EDITORIAL

Multidisciplinary Research

In industry, much important goal-oriented research and development has been successfully conducted by multidisciplinary teams. At universities, however, such collaboration is comparatively rare. The departmental structure and tribal instincts are barriers. In the physical sciences most of the opportunities for significant, easy-to-do monodisciplinary research have been exhausted. A major portion of the frontier lies in dealing with complex problems that require access to expensive equipment or participation in interdisciplinary programs.

A large-scale innovative response to the evolving research frontiers has been gathering momentum at the University of Illinois at Urbana-Champaign. There the Beckman Institute for Advanced Science and Technology is conducting broad-based multidisciplinary research. The institute is housed in a new 313,000-square-foot building which is superbly equipped and designed to foster collaborations. Among others, the staff includes electrical engineers, psychologists, biophysicists, computer scientists, molecular biologists, linguists, chemists, and physicists. There are more than 350 graduate students. Members of the institute have access to very high level computer science and equipment. One of the four National Centers for Supercomputer Applications also is housed in the building as is the National Center for Computational Electronics.

Most of the studies now being conducted at the Beckman Institute relate to three major program areas—Biological Intelligence, Molecular and Electronic Nanostructures, and Human Computer Intelligent Interaction. Other programs may develop. Brief examples of the many activities follow.

The basic goal of the Biological Intelligence group is to examine the ways in which neurally based systems manifest intelligent behavior and how such knowledge can be exploited in the design of intelligent devices. Prerequisites to intelligent behavior include perception, memory, and learning. Considerable information about these matters can be gleaned by experimentation employing electrodes attached to the skull. Mental activity also can be studied by use of magnetic resonance imaging. The institute has a high magnetic field instrument (4 tesla) that monitors events in animal brains. Experiments on rats have shown that aerobic exercise enhances blood supply to the brain and improves brain function. Investigation of possible similar effects in elderly humans is contemplated.

The group that conducts research on molecular and electronic nanostructures has many projects. One is a study of self-organizing structures formed from inorganic substances as well as from protein and other molecules of interest to life scientists. The research on biomolecules will include genetic engineering, sophisticated surface chemistries, spectroscopic measurements, and external manipulation of structures to construct hybrid biomolecular devices.

There have been significant results from research using the scanning tunneling microscope (STM) in fabricating semiconductor nanostructures. A prerequisite was magnificent equipment that facilitates conduct of STM manipulations under a very high vacuum. In one experiment, a clean crystalline silicon surface was exposed to atomic hydrogen with resultant coverage of exposed surface silicon bonds. Later it was possible to selectively remove a narrow band (0.001 micrometer) of the hydrogen. The narrow band could react with other chemicals while the hydrogen-covered silicon remained inert. The STM experiment could be a step on the road to new devices. The present technology for fabricating integrated circuits is approaching a limit of about 0.1 micrometer.

Graduate students at the institute are especially attracted to facilities that enable them to perceive in visual form digital data that they have collected. In another room the interactions of atoms of complex molecules can be visualized in large-scale, three-dimensional virtual reality.

Beckman Institute faculty members do not have tenure at the institute, which is now fully occupied and where space does not exist for individuals who lack merit. Faculty members with appointments in the institute are tenured or on tenure track at the University of Illinois, where some continue to have teaching, research, and service activities. It is too early in the life of the institute for it to have achieved its ultimate reputation and rate of productivity. However, the University of Illinois at Urbana-Champaign could become a model that others will find desirable to emulate.

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