Technology

A sight for shadowed eyes

Night-flying insects, such as fireflies, and many deep-sea creatures, including various worms and crustaceans, have remarkably sensitive visual systems for detecting faint, fleeting flashes of light (SN: 3/12/88, p.167). Studies of such eyes have led biologist Jerome J. Wolken of Carnegie-Mellon University in Pittsburgh to develop a new kind of lens that appears to capture light more effectively than most commercial lenses now available. This lens offers the possibility of improved vision for people suffering from the dimming effects of cataracts and other ailments that decrease the amount of light reaching the retina. The lens also could function as a light gatherer for a solar collector or as a fast photographic lens capable of producing high-contrast, high-resolution images at very low light levels.

Wolken's lens is the result of a long development process that combined observations from numerous animal studies with computer modeling. "I arrived at an ideal lens for collecting the maximum amount of light in the environment," he says. The lens itself is roughly pear-shaped with precisely computed and crafted curvatures. It takes in a wide field of view to produce a sharp, reduced image. The lens size depends on its application.

As an aid for persons with impaired vision, Wolken's lens is combined with a carefully matched convex lens for magnifying the image and a prism system for ensuring that the image is correctly oriented. This optical array is placed inside a tube about 1 inch wide and 1.5 inches long and mounted in an eyeglass frame. Although magnifying lenses that function like telescopes are already available for the visually impaired, Wolken's more compact and less obtrusive system is the first based on the optics of increased light sensitivity.

Preliminary clinical studies and other tests indicate the lens functions quite well, says Wolken. Much more work is needed to develop ways of manufacturing the lens and to test it more extensively. "It's an unusual lens," says Wolken, "but this work is just a sidelight to my main interest in tracing the evolution of the eye."

Flexible poles for monumental movements

The construction of the pyramids and other monuments in ancient Egypt often required the moving and lifting of massive stone blocks. How that was done – in a civilization that lacked simple machines such as the pulley and wheel and could not depend on domesticated animals for power – has long been a mystery. Now John Cunningham, a professor of design and sculpture at Skidmore College in Saratoga Springs, N.Y., suggests that the Egyptians may have relied on long, slender, flexible poles to help do the work of transporting and raising heavy objects. His proposal appears in a letter published in the March 3 NATURE.

The idea is to support the load on a set of parallel, evenly spaced rods long enough to extend beyond the load's edges. Each rod would bend according to the amount of force exerted directly on it. A single person could gradually lift the load by first raising the end of one rod to a new height, say, a fraction of an inch higher, then placing a support underneath it. The entire load moves up; the rods that haven't yet been shifted straighten slightly; and the one that has been lifted is bent a little more.

Applying this operation successively to all the rod ends elevates the load by the same distance that one rod is lifted – a divide-and-conquer strategy for coping with a massive weight. Using more rods under a given load makes it easier to lift each rod end. In contrast, rigid levers used for the same purpose would have to bear a large part of the full load at each step, making the lifting much more difficult. To demonstrate his idea, Cunningham orchestrated the lifting of a 2,600-pound load using 12 oak poles, each 1.75 inches square and 14 feet long.

"The method is astonishingly versatile," says Cunningham. "The force you can exert with these things is truly immense." A slight modification of the technique allows someone to move a heavy load in a horizontal direction. A similar principle applies when a group of people carry a load suspended from a set of poles made from bamboo or some other flexible material. The flexible poles ensure that the load's weight is fairly distributed among the bearers.

Evidence for Cunningham's scheme can be seen in ancient Egyptian art. "Loads are commonly depicted being carried on poles," he says, "and actual poles exist in museum collections." Levers, on the other hand, rarely appear in the paintings.

What surprises Cunningham is that such a simple idea has been largely lost to history. "Our modern technology is completely unaware of this force-multiplying effect," he says. "The ancient Egyptians, for example, may not have needed to use ramps in order to lift the massive building materials used in their great constructions on the Giza plateau. More importantly, there may exist new contemporary applications of the principle as well." Cunningham has applied for a patent on a structural system, based on the flexible-rod idea, that could be used in the foundations of large structures such as shopping malls to protect them from earth movements associated with earthquakes.

If it moves, catch it

Tracking the motion of a swimming protozoan against a motley background of stationary algae, fragments of extraneous material and other obfuscating elements would be simpler if it were possible to get rid of the background. Physicist Jack Feinberg and his colleagues at the University of Southern California (USC) in Los Angeles have found a way to do just that. They have invented a "transient detection microscope" that automatically displays moving objects while editing out stationary features. A report of their work appears in the March 31 NATURE.

Unlike digital electronic systems for detecting moving objects, in which the detector subtracts a stored image from the currently visible image point by point, the USC device uses an optical system and laser light. The optics produce a light interference pattern, or hologram, recorded in a barium titanate crystal. As each new image is read into the crystal, the old is subtracted from it, leaving traces only of objects that have shifted in position.

How well the microscope works depends on the quality of the barium titanate crystal. "The device needs only milliwatts of laser power," the researchers say, "and can detect objects moving at velocities of a few micrometers per second."

A nose for noxious gases

Hydrogen is an insidious gas. Odorless and colorless, it can seep undetected into a room or a laboratory, sometimes creating a potentially explosive situation. To make it easier to detect hydrogen and a variety of hydrogen-containing gases, researchers at the Sandia National Laboratories in Albuquerque, N.M., have developed a rugged, miniature electronic sensor capable of picking out several kinds of hazardous gases even when they are mixed together.

The sensor, about the size of a pencil eraser, consists of six tiny diodes etched in a silicon wafer. Individual diodes carry thin layers of metals such as palladium and gold or silver. The presence of hydrogen or hydrogen-containing gases causes a current to flow, which signals a potential hazard. By changing the diode arrangement and composition, the sensor can be tailored to detect a variety of different gases, including some that don't contain hydrogen.