Letters

Plan for Producing Significant Research

The appearance of man-made moons, shot up from the U.S.S.R., dramatically highlights the problem of the development of new knowledge in the United States. The situation can be summed up with the statement that the professional, as a rule, beats the amateur. In the modern sense, we have neither positions nor institutions whose primary task is to develop new knowledge. Thus, we have no professional science. We have a fairly good training program for developing scientists, but, after they have been trained, we have no positions for them as creative scientists. They are either employed by industry to develop commercial products or in medical institutions to find a cure for some disease, or they may obtain a teaching position at some university. In all these places creative research occupies a secondary role. The net return of fundamental knowledge compared to the talent invested is insignificant.

Until recently, this method worked, but the development of the professional scientist in the Soviet Union, placed in institutions whose primary object is to develop new knowledge, renders our present method as obsolete as was the bow and arrow when gunpowder was invented and applied to warfare.

Historically, there has been one example of a professional science organization in the United States, established by private funds. In 1902 the Rockefeller Institute for Medical Research was organized for the development of new knowledge. In the next few years, about twelve key men were employed to search for new knowledge in the medical area. Each one of these men had an appropriate number of associates, assistants, and technical services; the administration's role was to create psychological and physical conditions which would stimulate the development of new knowledge. The salaries paid these men were ample to provide a high standard of living. The accomplishments of these few men, during 25 years of operation under this system, changed medical history throughout the world. To cite a few examples: D. D. van Slyke, practically singlehanded, created the science of clinical chemistry which is now an integral part of medicine and has saved innumerable lives. Karl Landsteiner established the knowledge of blood-groups and immunochemistry. This laid the foundation for blood transfusions and a better understanding of vaccination. The indications are that this fundamental work will continue to serve as a reservoir for other practical applications. Alexis Carrel contributed significantly to the field of tissue culture, from which an untold number of discoveries were derived; the Salk vaccine is based on this knowledge. P. A. Levene, a giant intellect, elucidated the structure of nucleic acid, which is the basic unit of heredity and viruses and which is involved in the synthesis of proteins. J. Loeb laid a better foundation for the understanding of proteins, which are the key materials of life.

Later, this program became diluted by a departure from the original principles, resulting in a lowered production of basic knowledge, and thus this scientific institution, although still outstanding, no longer serves as an example of an ideal professional scientific organization. This example serves to illustrate, however, that science on a professional basis in a free society will be highly creative.

The proposal which I have in mind is to establish productive scientific study organized around a relatively small number of unusually gifted investigators—about a hundred of them in each of ten new institutions covering various branches of knowledge. Each one of these scientists should have an appropriate number of assistants and, in addition, should have immediate access to various technical services, such as libraries and glass-blowers' and toolmakers' workshops, and an administration whose purpose is the maintenance of conditions under which the search for knowledge functions most effectively.

The key scientists should possess minimum qualifications, such as extremely high intellectual capacity, proven talent, and first-rate training. They should each receive a salary of $40,000 a year or more, commensurate with the importance of their work to the nation, so that they could be drawn from any field of activity, including industry, and so that continuity of effort could be assured.

Such a development would be a tangible sign, for every gifted young man and woman in this country, that the development of new knowledge pays off. This would provide an incentive for our youth to undertake the study of science as a career. There would be an overflow of gifted, well-trained investigators, assuring qualified personnel for industry, the teaching profession, and project-solving teams (in such fields as missiles and cancer, for example).

I believe that such development in our scientific setup would have a snow-balling effect, resulting in reforms in our educational system, since, once it is realized that there are places to go to in science with self-respect and good pay, it will be seen that there is a good reason for undertaking such training and maintaining such activity.

The introduction of a program of professional scientists functioning in institutions whose primary objective is to develop new knowledge is suggested for three reasons: (i) to provide new knowledge at a faster rate; (ii) to reinforce our existing facilities for the development of knowledge, both in industry and at the universities; (iii) to inspire our youth to engage in science as a career. Our present universities and industrial development methods are essentially sound and should be kept intact, and, in fact, they will be reinforced by the stimulus of new knowledge from such professional scientists, just as they will, in turn, stimulate these scientists. The universities and industry have done a good job and will do an even better job, once we have proper scientific activities that feed new solutions into existing areas of research and create new projects.

The value of such a program of professional science for the United States would be that, when the Russians shoot up a sputnik, instead of merely imitating this accomplishment, we would be in a position to make their accomplishments obsolete. For example, a better understanding of gravity, or of social psychology, could render the threat of the sputniks obsolete. In peace, a foundation for better living and health would be created.

The introduction of such a program of professional science under the leadership of the gifted of the nation, under conditions that will promote more rapid exploration of new knowledge, would be a test of the flexibility of our system and is, in my opinion, essential for the protection and further evolution of the way of life we all hold so dear.

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The Maser

With reference to the statement in the article "The maser" by W. H. Culver [*Science* **126**, 810 (1957)] that apparently only in the microwave region of the spectrum can the necessary requirements for maser operation be met, it may be noted that a proposal for a solid-state radio-frequency maser was made by J. Itoh in the *Journal of the Physical Society of Japan* (September 1957).

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Electronic Extension of Optical Observation Techniques

Two articles printed in the special Instrument Issue [*Science* **126** (25 Oct. 1957)] present interesting complementary approaches to the electronic extension of optical observation techniques. Quite interesting, also, is the apparent lack of communication between the adherents of the two methods. We refer to the articles "Ultraviolet television color-translating microscope," by V. K. Zworykin and F. L. Hatke, (p. 805) and "Automatic particle and bacterial colony counter," by H. P. Mansberg (p. 823).

In both techniques, the optical image is decomposed through scanning in order to provide a conventional electronic signal—a voltage which varies as a function of time. Two choices for accomplishing this are available. In system A the illumination on the subject is continuous and undirected during the scanning time. The signal is "read off" the photosensitive element in the camera's image plane as this is scanned by an electron beam. In system B the illuminating system and the photosensitive receptors are interchanged. The light comes from a "flying spot" which scans across the face of a cathode ray tube; this is imaged onto the object, and transmitted or reflected light is picked up by suitably placed photomultiplier tubes. The photomultipliers are continuously active during the scan time.

The interesting and disturbing situation to which we call attention is the following. Although method B can be used in microscopy and has indeed been so adapted by Montgomery, Roberts, and Bonner [*Nature* **177**, 1172 (1956)] in Great Britain and in this country, this fact is not alluded to by Zworykin and Hatke in their article. Similarly, method A could be used in particle counting and sizing—but the possibility is not referred to by Mansberg in his article. Both methods of image translation are used in commercial television—no doubt this complicates the issue through introduction of legal points and competitive business practices. But it seems safe to say that both systems A and B have merit and promise to be quite useful in wide areas of instrumentation and scientific research.

Is it possible that, in the situation cited, the groups involved were not aware of each other's work? Regardless of the answer, the general problem may not be dismissed. This is because it *is* a general problem. The fact that the practitioners of a method A avoid reference to the work of those who use a method B is but one example of a widespread tendency. Free scientific inquiry is being threatened with suffocation in other areas as well. No doubt other readers are familiar with current examples, even in areas which are vital to our national defense.

As users (for research purposes only) of one of the electronic-optical observation methods mentioned, may we reiterate the following: The erection of artificial barriers between research groups cannot but hinder the progress of all.

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Heller and Gournay are entirely right in stating that the television-camera tube techniques utilized in the ultraviolet television color-translating microscope and the flying-spot tube techniques employed in the particle counter described by Mansberg are both applicable to television microscopy *and* particle counting. However, flying-spot techniques are not suitable for ultraviolet *color translation* microscopy, and reference to them in our article would have been a digression which did not seem justified. Mansberg had, without doubt, equally cogent reasons for omitting mention of articles dealing, for example, with the use of camera tube techniques for making blood counts.

In any case, the authors of the preceding letter are mistaken in attributing the omissions noted to a lack of communications or an effort to erect arti-