(military or otherwise) to Iraq. Iran ought to know about that pledge. Still, Iran wants to be the dominant power in the Gulf. It does not like either U.S. or Soviet interference. It may sense from U.S. debate the same internal weakness that made us vulnerable in Lebanon, and so it may test our resolve by attacking something of value to us—if not a ship, then perhaps an embassy or a barracks.

At a minimum, the administration must be sure of the security of all U.S. facilities and personnel in the region. It can't guarantee that U.S. ships won't be attacked or sunk, but it ought to do everything possible to provide them with the best protection that U.S. defense billions have bought. Among other things, it's time for Saudi Arabia, Kuwait, and Oman to give landing rights to U.S. fighter planes if they are needed to provide air cover for the Gulf. If the Saudis refuse, Congress is fully justified in withholding approval for the F-15 aircraft and air-to-ground missiles they want to buy. Congress should not expect the administration publicly to declare exactly what it will do if Iran attacks a U.S. target. As Reagan says, the Iranians should be left to worry about that. But the administration should know what it wants to hit—Silkworm missile stations under construction around the Straits of Hormuz ought to be a prime target—and congressional leaders should be informed about the plans.

The United States also must work harder to bring peace to the area. In fact, the administration has been working to obtain approval of a U.N. Security Council resolution designed to impose mandatory economic sanctions on parties (that is, Iran) that refuse to negotiate a settlement. The resolution also calls for a tribunal to fix blame for starting the war (on Iraq) and determine compensation for losses (which are catastrophic on both sides). And in what may seem an ironic touch, the U.S.-backed resolution calls for an arms embargo to both sides in the conflict. Critics of the Reagan administration certainly will guffaw at that, given the stupidity of the arms-for-hostages trade. But however justified, distrust of the administration's judgment should not lead Congress to force America to abandon the Gulf to the Iranians and the Soviets. The Gulf was vital when Harry Truman was president, and it will continue to be long after Reagan is gone.

SCIENCE AND SOCIETY

QUARK BARREL POLITICS

IN THE HALLS of Congress and state legislatures there is an intense interest these days in high-energy physics. Soon Congress must decide whether to spend $4 billion or more to build the administration's proposed superconducting super collider, and if the SSC is approved, the administration must choose a site. Several states want it badly. The machine would explore the subatomic world populated by such things as quarks and gluons. Few of those involved in the current discussions know or care much about quarks or gluons. They are concerned with traditional pork barrel bucks and a curious notion of how the government should invest in scientific research to stimulate economic growth.

High-energy physics, or particle physics, is the study of the constituents of matter. Since World War II this discipline has won a large, many say far too large, portion of the federal government's research budget. The SSC would continue the tradition. The Congressional Research Service estimates it would take up at least two-and-a-half percent of the civilian R&D budget through 1996, obviously at the expense of other science. The historical reasons for congressional generosity to the particle physicists are clear. They made the atom bomb, and after the war they had far more power in the government than other scientists.

Over the years the power of the particle physicists has faded. Many thought the government wouldn't spend heavily for bigger machines that produce only arcane data for physicists. Approval of the SSC confounded the skeptics. The most powerful accelerator now operating, Fermilab, west of Chicago, is a four-mile-long circle. SSC would be 52 miles long, about the size of the Beltway around Washington.

One man, a particle physicist of course, engineered the administration's backing of the gigantic project. Dr. Alvin Trivelpiece was until recently director of research in the Energy Department. He first persuaded his boss, Energy Secretary John Herrington, to support the project. Herrington is a former California prosecuting attorney who has a close relationship with President Reagan. At a Domestic Policy Council meeting on January 29 Trivelpiece presented the president and council members with the physicists' case for the giant accelerator, then others offered the budgetary arguments against it. Reagan decided to approve it. According to *Physics Today*, he announced his decision with a convoluted story involving writer Jack London and professional football quarterback Ken Stabler. Reagan said Stabler had once been asked to interpret a poem of London's. He then pulled a card from his pocket and read the poem, including the stanza: "I would rather be a superb meteor/ Every atom of me in magnificent glow/Than a sleepy and permanent planet." According to Reagan, Stabler concluded that the poem meant "throw deep." Reagan then told Herrington to "throw deep," and thus approved the most expensive civilian research project in history.

It is important to understand what the SSC will and will not accomplish. Ninety years ago physicists thought the world was made up of only 92 building blocks, the atoms of every known element. Of course, it was not that simple. In 1897 the electron was discovered, in 1919 the proton, and in 1931 researchers found the neutron. The atom had subunits. The study of those subunits and how they interact led to modern-day electronics as well as nuclear energy. It is the backbone of much of modern technology.

But the pure research interest of many physicists, especially those who had led the Manhattan Project, was to

find if there were parts even tinier than the proton, neutron, and electron. To search for them, the physicists had to build "atom smashers," particle accelerators. In the accelerators, protons or electrons are blown apart. In the debris, the physicists find the tinier subunits.

When particle physics moved from observing nature to atom smashing, there was a fundamental change. It entered an area that has nothing to do with the everyday world. The particles generated by current accelerators and those that would be produced in the SSC exist for a billionth of a second or less. If they ever occurred in nature, it was only in the first instant of the "big bang" of creation.

It is highly unlikely that these studies will yield practical applications in the foreseeable future. That fact often was misunderstood or ignored as Congress paid for bigger and bigger accelerators in the past, and it seems to be missing from much of the debate about the SSC. Indeed, one of the major parts of the administration's case for the SSC is that it will offer practical payoffs, that it will improve American industrial competitiveness.

A Department of Energy press release issued last February declared: "Past investments in studies of the interior of atoms have been repaid hundreds of times over in terms of new knowledge, new technologies, new jobs, national security, advances in medicine, and financial returns to the Treasury." That view is hardly universal. Dr. James Krumhansl, professor of physics at Cornell and vice president of the American Physical Society, wrote in a letter to Energy Secretary Herrington: "In the last 30 years I have not seen that particle physics has made any substantive contribution to technology generally, nor energy science and technology specifically. The proposed project will not be different. This investment will do nothing, either, to improve our scientific, technological, or industrial competitiveness."

Another of the administration's arguments for the SSC is that it will not cost us so much because other governments will pay for part of it. The newsletter *Science and Government Report* recently printed a long list of sharply contradictory statements by administration officials on the prospects for money from other governments. The prospects are bleak. Many physicists from Great Britain, France, and Germany who have been cooperating with American researchers have found themselves suddenly excluded because of security constraints imposed as SDI research has grown. Foreign governments are not likely to contribute to any American physics research effort.

One of the biggest forces pushing the SSC is that states are fighting harder for it than they would for most projects of that size. The 4,500 construction jobs created over an eight- to nine-year period and the permanent work force of 2,500 joined by 500 visiting scientists would certainly be worth having. But states lust after the SSC because of a widespread hope that the project will spawn a new region of high technology, low-polluting industry, the economic salvation that practically every state seeks. That is not likely to happen. Silicon Valley grew near Stanford and Route 128 near MIT and Harvard because research at those institutions created opportunities for quick commercial applications by new, small firms. The research carried out on a giant accelerator can be done only on the accelerator. There will be no high-tech venture capital companies set up to search for quarks.

IRONICALLY, the area of physics that is most likely to produce the next generation of Silicon Valleys offers one of the strongest arguments against building the SSC, at least now. In recent months researchers have made spectacular achievements in the field of superconductivity. This is the phenomenon in which some materials when cooled to very low temperatures conduct electricity with little or no resistance.

The SSC, as it name implies, would employ superconductivity. Its huge magnets would be cooled to allow more electricity to pass. The magnets would thus be much more powerful, accelerating the particles with more force. But the SSC would employ "old-fashioned" superconductivity. Its gigantic magnets would be cooled to temperatures close to absolute zero, about minus 450 degrees Fahrenheit, a formidable engineering project over 52 miles.

What is new in superconductivity is that scientists are finding how to create it at higher temperatures, with less difficulty and expense. These discoveries will almost certainly lead to commercial applications in areas from electronics to transportation to medicine. They are also likely to render the SSC obsolete before it is finished. It is possible that in ten years the same machine might be built for a fraction of the price or a much more powerful machine for the same price. So far the physicists supporting the SSC and their friends in the administration have resisted delaying the project because of the progress in superconductivity. They fear that any loss of momentum will be permanent, and they are eager to get on with their research.

There is no denying the importance of that research—as an intellectual construct. With the SSC the physicists hope to prove or disprove theories connecting the various forces of nature, and ultimately develop a theory that would explain them all. With the SSC the physicists hope to see more of the particles that were present at the instant of creation and thus understand more about the universe. These are complex and elegant studies that will tell us more about our world. Someday they could have enormous practical application. But that day, if it ever comes, is far off. The SSC, despite the hyperbole, is for pure research, and some areas of research are a lot more expensive than others. Some are more likely than others to improve our lives.

The list of scientific projects that could benefit from some of that money is endless. If we truly are interested in improving our industrial competitiveness, for example, we might consider ways of improving the awful science education in many schools. Perhaps American taxpayers want the SSC. But the taxpayers should know what they are buying and how much it costs.

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