Reaching 1 trillion calculations per second

Built with exotic materials and equipped with sophisticated electronics, the complex weapons in the U.S. nuclear stockpile are getting older. As the arsenal ages, joints begin to weaken, components start to fail, and materials change their characteristics.

The Comprehensive Test Ban Treaty, adopted last September (SN: 9/21/96, p. 183), bars participating nations from testing weapons by exploding them underground. To assess factors such as the impact of aging on weapons and to predict their performance, the Department of Energy has established the science-based stockpile stewardship program (SN: 10/19/96, p. 254). A major component of this program uses large computer simulations to examine various aspects of weapons physics.

However, no existing computer is powerful enough to calculate in precise detail what happens during a nuclear explosion or in an accident involving a lightning strike or fire. To meet the need for greatly increased computational power before weapons problems become too severe, DOE has created the Accelerated Strategic Computing Initiative, aimed at speeding the development of high-performance computers.

"In this program, we have to work with the computer industry to compress the length of time between . . . generations [of computers]," says Gilbert G. Weigand, DOE deputy assistant secretary for strategic computing and simulation.

Last month, a multiprocessor computer built for the agency by Intel in Beaverton, Ore., became the first machine to calculate at a rate of 1 trillion operations per second, according to a standard test of computer performance. The achievement is a significant milestone for high-performance computing, says Jack J. Dongarra of the University of Tennessee in Knoxville. Just 10 years ago, it was thought to be unattainable.

Built at a cost of $55 million, the Intel "ultracomputer" was assembled from thousands of mass-produced Pentium Pro microprocessors, originally developed for use in desktop computers and workstations. The microprocessors were linked by high-speed communications lines and packed into large cabinets.

The speed record was set with 7,264 processors installed in 57 cabinets. The units are now being shipped to the Sandia National Laboratories in Albuquerque, where researchers can start testing and programming the computer. In its final form, the machine is to have 9,072 microprocessors packaged in about 80 cabinets, which cover an area roughly equal to the floor space of a modest home. The computer should then operate at 1.8 trillion calculations per second.

The Intel ultracomputer is only one step toward the capabilities that DOE ultimately requires for its weapons simulations. Computers running at roughly 3 trillion operations per second are now being readied, one by IBM, the other by Silicon Graphics/Cray Research for the Lawrence Livermore (Calif.) National Laboratory and the Los Alamos (N.M.) National Laboratory. They should be completed in 1998 or 1999.

The DOE plan calls for achieving a performance level of at least 100 trillion operations per second by the year 2004.

As part of this massive, ambitious effort, the agency has established the Academic Strategic Alliances Program to create and fund university "centers of excellence." Officials of DOE expect these centers to assist the national laboratories in developing the technology and software needed for large-scale simulations. Researchers may also gain access to the DOE computers to do unclassified studies.

"We have directives from the President and the [DOE] secretary that our program is to be as open as possible," says Alexander R. Larzelere, director of the agency's office of strategic computing and modeling. "We know we don't have all the answers at the laboratories."

"We're expecting to work on very large, complex, unclassified problems," Weigand adds. — *I. Peterson*

Manic depression linked to absent DNA

To their surprise, researchers have found that a severe form of manic depression, usually beginning by late childhood, afflicts many people suffering from a genetic disorder known as velo-cardio-facial syndrome (VCFS). Further investigations of this formerly unsuspected connection may yield insight into genetic influences on manic depression, according to the investigators.

"This is the first reported link between these two conditions," says Demitri F. Papolos, a psychiatrist at the Albert Einstein College of Medicine of Yeshiva University in New York, who directed the new study. "The deletion of one or more genes in velo-cardio-facial syndrome may help to create a vulnerability to [manic depression]."

Primary features of VCFS consist of cleft palate, heart defects, learning disabilities, and a characteristic facial appearance that includes a long face, a large nose with a prominent tip, small ears, narrow eyes, and an emotionless expression. Robert J. Shprintzen, director of the Center for Craniofacial Disorders at Montefiore Medical Center in New York and a coauthor of the new study, defined this set of characteristics as VCFS in 1976. He estimates that it affects between 1 in 3,000 and 1 in 5,000 individuals.

Prior molecular investigations indicated that VCFS stems from the deletion of a specific segment of chromosome 22, Papolos notes. Between 25 and 30 genes, several of which have been identified, lie in that stretch of DNA.

The new study, described in the December AMERICAN JOURNAL OF PSYCHIATRY, included psychiatric evaluations and reviews of medical records for 25 people diagnosed with VCFS. Their ages ranged from 5 to 34 years.

Nearly two-thirds of the sample suffered from manic depression, also known as bipolar disorder, the researchers found. This condition typically features alternating bouts of euphoric agitation and severe depression that last several weeks or months. Some people with VCFS had appeared to be schizophrenic because of the severity of their untreated mania.

In the general U.S. population, manic depression affects about 1 in 100 people at some time in their lives and usually first emerges in young adulthood. In the VCFS sample, however, this psychiatric disorder was far more common and typically began at age 12. In many cases, it included rapid shifts between mania and depression, each state lasting only a day or two, Papolos holds.

In addition, nine participants received a diagnosis of attention deficit disorder (ADD), some with hyperactivity. Five people displayed both ADD and manic depression.

A gene known to be located in the deleted chromosome 22 region produces an enzyme that activates two chemical messengers, dopamine and norepinephrine. These substances have been implicated in manic depression, according to Papolos. He and his colleagues plan to examine deletions of this gene more extensively, both in people with VCFS and the population at large.

"For now, I consider this new report an interesting speculation," comments psychiatrist Elliot S. Gershon, chief of the clinical neurogenetics branch at the National Institute of Mental Health (NIMH) in Bethesda, Md. "We'll have to see if the results hold up in future studies."

He adds that four studies indicate that a gene located elsewhere, on chromosome 18, helps to produce manic depression in some people (SN: 7/2/94, p. 13).

The missing chromosome 22 region cited by Papolos' group may contain one or more genes that influence different mental disorders, depending on the presence of other DNA variations, Gershon suggests. — *B. Bower*