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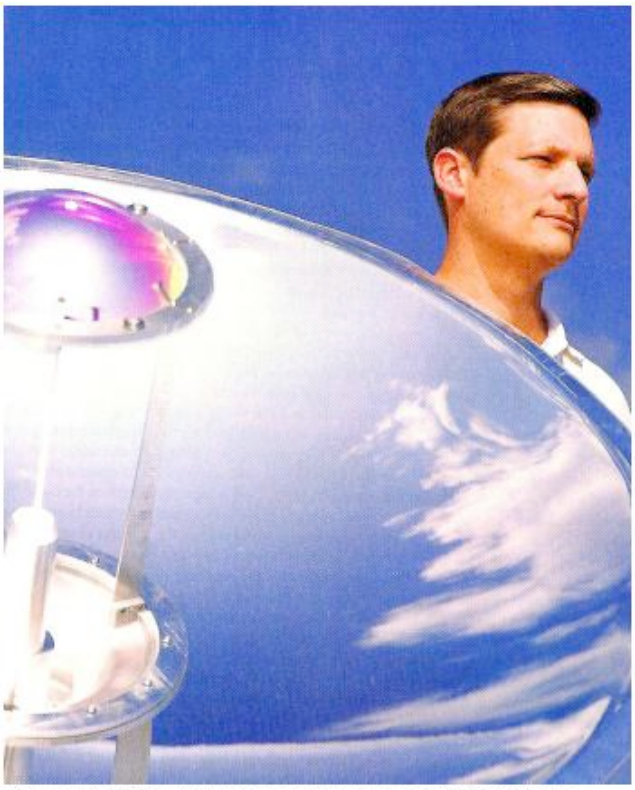
The Control Of Light

Scott Woolley, 10.31.05

Thomas Edison made a good start, but he really didn't get the whole picture with artificial light. He missed the nanotechnology angle.



Duncan Earl (Sunlight Direct) says his new system is far more efficient than lights drawing solar power from photovoltaic cells. These convert photons to electricity and electricity back to photons, wasting 98% of the sunlight's original energy.

Walking outside into the bright San Diego sunlight, Gregory Heinzinger flips open a pair of cell phones. The glare renders the screen of the first, a regular phone, unreadable. But the other phone's display, which uses the latest in nanotechnology, remains stunningly vibrant even in the sun, as bright and clear as a typical cell phone is in a dark room.

The new phone screen, built by a company called Iridigm that was acquired a year go by Qualcomm for $170 million, is a sign of the dramatic leaps being made in our ability to manipulate light. The new Qualcomm displays, due in regular phones and handhelds within two years, employ microscopic mirrors that move just a few hundred nanometers to reflect precise wavelengths of light, generating up to millions of colors instantly. By recycling existing light, the new displays operate with a tiny fraction of the battery power guzzled by traditional liquid crystal displays (LCDs), which are often the single largest power drain in a cell phone.

Heinzinger, who oversees display technology at Qualcomm, says that the new screens are perfect for the coming era of video cell phones. They'll help extend battery life by one-thirdfrom today's standards. In a dark room they will still have to rely on a battery-powered light, but will work just fine in a decently lit office. "LCDs fight the sun," says Heinzinger. "We use it."

Many of the recent technological developments involving light have to do with its use in storing or transmitting information (as in DVDs and fiber-optic cables). Now it's time for scientists to resume the work that Thomas Edison began, to illuminate the world for the human eye.

Mark Miles, an MIT-trained engineer who invented the Qualcomm cell phone screen, drew inspiration from the iridescence of butterfly wings and peacock plumage. Manipulating light to create beauty and thus attract mates is an old idea in nature. The animals' array of hues are the result of a clever evolutionary trick, tiny bubblelike cavities that reflect specific wavelengths of light.

By 2001 Miles had raised $18million to develop a micromechanical array of pixels that flutter open and then close to reflect colorful ambient light (see box, below) the way butterflies do. Eventually, he says, such biomimicry technology will take over the "skins" of everyday items like cars and laptops. "You can make all these things dynamic displays, not just to convey information but to look better," he says. "In the same way you download a ring tone, you will be able to download a look."

Besides looks, light science offers the prospect of efficiency--millions of barrels of oil saved. Lighting gobbles 22% of the electricity used in this country and bulbs are, for the most part, horribly inefficient at converting electricity into visible wavelengths. Edison's incandescent bulb runs at an efficiency of scarcely 2%. More precisely, it converts a watt of input power into only 10 to 15 lumens of illumination, whereas if every bit of the juice were turned into green photons (the color to which the eye is most sensitive), the output would be 683 lumens.

Fluorescents can do 50 to 100 lumens per watt, sodium vapor lamps as much as 180. Newly promising: light-emitting diodes, or LEDs. These devices, which contain semiconductors, emit a specific color based on their chemistry. Red and green LEDs have been around since the 1960s, but the introduction of blue LEDs in the late 1990s created the possibility of blending them into white light. Five years ago LEDs couldn't even match the efficiency of Edisonian bulbs. Now they are up to 45 lumens per watt. The Department of Energy expects LEDs to reach 150 lumens in six years; many LED scientists expect the number to be even higher. The light will also be far more pleasing to the eye than fluorescent light.

Traffic lights in dozens of U.S. cities have already swapped out regular bulbs for long-lasting LEDs. Qantas Airlines, the Australian carrier, has installed LEDlighting in its first- and business-class cabins, to soothe and refresh passengers on 20-hour-plus trips. Wal-Mart now lights some of its freezers with LEDs, which run cooler than regular bulbs.

E. Fred Schubert, a professor of engineering at Rensselaer Polytechnic Institute, is working on making LEDs smart enough to communicate. Since they have the ability to turn on and off rapidly, they can convey information to remote sensors in a sort of light-speed Morse code, while appearing to the human eye to be unblinking. Stoplights could warn a car if its driver is about run a red light; a brake light on the car in front of you could alert a sensor in your car to an impending collision faster than your eye could warn your foot to hit the brake.

"Edison asked: ‘How can I create light?' Now we are asking: ‘What kind of light should we create?' It's a very different question," says Schubert.

A company called Sunlight Direct has already found the perfect light source--the sun. Its system ships real solar rays indoors, without passing along the sun's heat and harmful ultraviolet rays. A curved mirror located on the roof and linked to a global-positioning satellite tracks the sun's location. The mirror focuses sunlight into a bundle of fiber-optic cables, which carry the light indoors.

Sunlight Direct Chief Executive Duncan Earl says his new system is far more efficient than lights drawing solar power from photovoltaic cells. These convert photons to electricity and electricity back to photons, wasting 98% of the sunlight's original energy. "That's a real shame. If we could just bring that daylight in directly, we could offset a lot of that energy usage," says Earl, who first helped develop his company's technology at the Oak Ridge National Laboratories. His system can deliver 50% of the sun's light indoors, though it starts to peter out after traveling through 30 feet of fiber-optic cable. Wal-Mart plans to test the new light source in its McKinney, Tex. store.

The big stumbling block is cost:Right now a single sunlight collector that can illuminate 1,000 square feet is around $24,000. Utility savings, even in a place like Hawaii that combines bright sunlight with stiff electricity costs, would only be $3,000 or so a year, meaning it would take eight years to pay back the original investment. Earl says that the costs of the system will drop to $12,000 by next year.

People naturally prefer sunlight to artificial light, Earl points out, especially retailers, since bad light can make merchandise appear off-color. Most people simply never notice how poorly lit most of their world is, says Earl, and will be pleasantly surprised by the coming improvements. "This is better than any light you can buy," he brags.