Research Report

The search for new knowledge

Look and Listen

Science has come a long way toward overcoming the ills of physical handicaps such as blindness and hearing impairment. But science has left subtle, frustrating effects behind.

Consider, for example, that the blind can read books (in braille), but cannot look at the pictures. Or that the hearing-impaired can hear with an aid, but often can't understand because the mechanism of the aid is so simple that speech is sometimes garbled.

Science continues to offer hope, though, in the form of John Brule, a professor of electrical engineering who is using computers to print pictures in braille, and Chris Turner, an assistant professor of communication science and disorders developing a brand new type of hearing aid.

Brule's work is directed toward blind people in an educational setting. "Teachers are facing new challenges in preparing materials for all their students, including those who are blind and in regular classes," he says.

"There is a great amount of information in graphs and diagrams," he adds. "As more blind students are mainstreamed into normal classroom settings, the need for new and updated braille materials—including graphic information—becomes crucial."

Brule has written a computer software package that drives an IBM-PC and a Cranmer brailler, a machine used to emboss braille symbols on paper. A picture is created on the computer screen, as with any graphic software, and then redrawn by the brailler in a form likely to be understood by the blind person. Finding that form has been Brule's challenge.

"One of our goals is to find the best way to teach a blind person to 'read' a picture, diagram, or drawing," he explains. "The blind have never been taught to get spatial information using their sense of touch."

Brule and graduate student Shrinath Narahari will continue to refine the package, working with a blind professor at the University of Louisville and, possibly, a blind student attending SU. They expect the result to be nationally available software.

Turner's work on behalf of the hearing-impaired follows a realization that "today's hearing aids are merely mini public address systems. While they amplify sound, they may not optimally match the sound to damaged nerve receptors in the ear."

Funded by the Deafness Research Foundation, Turner's research involves adjusting the variables of a sound signal—such as frequency and amplitude—to create a sound signal that a hearing-impaired individual would receive as normal.

Equipment in Turner's lab allows him to alter thousands of components of a sound. He is testing the ability of hearing-impaired subjects to discriminate between selected sounds of speech—"ooh" versus "ah," for example. A mathematical model derived from these experiments will allow Turner to draw conclusions about speech reception in a more casual environment. Ultimately, it will result in a hearing aid that is customized.

"It may be similar to how eyeglasses work," says Turner. "Each individual requires a certain prescription—a combination of lenses—to correct his vision. The nerves in each individual's ear also require a unique combination of sound elements.

"All near-sighted people get a certain type of lens that is then adjusted depending on their eyes," he adds. "I would like to come up with a general model for hearing-impaired subjects that can be fine-tuned to meet their needs."

Choices at the Beginning of Life

When a baby has been born so prematurely that survival is in doubt, someone has to make the important decisions. The powers of God are in the doctors' hands; they, or the parents, or a court, face tough choices about how these powers should be used.

The decisions they make are fraught with moral, legal, and ethical implications. That is why Fred Frohock, a political science professor with an interest in "what counts as membership in the human community," went into a neonatal intensive care unit two years ago to observe first-hand. His experiences are the subject of his book, *Special Care: Medical Decisions at the Beginning of Life*.

Frohock's research took the form of extensive taped interviews with staff members and his own observations kept in a daily log. The result is a work that exposes ethical conflict in professional lives. Staff members in the neonatal intensive care ward struggle daily with their human instinct to preserve life even when it is impractical.

"Neonatal staffs must sometimes decide whether to treat infants at all, and once treatment has begun, whether and how to end therapy if the treatment has not succeeded," Frohock writes. "Physicians must assess the physical conditions of infants who cannot talk, or complain, or even know what troubles them."

"One problem is that doctors can maintain life that cannot attain consciousness," Frohock says. "Because of the staff's capacity to bring back these infants—some of whom would have been routinely passed over for treatment a few years ago—we have become too skilled for our moral guidelines."

Don't Go to the Principal's Office

Back in 1980, education professor Arthur Blumberg took an unusual approach to studying high school principals. He sought to evaluate principals not merely as administrators, but as human beings who expect their jobs to provide happiness and fulfillment. The eight principals he studied portrayed themselves as happy; their formulas for success were the heart of Blumberg's book, *The Effective Principal: Perspectives on School Leadership*.

Last year, Blumberg went back to the principals, expecting to define the subtle changes in attitude that inevitably would occur in five years' time. He found changes, certainly, but they were far from subtle. Five of the eight principals had quit the profession entirely.

Consequently the new edition of *The Effective Principal*, cowritten by former SU education professor William Greenfield, is a book quite different from its predecessor. It serves as a case study of principal burnout, giving strong evidence that the job turns away promising, otherwise dedicated individuals.

"These people were all considered effective by their peers, but they simply wore down emotionally over time," Blumberg says. "Being a principal requires an enormous amount of intellectual, psychological, and physical strength.

"Some people may be depressed reading the vignettes in the book," he adds, "but clearly our conversations with the principals did not suggest they were depressed. Their attitudes simply reflect the enormous burden of responsibility these people feel in their jobs."

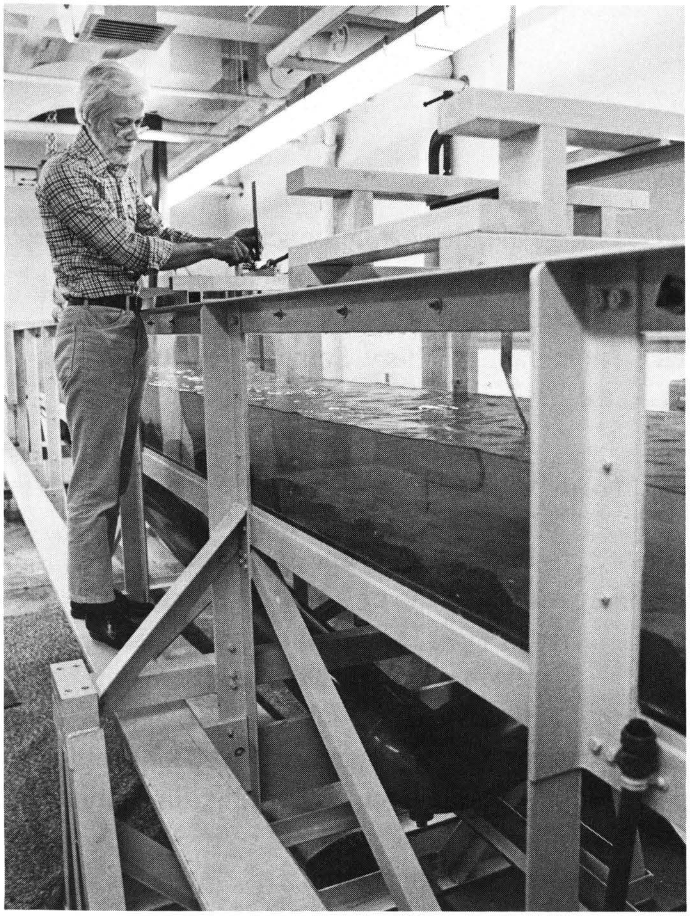
Blumberg's research implies a caveat for all future principals: a principal must have educational, organizational, and interpersonal know-how, and on top of that he or she still faces necessary risks.

"Being a nice person," Blumberg concludes, "just isn't enough."

Sedimental Journey

In an instant a sprawling cloud of sand billows up from a barren plain and wafts ominously toward lower ground, blanketing everything in its path with a thin layer of residue. You would half expect to see a tumbleweed pass by, but a fish is more likely, for this is a sandstorm on the ocean's floor. The medium is not wind, but the currents.

These violent underwater sandstorms are known as turbidity currents—muddy water traveling



Bryce Hand, associate professor of geology, uses a laboratory flume to study the effects of ocean-floor "turbidity currents." Often prompted by earthquakes and mudslides, these underwater sandstorms swiftly displace vast amounts of sediment.

down slope at speeds of up to 40 miles an hour, often triggered by earthquakes and resulting mudslides. They are considered extremely important by geologists; they transport huge amounts of sediment in a relatively short time. SU geologist Bryce Hand is a leading researcher of turbidity currents.

Hand's research is virtually impossible to conduct in the field because turbidity currents are short-lived and occur at great depths. Instead, Hand works in the lab, using a 30-foot-long Plexiglas flume. Water of varying speeds circulates constantly through the flume, into which Hand and assistant Bill Arnott spray several hundred pounds of sand. They observe how the rain of sand affects the formation of sediment ripples.

"What we're doing is mimicking conditions near the bottom of the ocean during a turbidity current," Hand says. "We're getting sort of a clam's-eye view of what happens."

Hand's research should explain why turbidity currents prevent the development of underwater dunes, even though dunes form naturally in streams or rivers traveling at similar speeds. His research, funded by the National Science Foundation, will also be of interest to petroleum geologists because sediment patterns are related to oil development.

Most of what Hand learns will be new. "What we know about how turbidity currents deposit sediment is highly speculative," Hand concludes. "We've been studying them for 30 years, but many fundamental questions remain unanswered."

Spying on Cells

One paradox of scientific research is that incredibly complex procedures are aimed at answering elementary questions. At this point, for example, scientists do not understand how cells move, though that movement is basic to such processes as muscle contraction and the spread of cancer.

SU researchers Ben Ware, Kenan Professor of Science, and Grant Krafft, assistant professor of chemistry, are responsible for a new procedure that one day may explain the mysteries of cellular movement. Ware is using a special type of fluorescent tracking molecule, developed by Krafft, to study the protein actin, a very important protein where cellular motion is concerned.

"Cells are controlled by some type of 'motor.'" Ware says. "Since actin is found in muscle cells and in all cells that move, we believe it plays a major role in cell movement and cell division. By tracking actin, we hope to identify this role and solve the mystery of how cells divide."

The probe molecules synthesized by Krafft—known as "photoactivable fluorophores" (PAFs)—attach to actin, and when a laser is beamed on them they become fluorescent. In tracking the movement of these fluorescent spots, Ware actually tracks the movement of actin. As a result, he has gained some preliminary understanding of the protein.

"Actin molecules seem to determine the motion of the cell by linking with each other and building a track," he explains. "If we can understand how this track is assembled, we may be well on our way to understanding how cells move."

It's a long row to hoe, Ware concedes. "Scientists are not likely to come up with the answers in this century, but we're trying. This technique has boosted our efforts."

The potential for controlling cell division and movement—including the spread of cancer—is too great to do otherwise.

Moment of Impact

Suppose your car leaves the road at 30 miles per hour, speeds down a 15-degree embankment, and then meets a steel-reinforced concrete abutment head-on. What injuries, if any, would you sustain?

The conventional approach to this research challenge is, in essence, try it and see. Crash dummies—the white plastic citizens of Detroit test tracks—are strapped into cars and sent hurtling down a runway to an abrupt fate. Assessments are made and conclusions drawn, at the cost of $40,000 per destroyed dummy.

SU's John Williams, assistant professor of mechanical and aerospace engineering, is among a handful of researchers who are taking a different—and, they think, more efficient—approach to the problem.

Williams is using a supercomputer at Colorado State University to redefine the human body as a mechanical device on which stress is brought to bear. Using this model and the rules of physics, Williams is able to calculate the results of impact on a body.

His specific area of interest is the head and neck. He has created a computerized three-dimensional model of the head and neck, representing the relationship of joints, ligaments, and cartilage in mathematical formulas and physical properties. The 22 major muscle groups also are represented, a feature unique to Williams' model.

On the computer, Williams simulates a car crash through a period of 200 milliseconds. The program brings precise amounts of stress and displacement to bear—amounts depending on the severity of the accident—and from these values Williams is able to predict the likelihood of injury. Funded by the National Science Foundation (NSF), Williams is refining the model to include the brain and its reaction to stress and displacement.

The purpose of this, of course, is not to quantify gross injury, but rather to prevent it. Williams will conduct an examination of the effectiveness of seat belts, seat backs, and headrests.

"There is no question that you're better off wearing a seat belt," Williams says, "but I would like to see if the stiffness of the belt and its positioning may be altered to provide better protection.

"We have very little information on how the seat back, headrest, and seat belt affect the head and neck on impact," he adds. "If we identify these effects, we can answer a number of questions: are headrests necessary, where should they be positioned, and of what material should they be made? Only then can we improve restraints now in use."

—Dana L. Cooke; research by Tom Armentrout, Mary Beth Berolatti, Renee Starzyk