in principle hostile to children" because they are a constant reminder that one is growing older and will die. New generations, Kass adds, are needed to renew society's sense of hope and aspiration.

Life-extending measures are difficult to condemn. But Kass worries that by diverting so much attention to living longer, we may sacrifice "our chance for living as well as we can and for satisfying to some extent . . . our deepest longings for what is best."

SCIENCE & TECHNOLOGY

After $E = mc^2$

"Chasing Particles of Unity" by Michael Gold, in *Science 83* (Mar. 1983), P.O. Box 10790, Des Moines, Iowa 50340.

Physicists have identified the particles responsible for three of nature's four basic forces—electromagnetism, gravity, and the so-called "strong force," which binds the nuclei of atoms together. But until recently, "weak-force" particles have escaped detection.

Japanese physicist Hideki Yukawa first predicted the existence of such particles, which cause radioactive decay, during the mid-1930s, notes Gold, a *Science 83* associate editor.

By the late 1960s, Steven Weinberg of the Massachusetts Institute of Technology and Abdus Salam of London's Imperial College had developed a mathematical "electroweak" theory that unified the electromagnetic and weak forces and predicted the existence of three "weak" particles: W^+ and W^-, both charged particles, and a neutral Z^0.

In 1980, the European Center for Nuclear Research (CERN) in Geneva, Switzerland, spent some $350 million to modify its four-mile-long particle accelerator in a quest for the elusive particles. For two months, the accelerator hurled beams of protons and antiprotons into head-on collisions at energies, Gold says, "comparable only to those reached in the first explosive seconds of . . . the Big Bang." In theory, the experiment should have yielded a grand total of 100 W and 30 Z particles—each existing for one trillion-trillionth of a second before disintegrating into electrons, muons, and other smaller particles.

The results confirmed the existence of both the W^+ and W^- particles, identified through telltale electrons. But no Z^0 particles were detected. The CERN scientists are not discouraged: They expect the more intensive second round of tests, beginning this year, to reveal the elusive Z^0.

The prize for finding them will probably be a Nobel. But proving the "electroweak" theory of Weinberg and Salam (who shared a Nobel Prize in 1979) would be the most significant result. Its ultimate usefulness, Gold notes, is hard to gauge. But when scientists in the past have validated such "unified" theories—thus proving that seemingly different particles and forces are only "different faces of a single, more fundamental property of nature"—the effects have been awesome. Television and radar sprang from Heinrich Hertz's (1857–94) work on the relationship between electricity and magnetism; Albert Einstein's famous $E=mc^2$ formula linking energy to matter in 1905 led to nuclear power —and the atomic bomb.

Interferon's Strange Career

"Interferon and the Cure of Cancer" by Sandra Panem and Jan Vilček, in *The Atlantic Monthly* (Dec. 1982), P.O. Box 2547, Boulder, Colo. 80322.

During the 1970s, high hopes that interferon would prove to be a cure for cancer spurred heavy outlays for research. But most of those hopes have been dashed. The episode, say Panem and Vilček, virologists at the University of Chicago and New York University, respectively, shows how politics and public opinion can influence science.

Interferon, a protein produced in minute quantities in the body, was discovered in 1957, earning its name because it "interferes" with virus infections. During the early 1970s, Dr. Hans Strander, a Swedish physician, used it to treat 15 victims of osteogenic sarcoma, a bone cancer, to try to block the disease from running its usual course of metastasizing to the lungs. He achieved partial success. At the same time, however, the incidence of such diffusion among other sarcoma patients also declined, undercutting his findings.

Meanwhile, Mathilde Krim, a Sloan-Kettering Cancer Center biologist, became convinced of the drug's potential. Using "personal charm, political finesse, and determination," the authors say, Krim raised enough public and private money to hold a major Manhattan conference on interferon in 1975. While it revealed nothing new about the drug, the conference galvanized public support for research.

In 1976, the National Cancer Institute spent $1 million for interferon research; two years later, the American Cancer Society committed $2 million, its largest grant ever. (It later spent another $4 million.) The publicity peaked in January 1980 when Biogen, a Swiss genetic-engineering company, announced that it had produced interferon in the laboratory. High costs—natural interferon treatments cost up to $30,000—would no longer hamper research.

Since then, hundreds of patients have been treated with interferon—with mixed results. Although it may eventually prove useful in treating *some* cancers, it is clearly no miracle drug. Indeed, interferon has produced unforeseen side effects, such as hair loss, and may actually be harmful to some cancer patients. Yet the drug may have other uses, chiefly in fighting viruses, the source of half of all infectious diseases.

No one is to blame for the diversion of research funds to interferon, Panem and Vilček say. But the costs have been high, not only in lost opportunities for other research, but also in the "emotional toll" taken of cancer victims and their families whose hopes were raised in vain.