ciate the opportunity to respond to the letter by F. Russell Huson and Peter McIntyre, as we feel that some of their statements may leave the reader with a confusing picture.

The design concept now being developed for SSC magnets was carefully chosen after a meticulous study of five different magnet styles, including two that were being worked on at the Texas Accelerator Center at the time. The study itself was of a year's duration and was based on information produced in studies spanning several years. That information had many components: model measurement and test results, engineering analyses, manufacturing process studies, cost studies and documented experience with operating accelerator magnets. The final recommendation to develop the current design was rendered by a panel of experts including senior scientists and engineers from the same companies, foreign and domestic, cited by Huson and McIntyre.

As a result of close collaboration among the DOE, the SSC magnet developers, university scientists and the US superconductor industry, US industry now produces the highest-performance superconducting cable in the world. This cable is the heart of any magnet and is now ready for application to a range of products, including manufacture of the SSC magnets in industry, as was foreseen from the beginning.

You will be interested to know that a full-length SSC dipole has now operated at 7.6 tesla, 1 tesla above the nominal SSC operating point.

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Science Burdened by Bureaucrats

In his Reference Frame column "The Big, the Bad and the Beautiful" (February, page 9) Leo Kadanoff has opened our eyes to the realization that our tremendous investments in big-science projects are not beneficial to science as a whole. But this is not the only factor that is driving the development of the world of science in the wrong direction. A far greater and more disturbing factor is this:

Our world of science is predominantly staffed by huge professional bureaucracies. A thousand scientists on the staff of a major laboratory is quite common. The operation of these large bureaucracies is dominated by one principle—the first law of bureaucracy. In these giant bureaucracies there are two types of people—the "promoters" and the "producers." The promoters dominate the managerial aspects of the agency. They make the budgets, allocate manpower and funds to particular tasks, and so on. The producers are the ones who produce the theoretical advances, create the research machines and make them work.

The first law of bureaucracy is this: As the years go by, the promoters get pushed up and the producers get pushed out. This goes on until there is such a pile of promoters riding on the backs of so few producers that the enterprise collapses. Then we have a disaster like the explosion of the space shuttle or the nuclear reactor catastrophe at Chernobyl.

Our nuclear weapons program is concentrated largely at the Lawrence Laboratory in Livermore. This laboratory started in 1952 with about 60 people. By about 1965 it had grown to a staff of several thousand, and it is currently running with a staff of 8500. This means that the first law of bureaucracy goes relentlessly on, and the promoters in our nuclear weapons programs have grown to great numbers while the producers have been reduced to a relative few. When that situation is reached, there are so many promoters riding on the backs of so few producers that the whole machine breaks down and a disastrous accident occurs. Therefore, for our nuclear weapons program this disaster cannot be far away.

HYMAN OLKEN
3/88 *Livermore, California*

THE ASSOCIATE DIRECTOR OF LIVERMORE REPLIES: In his letter Hyman Olken expresses his concern for "small science." At the Lawrence Livermore National Laboratory we strive for a balance of big and small. We have many small research contracts and grants that produce new results and new ideas on the scale of a single graduate student or postdoctoral researcher. We also have large-scale projects that qualify as big science. Each large-scale project includes many small-scale projects. But large or small, research projects at the laboratory depend on "producers," and LLNL is rich with producers in all parts of our organization.

While the laboratory as a whole has grown, its nuclear weapons effort is actually smaller than in 1965. The growth is due to new programs, including many small ones, in biology and medicine, energy and nonnuclear defense technology. We

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agree with Olken that the vitality of a large research institution, including its good safety record, requires producers at all levels. When Olken retired from the lab in 1974, our safety record was outstanding, and it has continued to improve. To disagree with Olken, the US nuclear weapons program is not "concentrated largely" at Livermore. Los Alamos and Sandia have similar efforts.

PHILIP E. COYLE
Lawrence Livermore National Laboratory
Livermore, California
5/88

Keep Space Promises Down to Earth

Irwin Goodwin starts his news story on the Ride report (October 1987, page 64) with the question "What happened to the nation that went first to the Moon and clearly dominated the exploration of the solar system for more than two decades?" Having been a part of that portion of the history of science and technology, I offer my own observation and conclusion: It was the dishonesty of leading scientists of that nation during that period.

It was the American scientist who promised such unsubstantiated results as "When we bring one piece of lunar material back to Earth, we shall be able to answer the fundamental questions on the origin of the solar system." At several meetings, I dared to raise the simple question of what, in particular, would the answer be, provided the lunar sample was such-and-such, but instead of an explanation, I received an admonition to be up to date. Now we have enough lunar samples to build, if not a family home, then at least an impressive rockery, and all we seem to have learned from them is a curious anomaly in their tellurium contents. Otherwise, the Columbia Plateau basalts would have been just as good.

The American public may be used to broken promises from politicians, used car dealers and peddlers of ointment for baldness, but I fear that the inclusion in that company of the scientist dates from that time.

If we want to get public money appropriated for future space exploration, I suggest that we be honest—spell out whether we are after a technological stunt or a scientific study; explain as precisely as possible what we want to accomplish; openly confront possible alternative findings with conclusions of rival theories; and freely admit both our ignorance and our curiosity. We may openly specu-