Computers may someday speed the art of synthesis, but so far they have helped little. The three-dimensional world of the organic chemist is hard to translate into the binary language of computers. And while a computer can list all the choices facing the scientist at each step of the way in building a new chemical, the scientist must still decide which offers the best chance of success. Hendrickson himself is working on computerized chemistry, but he doubts that much progress will be made until more of his colleagues "soften their resistance" and help develop a new computer technology appropriate to their unusual needs.

Inventing Plastic

"The Development of Plastics" by Herman F. Mark, in *American Scientist* (Mar.-Apr. 1984), P.O. Box 2889, Clinton, Iowa 52735.

Nearly everything in the industrialized world seems to be made of plastic or at least to contain some of it. Yet it was only a few decades ago that scientists began to understand this remarkable material.

As is so often the case with great discoveries, writes Mark, Dean Emeritus of the Polytechnic Institute of New York, plastic was first created by accident. In 1846, Swiss chemist Christian Schoenbein used his wife's apron to mop up some acids he had spilled and hung it in front of a hot stove to dry, whereupon it flared up and disappeared. Schoenbein had discovered cellulose nitrate. Others were quick to apply his finding to the manufacture of, among other things, explosives. A second step came in 1907, when chemist Leo H. Baekeland, an American, made the first plastic molecule that was entirely new, not a derivative of cellulose. "Bakelite" was soon used to make everything from billiard balls to gramophone disks.

But scientists did not begin to understand the chemistry of plastics until Germany's Herman Staudinger suggested in 1920 that "polymers," which include plastics, as well as wool, wood, and silk, were distinguished by the huge size of their molecules. One prominent chemist of the day objected that it was like being told that "somewhere in Africa an elephant was found that was 1,500 feet long and 300 feet high." In 1953, however, Staudinger received a Nobel Prize for his work.

Gradually, scientists have come to understand the structure of plastics: They are long chains of atoms. In their natural state, the chains are a more or less useless jumble. But they can be shaped in two ways to produce useful materials.

One way is to cause "crystallization" by applying mechanical force: The chains form themselves into relatively straight bundles, linked together by weak atomic bonds. The more crystallized a plastic is, the harder it is. Thus, the nylon in a fishing line is about 90 percent crystallized, the nylon in women's lingerie only 20 to 30 percent.

"Cross-linking" is the second treatment for plastics. It involves the formation of very strong chemical bonds between the "macromolecules." A plastic with the hardness of a television cabinet, for example, has far more chemical bonds between molecules than does the plastic of a surgeon's gloves.

Plastic manufacturing is now a $23 billion-a-year business in the United States. Mark foresees the application of plastics to ever more specialized uses—as wire-like electrical conductors, or as ingredients in replacement bones and arteries for humans.

RESOURCES & ENVIRONMENT

Gauging the Need For Electricity

"Lights Out in the Year 2000?—It Depends on Whose Forecast You Believe" by Rochelle L. Stanfield, in *National Journal* (Apr. 14, 1984), 1730 M St. N.W., Washington, D.C. 20036.

Americans take electricity almost as much for granted as they do the air they breathe. "Flick the switch," says *National Journal* correspondent Stanfield, "and the lights are sure to go on." But in Washington and at utility company headquarters around the country, specialists are debating how to ensure that the lights will still go on during the next century.

The problem: Nobody agrees on how much electricity will be needed. In a 1983 study, the U.S. Department of Energy predicted a dramatic increase in consumer demand for electricity by the year 2000 and recommended a $1.8 trillion building program to nearly double the nation's generating capacity. But environmentalists and "public interest" consumer groups say that the hundreds of new nuclear and coal-fired power plants called for would be too costly and too dirty. They point to a 1983 study by the Congressional Research Service. It concludes that sharp increases in energy conservation would eliminate the need for *any* new power plants.

Cautious utility company executives are caught in the middle. Prior to the 1973 Arab oil embargo and subsequent price increases by the Organization of Petroleum Exporting Countries (OPEC), utilities could count on about seven percent annual growth in demand for electricity and plan expansion accordingly. But after 1973, homeowners and industry cut back sharply on electricity use. Since 1972, America's power companies have canceled earlier plans to build 143 new nuclear-, oil-, and coal-powered generating plants, but plans for many other new plants have not been shelved. U.S. power companies are now capable of generating "half again as much power as the 20 percent cushion above demand considered to be a prudent reserve."

Future demand for electricity is "notoriously hard to forecast," notes Stanfield. During the 1970s, demand grew by about 2.5 percent annually. But last year it jumped by 5.5 percent. The utilities, once burned, are reluctant to embark on an ambitious expansion program. Says Stanfield, "Most experts still foresee an excess of electric capacity."

The utilities' luck has not been all bad, Stanfield adds. The mistakes of the 1970s have left them with enough surplus generating capacity to provide a "grace period" before they have to make tough decisions about what to do next.