IV. PAPERS

1. SCIENCE POLICY FRAMEWORK

FUNDAMENTAL PRINCIPLES OF AMERICAN SCIENCE POLICY

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When I was asked to participate in the seminar, I felt it would be important to first address principles and discuss why we are concerned with something called "science policy." It's characteristic of the United States that while we have national policies for some things, we do not have policies for other things. We have an economic policy in the United States and we now have an energy policy in the United States. But there are some areas in our country where we have no policy at all. We do not, or have not had until very recently, a productivity policy, or even an innovations policy. So I would like to discuss with you the reasons that we Americans are concerned with something called *science and technology policy.*

First I want to explain the reasons why we are now concerned with having a science and technology policy. I believe the answer is quite simple. The need for policy derives from the economic functions of science and technology. Very simply put, we now know that advances in science and technology, advances in knowledge, create advances in economic growth, in economic development and productivity. There has been a long stream of research showing that the rates of return, what society as a whole gets back from investments in science and technology, ranges between 30 and 50 percent. Now that is a very good rate of return. The best rate of return that we get in the U.S. on most other investments these days is, perhaps, 13 to 14 percent. So it is clear there is a good case for the overwhelming importance of advances in knowledge to our economic development.

I think you can look at the problem of economic development from two standpoints. Economists like to talk about what they call "static efficiency." This means making the best use of available resources to produce a given bill of goods and services. We use our land, our labor, our capital to produce commodities and services, and we try to be efficient in their use. We also have a concept called "dynamic efficiency." We look at the course of economy over time, and we ask ourselves can we create a flow of new goods and services. That is, are there new and improved commodities and services that we can substitute for the old ones? In the twentieth century the flow of new goods and services, we have found, has been substantially derived from science and technology. However, today we face the question of whether the U.S. economy is still dynamically efficient.

Because of the importance of science and technology in economic growth and dynamic efficiency, questions arise about the total volume of resources we devote to our science and technology. Questions also arise about the distribution of science and technology. What are the most productive directions in which we can invest? Finally, questions arise about the government role in fostering and directing our science and technology. It is these questions that, in a sense, are the essence of what a science policy might be or should be. I will try to explain the process by which the U.S. answers these questions.

In general the United States leaves the creation of new products, new goods and services to the private sector, except in the case of what we call "public goods." A public good to an economist is one that society as a whole must choose. National defense is a public good, and the government provides direct support for science and technology in national defense. But in other cases, in principle, we could leave science and technology to our private sector, and the private sector could pursue whatever science and technology the market said would be appropriate. In that case, the government might set the framework for investment, provide incentives for productive research, and provide the incentives for innovation. These would be reflected in other general policies such as tax, credit, monetary and fiscal policy. However, it turns out that in science and technology the market does not work well, and so the government has an inherent interest in setting science and technology policies.

Within this framework, there are a number of elements of U.S. government science and technology policies that I think would be useful in our discussions. Let me list three. First is our policy for the support of basic research. Although industry does a fairly large amount of basic research in the United States, the level of support for basic

research by the government is a critical policy choice.

The second element of American science and technology policy concerns direct and indirect incentives for new product development, testing, evaluation, and commercialization. We are concerned with this, because there may be insufficient private incentives to bring new products to market. At least we are quite concerned as we look back at the 1970's that the rate of return from investments in new products for industry was low. There is also an issue of timeliness, that is, industry might bring a new product or a new service to market but very late – 10 or 20 years from now – when we need it in 5 years. And there may be no institutional adjustments about policy that we can make that will persuade industry to move faster.

The third element consists of policies for addressing those problems which, themselves, are created by science and technology. Science and technology proceed along certain lines of their own and then problems appear. For example, research on recombinant DNA has led to a new genetic engineering industry, and there are a host of social problems stemming from this particular science and technology. The accident at Three Mile Island has caused an upheaval in American attitudes toward nuclear power. There is a constant stream of such problems that are derived from the natural course of science and technology. Policymakers naturally become quite concerned with them. So the very course of science and technology calls for policy-setting.

We were also asked to explain who sets science policy and explain how the process works in the United States. We have no central economic plan, and we have no central science and technology plan. There are many actors involved in setting science policy. These include, of course, many federal agencies, the principal one being the Office of Science and Technology Policy in the President's Office. There are also the R & D agencies, e.g., the National Science Foundation and NASA, and other mission agencies. Each mission agency – Energy, Transportation, Housing, etc. – in a way sets its own S & T policy through its research and development budget. These budgets are established in close coordination with the President's Office of Management and Budget, which has a science and technology branch.

In addition to the Executive Branch, there is the Congress. It has committees which deal with science and technology, and they have staffs which deal with science and technology policy. The General Accounting Office also is involved in science and technology policy through its monitoring and "watchdog" role for the Congress. We have a Congressional Research Service which also deals in these issues. But I would not want to say that these are the sole makers of American science and technology policy. I would also like to call your attention to the important role of the U.S. universities. Some 750 of these provide advance research degrees, of which three hundred provide the Ph.D. degree, and these institutions are extremely important in helping to set U.S. science and technology policy. And I would not want to give short shrift to the public at large. In the last decade public interest groups and the public, itself, have come to have an increasing voice in science and technology policy. So there are many different ways and many different actors involved in setting our science and technology policy.

In the U.S. there is seldom an announcement or clear proclamation of an S & T policy or a plan. There is a constant stream of discussion and argumentation over the needs expressed by our university and private sectors and then a response from the government sector. In the U.S. establishment of policy is a political process. It ultimately boils down to resolution of competing claims. What happens in the S & T arena is that constant discussion and bargaining occurs among and between the many actors involved. Finally, there is some outcome or some action.

For example, there is a good deal of concern in the U.S. today about the state of our engineering education. Those in universities who deal with engineering have been very active in speaking to the President's Science Advisor, and in speaking to the National Science Foundation. Proposals have been brought forth for a National Technology Fundation that would provide the same kind of support for engineering that the National Science Foundation provides for basic science. Hearings have been held and bills have been introduced. In this way an issue about engineering education has become prominent in recent discussions of American science and technology policy. And the issue of engineering education is related back to the issues of productivity and economic growth with which I began my talk.

The benefit of our pluralistic system is that very few good things to do are overlooked. This is especially true of good science. Somewhere, some agency or some group is bound to consider proposals for research and development or for the commercialization of productive activity which may have been overlooked elsewhere. The cost of our pluralistic science and technology system is that it is very hard to be coherent about it. It is very difficult to collect all the costs and benefits and come to some view about what makes sensible science and technology policy. So, although it is usual for our policymakers to want to derive a national policy for science, as for many of our activities, it is very difficult.

I want to go back to a few areas which I think provide the substance of current American science and technology policy. First, let me go to the budget for government support of basic research. It is our policy to have a three percent real annual growth for basic research. This has been true since about 1976. Both President Ford and President Carter perceived that real basic research had fallen and needed to be restored. It is also policy that there will be limited growth in government support for civilian technology demonstration and development. The United States is an economy that relies on the private sector, but where there are generic technologies, such as computer-assisted manufacturing, the government is prepared to provide some limited support.

It is U.S. science and technology policy to provide more incentives for innovation, and there is now a stream of activity to promote this. I will list a few. We have U.S. government activity in the transfer of technical information, strengthening our patent system, making sure that our antitrust policy permits efficient performance of needed R & D, providing more resources for small firms for venture capital, etc.

It is obvious U.S. policy to try to become, if not self-sufficient in energy, at least less dependent on oil. So we have established an energy corporation which is to develop, by 1990, 1.75 million barrels a day of oil substitutes. There are to be new incentives for development for heavy oil resources. We are to reduce the use of oil and gas in electric utilities, to provide energy assistance for low-income families. Finally, it is a U.S. policy to improve government regulations or to make them more effective. One of the reasons that our productivity has fallen off, it is widely believed, is the host of new regulations that affect our industry. Many of these regulations go to the ability of industry to innovate, to productively employ science and technology. It is policy to now examine the cost of regulations as they affect productivity and as they affect the ability of both industry and universities to do research and development. There are a whole host of measures, such as the regulatory calendar, which lets firms and universities know what the government is going to do.

My final point is that there are many, many U.S. science and technology policies. They arise in most of the issues that we deal with in the United States, e.g., energy, health, welfare, transportation, etc. What I have tried to do here in this brief time is to lay out this latent, hidden structure of science and technology policy and explain to you why it is so important to the United States, and why it is so difficult for intellectual scholars and analysts to deal with it in some rational analytic framework. I would hope that the framework that I have presented here might be useful.

Let me close by repeating the elements of concern in this framework. First there is the support of basic research. Secondly, there are policies concerned with development, demonstration, commercialization, innovation, and productivity. And, finally, there are policies that arise from the natural course of scientific invention and of technical innovation.

Since science is inherently unpredictable, I cannot tell you what the next problem arising in science and technology policy will be. I can only tell you I am certain the problems will be there.

THE STRUCTURE AND PRACTICE OF SCIENCE POLICY FORMULATION IN JAPAN

Akira TEZUKA

1. Two types of science policy: science policy formulated in relation to industrial policy and science policy which is independently derived.

In Japan there is no science policy formulated in conjunction with military and defense considerations. In fact, most Japanese science policies are directed toward industrial progress and improving the lives of the Japanese people, i.e., industrial policies, transportation and communication policies, national land and environmental conservation policies, health and sanitation policies, and education policies.

Among these, most science policies related to industry – especially industrial policies concerned with the manufacturing sector – implement administrative measures which promote Research and Development (R & D) in the private sector. (In the past, when Japanese industries were not competitive, protectionist measures were used to regulate foreign enterprises in the same field, i.e., import restriction, high tariffs, limitations on the introduction of foreign capital, and measures to encourage the use of domestic products. Although such measures no longer exist, today there are tax incentives to encourage capital investment in R & D, which facilitate smooth structural changes in Japanese industry. There are also incentives aimed at providing special financing from government funds.) Providing direct subsidies, etc., to industry for purposes of R & D is unusual.

Most other science policies related to policies for industrial development and improving the lives of the people are those promoting R & D by the public sector. However, the activities by public corporations such as the Nippon Telegraph and Telephone Public Corporation (NTT) and the Japanese National Railway (JNR), and the public capital formation activities such as harbor and road development, are closely related to industrial policy. These activities forsee and precede the development of industrial activity itself, but also serve as a vehicle for technical innovation in industry by procuring materials and facilities for these purposes.

Since government and government agencies do not want to assume a major role in R & D, the afore-mentioned policies should be thought of as enhancing the technological capacity of the private sector.

There are two closely related types of science policy which are formulated independently of industrial policy:

(1) those formulated in light of new scientific developments and

(2) those which systematically promote research in response to social needs.

Science policy formulated in response to new trends in science is primarily promoted in the universities under the Ministry of Education, Science and Culture (MESC) and The Science and Technology Agency (STA) also supervises various aspects of technological development the scale of which is too big for industry alone, for example, nuclear power and space technology.

Science policy which promotes research to meet social needs is carried out not only by the MESC and STA but also by other ministries, agencies and government-related organizations which have jurisdiction. In addition to recognizing the importance of carrying out fundamental scientific research in the universities, the MESC also actively encourages social needs-oriented research.

2. The structure and reality of overall science policy coordination

The STA is responsible for the overall coordination of the social needs-oriented science policies of government ministries and agencies – with the exception of those connected with the universities. Needless to say, the universities also conduct social needs-oriented research, but they are not supervised by this Agency because of the importance attached to conducting basic research in line with new, international developments in science on an independent basis.

There has, however, been a strong demand for coordination of science policies concerning university research and those of the various ministries and agencies, and a deliberative body called the Council for Science and Technology has been established in the Prime Minister's Office. The Council does not have its own office and its work is almost entirely handled by the STA. While the Council was probably established as a high-level decision-making organ, it is primarily concerned with narrowly delineated science policies – for the most part to planning and coordinating independently formulated science policies in response to social needs. In other words, it does not become very involved in industrial policy considerations. In fact, more importance is attached to specific measures relating to the scientific and technological aspects of science policy than to influencing policy formation with regard to specific industrial policy objectives. At the same time, research aimed at spearheading breakthroughs in science

is dismissed as being unrelated and academic in nature, and policy formulation is left to the MESC.

To achieve overall science policy coordination as a whole in Japan, the appropriate position of science policies falling within industrial and other policies must be determined vis-a-vis those concerned with the purer academic research, and these must be harmoniously integrated. Towards this end, meaningful and appropriate directions for industrial policy must be suggested from the perspective of science policy. We must also realize that the most difficult problems lie in the fact that the management of highly-advanced, pure academic research is not in consonance with the administrative system, itself. We can say that such overall science policy coordination simply does not exist in Japan today.

This lack of overall coordination is clearly reflected in the policies formulated in response to the recent energy problem. Few studies have been carried out to determine what functional roles should be played by the public and private sectors in developing alternatives energy or in conducting research on energy conservation. Furthermore, there have been no studies about what kind of formal systems are necessary to have universities participate in large-scale research projects or to facilitate cooperation on an international level.

In order to examine this problem, we must adroitly inter-relate the science and technology viewpoint, the socio-economic viewpoint (including the marketeconomy systems viewpoint), and a viewpoint which assesses the appropriateness of the administrative management structure in terms of policy objectives.

3. Issues and realities of science policy formation in the various ministries and agencies.

Policy formulation at the administrative level in the various ministries and agencies must be examined in order to understand science policy in Japan. This is because there is no consistent high-level science policy being articulated by the government as a whole.

In this regard, the roles of two ministries deserve special attention: the Ministry of International Trade and Industry (MITI) and the MESC. The MITI plays a particularly important role in promoting technological innovation in industry, and the MESC has jurisdiction over universities where researchers are especially aware of new scientific developments and carry out independent research.

I will discuss the structure and reality of policy formulation in each of the various ministries and government agencies in another presentation, and will only mention here certain points that are shared in common.

First, science policy formation is limited to the administrative level, there is a tendency for matters to be discussed in the individual ministries and consequently to be seen in too narrow a light. Furthermore, the problem-solving approach tends to be small-scale and gradualistic. (Drastic change and large budgetary increases are almost impossible.)

The second point concerns the policy-making mechanism at the administrative level in the various ministries and agencies. Although there are considerable differences in the administrative jurisdiction of the various ministries, one can point to three common elements which are constraints on policy formation:

(1) influence exerted on various ministries and agencies by strong pressure groups, the vested interests of whom are closely related to the way in which the mission of each ministry is performed.
(2) policy direction from the Diet, especially from the party in power (LDP) and
(3) the uniformity and inflexibility of the administrative structure which emanates from a powerful government bureaucratic system.

There are various problems associated with each of these and no clear-cut assumption of responsibility with regard to science policy formulation is possible. Thus, rather than having a well-defined policy formation process, policy in Japan seems to be articulated through the contention of these various forces or through a natural process revolving around a cooperative relationship among these forces.