Computers

Bigger slices of pi

The effort to determine the numerical value of pi (the ratio of a circle's circumference to its diameter) has now reached 2.16 billion decimal digits. Using their own custom-built, desktop computer, mathematicians David V. and Gregory V. Chudnovsky of Columbia University in New York City arrived at this number in the course of an extensive search for subtle mathematical patterns that may lurk among the digits of pi. Setting a new world record, their computation more than doubles the number of digits available for scrutiny (SN: 9/9/89, p.166).

Using an advanced supercomputer and a more conventional mathematical approach than that taken by the Chudnovskys, Yasumasa Kanada of the University of Tokyo reached 1,073,740,000 decimal digits in November 1989. Kanada says that if he can obtain access to a suitable supercomputer for a long enough period, he may be able to extend his computation of pi to at least 1.5 billion decimal digits.

Faulting the numbers

Federal policy makers routinely make major decisions concerning changes in social and tax programs on the basis of "numbers" spewed out by complex computer models, which are designed to estimate the effects of such changes on expenditures, revenues and human behavior. Now, a National Research Council panel warns that these estimates are generally of unknown quality and may be seriously flawed.

The panel's report, released Aug. 1, identifies two significant deficiencies: the poor quality of the available data and the lack of objective measures for assessing a given computer model's reliability and validity. "There is very little done to assess the validity of estimates, the amount of uncertainty in the estimates and the options for improving them," says economist Eric A. Hanushek of the University of Rochester, who chaired the panel.

Such deficiencies have led to incorrect estimates. For example, tax policy experts in 1981 misjudged the popularity of newly established individual retirement accounts, and their models greatly underestimated the subsequent revenue loss to the government. Other cost estimates have suffered because the only statistics available were out of date or incomplete. Arguing that detailed simulations of economic and social behavior are important to the policy process, the panel strongly urges the government to allocate sufficient resources to improve the quality of current computer models used for making cost estimates.

Phone glitches and software bugs

Flaws in the software used to operate sophisticated switches for routing telephone calls and providing other telephone services were the immediate cause of a string of failures that plagued several local telephone companies in late June and early July (SN: 7/6/91, p.7). According to officials at DSC Communications Corp. in Plano, Tex., which supplied the equipment involved in all the breakdowns, the problem occurred because of three faulty instructions in a computer program several million lines long. The flaws prevented a switch's computer from properly handling the congestion that resulted when messages had to be sent to other telephone network computers to circumvent such problems as a failed circuit board or an overloaded switch, at the same time that the network had to process a large volume of telephone calls.

DSC engineers inadvertently introduced the errors earlier in the year when they made a few "minor" changes in the signaling software. At the time, company officials deemed the alterations too insignificant to warrant the extensive testing usually conducted on new or revised software.

Materials Science

Defects don't improve a superconductor

Jin/AT&T Bell Laboratories

Spiral defects did not improve this superconductor.

Four months ago, when two independent research groups reported the discovery of billions of spiral defects in superconducting thin films, both teams suggested that putting these defects, called screw dislocations, into wires might boost their current-carrying capacity, or critical current density, to that of thin films (SN: 4/6/91, p.215).

In practice, however, that proposal hasn't panned out, says Sungho Jin, a materials scientist at AT&T Bell Laboratories in Murray Hill, N.J. After making wires that develop high densities of these defects, "we still see a critical current density two orders of magnitude lower [than that of thin films]," he says. In the July 26 Science, Jin and his colleagues conclude that even though screw dislocations could keep stray magnetism from interfering with electron flow, 1 billion to 10 billion defects per square centimeter of superconductor represented too few to explain the higher critical current densities seen in thin films.

Buckyballs shine as optical materials

Nonlinear optical films can streamline optical communications and could eventually make the dream of optical computing come true. Buckyballs—those 60-carbon molecules shaped like soccerballs (see story, p.120) — now show promise as one such material, two research groups report.

Nonlinear optical materials vary in their light-processing potential. Some show second-order properties: They double the frequency of the light passing through them and cease to transmit light when subjected to an electric field. Others show third-order properties: They triple the frequency of the light passing through them and switch on or off depending on the light's intensity. Buckyball compounds seem to do both fairly well, says Ying Wang, a physical chemist at the Du Pont Experimental Station in Wilmington, Del.

Using solutions of molecules, Wang studied the light-altering properties of buckyballs alone and of buckyballs linked with another material in a so-called charge-transfer complex. Buckyballs alone exhibit third-order properties, but the buckyball-containing complex lacks the symmetry of the solo molecules and thus adds second-order properties to the compound, reports Wang.

Zakya H. Kafafi, a chemist at the Naval Research Laboratory in Washington, D.C., decided to look into the buckyball's light-altering properties because the fluctuating double and single bonds between its atoms resemble those of other nonlinear optical organic materials. Unlike Wang's group, Kafafi measured optical properties in a buckyball thin film. She also tried depositing these brown films on materials used in optics, including glass, quartz and gold. "They adhere to all these surfaces very nicely," Kafafi says.

Buckyball films remain more stable chemically than most materials with comparable nonlinear optical potential, Wang says. And unlike other organic materials with this potential, buckyballs lack carbon-hydrogen and hydrogen-oxygen bonds, which can interfere with some nonlinear optical properties. Moreover, research on buckyball superconductors indicates that scientists can make these thin films easily and can chemically modify them to suit particular purposes. "It's a good potential nonlinear optical material," Kafafi concludes.

Both researchers presented their findings in Philadelphia this month at the University of Pennsylvania Workshop on Fullerites and their Solid-State Derivatives.