a political metaphor, I suspect that research as a political force has already attained its critical mass. It may not yet be a farm bloc. But there are enough people and institutions directly interested in it, and enough others persuaded of its importance, so that I doubt that even the sudden outbreak of peace on earth and good will in Moscow would have as much effect on our research as on our military budget.

But already the scientists have gone further with their processes of analysis and experimentation, with respect to governmental institutions, than most observers would have guessed. The contractual system has gone far beyond the process of buying recognized services from well-established companies or institutions. It has come to the point of creating private corporations specifically or exclusively for governmental purposes. Some of these corporations are doing work which in other countries would be considered to be at the heart of the most delicate and confidential aspects of military or diplomatic planning. The analytical approach of science could hardly go further than to break down the concept and the institutions of sovereignty to this degree. Such a far-reaching idea may lead some day to an even more radical notion; if the purposes of these new corporations are of such importance as to require administrative staffs of the highest degree of flexibility and competence, perhaps some day we will recognize that the function of creating them, coordinating them, and judging their products requires an equally high level of competence within the government. But that day is not yet with us.

Science and Freedom

My colleagues from Canada, Norway, and the United Kingdom and I have been making comparisons among institutions that are different enough but that nevertheless rest on the basis of a common assumption of freedom. All of us, however, have doubtless been making an implicit comparison not with each other and with our other free brethren but with the authors of sputnik.

All over the world people are comparing the institutions designed to assure the freedom of science with those which maintain science under a dialectic of dictatorship. It is significant, however, that at the time of the triumph of Russian technology, the prestige of communism among scientists throughout the world seems lower than it was in the days when Soviet science was still being discussed in largely theoretical terms.

Among free nations we will doubtless continue to manage our affairs and support our science in different ways. In the United States, it seems to me, our best hope is for a science which will grow, not as a guild under the patronage of a traditional sovereignty, but as a most important element in a highly diversified and free system. In this system the scientist gets his influence not from a complete detachment from politics but from sharing in the political obligations of society. And in this system, too, politics may get its strength not by meddling with the processes of research, and not by strait-jacketing science in an ideology, but by freeing science to question and improve all aspects of policy, all forms of social organization.

The economic and political system that Marx attacked is almost as obsolete as the one he envisaged. We have created something new in the United States through the influence that science has had on our society, and we are only beginning dimly to understand it. But we need to learn how to use it better if we are to continue to promote the general welfare as well as provide for the common defense. And we need to learn rapidly—to learn political wisdom and administrative competence as well as scientific ability—or there will not be any posterity to inherit the blessings of the liberty that we find so enjoyable.

Note

1. This is a layman's summary of the point of view expressed by Sumner H. Slichter in "Technological research as related to the growth and stability of the economy" [in National Science Foundation, *Proceedings of a Conference on Research and Development and Its Impact on the Economy* (Washington, D.C., 1958), p. 107].

News of Science

Power Projects for Atomic Energy Industry Examined in Annual Review by Congressional Joint Committee

Hearings on the status and future of the atomic energy industry got underway last month before the Joint Committee on Atomic Energy of Congress. More than 30 witnesses from government, industry, and other fields testified during the annual review which is required by the Atomic Energy Act of 1954. Clinton P. Anderson (D-N.M.), chairman of the committee, opened the sessions by welcoming John A. McCone on his first public appearance before the full committee since he became chairman of the Atomic Energy Commission.

Atomic Power Program

The sessions were concerned primarily with the AEC program for new power projects during the coming fiscal year. In his testimony before the committee, and in an earlier news conference, Chairman McCone said that the fundamental change for the immediate future would be a shift from a diversified program in which many alternatives are considered to a concentrated emphasis on developing those types of reactors which have shown the greatest promise. The primary concern reflected here, as the news conference indicated, is economy. Carrying a number of lines of research from theory to prototype is an exceedingly expensive process and, in an economy-minded administration, it is not something easily justified. Within this framework, the objective for the near future is nuclear power which can compete economically with that generated by fossil fuels in certain areas of the country. To this end the commission plans to have designed and under construction by the end of fiscal 1960 six experimental reactors. Three reactors will be used for experiments in cooling. The media to be tested are gas, sodium, and an organic compound made of terphenyls. This last coolant is being considered because it has a lower vapor point than water and therefore does not require the heavy

pumping and containing equipment that water does. The remaining three projects are a process heat reactor, an advanced boiling-water prototype, and a small power plant.

Congressional Response

Chairman McCone described this program as "aggressive, forward looking, and one that will get results." But before he had completed his testimony a number of committee members, including Senator Gore (D-Tenn.) and Representative Holifield (D-Calif.) began criticizing the program as "timid" and "wholly inadequate." This occasioned the first open break between McCone and the committee. A relationship which Anderson had called "very good" at the opening of the hearings deteriorated rapidly as McCone lashed back at his critics for over-hasty deprecation of his program. The exchange, which reminded many observers of the acrimony that characterized the commission-Congress relationship when Lewis Strauss was chairman of the AEC, was not taken to be a serious threat to cooperation between the two groups but just a break in the surface harmony. The fact is that the commission and the committee are in fundamental agreement on basic issues. A major aim is competitive nuclear power for some areas of the United States within 10 years. Another is power for certain European nations within 5 years.

A Question of Leadership

One issue which troubled the committee members was concerned with the commission's exact role in advancing atomic power in the United States. Chairman Anderson said he was disappointed that the commission now regarded the construction of experimental prototypes as the domain of industry. The commission now takes the responsibility for planning prototype development, but in Anderson's opinion it should also continue to build them, as it did in its earlier years. The current policy, as put forth by Chairman McCone, is to invite proposals from industry to build prototype reactors of specified types. If no satisfactory proposals are received, the commission then goes ahead and builds the reactors on its own sites. As an inducement to industry, the AEC has proposed to Congress the concept of construction grants. Under this plan, which has the approval of the Bureau of the Budget, up to 50 percent of reactor-construction costs incurred by industry could be covered by a grant.

A Question of Degree

Although the AEC and the Joint Atomic Energy Committee have no fundamental issues dividing them, questions that are primarily ones of approach remain. The major problems seem to be two: degree of leadership that the commission should exercise and size of the country's atomic power program. The commission, presumably reflecting the Administration's tight budget policy, has indicated that it prefers to give industry every opportunity to exercise some degree of leadership and, at the same time, share some of the financial burden. It would also limit development to the more promising programs. The committee, concerned less with money than with the United States Government's domestic and foreign leadership in atomic energy, is calling for a more positive governmental role and a larger program. Moves made to date, including the restoration of a canceled public power project by the AEC, indicate that, despite that initial flare-up, there is a willingness to reconcile the two differing views on leadership and size.

Desert Agriculture in Israel

A study is under way in Israel to determine whether or not it is possible to farm the Central Negev Highlands with the exclusive use of rain and floodwater, as did the ancient peoples. Michael Evenari, botanist and vice president of the Hebrew University in Jerusalem, and his wife have been living this winter in a 2000-year-old farmstead at the site of the former Nabatean city of Subeita in the Negev desert.

The farm—five terraced acres with a network of channels, spillways, and regulators—has been reconstructed, and the well-preserved five-room farmhouse has been repaired. The couple expects to stay in residence for at least 2 years, the minimum time required for crop study.

Historical Background

Extensive remains of ancient habitation and agriculture are found in the Negev desert, which covers 60 percent of the total area of Israel. Flood irrigation, ancient terracing, stone clearing, and all other phases of irrigation work were carried out with outstanding technical skill by the ancient civilizations. Archeologists have studied the general form of the civilizations that were connected with these agricultural projects, but very little, if any, field and research work has been done to understand the basic features of these agricultural systems. Even less is known about the irrigation methods, crops, and agricultural practices that enabled these farming communities to flourish in the desert.

Most of this ancient desert agriculture is concentrated in the Central Negev Highlands, which lie at an elevation of 1200 to 3000 feet above sea level and consist of rugged rocky hillsides, cut by narrow wadies leading to broad flood plains. The typical loess soil of the area forms a shallow cover on the hillsides, while in the wadi bottoms and flood plains it reaches a depth of several meters. The annual winter rainfall is sporadic and seems to fluctuate widely, with a mean between 70 to 120 mm per year (3 to 5 inches). Very little climatological data are available for the region.

The ruins of at least five large cities have been found in the area—Abda, Subeita, Auja, Kurnub, and Halutza. These cities had a total estimated population of 80,000 to 100,000 inhabitants at the peak of their development. Most of them were originally founded by the Nabateans (200 B.C. to A.D. 100) and were later expanded and developed at the time of the Byzantine Empire (A.D 300 to 700). In the vicinity of these towns, well-developed agricultural projects have been identified that date back to the same periods. Some of these projects are relatively small in size—farm units of 1 to 4 acres—while others cover from 100 to 300 acres.

Ancient Desert Agriculture

Agriculture was developed only in the depressions, wadies, and flood plains, where loess accumulated. The slopes of the hillsides served only as water collectors for providing irrigation water and also for extensive grazing. The fields in the wadi bottoms and flood plains were always terraced with strong, well-built stone walls to stabilize them and enable the runoff water to penetrate into the soil.

Only the runoff water from the hillsides was used for irrigation. This runoff is caused by even a very light rainfall, since the loess, when moistened, forms on its surface a thin crust that is almost impervious to water. This crust insures a high rate of runoff from the slopes. On the terraced fields the same crust is formed, but the leveled fields and the stone walls prevent the water from running off and it slowly penetrates into the soil.

The runoff from the hillside slopes, which was the only water source, was artificially increased by stone-clearing and exposing the soil surface directly to the action of the rain. The runoff water was directed into the fields by exploiting the natural water courses where they were impermeable. However, in those areas where the water courses were composed of permeable fissured rock or gravel, the runoff water was led to the fields through artificial conduits.

Large tracts of land in the flood plains lying adjacent to the main wadies were irrigated by means of diversion works and canals. The canals were often