Ivars Peterson and Rick Weiss report from Boston at the annual meeting of the American Association for the Advancement of Science

Arboreal storage for carbon dioxide

As carbon dioxide levels in the atmosphere continue to rise, researchers are taking a closer look at potential methods for limiting the increase in order to avoid adverse changes in global climate. "What is required," says Gregg Marland of the Oak Ridge (Tenn.) National Laboratory, "is some way to collect carbon and some place to put it so that it does not accumulate in the atmosphere as carbon dioxide." One possibility, at least in the short term, would be to stimulate the growth of forests. Recently, Marland evaluated what it would take—by increasing either forest area or tree growth rates—to remove an additional 5 billion tons of carbon per year from the atmosphere.

His study shows that increasing the area of land covered by forest does not look promising. Although the amount of forested land in the United States and a few other countries has actually increased slightly in recent years, in many parts of the world, especially the tropics, forests are still being cleared without being replaced. Even if the loss of existing forests were halted, it would still take an area roughly the size of Australia planted with a fast-growing tree species such as American sycamore to meet the target reduction in carbon dioxide. "Where would we put the trees?" asks Marland. "This ultimately becomes a political question."

A better approach may be to concentrate on increasing forest productivity, says Marland. "There is much one can do to raise yields," he notes. Techniques such as fertilization, irrigation, and weed, fire and pest control have a great impact on growth rates. Genetic engineering may also contribute to increased yields. The trouble is that young trees take up carbon dioxide much more quickly than mature trees. This means having to harvest trees regularly while finding ways to keep the wood from oxidizing back into carbon dioxide, perhaps by using it for construction. Even then, the net annual yield of all of the world's forests would have to be doubled to remove enough carbon from the atmosphere.

"The cost of such a scheme is immense," says Marland, "but it needs to be compared with the costs of other approaches to dealing with atmospheric carbon dioxide or of coping with the attendant changes in climate." He adds, "This analysis suggests that although looking to forests to solve the carbon dioxide problem is unrealistic, reforestation could indeed play a significant role as one component among a variety of measures taken to address increasing carbon dioxide."

Motoring in liquid nitrogen

It hasn't taken researchers very long to put high-temperature superconductors to work. Recently, technicians at the Argonne (Ill.) National Laboratory used one of the new materials to construct a simple, electrical motor based on the property that superconductors repel magnets—a phenomenon known as the Meissner effect.

The Meissner motor consists of a circular aluminum plate, 8.5 inches in diameter, with 24 small electromagnets mounted along the bottom of its outer edge. The plate rotates above two disks composed of yttrium-barium-copper oxide, a superconducting ceramic. Because this material becomes superconducting at the relatively high temperature of 94 kelvins, or −290° F, liquid nitrogen is cold enough to keep the disks at an appropriate temperature. Repulsion between the electromagnets and the superconducting disks causes the plate to spin at a rate of 50 revolutions per minute.

"It's too small for practical use and produces negligible power," says Argonne's Roger Poeppel, "but it demonstrates . . . that these motors are possible."

Meanwhile, researchers at Cornell University in Ithaca, N.Y., have developed a superconducting motor that spins at up to 60,000 rotations per minute. Developed by Francis C. Moon and Rishi Raj, the motor has a magnetically levitated rotor weighing about 10 grams nestled in a superconducting bearing specially designed to provide stable levitation forces. The use of superconducting materials simplifies the design of magnetically levitated, high-speed rotors, which, when fabricated from conventional materials, require special feedback circuits and operation in a vacuum. The new motor may turn out to be useful for gyroscopes and in robotics applications.

Taking corrosion's magnetic pulse

By detecting and analyzing the tiny magnetic fields associated with electrical currents that occur during corrosion-causing chemical reactions, researchers are beginning to develop methods for monitoring corrosion effects even before they are visible to the eye. The technique is also proving to be a useful tool for investigating what happens at the atomic level during corrosion. This research, by physicist Margaret L.A. MacVicar and graduate student James G. Bellingham of the Massachusetts Institute of Technology, is an extension of the discovery two years ago that such magnetic fields are detectable (SN: 8/30/86, p.132).

Using a method for detecting magnetic fields that is now about 100 times more sensitive to corrosion currents than the original equipment, the investigators can study how the electrochemical current changes over time at a given location on a metal surface. "We see the fluctuations of electrochemical, or corrosion, current as a noise in the magnetic field," says MacVicar. "By looking at the frequency profile of the magnetic field, we are getting a snapshot of the mix of the kinds of atomic activities going on." The noise profiles provide new information about corrosion mechanisms. That information may make it easier to intervene during, say, manufacturing processes, to avert potential corrosion problems. "The power of the method is now becoming clear," she says.

Bellingham and MacVicar typically work with zinc immersed in hydrochloric acid. At a given location, zinc atoms may be losing electrons to become positive ions or hydrogen ions from the hydrochloric acid may be picking up electrons to form hydrogen gas. When two zinc wires touch the metal surface, a current flows if there is an electrochemical difference between the two spots. A magnetic-field detector picks up the magnetic field caused by the current.

"You're looking at two sites interacting electrically," says Bellingham. Sometimes that interaction leads to strong oscillations, in which the current changes direction at regular intervals. "What's happening is that there are some random processes in the reaction that occasionally set up the circumstances to drive an oscillation. But those conditions don't always exist." The occasional occurrence of oscillations, however, provides powerful clues about possible corrosion mechanisms.

Bugs for cleaning up sludge

Recovering crude oil from thick sludges at the bottom of storage tanks is proving to be easier with the use of a chemical obtained from living microorganisms. The microbes are specially selected mutations of naturally occurring bacterial strains, says Ananda M. Chakrabarty of the University of Illinois at Chicago, who developed the bugs (SN: 4/18/81, p.246).

In a recent test, the chemical, which behaves like a detergent, was added to a 180,000-barrel storage tank containing about 6,200 barrels of sludge. After four days, workers were able to extract 5,600 barrels of crude oil from the waste. "Not only did the process help the firm reduce its waste," says Chakrabarty, "the company made money from the additional oil recovered." Petrogen, Inc., of Arlington Heights, Ill., conducted the test.

Thinking too much might not be smart

Figures of speech describing the process of problem-solving often use energy-intensive imagery in which our brains are kept busy "cranking out answers," "grinding away at problems" and "crunching numbers." But new research suggests that mental performance need not be so trying.

Richard Haier of the University of California at Irvine has preliminary data showing a relationship between higher scores on intelligence tests and lower rates of metabolism in the brain's cortical areas. One interpretation of the research, he says, is that people who perform better on intelligence tests may have more energy-efficient neural circuitry.

Haier had his subjects perform the Raven's Advanced Progressive Matrices test, a difficult, standardized, nonverbal test of abstract reasoning, while he performed positron emission tomography (PET) scans on their brains. The test requires that subjects recognize a pattern within a matrix of abstract designs and then select another design that completes the pattern. PET scans allow direct measurement of brain function by graphically depicting areas with higher glucose metabolism.

"Although one might assume that a good performer's brain would 'work harder' than that of a subject who did poorly," says Haier, "our data suggest that the opposite is true."

Babies or barbells: Make your choice

Strenuous exercise, especially when accompanied by unusual diets or substantial weight loss, has been known to upset hormonal control of reproduction in humans. Recent research is helping to explain the nature of these troublesome imbalances, which can delay the onset of menstruation, and is suggesting a few possible benefits as well.

David C. Cumming of the University of Alberta in Edmonton reports that exercise can change the pattern of hormonal pulses that normally initiates a menstrual cycle. Normally, gonadotropin-releasing hormone is released from the brain in pulses every 90 to 120 minutes, causing a similarly pulsed release of luteinizing hormone (LH) from the pituitary. The frequency and amplitude of these pulses are decreased in some women athletes, especially after exercise, causing amenorrhea or lack of menstrual periods. Moreover, many women athletes who do menstruate nevertheless fail to ovulate and so cannot become pregnant.

Although exercise-induced amenorrhea is usually reversible, other medical consequences of these changes may be more significant, Cumming says. For example, amenorrheic women tend to gradually lose bone mass. Cumming says amenorrheics in their 20s and 30s, who should be building up to their peak bone mass, may be at greater risk for osteoporosis, a degenerative bone disease, later in life.

But according to Rose E. Frisch of the Harvard School of Public Health in Boston, exercise-induced suppression of the reproductive system may have benefits, too. Studies by Frisch and her colleagues show that women who were athletes in college have half the rate of breast cancer and less than half the rate of reproductive system cancers compared with women who were not athletes. Lower hormone levels have in the past been associated with lower rates of cancer, and Frisch hypothesizes that the latest observations can be explained by the lower estrogen levels found in women who exercise more.

In the distant past, she says, such a mechanism might have had survival advantages by preventing pregnancy during strenuous times, such as when a tribe was moving to a new area. She suggests that the relative lack of exercise in modern life may be contributing to a gradual trend toward earlier onset of menstruation. Girls today begin menstruating three years younger than their counterparts did 100 years ago.

Bridge-to-transplant given good marks

With thousands of heart transplants now being performed worldwide, medical personnel in a hospital's cardiac unit frequently find themselves buying time while searching for an appropriate donor heart for transplant. Because the hours and days often needed to locate a well-matched heart can literally mean the difference between life and death, researchers have been studying artificial hearts as potential bridge-to-transplant devices—keeping patients alive until donor hearts arrive. The bridge-to-transplant concept has had its controversies and problems, as the target of criticism that the mechanical devices lead hospitals to waste scarce donor hearts on patients too sick to benefit from transplantation (SN: 1/4/86, p.4). Those concerns may be misplaced, according to a new study.

After using mechanical devices to pump blood in 21 patients who later received a donor heart, researchers at several medical centers in the United States conclude in the Feb. 11 New England Journal of Medicine that such "bridges" are both safe and effective. Led by David J. Farrar and J. Donald Hill of Pacific Presbyterian Medical Center in San Francisco, the researchers say that, at the time of the report, 19 of the 21 heart recipients were still alive seven to 39 months after their transplant. Eleven of the original 12 had survived at least one year. Thus far, say the authors, these survival rates are comparable to or better than those seen in transplant patients not receiving the so-called ventricular assist device. One risk anticipated by the scientists — that of serious infection due to inserted tubing — was not a life-threatening problem with the device used, although patients were on support from eight hours to 31 days before transplant, Hill told Science News. He says more recent data continue to support observations that more than 80 percent of bridge-to-transplant patients should survive a year and longer. Since the current report was compiled, a total of 57 patients have been put on the pump, with 46 eventually receiving hearts.

The authors caution that the decision to use assist devices be made carefully, however. At an average age of 36, the patients were relatively young and considered healthy enough to withstand necessary surgery. In addition to the 21 patients in the study given hearts, eight others placed on the pump had not been stable enough to receive a heart and later died.

Two for AIDS: New drug and new patent

• Federal officials announced last week that the anti-cancer drug trimetrexate has been approved for limited use in treating *Pneumocystis carinii* pneumonia, a serious infection often associated with AIDS. It is the first AIDS-related drug to be approved under the Food and Drug Administration's drug evaluation process called treatment IND (investigational new drug), an accelerated procedure adopted last year to provide experimental drugs to patients with life-threatening diseases (SN: 3/21/87, p. 189). Because of its toxicity, trimetrexate must be given with the drug leucovorin, which protects cells from trimetrexate exposure. Although drugs against the infection are already available, researchers have considered trimetrexate a less toxic or more effective alternative if used in conjunction with leucovorin.

• In a decision that could mean big bucks and have wide-reaching effects in AIDS research, Harvard University was granted a patent last week for commercial use of the protein gp120, found in the wall of the AIDS virus. Although gp120 is a naturally occurring substance, its isolation in 1984 by Harvard scientists made it patentable under current laws. Many of the tests and vaccines for AIDS now being developed by researchers depend on gp120 as part of the development process. The patent, however, does not extend to the use of gp120 for research-only purposes.