our whole perspective on how science ow things can be put together, changed.

thin needles. If they are pushed at an angle, they snap. The needles had to be redesigned—made short, fat, and conical—but that meant a complicated change in the mathematical algorithms that translate electronic measurements to thermal conductivity data. That challenge initially seemed insurmountable.

Compatibility Clashes

Then there was the challenge of using a 12 bit digital to analog converter. The KD-2 used a 24 bit converter. The 12 bit converter reduced resolution by orders of magnitude and was another major hurdle. Then the add-ons started. Originally, the TECP was only intended to measure the thermal conductivity of soil on Mars. But as development progressed, the queries started.

Feature Creep

Could you measure electrical properties? How about electrical conductivity? Humidity? Wind speed? In the end, the little instrument that could became a Swiss Army knife of sensors. And when Phoenix left for Mars, all those sensors were working.

Deeper than Mars

Scientists, at Decagon and elsewhere, are excited about what TECP will tell us about Mars. But here at Decagon, it's interesting to discover what TECP has told us about ourselves.

Freedom to Stretch Ourselves

"It's kind of like when I started running," Campbell says. "I had a set route in town. I would make it longer, run farther, but I kind of had a boundary. One day I went running with a friend and discovered that he was covering a lot more ground—going outside town, running out on rural roads. I never thought you could run that far. Then I realized you're free to go as far as you'd like.

▲ **Dr. Doug Cobos tests an ECH_2O sensor which measures soil moisture, temperature, and electrical conductivity. Improvements to the TECP mathematical model ultimately increased the accuracy and capabilities of Decagon's commercial instruments.**

Expanding Horizons

"With the Mars Lander, our whole perspective on how science is done, how things can be put together, changed. It made me realize that if there's a project we want to do, we have the people and the skills and the know-how. We can accomplish almost anything we want to do if we decide to do it." ■

Unbelievable AquaLab

■ A CONSUMER bites into his Raisin Bran. The flakes are not quite as crunchy as he hoped they would be. The raisin is like a rock. **It breaks his tooth.**

If the raisin bran manufacturer had matched the **water activity** of the flakes and the raisins, the flakes would have stayed crunchy and the raisins **soft and chewy.**

▲ **Decagon customers also use water activity specs to monitor quality,making sure for example that dog food stays moist, plastic doesn'tlook streaky, and the icing doesn't slide off cakes as they defrost.**

Most big—and small—companies measure water activity to assure the safety and quality of their products. In fact, the biggest and most respected food companies in the world check water activity to comply with USDA and FDA safety standards. And nearly all of them use Decagon's AquaLab water activity meters.

AquaLab Gives Fast Results

AquaLab was a revolution—it read water activity in five minutes, and with five times greater accuracy. It was affordable. It could be run—easily—by a lab technician.

Too Good to be True?

In fact, initially one of our competitors' most persuasive arguments against AquaLab was that its speed and accuracy were simply too good to be true. A prominent researcher admitted, "I didn't believe you until I actually did the test myself. I didn't believe that you could do it."

Proving We're Serious

Several leading scientists published peer-reviewed papers verifying that AquaLab did do it. Decagon used to send those papers out regularly to the doubters. For a while, Decagon also used a phone demo. We'd ship the customer an instrument and teach them to use it over the phone. Once a company got the instrument in their hands, they rarely sent it back.

■ A FARMER dries harvested nuts until they contain only 4% water, just like he has for years. He ships the nuts. When they arrive in stores, **they're all moldy.**

If the pecan producer had measured water activity instead of water content, his pecans would have stayed **fresh** and his customers would have stayed **happy.**

You may not have heard of water activity, but you should be glad most branded foods in your pantry are tested for it.

▲ **Decagon's customer service team gets rave reviews:**

" I was very surprised to see our unit returned to us the very next day after my request to expedite the maintenance and calibration ... dealing with outside vendors for calibration and services can often be a headache ... Dealing with Decagon has been a pleasure. "

" We rely on AquaLab to work when we do! And it has not disappointed us! "

Unknown Becomes de Facto Standard

Now phone demos are a thing of the past, and the papers mostly sit in a pile on the literature rack. There aren't many doubters left. AquaLab is the industry standard water activity meter. Competitors still can't come close to matching its speed and accuracy.

We're Ready for Tomorrow

But Decagon's scientists and engineers have never really watched the competition. We're mainly competing for better solutions to still-existing problems in food quality and safety.

Success Repeats Itself

Decagon's new Vapor Sorption Analyzer is set to revolutionize isothermtesting. Until now, isotherms have taken weeks of painstaking work byhand. The VSA generates dynamic isotherm curves within about 48 hourswithout any hands-on work. New capabilities will also offerresearchers the ability to hold a sample at one specific relativehumidity for kinetic testing. ■

■ A WOMAN opens a package of beef jerky and eats a piece. Hours later she is rushed to the hospital, **violently ill.** The jerky was tainted with salmonella.

If the jerky producer had measured water activity, the jerky would have been **safe** and the woman would have been a consumer instead of a plaintiff.

◄ **Every company has it's passion. One of Decagon's is a high-tech machine shop. The shop was originally built to machine prototypes, but when Decagon found itself reworking supplier-made parts to meet quality standards, the shop grew into a full production facility. Most of Decagon's precision parts are produced here.**

" We exist not so much in the quality and breadth of our sensors and instruments as in the ingenuity, determination, creativity, and skill of our past and present employees. "

At age 14, Scott Campbell started his career at Decagon. He was a janitor. His initial attempts to climb the career ladder were not successful. (He asked his boss what he could do to get a raise; the answer: "Actually, I've been thinking of firing you.")

Scott made a better marketer than janitor. By the time he finished college (BS Chemistry, 2000), he was working as Decagon's first International Rep Coordinator. Our reps loved him, and he did a great job.

He didn't stick around long, though. I was so impressed by the fact that he knew where he wanted to go and he knew how he was going to get there. He studied, got the scores and grades he needed, and went to one of the best business schools in the nation.

When he graduated with an MBA from Wharton in 2004, he went to work for PPG, a Fortune 500 company, but I had already started thinking about how to get him to come back. He did some consulting work for us, and it was obvious that he had the super-skills we wanted. He had a plan for the company and a way to get there aggressively.

Scott will become our new President and CEO on January 1, 2012. He has a strategic vision for Decagon's future and an assertive, no-holds-barred approach to attacking problems. Our reps who knew him as an undergrad are excited to know he's back, but they can't be more excited than I am.

I look forward to going where he plans to take us and give him my full support.

Sincerely,

Tamsin Jolley
President & CEO

DECAGON DEVICES

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