of solar energy. It is to be hoped that this collation of available facts will encourage a quick and successful attack on this urgent problem of the storage of solar energy.

References and Notes

1. Anon., *Chem. Eng. News* 31, 2056 (1953).
2. F. Daniels, *ibid.* 31, 3868 (1953).
3. E. Rabinowitch, *Photosynthesis and Related Processes* (Interscience, New York, 1945).
4. F. Daniels, in *Centennial* (AAAS, Washington, D.C., 1950).
5. H. A. Spoehr, *Photosynthesis* (Chemical Catalog Co., New York, 1926).
6. D. I. Arnon, M. B. Allen, F. R. Whatley, *Nature* 174, 394 (1954); D. I. Arnon, *Science* 122, 9 (1955).
7. C. S. French and H. Milner, *Symposia Soc. Exptl. Biol.* 5, 232 (1951).
8. R. Hill, *Nature* 139, 881 (1937).
9. A. S. Holt and C. S. French, in *Photosynthesis in Plants,* J. Franck and W. E. Loomis, Eds. (Iowa State College Press, Ames, 1949), Chap. 14.
10. J. D. Spikes, *Arch. Biochem. and Biophys.* 35, 101 (1952).
11. E. U. Condon, *Phys. Rev.* 28, 1182 (1926).
12. ———, *ibid.* 32, 858 (1928).
13. J. Franck, *Trans. Faraday Soc.* 21, 536 (1926).
14. ———, *Z. physik. Chem.* A120, 144 (1926).
15. R. J. Marcus, B. J. Zwolinski, H. Eyring, *J. Phys. Chem.* 58, 432 (1954).
16. J. Weiss, *Proc. Roy. Soc. London* A222, 128 (1954).
17. E. Rabinowitch, *Revs. Mod. Phys.* 14, 112 (1942).
18. R. Platzman and J. Franck, in *L. Farkas Memorial Volume,* A. Farkas and E. P. Wigner, Eds. (Research Council of Israel, Jerusalem, 1952), Chap. 5.
19. L. E. Orgel, *Quart. Revs. London* 8, 422 (1954).
20. J. G. Calvert, *Ohio J. Sci.* 53, 293 (1953).
21. F. S. Dainton and D. G. L. James, *J. chim. phys.* 48, No. 9/10, C17 (1951).
22. J. Franck and F. Haber, *Sitzber. kgl. preuss. Akad. Wiss.* 1931, 250 (1931).
23. J. Franck and G. Scheibe, *Z. physik. Chem.* A139, 22 (1929).
24. H. L. Schlaefer, *Z. physik. Chem.* NF3, 222, 263 (1955).
25. S. Freed and K. M. Sancier, *J. Chem. Phys.* 22, 928 (1954).
26. N. Uri, *ibid.* 20, 348 (1952).
27. ———, *Chem. Revs.* 50, 375 (1952).
28. B. J. Zwolinski, R. J. Marcus, H. Eyring, *ibid.* 55, 157 (1955).
29. L. S. Levitt, *Science* 118, 696 (1953).
30. ———, *ibid.* 120, 33 (1954).
31. R. L. Petty, A. W. Davidson, J. Kleinberg, *J. Am. Chem. Soc.* 76, 363 (1954).
32. E. Bartholomé, *Naturwissenschaften* 36, 171, 206 (1949); H. Sachsse and E. Bartholomé, *Z. Elektrochem.* 53, 183 (1949).
33. Figures on the expected efficiency of hydrogen utilization were supplied by Robert H. Eustis of Stanford Research Institute.
34. R. O. King, *Can. J. Research* F26, 228 (1948).
35. R. O. King and M. Rand, *Nature* 174, 975 (1954).
36. R. O. King, W. A. Wallace, B. Mahapatra, *Can. J. Research* F26, 264 (1948).
37. Anon., *Ind. Eng. Chem.* 46, No. 10, 11A, 13A (1954).
38. F. S. Dainton, *The Kinetics and Mechanism of Inorganic Reactions in Solution,* K. W. Sykes, Ed. (Chemical Society, London, 1954), pp. 18–40.
39. L. J. Heidt, *Proc. Am. Acad. Arts Sci.* 79, 228 (1951).
40. L. J. Heidt and A. F. McMillan, *Science* 117, 75 (1953).
41. J. W. Gryder and R. W. Dodson, *J. Am. Chem. Soc.* 73, 2890 (1951).
42. J. S. C. Wessels and E. Havinga, *Rec. trav. chim.* 72, 1076 (1953).
43. F. D. H. MacDowall, *Science* 116, 398 (1952).
44. W. Vishniac and S. Ochoa, *J. Biol. Chem.* 195, 75 (1952).
45. R. Lumry, J. D. Spikes, H. Eyring, *Ann. Rev. Plant Physiol.* 5, 271 (1954).
46. J. D. Spikes, "The energy conversion reactions in photosynthesis," *The Physical and Economic Foundation of Natural Resources: Photosynthesis—Basic Features of the Process* (Interior and Insular Affairs Committee, U.S. House of Representatives), in press.
47. D. L. Douglas and D. M. Yost, *J. Chem. Phys.* 17, 1345 (1949).
48. R. H. Betts and F. S. Dainton, *J. Am. Chem. Soc.* 75, 5721 (1953).
49. T. B. Copestake and N. Uri, *Proc. Roy. Soc. London* A228, 252 (1955).

50. I wish to thank Bruno J. Zwolinski of the National Science Foundation for directing my interest to the conversion of solar energy and for suggesting the sequence of energy-storing reactions that starts with the Hill reaction. Various parts of the subject matter were clarified by discussions with Dan McLachlan, Jr., of Stanford Research Institute, C. Stacey French of the Carnegie Institution of Washington, and John D. Spikes of the University of Utah. I am also indebted to Spikes for permission to quote material that is as yet unpublished.

Study Center for Behavioral Scientists

Ralph W. Tyler

The Center for Advanced Study in the Behavioral Sciences, located on a knoll a mile west of the Stanford University campus, is a place where each year 50 selected students of human behavior come on postdoctoral fellowships to study individually and with others in seeking to broaden and deepen their competence. The center was established by the Ford Foundation on the unanimous recommendation of a committee of 12 scientists and academic administrators as one major means for the further development of the behavioral sciences.

Obviously, the center is not the only important way of facilitating this development. More time and funds for research, greater attention to fundamental problems, better Ph.D. training, greater incentives for able minds to devote themselves to the study of human behavior, more opportunities for competent research workers to free themselves periodically from activities that distract them from intensive research efforts, and more encouragement in universities for interdepartmental communication on common problems would all help to speed up the development of the behavioral sciences. The center offers one kind of opportunity not previously available. For 1 year, it provides the scholar both with free time to devote entirely to his own study and with access to colleagues of the same and related disciplines who are interested in some of the same problems.

This concept of the center was outlined by a planning committee of scientists and submitted to the Ford Foundation, which in the summer of 1952 approved the proposal and appropriated $3.5 million to establish the center and to pay for 5 years of operation. The foundation also appointed a board of directors who were to incorporate the center as a nonprofit institution and to take full responsibility for it. The directors are Frank Stanton, psychologist, president of Columbia Broadcasting System, who is chairman of the board; Paul H. Buck, historian of Harvard University; F. F. Hill (*1*), economist, provost of Cornell University; Clark Kerr, economist, chancellor of the University of California at Berkeley; Robert K. Merton, sociologist of Columbia University; Robert R. Sears, psychologist, Stanford University; Alan T. Waterman, physicist, director of the National Science Foundation; and Theodore O. Yntema, economist, vice president-finance of the Ford Motor Company. The directors invited me to become executive director of the center, and I began this work on 1 October 1953. The year 1953–54 was spent in finding a site, erecting buildings, and selecting the fellows for the first year of operation, which began in September 1954. Hence comments about the way in which the center is serving the purposes intended are based on the first year of operation.

The original plan for the center con-

The author is executive director of the Center for Advanced Study in the Behavioral Sciences, Stanford, Calif.

templated a maximum of 50 to 60 fellowships per year with only half of that number for the first year, because of the need to work through the inevitable problems involved in launching a new institution. Actually, 36 fellowships were granted for the first year and 50 for the second. It is planned to provide 50 for each year of operation in the future. With so small a number, the selection process is highly important. It involves several steps.

Selection Process

The first step in the selection process is nomination. Letters were sent to all the behavioral science departments of accredited universities in this country and to many centers abroad explaining the purpose and plan of the center and asking for nominations of faculty members, former students, or other behavioral scientists well-known to them who were judged to be of very high competence and who would be likely to benefit from a fellowship. Individual applications were also placed in the file of nominations. Between 3000 and 4000 nominations resulted. This process will be continued in subsequent years so that scientists who have recently come to academic attention will not be left out.

The total file of nominees is then made into lists by academic fields. Each list is sent to a panel of five to seven senior scientists in that field who represent various institutions and various facets of the field and who are recognized as having wide acquaintance and high standards of judgment. Each member of the panel is asked to rate those persons on the list who are known to him in terms of the quality of their research or—for younger scholars—their promise.

There is no difficulty in getting consensus from the panel on senior nominees —that is, those over 45 years of age—who are usually full professors in universities. Also, for most of those who are in the age range 35 to 45 and are usually associate professors, a majority of the ratings are in agreement. These nominees have worked in the field long enough to have produced publications and to be generally known to their colleagues.

The juniors, on the other hand—those under 35—have not been in the field very long. Few of them have published works that have become widely known. Before they can be judged intelligently, the panel needs to have more information about them. For this purpose, we build a dossier on each nominee who is not well known to a majority of the panel. The dossier includes a personal history, copies of his publications, and ratings and comments from colleagues who know him. If these indicate great promise, arrangements are made for interviews by panel members.

Since about 2000 of the nominees are juniors, a major task of the past 2 years has been the building of dossiers that will provide adequate bases for panel judgments. Many hundreds of dossiers are still incomplete, but the task will be carried through to completion so that no nomination will fail to be acted upon carefully.

As rapidly as panels recommend nominees for fellowships, the names go to the board of directors for approval. They are then invited to come to the center at some time during its existence. As acceptances are received, the prospective fellows are asked to indicate when they will be able to come, to outline the plan of study they would like to pursue, and to name or to characterize other scientists whom they would like to have at the center and who could be of help on the study planned. The replies to this inquiry provide information for building a roster of fellows for each year.

Building the roster for a given year is largely a matching process. For example, Smith, who has been invited, has written that he will be able to come to the center in 1955–56, that he plans to work primarily on the development of language behavior, that he hopes Jones, Brown, White, and Green, or other psycholinguists, anthropologists, and neurophysiologists, can be in residence at the same time. We find that Brown and White have already been awarded fellowships and both can come in 1955–56. Furthermore, another neurophysiologist, not Green, is interested in coming to the center that year. Tentatively, then, we plan for a group studying linguistic behavior for 1955–56 that will include Smith, Brown, White, and another neurophysiologist. Further correspondence with these fellows identifies two other scientists whom they would like to work with and who have been awarded fellowships. These two can also come in 1955–56. On this basis we decide to invite the six for this year.

This type of procedure accounts for about two-thirds of the roster of fellows for a given year. The other third is made up of persons who have been awarded fellowships and can come that year but who have not developed previous connections with particular fellows. In each case, however, the plan of study involves some communication with scientists in the same and in related fields, and scientists in these fields are to be at the center during that year, so that they will be able to do some study collaboratively as well as individually.

In building the roster for a given year, consideration is also given to representation of the various fields that comprise the behavioral sciences and to a balance among the three age groups—above 45, between 35 and 45, and below 35. The roster for 1955–56, for example, includes anthropologists, economists, historians, a humanist, linguists, a logician, mathematicians, a neurologist, political scientists, psychiatrists, psychologists, sociologists, and statisticians. There are 16 who are 45 or older, 18 who are between 35 and 45, and 16 who are under 35.

Activities

The program of activities carried on at the center is a matter of continuous concern and study. The basic purpose of the center is educational—that is, to help fellows develop greater competence as behavioral scientists. There are no long-standing traditions regarding effective procedures for postdoctoral study of this sort. Hence, we have been feeling our way, seeking to examine and review carefully each activity that has been carried on.

An early decision was made not to employ an instructional staff but to emphasize mutual education, fellows learning from one another. A second early decision was made by the board of directors: the administration would not tell the fellows what they ought to study or who should teach them. The directors, largely drawn from academic institutions, agreed that, although universities were providing more time and better facilities for research than they had been a decade ago, the emphasis on specified research projects and on training students in the things that a faculty member already knew best greatly restricted opportunities for him to explore new possibilities, to round out gaps in his previous training and experience, to pursue new and untried lines of work, and to feel free from the tension of schedules and publication deadlines. Freedom in these respects was deemed the rarest and most important opportunity that the center could provide for the scientist. However, when the responsibility for the choice of activities and the development of these activities is left to each individual, he needs to know what resources are available, what activities are possible, and what values they might have.

The physical resources are generally easy to describe. The center's plant provides an individual study for each fellow, meeting rooms, a dining room, and a library. In the library, an effort is made to purchase every book or journal that the fellows expect to use frequently. This forms a working collection in the library. In addition, the center has a contract with the Stanford University library to loan materials not available in the working collection. Typewriters, calculating machines, the more common

items of I.B.M. equipment, and a room with a one-way vision screen for study of small group behavior complete the physical plant. Secretarial and research assistance are provided. The center has the facilities usually used in analyzing data previously collected and in guiding interpretations. We are prepared to arrange for other research facilities as needed; and during the past year, various studies were conducted that involved field work, opinion polls, administration of tests, and the like. However, a major question in seeking to extend research facilities of this sort relates to their value in connection with the study plans of the fellows. Obviously, the center should not duplicate expensive facilities that are already available in the universities. Furthermore, a fellow is missing the unique opportunity available at the center if he uses the year in conducting an experiment or investigation that he could do as well or better in his home institution. What we must learn is the kind and extent of facilities required to explore promising ideas and to carry on pilot studies that can guide thinking, discussion, and planning.

Although the physical resources are useful, the unique and most valuable resources of the center are the fellows themselves. Each fellow potentially might draw upon 49 others. Yet, clearly, the limitations of time would make this impossible, and not all would have major contributions to make in terms of the particular interests and needs of any one fellow. Most fellows limited their working relations to six to ten others in order not to spread themselves too thin.

In what ways can these various resources best be used for postdoctoral study? We can describe the various kinds of activities undertaken, but in only a few cases is evidence yet available concerning the relative effectiveness of a particular kind of activity. The purposes to be served, the individual habits of the person involved, and the stage of development of the idea or plan probably operate as important factors in the effectiveness of a study procedure. Reading, analyzing data previously collected, writing descriptive reports, writing interpretations of data, and writing up research plans were, of course, frequent study activities. Informal conversations were also frequent and were considered valuable by most fellows. The next most frequent activities were small working groups of two to six members, attacking a common problem, each assuming definite responsibilities in connection with the study. For example, one group worked at some length on "Social factors in perception." The relevant literature was reviewed, several previous studies were analyzed in detail, some preliminary pilot experiments were carried on, and a plan was drawn up for a more extensive investigation to be undertaken after the members of the group returned home. This working group included two psychologists and a sociologist.

Another example of work done by a small working group was the study undertaken in a Bay Area school district to identify the social forces in the community that influenced the attitudes and practices of high-school teachers of social studies. This too was a pilot investigation involving observations and interviews within the school and the larger community. Since the participants included psychologists, sociologists, and political scientists, it provided an opportunity for testing various hypotheses regarding social stratification, political power structure, and interpersonal relationships in their effects on teaching. This study will be continued on a larger scale after the fellows return to their home institutions.

Early in the planning for the center, much emphasis was placed on seminars as a type of activity considered particularly appropriate for postdoctoral mutual education. The seminar was viewed as an opportunity for 10 to 20 people to discuss one or more major problems or problem areas, to criticize alternative ways of conceptualizing and attacking the problems, to review relevant data and findings, to formulate and criticize possible interpretations of findings, and thus to organize and relate various specific studies and modes of attack into a more comprehensive formulation.

A dozen or more seminars were begun during the past year, but only three or four endured. Most of them were judged by the fellows participating to be less rewarding than the small working group. This may be inevitable or it may be that an effective seminar requires careful organization, clear assignment of leadership responsibility, the preparation of appropriate materials, and definite assignments between sessions of individual or small group efforts. In order to safeguard both freedom of individual choice and opportunity to shift efforts as a fellow saw more clearly the requirements and consequences of different activities, we depended on spontaneous interests to form seminars and developed no formal mechanism for conducting them. This year we are exploring ways of meeting the conditions required for effective seminars without greatly reducing freedom of individual choice and flexibility of individual commitments.

Another device that the center planning committee had thought would be widely useful was the short course of formal instruction. For example, several anthropologists might want to learn about projective tests—not only the theory underlying their development and use, but also specific techniques for administering and interpreting particular tests such as the TAT. A clinical psychologist at the center might be willing to give a short course on the TAT for this purpose. The planning committee mentioned a dozen illustrations of this sort as likely possibilities.

There was some use of formal short-courses at the center but not as much as had been anticipated. Anatol Rapoport of the Committee on Mathematical Biology of the University of Chicago offered to teach a refresher course in mathematics. This met for 45 minutes daily for 6 months, and about half the fellows participated. Similarly, Ralph Gerard of the University of Illinois Medical School taught a short course in biology basic to human behavior. This ran for about 4 months and involved about one-third of the fellows. Short courses on a few more specific subjects were also given—for example, latent structure analysis, the use of mathematical models, and general systems theory. The majority view of the fellows was that such courses are useful when they facilitate their broader study plans, but whenever possible, needs for this kind of specific instruction should be anticipated and such instruction should be obtained at home universities before fellows come to the center.

Frequent use of lectures was made during the first few months, calling upon both fellows and outside scholars. During the first month, the lecture schedule averaged three per week from 3:15 P.M. to 5 P.M. After that, the lectures tapered off, so that during the last 3 months there were fewer than three per month. The consensus of fellows was that the lecture is not an economical way for postdoctoral people to gain understanding of concepts, methods, or findings, except when the lecture can be focused sharply on the particular concerns of the audience. Hence, less use will be made of lectures in the future.

The experience of the first year thus indicates important values from four kinds of study activities—namely, individual work, informal conversations with other fellows, small working groups, and short courses of formal instruction dealing with definite subjects needed by the fellows participating.

Evaluation

Now that the first year is past, how is the center to be evaluated? We recognize the need for two kinds of evaluation. One purpose is to find out whether the center as an educational institution is really contributing to the development of greater competence on the part of behavioral scientists. Have the fellows actually gained greater knowledge and

understanding and more adequate skills? This will require time to ascertain. We have the works that the fellows published before they came to the center. We know the courses they taught and something of their research and teaching plans. After 1, 2, and 5 years, we shall examine the publications, the research plans, and the teaching activities of former fellows to find out how they differ from those before their center experience. Where there are differences, we shall try to find out whether and how they are related to activities carried on at the center. This will give some insights, although we cannot specify with certainty that any changes observed might not have developed without the benefit of the center experience.

A second purpose of evaluation is to guide the planning and operation of the center. Which policies facilitated productive study? Which ones interfered? Which activities were productive? Which ones were sterile? What problems were encountered by individual fellows? How were they solved? Which materials and services were helpful? Which ones were of little value? Answers to these questions can help us to improve the operations of the center. To obtain them, two procedures are being used. At the close of the year, each fellow was asked to write an evaluation of his center experience. He was guided by an outline of possible points with the following instructions: "Please comment on those points that suggest to you something worth saying, but do not feel bound to mention all of them. Please add your comments on points not included which seem important to you." These essays are very helpful in suggesting ways for improving the center program.

Some months after the fellows' return, we plan to follow up these essays with interviews and letters to get further judgments regarding center experiences and to get more detailed suggestions on points frequently mentioned in their written statements. Several comments are nearly universal in the essays. All of the fellows mentioned their great satisfaction with the year. The opportunity for free choice of study activities in an ideal physical setting was unique in their experience and highly valued. All of them mentioned the excellent library service, the fine secretarial assistance, the help they got from other fellows in criticizing papers and memoranda. Most of the younger men commented on the anxiety developed by the wide freedom available to them. They felt more keenly the responsibility for using time wisely when lack of productive effort could not be blamed on a heavy teaching load or routine responsibilities. In learning to use their freedom intelligently, many said that they discovered the insidious dangers of dissipating time and energy on trivial problems.

A majority of the essays emphasized the values obtained from working with people interested in similar problems but with quite different backgrounds of training and experience. However, several essays pointed out that interdisciplinary work requires solid links connecting the two or more scientists from different fields. Constructive efforts, they reported, required common problems and data on which to draw for questioning, analysis, and interpretation. Talking without common concrete contextual background did not get very far.

Several of the fellows commented on the "pay off" that had come from unexpected collaboration not foreseen in original plans, and they urged continuation of the policies of freedom and flexibility. Finally, most of them mentioned their eagerness to go on with work begun at the center.

There has not yet been time enough to follow up these essays, but these comments are helping to shape operations this year. The center is a new institution for the postdoctoral education of behavioral scientists. It has little tradition to guide it. If it is to be successful, it must utilize the insights and considered judgments of those who are and have been participants in this effort at mutual education.

Note

1. Mr. Hill resigned from the board of directors in September 1955 to become a vice president of the Ford Foundation.

W. D. Scott, Pioneer in Applied Psychology

Walter Dill Scott combined within himself distinction in the field of scientific inquiry, administrative ability of the highest order, a granitelike integrity, deep interest in people, and personal qualities of a most endearing character, the whole enlivened by a whimsical sense of humor.

It was my good fortune to come to know Walter Scott during the years prior to World War I when he was professor of psychology at Northwestern University and I was employment manager at the Curtis Publishing Company. When the war broke out in April 1917, he summoned to Washington a group of younger men who were active in the then new profession of "employment management," later to become known as personnel administration. I was fortunate in being a member of this group, which, under Scott's inspiring leadership, organized the Committee on Classification of Personnel in the Army. This committee planned, organized, and directed, with its military associates, the work in the Army training camps in this country and in the AEF that ascertained, so far as was then possible, the particular skills and qualifications possessed by each man being inducted into the armed forces and a military assignment in which he could use these skills and qualifications. The success of this work was due overwhelmingly to Scott's imagination and initiative and the respect he compelled on the part of military men.

When the war was over in the fall of 1918, Scott and five other members of this Army group organized a program to offer personnel consulting services to business and industrial interests. Walter Scott was the president of this group, which, borrowing his name, became known as the Scott Company. During the next few years personnel surveys were made of some 50 leading business and industrial organizations to determine in what ways the personnel situations in those organizations could be strengthened and improved, problems resolved, and morale and efficiency strengthened. After 4 years of useful and fruitful operation, the Scott Company suspended operations when Walter Scott was elected to the presidency of Northwestern University and the other members of the group transferred their energies to related work in education and industry. During the