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Computers Aid Science,

By Amiel Kornel

PARIS — Lending their intelligence to everything from the design and manufacture of dental crowns to the visualization of the infinitesimal, computers are aiding surgeons, physicians and scientists in expanding the frontiers of health care and scientific research.

The latest applications go well beyond the so-called number crunching and data storage for which digital computers have been renowned since their invention more than 30 years ago. In addition to its rapidity in performing complicated calculations, the computer has an ability to reduce, rearrange, and reconstruct information that is proving to be an invaluable asset in science and medicine.

While many areas of scientific research rely heavily on the use of computers, physicians and surgeons are just beginning to discover how the quintessential 20th-century tool can help their work.

Two dental surgeons from Grenoble, France, demonstrated a computer-based system for making dental crowns recently on French television. Using the techniques of Computer Assisted Design and Computer Assisted Manufacture, or CAD-CAM, the dentists can prepare a patient's crown in one hour during a single visit, with a precision 10 times greater than that offered by conventional methods.

The procedure looks deceptively simple. An optical probe introduced into the patient's mouth generates a contoured image of the tooth and adjacent area. The computer uses the data to reconstruct a digitalized map. A program then designs a crown based on a predetermined theoretical tooth, taking into consideration the position of the patient's teeth and form of jaw. A second program directs a sophisticated milling machine to make a crown according to the blueprint created by the design software.

Doctors at the Hospital for Special Surgery in New York are developing a similar system for the manufacture of prosthetic body joints, such as artificial knees. These systems will lower medical costs, speed up surgery and ensure better quality control of prostheses, according to their developers.

Not all medical applications are originating in hospitals or academic institutions. MediSoft, a year-old California software firm, is marketing two educational programs that may eventually evolve into clinical tools. "We use mathematical modeling systems to simulate anatomical and physiological portions of the human body," said Dr. Larimore Cummins, president of MediSoft, in a telephone interview from Santa Cruz.

One of the programs teaches physicians and nurses how to diagnose and treat heart ailments. After inducing a heart attack in a three-dimensional graphical representation of a beating heart, users prescribe the drug and therapy necessary to treat the resulting arrhythmia. "They must match the right therapy with the right diagnosis and follow the heart's response," Dr. Cummins said.

MediSoft, as well as other research groups in North America and Europe, is attempting to develop a program that will create computer models of the heart based on an analysis of electrocardiograms. Such software would permit a physician to feed a patient's electrocardiogram into a computer and get back an image of the heart, enabling the physician to quickly see its weak areas.

Another of MediSoft's programs simulates the effects of a biolaser. Surgeons use lasers to burn away human tissue and stop internal bleeding. The video simulation duplicates the effects of varying levels of radiation on different types of tissue. "It allows them to develop an intuition" for the intensity and direction of the laser beam necessary to treat a particular tissue and ailment, according to Dr. Cummins.

He described this educational application as only the first stage in the product's development. The next stage, which he qualified as "a futuristic perception a good way from being realized," would "build in intelligence to have the laser adjust itself" during actual surgery.

In addition to flashes of insight and a good dose of luck, scientists have always relied on the empirical in their investigations. For experimentalists, the computer has helped satiate the hunger for information and digest the subsequent mass of data.

The computer's place in physics research is exemplified by the role it plays at the European Center for Nuclear Research, or CERN, in Geneva. "The typical physics experiment nowadays is attached to a computer," said Victorio Frigo, a computer specialist at CERN.

Scientists at CERN use between 200 and 250 computers to do the computation on, and analysis of, the avalanche of data their experiments produce. The machines extend in size from micro-computers located on scientists' desks to larger computers grouped in a computer center. "An experiment can sometimes generate more data than even a computer center can handle," said Mr. Frigo.

But the computer's utility is not limited to the experimentalist. It has provided theoreticians with a means to build and test models in minutes or hours that would once have taken months or even years to elaborate and verify. "You can do things that you wouldn't do by hand," said Mr. Frigo.

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