DUNCAN EARL CAN MAKE YOU SPEND MORE MONEY. He can also make you work harder to earn it. A little sun, a little plastic, a little ingenuity cooked up at Oak Ridge National Laboratory—that’s all it takes.

Dr. Earl is chief executive officer of Sunlight Direct, a company that harnesses natural light to boost consumer sales for retailers and productivity for employers. He was working in ORNL’s Engineering Science and Technology Division when an idea came along that would ultimately send him into the private sector.

“There was a project for hybrid solar lighting that was funded by the Department of Energy. It was just in the conceptual stage,” he said. “About 30 percent of commercial building energy usage is associated with lighting . . . and the Department of Energy wanted to find a way to offset that.”

Because most of that energy is used during daylight hours, the obvious approach was finding a way to use natural sunlight instead of electricity. The idea, he explained, was “to develop alternative ways for getting daylighting in where you could deliver the benefits of natural lighting but the convenience of artificial lighting.”

Jeff Muhs of ORNL was the catalyst for the work. He was the project’s principal investigator and led the development of the HSL technology. The endeavor began in 1996 in what he called the “cartoon phase—(when) all you have is an idea.” The funding followed in 1999, after which development took off. Dr. Earl came in on the technical side, helping build a prototype.

“He’s one of those unique individuals who can cross over from scientific discovery to implementation,” said Mr. Muhs, who is now a legislative fellow and scientific advisor to Senator Lamar Alexander. “He deserves a lot of credit for the success of the program.”

Hybrid Solar Lighting

If you ask Dr. Earl what HSL is, his answer is short but descriptive. “We’re basically piping in sunlight,” he said.

The system borrows from both natural and man-made energy.

“We have a solar collector that’s mounted to the roof,” he explained. “It’s tracking the sun and concentrating all of the sunlight into a bundle of optical fibers. This is the same type of stuff you get at the fair,” he said, smiling, as he grasped a handful of plastic fibers. “It’s not really too high-tech.”

The fibers pass through the roof and are distributed just like electrical wires to special lights called hybrid luminaires. They look like regular light fixtures, but they have an extra element—a piece of plastic with micro-etches that scatter the light and mimic a fluorescent tube.

“In the hybrid luminaire we have artificial light and we have the sunlight—they’re blended together,” Dr. Earl said.

A daylight harvesting sensor monitors the room intensity. When sunlight brightens a room, the system dims the artificial light.

When cloud cover masks the sun, it revs up more electricity. The set-up requires a relatively flat roofline, and can light a one-story building or the top floor of a multi-story structure.

“Fibers only run so far,” he explained.

In roughly five years ORNL developed a system mature enough to capture the attention of utility companies, as well as other businesses. The project generated enough interest to make Dr. Earl believe that HSL technology had a niche in the commercial market. ORNL granted him entrepreneurial leave to pursue the idea.

“It’s something they’re really encouraging now at the national laboratory, ever since UT-Battelle took over,” he said. “They allow you to work part-time at the lab… and the rest of the time you can work at your small business. It’s a real generous arrangement.

“This technology was invented by the lab and they patented it,” he explained. “I had to license that patent, and they own a portion of my company as a result. So they’re really interested in seeing my company succeed.”

Selling Sunlight

Sunlight Direct became a viable business in November 2004, when Dr. Earl spun out from ORNL and sold about 10 HSL systems. Tech 2020 in Oak Ridge provides the company with office and production space. (Tech 2020 is a nonprofit public-private partnership that draws from technology resources in East Tennessee to launch private sector endeavors.) Dr. Earl is the CEO. The president is John Morris, who co-founded NetLearning, a company that sells online training systems to hospitals.

Currently Sunlight Direct is beta testing, mainly at utility company sites. They also have systems at a Wal-Mart in Texas (with ORNL as a co-sponsor) and at Opry Mills Mall in Nashville. The Tennessee Valley Authority is sponsoring a system at the American Museum of Science and Energy in Oak Ridge. Each beta system costs about $24,000 and illuminates 1,000 square feet.

“That cost should be coming down pretty quickly,” Dr. Earl said. The benefits of natural light make the system attractive to a range of clients. Retailers like the fact that shoppers spend more money in natural light, and products look more tempting.

“If you’re a sales jeweler, so you’re lighting your products, you want those to look the very best,” Dr. Earl said. “Diamonds, for example, look a grade better under natural light than under artificial lighting.

“We don’t just do fluorescent lighting,” he continued. “We can do track lighting, accent lighting . . . we integrate this with their conventional electric spotlights. It’s premium lighting. If you want the best lighting system money can buy, this is it.”

Studies have also shown that employees’ productivity increases when they’re working in natural light as opposed to a purely artificial environment.

Commercial applications are the best fit for the technology, although there have been limited experiments in the residential realm.
“There has been a residential unit done,” Dr. Earl said. A few years ago, ORNL worked with the University of Virginia on a system for a solar decathlon. It was smaller than the beta units, lighting only a couple of bedrooms. And because concentrated sunlight is a power source, there are necessary precautions that preclude it from home use at present.

“The main reason we don’t offer a residential system is safety concerns,” Dr. Earl said. “It has to be installed properly and maintained properly. Until we understand all aspects of the technology and the safety concerns, I don’t think we’ll move into the residential. Commercial is a great setting because it’s a very controlled environment. You can maintain the product when it’s out there. That’s where we want to start.”

As the costs for the system come down, he said the company would like to expand into schools and industrial sites. That will mean staff additions for the company, which is fully self-funded. Publicity via Forbes, Popular Science, Scientific American, MSNBC and the Discovery Channel has also helped generate investor interest.

“In the last four months we’ve tripled our number of employees,” Dr. Earl said. “That means we’re up to three.”

He hopes to add more staff within the next six months, and sees great potential in the company beyond the current system.

“Right now we can put a photovoltaic on our solar collector platform,” he said. “We can generate electricity with five times the cost effectiveness of current photovoltaics, mainly because we’re concentrating the light into a small area so it takes a smaller photocell. So once we get all these units on rooftops, then we can come back, put photovoltaic units on it, and now we’re generating electricity. What’s really neat about this technology is that lighting is really just the first application,” he continued.

Right now they’re concentrating on the visible light, not the infrared.

“We collect it too, but we don’t put it into the fibers,” he said. “It’s waiting for our next product.”

**From Summer Program to Entrepreneur**

Dr. Earl is no stranger to following the next new thing. His father was in the military and consequently he lived in Italy, Germany, and Greece before moving to the United States at age 16. The transition wasn’t really all that difficult, as he had family in East Tennessee and spent a lot of time here.

“We visited a lot,” he said. “It was kind of funny; for vacations we’d leave Venice and places like that and we’d come to Grainger County, Tennessee. We loved it. I thought K-Mart was the coolest.”

He enrolled at UT, where he was introduced to the national laboratory through a Science Alliance Summer Research Fellowship. He earned a bachelor’s degree in engineering physics in 1993. After graduating, he started working at ORNL while pursuing a master’s in physics. When he finished the degree in 1997, he thought he was finished with school. But Dr. Al Trivelpiece, who was ORNL Director at the time, saw some of the young scientist’s work and suggested he go back to UT for a doctorate. The national laboratory paid his full salary for two years while he started working on his Ph.D., which he completed in 2004. He and his wife Jamie had their son, David, during that time.

“I finished my Ph.D. when he was between birth and one year old, so that made it extra challenging,” he said good-naturedly. “There wasn’t a lot of sleep during that period.”

He also chose to go in another direction with his doctoral work. “I switched from physics to electrical engineering because I wanted something a little different,” Dr. Earl said. And having options is part of what attracted him to the sciences in the first place.

“I come from a long line of soldiers,” he said. So when I wanted to be a physicist, everybody sort of looked at me like, ‘What do you do with this?’ I had exactly the same question. The Science Alliance was my first exposure…at the national lab, and I really kind of got a flavor for what you can do. The thing I liked about it was that you could do so many different things and you could change. This is a good example of that. I never thought I was going to be doing a solar-related technology, but that’s where it went.”

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**In the right light, at the right time, everything is extraordinary.**

-Aaron Rose