abandoned in favor of a kind of education designed to produce men with the impulse and equipment to go on growing. No one whose education ceased at age 25 is an educated person at age 50. The test is not what the institution pours into the student but what it succeeds in planting to continue to grow. This, in my view, is what can make an education liberal.

It is ideas that enable us not only to find our way among the myriad facts of any one area but even, now and then, to take excursions into neighboring territory. In any branch of science it is the conceptual framework which, like the steel frame of a building, determines its form and structure. Isolated facts are as far from constituting a science as piles of building materials are from being a building. The dictionary definition of science as "classified knowledge" is far less than the truth. It corresponds only to an orderly arrangement on the ground of the various building materials. It applies to a science only in its early stages. The materials must be put together according to a design appropriate to their nature and to the function intended for the structure. Thus the biological sciences, beginning with natural history and taxonomy, gathered scientific significance by advancing to ecology, physiology, and genetics. Chemistry has progressed far beyond the mere description of substances and their properties and now incorporates the comprehensive ideas of kinetics, thermodynamics, inter- and intramolecular forces, and the relationship of atomic and molecular structure to physical and chemical behavior. It is ideas such as these that save us from being overwhelmed by the mere description of the half-million known chemical compounds and make of chemistry a manageable and predictive subject. They indeed "synthesize" and "integrate."

A student asked me recently to define chemistry. I answered with the best definition I can construct, "Chemistry is what chemists do and how they do it." It is essentially an enterprise, not a defined content. The most important element in the education of a chemist—I mean a scientist, not a technician—is association and apprenticeship with chemists at work and thinking. The graduate students in the department to which I belong are trained mainly by doing research and participating in seminars on live, controversial topics, with only a bare minimum of courses, and even these emphasize the powerful methods now available, not material to be memorized.

I am using a similar approach in a course for junior and senior students with a wide variety of nonscience majors, called "Methods and concepts in physical science." I advised the students, at the beginning, not to take notes, saying that I would not expect them to memorize and recite anything I would say; I would deal rather with the ways in which scientists work and think, ways which I hoped they would find suggestive for work and thought in other fields. A pleasing result was that I looked into faces instead of at the tops of heads. One student expressed what was evidently the general opinion, saying: "This is a think course, I have never had anything like it." That all did a good deal of thinking was evident from term papers and final examination.

By way of summary and in conclusion, the sciences should not play two distinct roles: one for the technicians, the other to give a smattering of scientific facts to future "philosopher-kings" who are supposed to guide society. The scientist should not be a "mere technician," he must be a wise member of society; nor can society be well guided by men who are ignorant of those criteria for reaching sound conclusions that are the essence of science. There is no more important task ahead for scientists than to teach the science to both groups, not merely as information, but as science.

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Science in International Cooperation

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THE International Scientific Unions are the backbone of all scientific collaboration of an international character, and it is important that all scientists, young and old, should be acquainted with the over-all structure of the International Council of Scientific Unions, known among the initiated as the I.C.S.U. The United States adheres to the I.C.S.U. through the National Academy of Sciences and the National Research Council, with the principal liaison being provided, and very effectively so, by the Office of International Relations of these two organizations under the direction of Wallace W. Atwood, Jr. The I.C.S.U. represents the central office and, in a sense, the parliament for the adhering scientific unions, 11 of them at the present. The scientists of the United States participate in the activities of their unions either as members-at-large or as members of specific commissions of the various unions.

Basically the strength of the International Scientific Unions depends on the loyalty and effective cooperation received from the membership and here our United States record is one of which we can be truly proud. In astronomy, the International Astronomical Union is the one major coordinating body for the field, which happens to be one in which international cooperation in research has always played a major part. The older astronomers are serving the union in two ways, first of all by their enthusiastic effective support of union activities and, second, by seeing to it that the promising younger generation of astronomers is as promptly as possible integrated into the union picture. Any scientist who wishes to make a contribution to international scientific cooperation can do so safely and effectively within the framework of the international unions.

The activities of I.C.S.U. are not limited to those relating to the 11 major unions alone. There are in addition seven permanent joint commissions, among them commissions for the ionosphere, for oceanography and for solar and terrestrial relationships. And, to complete the picture, we should not fail to mention the two special committees, one for the International Geophysical Year 1957–58 (Joseph Kaplan is the chairman of U.S. National Committee) and the other the I.C.S.U. Abstracting Board. The first of these will presumably be a self-liquidating committee, but it has a very important function in the preparation of what is obviously one of the major cooperative undertakings of our century. The organization of abstracting services is a never ending task and few would dare to predict when the second special committee may be said to have completed its assignment. American scientists are again in a position to act in a positive fashion in support of international scientific cooperation by giving their best to the work of these two important international scientific activities.

Much of the work of I.C.S.U. is closely associated with that of UNESCO's Department of Natural Sciences. UNESCO's program in the natural sciences is a triparted one. The first part is concerned with the development of international cooperation in pure science. The second deals with the promotion of research for the improvement of the living conditions of mankind, and the third is included under the heading "the teaching of science and the spread of scientific knowledge and methods."

A close working agreement between UNESCO and I.C.S.U. has been in effect almost from the day that UNESCO began operation, with the result that in the post-war era UNESCO funds (about $200,000 a year) have contributed about half the financial support for I.C.S.U. and related activities, the remainder being contributed by the adhering countries.

From the start, UNESCO has shown a great interest in the development of international scientific laboratories. Here the role of UNESCO has been to stimulate and initiate rather than to operate. The finest example of this type of activity is that of the formation of the European Center for Nuclear Research. All twelve nations whose representatives signed the original convention, have now ratified, and the project is ready to begin operation. There have been other ventures—not all as fortunate as the one just mentioned—in this area, but we should always bear in mind that UNESCO is not an operating agency and that the success or failure of any venture it initiates depends upon sustained support from individual scientists, groups of scientists, and national adhering bodies. Those of us who enter upon specific activities in international scientific cooperation must see to it that our efforts are well planned and that we do not abandon an international project when the going gets rough.

UNESCO's program for promoting research to improve the economic and social conditions of mankind is closely related to its share in the United Nations Expanded Program for Technical Assistance. One could readily write a paper on this part of the work alone, but I shall limit myself to the description of a single important project initiated by UNESCO: the establishment of the Advisory Committee on Arid Zone Research. The basic philosophy underlying the formation of this committee was that in some fields there is more need for supporting existing research organizations, and for the holding of meetings to exchange and discuss the results obtained in widely separated parts of the world, than there is for founding a new research institute. This happens to be the case in the field of arid zone research. In connection with this program, UNESCO supports the holding of one or two conferences each year, assists with problems of publication, helps secure the needed funds for research, and offers a number of research fellowships. UNESCO is now developing in a similar fashion an Advisory Committee on Humid Tropics Research and is looking into the question of a similar approach to the problems of physical oceanography and marine biology.

UNESCO's program on the dissemination of science is extensive. To illustrate its approach, I shall describe one important project, that of the Travelling Science Exhibits. Very successful exhibits have toured Latin America: the first one on physics and astronomy was withdrawn in 1952 after having circulated there for 3 years. The plan is to prepare one new exhibit each year and to retire one for replacement and rebuilding.

No description of UNESCO's work in the natural sciences is complete without reference to the Science-Cooperation offices. There are at present four major offices—in Montevideo, Cairo, New Delhi, and Djakarta, and two branch offices—in Istanbul and Manila. These offices arrange tours by lecturers of competence of the areas for which they are responsible, they fulfill important "post-office" functions for the scientists in the area who may not know where to turn for advice and help, and they play important parts in connection with the establishment of regional research institutes and projects.

Now, you might well ask, what is it that the individual American scientist can do to help UNESCO carry out its program more effectively. First of all, he can and should inform himself about the whole UNESCO program, and especially about the parts closest to his field. The UNESCO *Courier,* an excellent publication, and the recently reinstituted bulletin, *Science in UNESCO,* issued by the Office of International Relations of the National Academy of Sciences–National Research Council, are the key publications. Next, he should not refuse lightly when a request comes to participate in one of UNESCO's affairs, whether it is a meeting, the preparation of a report, or a request to help select a man or woman for a special UNESCO post. We need scientists, young and old, who do not feel that international cooperation is a fine thing for the other fellow to practice, something that it is not for him or her! Third, UNESCO exists only by the grace of the governments of its member nations. If a program item is a good one, any American scientist who is competent to judge it should not hesitate to let the National Research Council, the Department of State and especially his Congressman and Senators, know how he feels about it all. Without strong support from those competent to judge the value of its program, United States participation in UNESCO cannot remain truly effective. In the present climate of growing suspicion of international activities, the Congress and the American people should turn to their experts in the field—in this special case to the American scientists—to ask for advice on whether or not it is of value for the future of our relationships with the rest of the world that we continue to support UNESCO to the fullest possible extent.

A small group of American scientists—of which I happen to be one—has followed the UNESCO program closely and we think it is a good one. But many more individuals should take an active interest in the whole program of UNESCO if the organization is to operate with broad American support. I know of no way in which a young American scientist desirous of participating actively in international scientific cooperation can work more effectively on a broad scale than by looking carefully into the work that UNESCO is doing in the sciences and then by following up his study by informing the American public and our Congress about what he has learned.

Barriers to international cooperation. International cooperation can be effective only if individual scientists or groups of scientists of different nationalities are willing and able to communicate freely. In the present climate of world opinion, with its strong emphasis on national security and partial secrecy in scientific research, the permission to collaborate across national borders cannot always be granted freely. It is necessary that we examine carefully the barriers to international scientific collaboration that are in effect today, that we inquire into their reasonableness, and that we see how some of them, at least, may be overcome.

There are many barriers to cooperation among scientists living on different sides of national borders. The height of the barrier and the quality of the barbed wire used to render it effective depend very much on who wants to talk to whom, and across what border. But there is no denying that the average scientist is concerned with some sort of barrier in most of his contacts with his colleagues abroad.

The simplest and yet one of the most formidable of all barriers is that of language. National pride is the principal reason for publication in a language known to only a relatively small fraction of the people working in a given area of science; the difficulty of translating from one's own into another language is a secondary reason. Since the end of World War II, scientists from the United States and from many other countries have been especially concerned about the fact that most papers from the Soviet Union are published only in Russian, or in one of the languages of one of the Soviet Republics. However, before we condemn this Soviet practice too violently, we should bear in mind the offense that we Americans are giving by our often rather arrogant presumption that everyone the world over should consider the English language as the sole reasonable medium for international communication.

The language barrier, however, can be and is being overcome. The most direct approach is to take the time to learn to read and translate the new foreign language; some of our budding scientists are doing quite well in this respect; more power to them! It is, however, not practicable for most of the busy older scientists to learn a new language, and various services are assisting the scientist to overcome the language barrier. In astronomy, we have for many years solved the problem of the preparation of abstracts in English for papers in Russian on a cooperative and voluntary basis, through a series of mimeographed Astronomical News Letters. Special translation services have been instituted and a variety of multilingual abstracting journals have come into being. In this connection we should note the valuable assistance and initiative that UNESCO has provided to help create and support adequate abstracting and summarizing services. We note, further, that some progress is being made with the suggestion that it would not be difficult for the Soviet scientists to provide English, French, or German abstracts with their papers; such a plan might have political appeal if Western European and American journals were to issue in Russian abstracts of their published papers in return.

The problem of barriers to personal communications by mail is not a serious one for scientists in most countries of the world, but it must be considered briefly in connection with relationships between American and Soviet scientists. I am not concerned here with correspondence relating to classified material, an area in which world-wide communication is out of the question. The insurmountable barrier that exists in the classified area should not, however, discourage American scientists from communicating directly by mail with their colleagues in the Soviet

Union (and in other iron-curtain countries) anything worth writing about in the nature of pure and unclassified research. I am sure that America, and American science specifically, will stand to gain by the reestablishment of the normal practices of scientific correspondence with colleagues in all parts of the world. Here is one important area in which every scientist can act within the bounds of propriety as laid down by government regulations relating to classified material. It will take some honest courage and initiative for most of us to communicate with our colleagues on the other side of the iron curtain as freely as we do now with our scientific friends in Great Britain and Western Europe, but I believe firmly that all of us should make an honest effort to do so. In the absence of such effort our own science is in danger of turning provincial.

The most serious barrier to international cooperation in our time is inability to travel freely across national borders for scientific discussion, laboratory visits, for attendance at scientific congresses. This barrier has two aspects: inability to obtain a passport and inability to obtain a visa.

The passport problem for American scientists who wish to travel abroad is, at the moment, the less serious of the two problems. On the basis of my own personal experience, I would advise every American scientist who desires a passport for travel abroad to apply for it in plenty of time, preferably 4 months ahead. Given time, I think that the majority of decisions of the Department of State are fair and reasonable ones.

The major problem today rests in the visa question —the problem of obtaining a visitor's visa for a foreign scientist who wishes to come to America. Our Department of State should not alone be held responsible for the present unsatisfactory situation with regard to visas for foreign scientists desiring to visit the United States. Rather should the major blame rest upon the 82nd Congress that passed the McCarran-Walter Immigration Act (over the veto of President Truman) and upon the 83rd Congress that did nothing to modify any of its provisions. It will not be necessary for me to go fully into the whole history of the present visa problem, since I may refer you at this point to two excellent articles by Victor F. Weisskopf in the *Bulletin of the Atomic Scientists* [**8**, No. 7 (Oct. 1952); **10**, No. 3 (Mar. 1954)]. A special visa committee of the Stanford Chapter of the Federation of American Scientists is at present extending the earlier surveys and its report will be awaited with great interest.

The present situation with regard to the visa problem may be summarized briefly as follows: To obtain a visa for a visit to the United States, a foreign scientist must pass through a detailed, time-consuming, and often painful, investigation by an American consul in his home country. The investigation places great stress upon past associations, and many of the visitors-to-be feel that the whole tone of the inquiry is one of intrusion into his private affairs. Delays in the completion of investigations are the order of the day, so much so that many scientists who are invited to visit the United States for a specific scientific meeting receive their visitors' visas long after the meeting has been held! Every one of us with administrative responsibility here at home and with connections abroad observes repeatedly for himself the frustrating effects of our present policy with regard to visitors' visas. The situation has become sufficiently bad that many scientists abroad—and not only the physicists, who are hardest hit by these rulings—prefer to give up entirely, for the time being at least, the idea of coming to the United States for a visit.

One direct result of the present restrictions regarding visitors' visas is that fewer and fewer international scientific congresses are being held in the United States. Fortunately our Department of State is aware of the gravity of this aspect of the problem, and informal assurances have been given that every effort will be made to continue to make it possible for American scientists to be hosts to major international congresses, including those with members in iron-curtain countries. One case in point is the International Astronomical Union; Otto Struve of the University of California, President of the I.A.U., was encouraged by the Department of State to invite the astronomers to meet in the United States in 1958 or 1961; there is a good chance that the invitation will be accepted.

Hopeful as these signs of an easing of restrictions may seem, we should not lose sight of the fact that the basic source of all difficulties is the McCarran Act; it can be changed only by Congressional action.

Basis for International Cooperation in Science. To the average nonintellectual in the United States, in my native Holland, and presumably also in the Soviet Union, international cooperation appears to be a noble but rather remote concept. When political and economic conditions combine to create a favorable atmosphere between two nations, then the average man —or woman—takes a real interest in what happens across the border of the friendly nation and expressions of good will flow happily back and forth. But it often takes only a minor change for the worse in the political climate to effect a rather abrupt change of attitude, and vice versa. Perhaps the most striking case of such a reversal of public attitude has occurred since the end of World War II. Pearl Harbor and the Pacific war that followed aroused in the American people a deep hatred for Japan and its people, but within a short time after the war our attitude became a directly opposite one and Japan and its people are now considered among the best of our friends. It is significant to note that this national change of heart was brought about without the use of any obvious propaganda machinery on either side. Through our experiences with the fascist and communist worlds, we have learned how public opinion of one nation with regard to another may be modified in even shorter order by the ruthless use of carefully designed propaganda techniques.

In general, the scientist is somewhat less affected than the average person by sudden changes in the political climate. Most scientists have learned by experience that international friendships are a precious commodity, and that they go far deeper than formal relations between governments. I shall illustrate this point by citing my own experience with regard to Mexico. My first impulse to establish friendly relations with Mexican scientists was fostered in part by the effective Good-Neighbor Policy of the Roosevelt Administration. But it did not take long before some of my most cherished personal friendships grew out of my acquaintance with Mexican scientists, mostly astronomers and physicists. No official cooling in political relations between our governments, no incident real or imaginary, could readily change my basic attitude toward our southern neighbors.

There is one special reason why, as a scientist, I am naturally in favor of international cooperation. Every scientist can reel off without prompting the names of a dozen scientists from different nations who have contributed greatly to the advance of research in his special field. No list of astronomers who have brought my own field of Milky Way research to its present level would be complete without the names of one or more astronomers from the United States, Great Britain, Holland, Sweden, Germany, the Soviet Union, Canada, Mexico, and at least a half-dozen other nations. A scientist is often more keenly aware of the research project of a fellow-scientist in another country who is working close to his own specialty, even though the two may be thousands of miles apart, than he is of the researches of a close personal friend in another field in the laboratory next door. It is because of this universality of common interest in science, which concerns itself very little with national borders, that scientists are by nature internationally minded. The large existing reservoir of good will among scientists of all nations should be tapped for the benefit of all people in all parts of the world.

I might, in conclusion, dwell for a moment on the problem of the extent to which scientists should be proponents of world peace. On the highest level I feel strongly that as scientists we have much as any class of people a mission of upholding the basic Christian doctrine that all men are brothers. Like everyone else in his right mind, we, as scientists, should help create conditions conducive to world peace and we should constantly bear witness to the unifying influence of science.

I see my function as a scientist more like that of a missionary, or—perhaps more correctly—like that of a special ambassador. It is important to the future of the world that individual scientists on opposite sides of national borders should remain in contact with one another even in times of political tension. For as the political climate changes and the time comes for real progress toward world peace, we shall need ambassadors of good will from both sides who have long ago learned to speak each other's language and who are capable of acting for the common good.

News and Notes

Friends of the Pleistocene

The annual field meeting of the Friends of the Pleistocene was held 21–22 May at Malone N.Y. with about 70 people present. The meeting was under the leadership of Paul MacClintock assisted by Paul Bird, senior engineering geologist, New York Department of Public Works.

Demonstration and discussion centered about (i) the possibility of two till sheets representing two episodes of glaciation separated by an ice-free episode of the St. Lawrence lowland; (ii) the existence of large ice-dammed lakes, such as Lake Iroquois, in contrast to independent ice-marginal lakes whose shore lines may not reveal isostatic rise; (iii) the Pleistocene stratigraphy of the so-called "Malone Delta" which shows lower red-brown till below gray to buff till below dense silt capped with pebbly sand; (iv) the problem of whether the rounded NE-SW hills are drumlins or are ice-marginal features subsequently modified by the waters of the Champlain sea which has left their summits capped with a residual deposit of stony, bouldery material impregnated with saxacava and macoma shells and the surrounding lowlands buried in marine clays, silts, and sands; (v) the engineering problems, encountered in construction of the St. Lawrence power and seaway project, of handling the "sensitive" clays of the area.

At the dinner meeting Bird discussed the glacial geology as encountered in engineering of the St. Lawrence Seaway. Nelson Gadd, of the Canadian Geological Survey, displayed his maps and described his tentative findings in the St. Lawrence valley in Quebec. Richard Goldthwait showed a new colored and sound educational film that he made last summer in North Greenland.

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Report on Government Research

A report on *Research and Development in the Government* was submitted to the Congress on 31 May by the Commission on Organization of the Executive Branch of the Government, of which former President Herbert Hoover is chairman. The report points out that the Federal Government has organized the "largest integrated scientific and technical endeavor that any nation has ever attempted." The cost for the