4. This figure was presented at the State Department conference on the brain-drain problem in the spring of 1966; it was prepared by the Advisory Commission on International Educational and Cultural Exchange.
5. H. Grubel and A. D. Scott, "The immigration of scientists and engineers to the United States," *J. Political Econ.* (Aug. 1966).
6. Advisory Committee on Medical Research, Pan American Health Organization, "Migration of Latin American physicians to the United States."
7. H. Grubel and A. D. Scott, in *ibid.*
8. ———, "The characteristics of foreigners in the U.S. economics profession," *Amer. Econ. Rev.*, in press.
9. T. J. Mills, "Scientific personnel and the professions," *Ann. Amer. Acad. Political Social Sci.* (Sept. 1966).
10. H. Grubel and A. D. Scott, "The cost of U.S. college exchange student programs," *J. Human Resources* (Nov. 1966).
11. "The international migrations of Canadian economists," mimeographed.
12. This argument is developed at greater length in H. Grubel, "Non-returning students and the costs of foreign student exchange," *Intern. Educ. Cult. Exch.* (spring 1966).
13. S. Dedijer, *Science* **133**, 2047 (1961).
14. This article is based on research (in collaboration with A. D. Scott) financed by a Rockefeller Foundation grant administered by H. G. Johnson of the University of Chicago. "The international flow of human capital: The brain drain," giving the complete results, is in preparation.

NEWS AND COMMENT

Grant Swinger: Reflections on Six Years of Progress*

The genesis and history of the National Animal Speech Agency (NASA) are too well known to require detailed treatment before this audience. But, as one who has been privileged to witness the development and growth of this remarkable organization, I believe it would be useful to set forth a few points that perhaps have been overlooked in the general rush of events.

As will be recalled, NASA's incredible growth had its origins in the President's challenge to the nation "to teach an animal to speak in this decade." It has been contended, of course, that the challenge was simply a device to divert attention from the failure of certain foreign ventures. But a more realistic view, I contend, is that both the presentation and the acceptance of this challenge were inevitable consequences of national dynamics. Clearly, any nation that aspires to greatness cannot assent to a subordinate position in a technology so rich in military, economic, and cultural implications.

Be that as it may, the fact is that the acceptance of the challenge released a stream of energies of unparalleled dimensions in our nation's history. Let us briefly consider just a very few of the multitudinous consequences of that decision. "To teach an animal to speak in this decade" is a goal that can be stated in less than a breathful of words, but, as we are all well aware, it is a goal whose attainment has required a marshaling of effort and excellence that is remaking the nation.

Look back, for example, at the uncertainties that faced those few administrators, scientists, and engineers who courageously developed this proposal. Teach an animal to speak. Yes, but which animal? And what should the animal be taught to say? At the present time, when we estimate that we are two-thirds along the way in this great national undertaking, such questions seem elementary and remote. But it is necessary to recognize that just a very few years ago these questions symbolized matters of the greatest uncertainty. Fortunately, the nation had the services of several men of great foresight, courage, and experience to lead the way. For, let us not forget those skillful few who, in now happily forgotten days of strife, had pioneered in this great work. To our great gain, in those bygone days they had developed a primitive technology of animal speech. This speech, it must be acknowledged, was of the most scurrilous, vituperative, and vile nature, but it is difficult to argue with the explanation that in those long-ago circumstances the men who taught animals to speak could not be held responsible for what the animals chose to say.

Now, there is no need to dwell on the vast amount of uninformed carping that has been directed at this program. Success, needless to say, speaks for itself, but, if Project Mother Goose had to defend itself, there would of course be no difficulty in justifying the admittedly vast expenditures that it has entailed. In terms of pushing back the frontiers of knowledge, the project has been an unprecedented boon to virtually every scientific discipline. The initial phase, as we all know, required the collaborative efforts of zoologists and geographers to inventory the possible subjects; psychologists, physiologists, and linguists to develop a theory of animal speech; audio-engineers, biologists, and veterinary surgeons to tackle the once seemingly impossible problems of somatic reconstruction necessary for success. Out of these efforts have come many intellectual triumphs, not the least of which is a new scientific discipline, low-temperature linguistics; while the objectives, methods, and purposes of this new field of scientific pioneering are yet to be determined, its work proceeds at a rapid pace, for which we are all grateful.

And let us not forget the great variety of other disciplines that have been drawn into the project: the legal scholars, for example, who, with great foresight, have been wrestling with the problem of the admissibility of animal testimony in legal proceedings. All these efforts, needless to say, have spun off valuable products and techniques of immeasurable worth to the nation's economy. In fact, if the project can claim no more than invention of the reusable tongue depressor, now in an advanced stage of development, it will have more than paid for itself in social worth.

Under the newly established University Program for the Comprehensive Handling and Utilization of Knowledge, known as Project UPCHUK, we are diligently searching for still other applications of the knowledge that has been specifically developed for Mother Goose.

Furthermore, how can one compute in dollars the value of the scientific stimulation that has resulted from the

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project? I cannot assign a price tag to this factor, but I think it can be easily argued that we have all benefited from the at times violent debate that has raged over whether the mule is essentially bass or baritone. In these speculative controversies, I believe it is no exaggeration to say, careers have been placed on the line, and we all eagerly await the outcome.

The first stages of the project were, as we all remember, halting and cautious but, at the same time, immensely encouraging. When Owl-I mounted the podium at the Center and, before the eyes and ears of the world, uttered the first word of the *Star-spangled Banner*, "Oh," there were those who scoffed, those who contended it was not a word, those who, with not a few snickers, pointed out that a Soviet ox had already recited the first four words of the *Internationale*. Well, so it had, but we started late, and we had to pay for our lack of foresight with time—time to develop the capacity to work with heavy animals. But we are making progress.

Now, where do we stand? The answer is that we are advancing across a broad front, with peaceful and military efforts closely coordinated to assure maximum efficiency. The Defense Department, of course, has had great success in its project to develop a reconnaissance squirrel, as well as other projects that I need not go into here. We are on our way.

With the advice and cooperation of some of our leading scientific institutions, which have at last wised up, we can with confidence begin to formulate plans for post–Mother Goose. Should we perhaps strive for a duet of St. Bernards doing *Old Man River*? I don't know. But, needless to say, this proposal is being given serious consideration.

The next step, however, remains to be determined. But what is certain at this point is that we have the momentum, the talent, and the will to succeed. In conclusion, let us recall that it was Benjamin Franklin, or possibly Benjamin Spock, who said, "What good is a baby?" And I believe it was Faraday who, when asked about nuclear fission, said, "Someday you'll tax it." I think the lessons of history are there for us to read. Let us hope that we can read them clearly. Thank you.

(Dr. Swinger wishes to thank his colleagues at the Institute and at the Center for their kind assistance in the preparation of this manuscript. Since all their recommendations were followed, he thinks it is only fair that they share responsibility for any errors of fact, emphasis, or interpretation.)

—D. S. GREENBERG

Trained Manpower: British Studies Call for Better Use of the Supply

London. The brain drain has been back on the front pages in Britain with word of a government inquiry into the emigration of the technically trained, heralded by headlines such as "Drift to the US leaps by 50 percent." But while the brain drain represents an obvious loss of premium manpower, a much less easily dramatized and more serious problem for the British economy lies in the pattern of utilization of the total "stock" of scientists, engineers, and technologists.

Two reports* published by the government in October have given clearer definition to manpower problems at home. The verdict of the two reports is that a disproportionate number of the abler graduates in science and technology find employment in universities and in government research and that, unless more of the graduates take up work in industry and teaching in the schools, the country's ability, on the one hand, to finance scientific research and education and, on the other, to produce new crops of good candidates for university programs in science and technology will be impaired.

The two studies suffer from the same shortcomings which afflict similar manpower studies in the United States. There is a seemingly inevitable lag of at least a couple of years between the time data are gathered and the time they are published. Statistics for some sectors of employment are unavailable and must either be left out or more or less crudely estimated. Classification is usually by qualification, and this can be misleading. A man classified as a physicist may, for example, be functioning as an engineer, or vice versa.

In Britain, as in the United States, classification methods are under scrutiny and ways are being sought to apply occupational rather than disciplinary criteria. But the urgent need for manpower data makes it necessary to get on with the job with the tools available.

Manpower reports are usually accompanied by recommendations for action, and since World War II the British have done reasonably well in achieving round-figure goals set by a succession of survey panels. In the years immediately after World War II, Britain was producing scientists at the rate of about 2000 a year, approximately the prewar figure. A Treasury committee did a survey on the supply of scientists only, using straightforward actuarial methods, and recommended a very substantial increase in the output.

By 1956 the annual output of scientists and engineers had risen to about 10,000. A subcommittee of the advisory council on scientific policy took a national survey of science and engineering, with a look at demand, and urged that output be doubled in 10 years. Now, a decade later, the annual output of scientists and engineers has, in fact, reached approximately 20,000.

The increase has been achieved by a briskly implemented policy of expansion of higher education since the war and particularly in the past decade. By explicit design, at least half the new places created in higher education have been in science and technology.

Recently, however, manpower plan-

**Report on the 1965 Triennial Manpower Survey of Engineers, Technologists, Scientists and Technical Supporting Staff* by the Committee on Manpower Resources for Science and Technology, Professor Sir Willis Jackson, chairman, and *Interim Report of the Working Group on Manpower Parameters for Scientific Growth*, Professor M. M. Swann, chairman.