JUDGE SSC (AND OTHER BASIC SCIENCE) ON ITS POTENTIAL FOR REWARD, NOT ITS 'SIZE'

Lon Hocker's letter on the SSC (March, page 13) would be easier to understand had it been written at the end of the 19th century, when many physicists believed that physics had reached the end of the road, leaving them nothing to do but develop the consequences and applications of a complete and perfect theory. The discoveries of the next 25 years revealed the folly of that view and became the basis of then unimaginable technologies that have transformed our world. The impossibility of predicting the consequences of discoveries in fundamental science is underscored by the famous remark by Ernest Rutherford, discoverer of the nucleus, that the nucleus could never conceivably have any practical importance. Likewise modern electronic technology and materials science were unimaginable even to the physicists who created the atomic physics from which they came.

There are no certainties in basic research. Support of basic research involves a mix of risk and reward—as does any investment. Like atomic physics in the first quarter of this century, high-energy physics continues the search for new forces and forms of matter and for new insights into the structure of space and time. Contemporary conventional wisdom concerning its eventual "practicality," even that of the high-energy physicists most directly involved, has no more value than did the conventional wisdom that preceded our current technological explosion.

"Big" versus "little" science is a misleading categorization. "Good" and "bad" are more to the point. The size of the SSC is fixed by the need to address important basic science: the discovery of a new force of nature that generates the masses of the elementary particles from which all known forms of matter are constructed. The very successful "standard model" of the four known forces predicts the range of energies needed to observe the new force and therefore determines the size needed for the SSC. Experiments at the SSC will find the new force or, if not, they will overturn the theory of the electroweak force and provide the first view of a deeper theory. In either case this will be a profound discovery, though the theoretical and practical consequences are both truly unforeseeable.

The economic times do not call for an end to investments in good basic science. A "prudent" national portfolio will continue to contain a mix of science investments, including support for high-quality applied science to exploit previously discovered laws of nature and for high-quality basic research to discover new laws of nature and build the scientific and technological base for tomorrow.

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4/93

HOCKER REPLIES: Physicists knew near the turn of the century that the Sun's energy production was related to the inner workings of the atom. The potential of harnessing this energy was not inconceivable. Similarly, atomic scientists knew at the turn of the century that their research was probably relevant to chemistry. Certainly they couldn't know what the consequences of their work would be, but there was no question of its potential.

Michael Chanowitz's central point, however, is that science should be categorized as "good" or "bad," not "big" or "little." But distinguishing "good" from "bad" requires a perspective, one that is in this case connected to the political and physics establishments. Couldn't this situation lead to a reversal of the hoped-for causality, so that "good" is defined by "was funded," instead of projects' being funded because they are good?

The SSC is a product of two effects. The first is obvious. A large, government-funded project is an opportunity for pork-barrel spending. Once started, it's almost impossible to stop: Politicians won't allow the military to close down unneeded bases, the welfare system continues even though it exacerbates rather than solves poverty, and the space station project survives despite substantial scientific opposition.

The second effect is associated with peer review. Reviewers are necessarily established in the physics community. They will be supportive of established (their) programs rather than truly innovative programs. (Innovative programs are, necessarily, not established.) How supportive was the established physics community when Boltzmann presented statistical mechanics?

The SSC is a huge opportunity for pork-barrel spending as well as an uninspired extension of a remarkably useless but established science. Progress in science requires inspiration. You get progress more efficiently gambling on the creative genius of scientists running a myriad of small independent programs than through giant programs with tunnel-vision goals or permanently funded government labs.

We have plenty of compelling projects to spend our resources on. We know so little about sociology that we can't solve problems like those of Waco, Bosnia or Somalia. We appear to be almost helpless in our confrontation with AIDS. Our cities are approaching a state of anarchy. Our ability to manufacture our technology seems to have evaporated. We have become so greedy as a nation that we are willing to sell our children's birthright to maintain our life-style.

The SSC, like so many "big" science projects, has no imaginable relevance to any current problem. If the supporters of the SSC feel that relevance is not important, and it is "good" because of the beauty of its physics, they should seek funding for

it from the National Endowment for the Arts.

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Particle Physics Spinoffs, Religion: Replies to Roy

Rustum Roy's comments (November 1992, page 13) to the contrary, had particle physics received an order of magnitude less funding in recent decades, hundreds of thousands of nonscientists would have noticed. Spinoffs of particle physics techniques into medicine are a case in point. Many thousands of cancer patients have received particle-beam therapy at the Harvard cyclotron, the Berkeley Bevatron, Fermilab and other institutions around the world.[1] Researchers trained in particle physics were instrumental in the commercialization of computerized axial tomography. Fermilab's Tevatron project stimulated a factor-of-20 increase in the industrial capacity for large-scale manufacture of superconducting cable, an essential step in the commercialization of magnetic resonance imaging.[2] Indeed, medical applications of particle physics techniques continue to proliferate: Witness the Loma Linda synchrotron, developed at Fermilab,[3] and the application of scintillating fibers to positron emission tomography.[4]

Particle physics has made important contributions in other areas as well. Electronic instrumentation developed for particle physics has found application in a wide variety of other fields, ranging from disk-drive testing to materials research and development. Synchrotron radiation has spawned an entire field of condensed matter physics with applications including semiconductor electronics, pharmaceuticals and biomaterials.

While spinoffs are not the ultimate reason for doing basic research, they are the first benefits to be derived. If history is any guide, improving our understanding of matter and energy on the most fundamental level will lead to further applications in coming decades. Superconductivity, discovered in 1911, is a striking example: It was some 70 years before the first large-scale applications were found. Some recent or soon-to-be-found result of particle physics could have considerable significance for civilization 70 years from now.

References

1. J. Sisterson, Particles **10**, 14 (July 1992). Fermilab Neutron Facility Newsletter, 31 December 1992.
2. Ferminews **15**(19), 2 (October 1992).
3. Ferminews **15**(19), 3 (October 1992).
4. R. C. Chaney *et al.*, IEEE Trans. Nucl. Sci. **39**, 1472 (1992), and refs. therein.

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1/93

I object strongly to the blatant anti-Catholic comments and innuendos that PHYSICS TODAY published in a letter by Rustum Roy (November 1992, page 13).

Roy is very insulting to the Blessed Mother of Jesus Christ by using the term "Immaculate Assumption" in connection with the deceptions presented to the public about the benefits of high-energy research. Comparing the Blessed Mother—the Immaculate Conception—with the physics elite's false rationalizations for increasing funding demeans and defames the Mother of God, Mary most holy.

Roy also insulted and defamed many holy and selfless churchmen in the Vatican by comparing them to the compassionless wonders who are running the lobbies for the high-energy physics programs.

Roy could have easily made his attacks and comments without impugning or even mentioning the Blessed Mother and the Catholic College of Cardinals. His comments were gratuitous insults to 900 million Catholics. During the modern era (from 1517 until today), heroic popes, cardinals, bishops and priests have had to contend with the debacles caused by the usurpation of ecclesiastical functions and properties by greedy laymen, the blatant robbery of church goods and the forced disestablishment of religious orders by brutal anticlerical regimes. Their staunch defense of the faith and of proper ecclesiastical independence from secular rulers has merited these churchmen a high crown that should not be dimmed by Roy's unsubstantianted sneers.

In the present situation, it is only we Catholics who are obliged to sit quietly as the brunt of everyone's stupid comments, while history shows that the whole enterprise of modern science arose from the Catholic milieu of the Middle Ages, and the Church has always contributed outstanding leaders to science. The famous pioneers Galileo, Copernicus, Mendel and Lemaître were all employees of the Church. Pasteur also was a devout Catholic.

To answer the attacks against the Church and Church leaders, I and others have formed the Catholic Association of Scientists and Engineers. Readers can obtain further information about the association by contacting me at the address below.

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ROY REPLIES: I am amazed that Francis Kelly could find in my letter anything that anyone could construe as anti-Catholic. I count several Catholic priests and nuns among my close friends; they too were amazed at Kelly's interpretation. As the first chair of the National Council of Churches' Committee on Science, Technology and the Church and a member of Pope John Paul II's very first Nova Spes meeting—his first attempt at a rapprochement with science—I am rather familiar with the issues of the relation between science and religion.

Perhaps it is Kelly who "demeans"—namely, demeans the English language, when he takes offense at the use of an ordinary play on words. Moreover he is clearly in a tiny minority of Catholics, since in Pittsburgh, a very Catholic city, an analogous pun has become a household word. Franco Harris's catch for the 1972 winning touchdown for the Steelers against Oakland has been known for a decade as the "Immaculate Reception." No offense intended or taken by millions of Catholic Steeler fans. Lighten up, Mr. Kelly, and thanks for your support against the high-energy physics lobbyists.

Daniel Kaplan's letter repeats the same old erroneous claims about the "spinoffs" from subnuclear particle physics. In most of his examples the net flux of spins is certainly *in* toward particle physics, not out from it. Think of building the SSC without the civil engineering advances in building tunnels. We poor benighted electrical and materials engineer types have built all the electronic devices without which no SSC detector or circuit would work—spin-in again. Nicolaas Bloembergen, recent APS president, has already dealt in a "fiery letter" (*Science* **253**, 1204, 1991) with the nonsensical claims by SSC proponents with regard to magnetic resonance imaging and so forth. As to the SSC's helping magnet research, Japanese materials and electrical engineers, I am told, already have magnets more powerful than those planned for the SSC that would reduce its size by over one-half—materials science's spin-in to particle