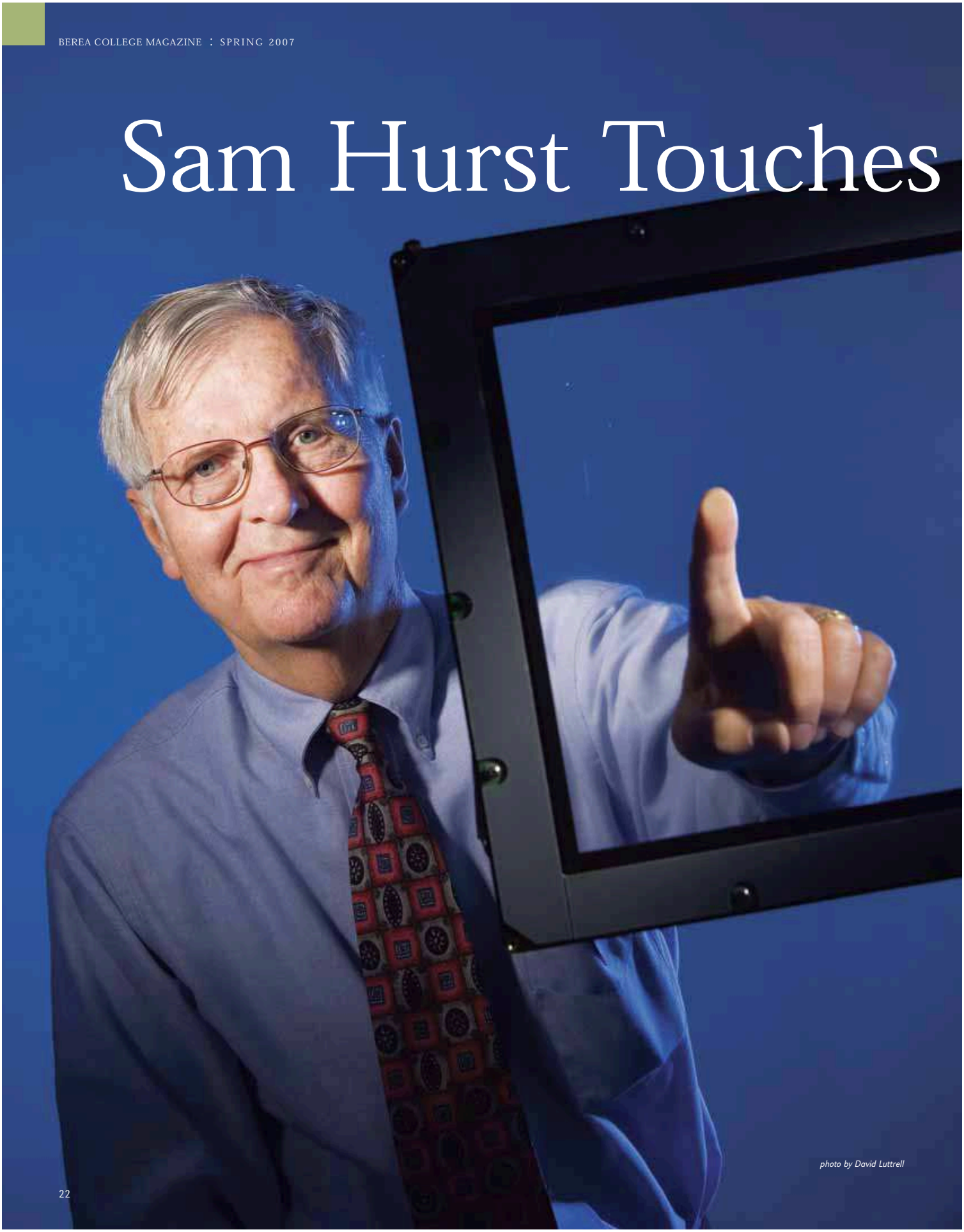
Sam Hurst Touches



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on a Few Great Ideas

By Normandi Ellis

The father of one-atom physics and the inventor of today's omnipresent touch screen technology, G. Samuel Hurst, '47, let curiosity lead him. In the process, he created a technological revolution that has changed the way we interact with our world.

In southeast Kentucky, between the Cumberland and Pine Mountain ranges, nine miles east of Pineville where Yellow Creek runs into the Cumberland River sits Ponza, a little community beside the CSX railroad. There in 1940 lived a boy with bright blue eyes and a mind full of questions. He was the kind of boy who wanted to know how things work – the kind of boy who sought answers. With his cousin Earl Jones, Sam 'invented' the submarine for exploring ocean depths. Imagination and fantasy were all they had for amusement in those days. And because he was curious, a whole world awaited his discovery.

Growing up in the heart of Appalachia, G. Samuel Hurst, '47, never lacked for learning experiences. In fact, his love of science began right there in Bell County. Fascinated by the notion of radio waves, Hurst and a friend built a radio transmitter. He shocked his mother when he transmitted his own voice to her Sears Silvertone radio. From the manager of the train yard he learned how the pumping station worked and how to "stoke the furnace, boil that water, and make the pumps work."

All of his later accomplishments, including his more than 30 patents in the fields of radiation detectors, touch screens, and resonance ionization spectroscopy (RIS), began in Ponza. It was a matter of developing his innate curiosity. Some evenings, Sam says, he waded across the Cumberland River to sit on the porch of his high school math teacher, Charlie Taylor. The two spent evenings talking about the stars. "He saw something in me that I didn't see in myself," Sam muses.

Sam speaks with a measured mountain drawl punctuated by an elfish grin. As his wife, Betty Partin Hurst, '50, listens to Sam's story, she says sensibly, "There was a road there you could have walked on, Sam, and crossed at the bridge. You didn't have to wade through that river."

"Well," he replies without missing a beat. "That was too far. His house was just across the river from mine."

That's how it is when you crave an answer.

Berea and Dr. Waldemar Noll

At age fifteen Sam left Bell County to attend Berea College where soon enough he met Betty, also from Bell County. "I'd seen her in the ice cream shop in Pineville," he says, "but I had never had the courage to talk with her."

"He kept trying to make an impression on me," Betty explains. "We weren't supposed to have music in the dorm, but Sam made me a radio."

"A battery operated radio," Sam adds, "to get her attention."

The radio became the conduit to his two loves—Betty and science, but it wasn't until he came to Berea that he learned more about radio's electromagnetic waves from physics professor Waldemar Noll. Professor Noll encouraged his students' curiosity. He and his students invited the campus to science open houses. A welcome sign with visual and sound effects operated by an invisible light beam greeted visitors entering the building.

"We made Dutch tear drops. Do you know what they are?" Sam asks.

I shake my head 'no' and Sam explains enthusiastically.

"If you melt glass, and let drops of it fall into cold water to solidify quickly, you will get a spherical thing with a tail on it. If you beat the spherical part with a hammer, it won't break; but to gently tap the tail would shatter the whole thing." He patiently explains the concept of crystalline structure and how the molecules are packed.

The discussion moves into Dr. Noll's x-ray machine. "Students loved looking inside things—looking at their bones and so forth." Now, Sam moves into a discussion of radiation exposure, its effects on humans, and the facets that were not known when he was a student in the years following the end of World War II.

Sam Hurst also has a passion for looking into things deeply. Dr. Waldemar Noll taught him that "Everything is a hypothesis. Keep your mind open. Dr. Noll was one of the wisest people I've ever known and he stimulated deeper thinking."

Inside an Inquisitive Mind

After receiving his bachelor's degree in physics, Sam earned his master's in 1948 at the University of Kentucky (UK) and his doctorate from the University of Tennessee in 1959. Innate curiosity propels him. "In my mind, I am always trying to invent something," he says. "I try to find a solution to basic problems of physics. I like a variety of things, but, fundamentally, it is curiosity."

Not only has he developed touch screen technologies, Sam Hurst has been honored for advances in neutron and gamma ray dosimetry, the transport of electricity through gases, and the development of laser-based one-atom detection. For 33 years he worked primarily at Oak Ridge National Laboratory (ORNL). Being part of a collaborative research team exhilarates him. He recalls with pleasure his years teaching at UK, working at ORNL, and then founding several start-up technology businesses (including Elographics, Consultec Scientific, Atom Sciences, Pellissippi International, and a current business, TopoTec). He quickly names the many talented individuals, such as Bruce Warmack, Rufus Ritchie, and professor Don Bouldin who helped to develop these ideas.

"Whatever praise I have received," he says, "relies upon the good work of my colleagues."

Among them he cites theoretical physicist Marvin Payne, '58. He and Sam had similar ideas about both atomic physics and the use of lasers in RIS. "Marvin could calculate a problem entirely in his mind," Sam muses. "We rolled out ideas, and Marvin could evaluate them in real time; thus, we made rapid progress."

Other Berea alumni come to mind, including two student researchers – Robert Compton, '60, and Jim Parks, '61. When Hurst accepted a research teaching post at UK in Lexington, Kentucky, Parks went with his mentor to work on his doctorate.

The World at One's Fingertips

To study atomic physics the research team used an overworked Van de Graff accelerator that was only available at night. Tedious analyses slowed their research. Sam thought of a way to solve that problem. He, Parks, and Thurman Stewart, another doctoral student, used electrically conductive paper to read a pair of x- and y- coordinates. That idea led to

Sam Hurst, as a boy in Bell County, Kentucky

the first touch screen for a computer. With this prototype, his students could compute in a few hours what otherwise had taken days to accomplish. And they did not know that they had created a new industry.

UK applied for the patent on their behalf, but scientific applications for their brainchild proved "a dismal failure," Sam recalls. No market yet existed for such a product, but the idea did not go away. "I thought it might be useful for other things."

Sam returned to ORNL in 1970. Privately he gathered nine friends – experts in their fields. They began an after-hours basement business called Elographics. "We got the idea that if we could put a touch screen on a computer monitor one could interact with a computer just by touch." The touch screen has now put computer technology into the hands of consumers in shopping malls, in grocery stores, and in banks. The idea of it excited him, not only for its technological evolutions, but for its sociological implications. One need not be technologically savvy to access necessary information.

"You could just look at a screen, poke your finger, and get an answer," Sam explains. "Anybody can poke a finger!"

An important trick was to create a conducting cover sheet that could contact a transparent substrate along the x- and y-axes. The question was what to place between the screen and the conducting sheet to prevent accidental contacts. Sam found his answer in the intuition of his most long-standing collaborator—his wife, Betty.

"She came up with the idea of a bridal veil," Sam says.

While Betty has little background in physics, she listens to her husband think aloud. "He talks to me as if I understand what he means. Every day he talks to me about this or that."

Sam nods. "She comes up with things that I should have thought of already," he says. "Her name should have been on that patent…"

"Well sure, you say that now!" Betty exclaims and laughs.

Elographics eventually sold to "good folks in California" and became EloTouch, Systems, a world leader in touch screen technology. Last October the company celebrated its 35th anniversary, coincidental with Sam Hurst's 79th birthday. Running a business, however, is not his motivation. For him, "Science is more interesting than technology. All of technology comes out of science, and I wanted to stick with science."

The World in a Grain of Sand

After Elographics began, Sam kept working in the laboratory at ORNL. "I just love research and I was trying to find something new."

He had already worked with another collaborator, Rufus Ritchie, a Kentucky

President Jimmy Carter greets Dr. G. Samuel Hurst during a tour of Oak Ridge National Labs in 1978.

mountain boy like himself. Soon after the end of the Second World War, the two studied the effects of radiation on the environment and human health. They became experts at determining the dose of radiation exposure received by people at such sites as Hiroshima and Nagasaki, as well as those who were present during accidental leaks in research facilities such as Oak Ridge, in Yugoslavia, and elsewhere.

By 1978 Sam wanted to find a way to detect atoms. Geiger counters, for example, only count decayed radioactive uranium. The Oak Ridge group searched for a way to detect atoms without relying on their being radioactive. He and Marvin Payne found a way to tune a laser light to detect individual atoms in gaseous phases. With RIS, tuning a laser light resembles tuning a radio to a particular frequency – a resonance must be established between emitter and receiver to remove an electron in a multi-step process from a selected type of atom.

Out of billions and billions of atoms, the team could find one particular kind of atom. Lasers were the key to counting atoms, and elements could be identified by the color, or the wavelength of the light they absorb. "Personally," Sam says, "solving that problem, and then using the RIS process to solve a long-term physics problem addressed by the famous Danish physicist Niels Bohr gave me the most satisfaction of any of my work as a physicist."

His work with Atom Sciences, the company he co-founded in 1978, created the opportunity literally to see the world in a grain of sand. As a matter of fact, a grain of sand holds more than a mixture of the silicon and oxygen that make up quartz. Inside a grain of sand a scientist may find at least one atom from nearly the entire table of elements.

Why would a person want to count atoms?"

The reasons are as fascinating as they are diverse. Among the other possibilities, one-atom physics will allow us to:

- find impurities in smaller and smaller electronic chips so that future problems may be circumvented
- count a few noble gas atoms in physics research, such as detecting neutrinos from the sun
- draw less blood to sample when preparing for neonatal surgery
- identify traces of food allergens, such as peanuts, in products
- identify trace amounts of precious metal, minerals, or elements in streams of water
- study issues related to global warming using core samples of polar ice
- detect environmental pollutants caused by radiation, global warming,

or other effects of chemical or human waste
- find trace elements in the body, in the environment, in space, and on other planets
- determine the age of the planets, stars, and galaxies to find the origin of their matter.

If a scientist could identify a substance down to a single atom, if he could verify that it does, or does not, contain a particular element, then the chemical composition of everything could be entirely known. Truly, one could peer beyond the surface of things.

A World of Ideas and Imagining

Sitting in his sun room in Knoxville, surrounded by green plants and bathed in light, Sam places on the coffee table between us a much read copy of *On the Nature of Things* by Lucretius. This didactic poem, written in 50 BC to develop the philosophy of Democritus (460-370 BC), suggests that the universe is composed entirely of *atmos* (a Greek word for atoms) dancing in an infinite void. Democritus theorized about the movement and varieties of atoms and atomic weights, but, Sam says, "It was all speculation. The Greeks got their idea of atomism from ordinary observations. The Greeks were not known to be experimentalists – but they were astute observers of nature.

"After we began counting atoms," Sam says, "I went through and compiled 100 quotations from Lucretius that applied more or less to modern atomic concepts. I was shocked to find that many references."

I am intrigued that Sam marked them all.

"What so amazes me," he continues, "is that centuries later many of those vague ideas were suggestive of modern concepts."

Our talk begins bouncing faster than a laser light from science to religion, then back again. In the world of Democritus, there were either atoms or there was the void. There was no in-between. Thus, came a conflict with religious ideas. Sam and I talk about free will and determinism, and whether Lucretius or Democritus gave that any thought. Lucretius, it seems, provides us with a notion that atoms might 'swerve' a bit in order to avoid colliding. Sam finds the passage in Lucretius about the atom's weight determining its path as it falls. "That swerving," Sam explains, "relates to the uncertainty principle in quantum mechanics."

The talk returns to science, but suddenly swerves from Einstein to Spinoza. I'm beginning to feel a bit like an electron swerving myself, frantically trying to cling to a premeditated orbit around a nucleus.

"Spinoza was a determinist," Sam explains. "Einstein accepted this thought. He didn't believe anything about chance phenomena or quantum mechanics. Even though he developed a lot of what became quantum mechanics, Einstein didn't


Samuel Hurst and Betty Partin Hurst in their Knoxville home.

believe in it. To me, it's this aspect of chance that gives us free will." Sam pauses to let that sink in. "If everything were predetermined, we'd have no influence on it; if everything were totally probabilistic, then we wouldn't have any influence on it either. But if it's a mix of the two – chance and determinism – then you can influence one over the other."

I nod and stare at Sam's wall where a poster of Einstein superimposed on a geometric cube hangs. I remember a quote by Einstein in which he says, "Science without religion is lame; religion without science is blind."

Before I know it we are talking about teleporting information in real time – faster than the speed of light. Sam asks me to imagine scenarios in which it might be useful to teleport information to Mars, or to the other side of the world. How far away are we from that type of technology? Would you be surprised to find that Sam is writing a paper on the subject?

"Just Google the words 'quantum teleportation' on the web. You'd be surprised what you'll find. Physicists can already teleport atoms." He gives that twinkling-eyed smile of his.

Here, I thought I had come from Berea to Knoxville to interview the man who invented touch screen technology. Somehow, instead I find myself sitting on the edge of his sofa on the brink of what can only be described as a Star Trek moment. This mild-mannered techno-wizard has sent me scrambling to look up atomic poems by classical writers then refers me to internet articles on quantum mechanics and the current work of teleportation. I almost feel tiny atoms inside me accelerating and whirring at a much faster pace. I feel practically giddy. I wonder if these are the types of things that wide-eyed boy and his teacher in Ponza might have talked about while sitting on the porch and counting stars.

Back in the Moment

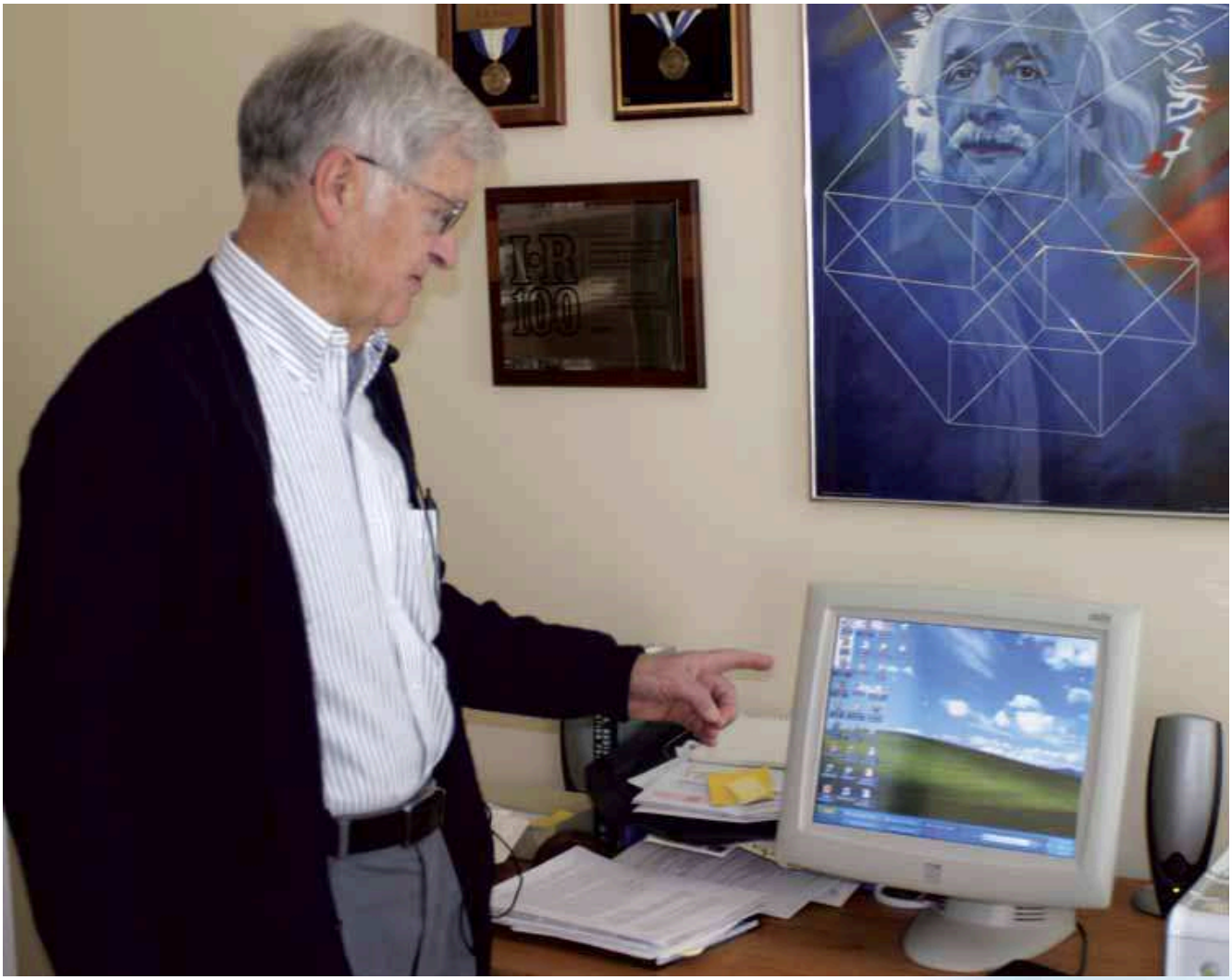
Sam has never really retired. "It's almost a shame to sit around," he says, "because now I have all the time to work on these ideas."

Betty nods in agreement. "He has all these new patents he's working on. He is still having fun."

The wide swath of his curiosity extends in many directions. He meets regularly with a local group to discuss science and religion. He and longtime collaborator, Rufus Ritchie, among others, continue creating advanced touch sensor technology with their company, TopoTec.

Increasingly, the market demands more user friendly equipment. Multiple touch screen technology could fill some of that need. "At present we live in an awkward age of technology." From his chair in the sun room, Sam gestures toward his cable television, digital video recorder, his CD and stereo speakers, the desk model computer screen, and tower.

"In a few years from now, it all will be user friendly," he assures me, "so you won't have to program them all separately. You



Normandi Ellis

Although he has retired, Dr. Samuel Hurst stays in touch with colleagues and industry developments via his home computer.

might not have to leave your high definition television to be able to turn on your microwave and start dinner from your easy chair."

As technology moves apace, many high-tech companies compete for a market share. Apple and TopoTec came out with their patent application for their multiple touch technology on the same day; however, TopoTec's patent disclosure beat Apple's by a month. "It's not uncommon when you get a new idea for someone else to get the same idea." Once scientists set the stage through basic work, the timing for invention and commercial application is right.

Technological advances occur in three steps: discovery, invention, and application. "Most scientists stop at the first step. They forget about inventing in some cases because of their excitement about pure research." Sam says. If one follows all three steps, one moves out beyond science and into entrepreneurship.

Sam envisions a market in which advanced touch screen technology can bring jobs and education to Appalachia. For an out-of-work coal miner or a student in an isolated region, the world could exist at their fingertips. "I can imagine a hundred applications," he says. "Using touch screen, you could get to the internet more quickly and with less confusion. You'd have to learn less about the computer and have more time to learn about the subject you're interested in."

Before leaving, I leaf through a few photographs that document Sam Hurst's multifaceted life. I am drawn to the image of that young boy with a safety pin to hold up his galluses. His pale blue eyes stare straight into the camera. Did that boy ever imagine that he'd shake hands with a president and try to explain to him solar neutrinos? Or was that boy simply looking, as he always has, with curiosity about how things work.

What drives him to work on a problem when others might have quit, I ask. Sam has a ready answer. "The biggest thrill is to discover something new and to realize at that moment you're the only one who knows."