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Science and Human Welfare

The AAAS Committee on Science in the Promotion of Human Welfare states the issues and calls for action.

For nearly two decades, scientists have viewed with growing concern the troublesome events that have been evoked by the interaction between scientific progress and public affairs. With each advance in our knowledge of nature, science adds to the already immense power that the social order exerts over human welfare. With each increment in power, the problem of directing its use toward beneficial ends becomes more complex, the consequences of failure more disastrous, and the time for decision more brief.

The problem is not new, either in the history of human affairs or of science. What is without past parallel is its urgency.

Four years ago, the report of the AAAS Interim Committee on the Social Aspects of Science (*1*) stated: "We are now in the midst of a new and unprecedented scientific revolution which promises to bring about profound changes in the condition of human life. The forces and processes now coming under human control are beginning to match in size and intensity those of nature itself, and our total environment is now subject to human influence. In this situation it becomes imperative to determine that these new powers shall be used for the maximum human good, for, if the benefits to be derived from them are great, the possibility of harm is correspondingly serious."

The Interim Committee also concluded that "there is an impending crisis in the relationships between science and American society. This crisis is being generated by a basic disparity. At a time when decisive economic, political, and social processes have become profoundly dependent on science, the discipline has failed to attain its appropriate place in the management of public affairs."

In the last few years the disparity between scientific progress and the resolution of the social issues which it has evoked has become even greater. What was once merely a minor gap now threatens to become a major discontinuity which may disrupt the history of man.

Recent events have lent substance to the conviction of our committee and of its antecedent groups—and we believe to that of scientists generally—that scientists bear a serious and immediate responsibility to help mediate the effects of scientific progress on human welfare, and that this obligation should be reflected in the program of the AAAS.

In the present report we endeavor to translate this conviction into action by suggesting a general approach and some specific procedures which may serve as a guide for the development of a AAAS program on the role of science in the promotion of human welfare.

Now, as in 1956, our premises are these (*2*):

1) We are witnessing an unprecedented growth in the scale and intensity of scientific work.

2) This growth has been stimulated by an intense demand for the practical products of research, especially for military and industrial use.

3) The public interest in, and understanding of, science is not commensurate with the importance that science has attained in our social structure. It cannot be said that society provides good conditions for the proper growth of science.

4) For reasons such as those just cited, science is experiencing a period of rapid but rather unbalanced growth. Basic research, which is the ultimate source of the practical results so much in demand, is poorly supported and, in the view of some observers, lacks vigor and quality.

5) The growth of science and the great enhancement of the degree of control which we now exert over nature have given rise to new social practices, of great scope and influence, which make use of new scientific knowledge. While this advance of science has greatly improved the condition of human life, it has also generated new hazards of unprecedented magnitude.

Members of the committee are Barry Commoner, Washington University, *chairman*; Robert B. Brode, University of California, Berkeley; Harrison Brown, California Institute of Technology; T. C. Byerly, Agricultural Research Service; Laurence K. Frank, 25 Clark Street, Belmont, Mass.; H. Jack Geiger, Harvard Medical School; Frank W. Notestein, Population Council, New York; Margaret Mead, American Museum of Natural History (ex officio Board representative); and Dael Wolfle, AAAS (ex officio).

An Estimate of the Present Situation

Since 1956 this general pattern has taken on some new features which concern us at this time.

1) The conscious exploitation of science for military advantage continues at an accelerating rate. But in recent years this process has merged with another, equally important trend: science is being pressed into the service of international politics. Scientific accomplishment per se has become an accepted—and at present dominant—factor of prestige among nations. The philosophy of "getting ahead of the Russians" (or Americans), which once referred only to military matters, now includes scientific achievements as well. This rivalry has strongly motivated the recent intensification of government support for scientific research.

2) The rapid emergence of political independence among the "underdeveloped" nations of the world, and their natural desire to exploit modern technology, has added to the importance of international exchange of scientific knowledge and personnel. Perhaps one reason for the rivalry for scientific preeminence among the more advanced nations is the expectation of political advantage from this exchange.

3) Certain recent scientific advances add directly to the ease with which our knowledge of nature can be applied to the control of human beings and of social organization. Development of new psychotomimetic drugs and psychological techniques have suggested, to some, effective means for controlling the behavior of social groups. Progress in the science of cybernetics and the development of automation techniques result in new capabilities for direct control of social and economic processes.

4) Despite some recent effort toward improvement, there is no reason to alter the earlier conclusion that our present social environment does not favor the development of an understanding of science, or of science's aims and needs. The increasingly spectacular practical achievements of science have only accentuated misconceptions about the relative significance, for the growth of science, of practical results and the advancement of basic knowledge. To many people physical science means nuclear energy and rockets. The public is sometimes led to expect that biological and medical research will conquer every human ailment—will overcome death. There is a tendency to equate scientific progress with a sum of money and a number of people. There is insufficient appreciation of the significance of basic research, or of the conditions in which it can flourish.

The situation appears to be this: We are witnessing an unprecedented and accelerating rate of growth in man's power over his environment. Science, the instrument which produces this power, is being consciously exploited for industrial, military, and political purposes. At the same time there is little recognition of the internal needs of science, or of its purposes as a discipline of the human mind.

In this situation it is inevitable that the inner strength of science should suffer, for what is essential to the proper growth of science is often in conflict with the conditions of its service to military and political affairs.

An important example of this effect is the matter of "competition." The military and political advantages, to a nation, of scientific progress within its own borders are self-evident. Yet, it is a truism—but nevertheless a vital one—that nature is the same everywhere, and that the study of nature is an activity of the whole human race. Any effort to divide science into fragments which are delimited by national boundaries, and dominated by a local social philosophy, will inevitably restrict the free discovery and communication of new knowledge that is the substance of scientific progress. A "nationalistic" science is an anachronism which cannot long continue without damage to science, and eventually to the nation.

What, then, is the scientist's responsibility to his own nation's scientific effort? Clearly, we need to understand that what science contributes to the national purpose is measured by what it adds to the sum of human knowledge; science serves the nation by serving humanity.

A further examination of the effects of the present social uses of science on life inside the house of science itself leads to even more disturbing conclusions. There is some evidence that the integrity of science is beginning to erode under the abrasive pressure of its close partnership with economic, social, and political affairs.

In recent controversies about fallout and the detection of nuclear explosions, partisanship on the part of some scientists for a particular political approach to the problem has been so intense in some instances as to cloud—at least in the public mind—the identity between science and an objective regard for the facts.

The grim international competition for "supremacy" in scientific accomplishment also endangers the integrity of science. Unseemly claims of priority may be encouraged. Premature reports of new scientific discoveries, which will occur to some extent in any circumstances, may be permitted to acquire a semblance of credibility.

An illustration—as yet unrealized—is the matter of "the creation of life." Some scientists believe that the properties of life are inherent in the chemistry of nucleic acid, and would regard the artificial synthesis of a reproducible nucleic acid or nucleoprotein molecule—which may occur in the reasonably near future—as the "creation" of life. Other scientists would disagree with this interpretation because they believe that nucleic acid, nucleoprotein, or anything less than a living cell is not "life," for the reason that it is not a self-sufficient replicative agent.

Under ordinary circumstances this difference of opinion would be occasionally debated among scientists and finally resolved when the weight of evidence on one side or the other became sufficiently strong, or when a new and more acceptable idea emerged. However, in the present circumstances this matter may take another course. There is some evidence that a claimed "creation of life" based on the test-tube synthesis of an infectious molecule might be regarded by a government as a scientific accomplishment of great political importance—a kind of "biological Sputnik." In this case, scientists may be hard pressed to persuade government officials—and perhaps even some of their colleagues—that the discovery should be given an interpretation which is less dramatic but more in keeping with the divided scientific opinion of its significance.

It is evident that the accelerating progress of science has evoked a number of serious problems that affect both the social order and the internal situation of our scientific establishment. Having become a major instrument in political affairs, science is inseparably bound up with many troublesome questions of public policy. That science is valued more for these uses than for its fundamental purpose—the free inquiry into nature—leads to pressures which have begun to threaten the integrity of science itself.

Scientists' Approaches to Their Social Responsibilities

It can be seen from the foregoing discussion that the scientific community is faced with numerous problems that very seriously affect the development of science and the future of society. How have scientists responded to this challenge?

Since World War II there has been a considerable growth in scientists' participation in political affairs. The growth has been intermittent, and based on a variety of views of the scientists' relation to social problems.

The Federation of American Scientists, initiated by scientists involved in the wartime atomic bomb project, is frankly designed to give scientists a direct voice in discussions of political matters that relate to science. The Pugwash movement and the less formal groupings represented by the *Bulletin of the Atomic Scientists* take the view that scientists can serve a useful function in proposing political solutions to the international problems that result from the applications of modern science. This approach results in a deliberate effort, on the part of these scientists, to persuade government agencies to follow a recommended course of action. A third group is typified by the Society for Social Responsibility in Science, which takes the view that scientists have a moral responsibility to try to limit to ethical uses the applications of science and technology.

In the 1956 Presidential campaign, *ad hoc* groups of proponents for both political parties developed among scientists. During the past year both parties have organized scientific advisory committees, which will presumably provide the "scientific authority" for the positions that these parties will take in the 1960 campaign.

Finally, some scientists take the view that their proper role with respect to questions of policy that are related to science is to bring to public attention the relevant facts and scientific principles and an explanation of the limits of accuracy and alternate interpretations that apply. Thus informed, the citizen is prepared to make his own choice between possible solutions. This approach has been the basis for the formation in St. Louis of the Citizens Committee for Nuclear Information, a group of scientists and citizens devoted to the dissemination of information about the radiation problem. A group of scientists with a similar purpose, the Scientists Committee for Radiation Information, has been organized in New York City under the auspices of the New York Academy of Science.

This account shows that scientists are trying to meet their social responsibilities in a variety of ways. It also suggests that no single approach has as yet won the active participation of more than a very small part of the scientific community. Nor has there been a sustained development of these activities. Indeed, in the last few years activity on these matters within the scientific community has been relatively slight.

If we regard participation in the resolution of public issues related to science as a part of the scientists' professional responsibilities, we must conclude that the scientific community has not yet developed a consistent, widely supported way of meeting this obligation.

A Suggested Approach

This committee and its antecedent groups have developed a distinctive approach to the matter of how scientists and their professional organizations (and in particular, the AAAS) can best function with respect to the public issues that involve the progress of science.

To begin with, we suggest that the issues fall into two classes with respect to where, in our social structure, their ultimate solutions lie. Certain problems—for example, the effects of public policy on the development of science itself—are matters in which scientists, as scientists, have a particular interest, responsibility, and experience. In the solution of these problems, the opinions of the scientific community should carry some special weight, and scientists should accept the obligation to develop and explain these opinions.

The more difficult problems are those which do not so exclusively concern scientists but which have a broad relation to public policy and affect all citizens equally. An example of such a problem is public policy in relation to nuclear energy, but this is only the most obvious of a growing class of troublesome issues.

It is our view that such problems are in essence social and political. We expect the choice among alternative solutions of these problems to be made through the normal, democratic processes of social and political decision-making, in which all citizens participate.

In this respect the general issues that relate to scientific developments do not differ from other social and political questions. The difference between them lies at a less fundamental level. In the case of the more familiar questions of public policy, the facts which the citizen, or the government official, requires to make an informed choice between alternative solutions are relatively accessible and the consequences of different solutions are more or less apparent. On the other hand, the factual background and implications of the issues with which we are concerned involve scientific and technical data, often in areas relatively new to science, which are in themselves complex. Many citizens are neither familiar with science generally nor well informed about the specific developments which are at the root of present public issues. Scientists as well as other citizens often lack the relevant scientific facts and are unable to visualize the effects of alternative courses of action. In these circumstances, there is little reason to hope for informed decisions about questions of public policy that relate to science.

In our view, this deficiency is a major cause of the difficulties that now impede the proper development of public policy on science-related issues. This conclusion can be documented in detail from recent experience regarding public policies on radiation hazards, food additives and insecticides, the significance of space exploration, the nature of modern warfare, the population question. This list also illustrates the importance which such issues have assumed in public affairs.

The foregoing analysis leads to a distinctive view of the part which the scientist and his professional organizations should play in the social processes involved in the resolution of science-related issues.

With respect to the process of decision-making, the scientist's role is simply that of an informed citizen. Like any other citizen, the scientist is free to express his opinions regarding alternative solutions for matters of public policy and will perhaps join with like-minded citizens in a group effort to foster the solution he prefers. This role does not derive from the scientist's professional competence or obligations but only from his citizenship, and therefore it bears no direct relationship to his professional organizations.

But in the matter of providing citizens with the knowledge required to make informed decisions on science-related public issues, the scientist and his organizations have both a unique competence and a special responsibility. As the producer and custodian of scientific knowledge, the scientific community has the obligation to impart such knowledge to the public.

The scientific community has another special competence (which derives naturally from its concern with new and potentially significant attributes of nature), for attempting to detect incipient problems before they become unnecessarily acute. For example, the likelihood that the relation between nutrition and the development of cancer would eventually become a practical problem for the food industry—a matter which is at present agitating farmers and food processors—has been apparent from the work of investigators in many countries for the past 15 to 20 years.

Early detection of such problems is one of the most important direct contributions science can make toward their solution. Too often the most serious obstacle to the solution of such issues is that they are recognized only after the commitment of massive and essentially irreversible economic and social investments. If the Los Angeles area were now about to be settled, it would be a relatively simply matter, given our present knowledge about the causes of smog, to make plans that would prevent a future smog problem. How much more costly is the real situation, which may require that an entire community's reliance on gasoline-powered transport be altered! In its fields of competence, foresight is a capability and, in our view, a responsibility of the scientific community.

It follows, then, that the scientific community should accept the obligation to determine how new advances in our understanding and control of natural forces are likely to affect human welfare, to call these matters to public attention, and to provide for the public and its social and political agencies the objective statements of the facts and of the consequences of alternative policies that are required as the basis for informed decisions on the relative merits of proposed courses of action.

At what point in the social process should the scientific community enter as an agency of information? One view is that, since most social decisions are executed by government, the scientist's function is to inform and advise government departments and officials. The government does, of course, need such advice, and a number of useful methods of providing it have been evolved. In these instances, scientists serve only by invitation. Inevitably, the general content of the information that is provided and the tenor of the advice that is offered are to some degree conditioned by the particular interests of the requesting agency, which determines what questions are asked and who is given an opportunity to answer them.

Such a relationship does not wholly fulfill the scientist's social role, as we see it. In dealing with social issues, the scientific community must demonstrate its responsibility and its inherent regard for truth and objectivity and must zealously preserve the freedom of thought and communication that is essential to the pursuit of these goals. Accordingly, we believe that the scientific community ought to assume, on its own initiative, an *independent* and *active* informative role, whether or not other social agencies see any immediate advantage in hearing what the scientist has to say.

We believe, also, that what scientists have to say about the social implications of science should be addressed directly to the general public. Our traditional preference for democratic procedures requires that the citizen be sufficiently informed to decide for himself what is to be done about the issues that scientific progress has thrust upon us. Furthermore, our command over natural forces—for example, the destructive potential of nuclear war—is now so great as to create social and moral questions of such great moment that no social agency ought to intervene between the issue and the public.

In sum, we conclude that the scientific community should, on its own initiative, assume an obligation to call to public attention those issues of public policy which relate to science, and to provide for the general public the facts and estimates of the effects of alternative policies which the citizen must have if he is to participate intelligently in the solution of these problems. A citizenry thus informed is, we believe, the chief assurance that science will be devoted to the promotion of human welfare.

Questions of Immediate Importance

Many specific problems command the attention of scientists who are concerned with meeting their responsibility to mediate the interaction between science and society. In choosing certain issues for emphasis, we have adopted the view that it is more important to learn how to deal with the difficult problems than with the simpler ones.

The problems presented below have been chosen with this in mind. Other issues may appear to be more important to other observers; we shall welcome our colleagues' recommendations in this regard.

1) *The social consequences of technological progress.* It is characteristic of the present situation that scientific advances lead to a very profound level of control over our environment and to widespread effects on nature. Often the benefits which are the original aim of a particular application of science are accompanied by secondary effects that cause unanticipated harm. The application of new scientific advances calls for social decisions which weigh the benefits against the disadvantages, and the public needs to have the facts relevant to such a decision. The scientific community faces an immediate need for developing the necessary educational programs. Important examples of such problems include: (i) the general effects of technological advances, such as that of automation on industrial development, or of rapid social changes on health; (ii) the effects of radiation from military and peaceful applications of nuclear energy; (iii) the effects of new organic insecticides, food additives, and food colors on animals and man; (iv) artificial control of the weather; and (v) population control.

2) *The association of scientific research and military activities.* Military usefulness is, at present, a dominant motivation in the social support of scientific research and has a profound effect on the development of our scientific establishment. Any significant change in the pattern of military activities—disarmament, for example—is likely to cause serious changes in research opportunities. The close association of science with recent military advances tends to foster a public image of science and the scientist which is not in keeping with the inherent goals of the discipline. The secrecy associated with military applications may restrict the development of science. Some observers regard the problem of preventing the catastrophic application of the power of science in war as a matter which overshadows all others.

There is an obvious need for the scientific community to give attention to the wide range of problems arising from the close linkage of science and military activity. The role of science in possible efforts toward disarmament and the practical impact of disarmament on scientific research are of immediate concern.

3) *International aspects of science.* Science figures prominently in the intense political rivalry among the major nations of the world. This use of science tends to conflict with its basic international character, and means must be found to resolve this difficulty. A useful innovation has been the development of collaborative international scientific programs, such as those associated with UNESCO, the World Health Organization, CERN, and the IGY. A number of proposals for similar programs in medicine, space research, and oceanography have been made. This area is a fruitful field for developing new ways to foster a sound development of collaborative science. Of particular importance are international programs to provide scientific and technological assistance to underdeveloped nations.

4) *Government support for scientific research.* This problem has received considerable attention in the last few years, but two recent discussions [the Parliament of Science (March 1958) and the Symposium on Basic Research (May 1959)] have shown that no adequate solution is in sight. The basic difficulties seem to be the absence of any over-all rationale in the support of science and the overemphasis on projects that give promise of immediate practical results. We find, as a consequence of this emphasis, that the major part of governmental research support (about 87 percent in the projected 1961 budget) is in the military area, that basic research is inadequately supported, that the pattern of support is not conducive to the development of free inquiry into nature, and that the narrow base of support is distorting the development of science as a whole, in our universities in particular. Various solutions have been proposed, none of which has as yet received really wide support in the scientific community. A specific example is the proposal for the establishment of a federal Department of Science. Clearly, further analysis and discussion of this problem are greatly needed.

5) *How can scientists best meet their social responsibilities?* From what has been said above it is clear that the scientific community has not yet developed a widely accepted means of performing its function in connection with public issues related to science. It would be useful, therefore, to stimulate discussion among scientists on how such activity can best be developed and to encourage efforts which seem to promise success.

6) *The integrity of science.* As science becomes more deeply involved in the frequently discordant affairs of public life and in highly competitive social endeavors, we may expect a growing pressure toward relaxation of the traditional rules for the conduct of science: objective, open communication of results; rigorous distinction between fact and hypothesis; candid recognition of assumptions and sources of error. It is these rules which permit science to progressively increase our understanding of and control over nature. Without them science becomes useless, and even dangerous to the social order. If the scientific community is to accept the obligation to participate in public affairs, means must be found to strengthen the discipline's rules of conduct. Some observers favor the adoption of a code of ethics; others propose less direct means of maintaining scientific objectivity. To begin with, there is a clear need for candid discussion of this problem.

Proposed Procedures for AAAS Consideration

We wish to confirm the general procedural approach suggested by our antecedent committee in its 1958 report to the AAAS Board of Directors. In summary we suggest that AAAS activities follow these steps with respect to any given issue:

1) *Stimulation of discussion, within the scientific community, of issues relating science and human welfare.* Such discussion would result in the identification of issues which the scientific community regards as of most immediate interest and would serve as a guide for the development of a specific program. We urge our colleagues to submit articles and comments for publication, and we welcome direct communications to this committee as well. Symposia and other discussions on these matters should be organized in connection with the AAAS annual meeting.

2) *Assembly of the facts relevant to a given issue.* We propose that a detailed report directed toward the scientific community be prepared after an issue has been identified. Such a report would include the relevant data, a discussion of assumptions and sources of error, and a description of the expected consequences of alternative courses of action. The report would not recommend a specific course of action. The report would be made widely available to the scientific community, either directly or by publication in a suitable journal. For the preparation of such reports we would rely on *ad hoc* committees, conferences, and symposia.

3) *Preparation and dissemination of reports for the general public.* We propose that the content of the report should then be translated into forms suitable for distribution to the public through all available channels. This step is part of the program of the AAAS Committee on Science and the Public and would be carried out in accordance with plans which that committee is developing. An important aspect of these activities is the proposed appointment of a new member of the AAAS staff to supervise work in this area. Our own committee will cooperate in this stage of the program.

4) *Development of liaison between scientists and the public on a local basis.* It is expected that, as the foregoing program progresses, citizens will develop an increasing interest in learning more about the facts relevant to a particular issue directly from scientists in their own community. Many scientists report an increasing demand from local civic groups for lectures on contemporary issues. As already noted, in some communities scientists have formed organizations devoted to informing the public about radiation problems. The British Association for the Advancement of Science has organized local groups to meet public demand for information on these and related problems. The success of these activities suggests possible extension, both geographically and with respect to the types of issues considered. Our committee may serve a useful function in stimulating such developments.

Conclusion

In this report we have reviewed the momentous problems which result from the interactions between the social order and the progress of science. We conclude that the scientific community bears a serious responsibility for helping to solve these problems, and have suggested a program that might accomplish this aim.

Such a program does not yet exist, and it would be appropriate for the AAAS to help bring it into being. The task is not an easy one. It will add to the scientist's burden of work; it will require from the citizen more attention to public affairs; it will demand new social inventions. But we believe that a society capable of producing the enormous new powers of science ought to be capable of finding the means of comprehending their effects on the social order. And we are confident that with such understanding, science—as an expression of the creative gifts of the human mind—will flourish, and the power which it endows will be turned more fully to the promotion of human welfare.

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Some Vistas of Astronomical Discovery

New developments in instrumentation have opened up new possibilities in optical astronomy.

W. W. Morgan

As is the case with all epochs, the present one has its own characteristics, both in its political and its scientific aspects. The science of 1960 is not the science of 1920, and, most emphatically, the astronomy of 1960 is not the astronomy of 1920.

The differences are not entirely differences in instrumentation and in techniques; even if the instruments of the 1950's had been identical with those of 1920, we would have been doing different things with them, because our thinking has matured and our approximation to reality in the astronomical field has improved through the investigations of the intervening years.

But the appearance of the new fields of radio astronomy and space science, with the accompanying revolution in instrumentation, is certainly the most spectacular astronomical development of the past 30 years, and the implications for the future in these fields lie beyond the range of the imagination.

However, the field of optical astronomy has also its charms for the future —even for earth-bound astronomers and telescopes, and I should like to describe some of these possibilities as they appear to a simple observer. The omission of further reference to radio astronomy, and to space, does not mean that I consider these fields unimportant but is, rather, a confession of inadequacy on my part to discuss them.

Continuities in 19th-Century Science

A perceptive observer, Jerome S. Bruner, emphasized a basic development in 19th-century science—the recognition of continuities—and he has pointed out the two giant figures in this development, Charles Darwin and Sigmund Freud. The former removed, dispelled, the concept of discrete categories for living forms and showed that organic connections, relationships, exist everywhere, and that man himself could no longer be considered a completely detached phenomenon.

Freud showed that in the case of the mind itself such absolutes as conscious-unconscious and sane-insane have to be abandoned, and that, in the case of these apparent opposites, a continuous sequence of phenomena has to be considered. In addition, developed and archaic qualities exist simultaneously in the same human mind.

Continuities in Astronomy

The development toward a concept of continuities has been a major feature of 20th-century astronomy. The idea of some uniqueness in the location of the earth, or the solar system, received three destroying blows in this century: (i) the demonstration by Shapley that the solar system is located far indeed from the central region of what Kapteyn had called "The Sidereal System"; (ii) the demonstration by Heber Curtis and by Hubble that our own stellar system is by no means unique, and that, on the contrary, multitudes of such systems exist; and (iii) the revision of the scale of distances by Baade, with its accompanying conclusion that our own stellar system is not unique in size. And, as we pass through the mid-century period, we find that more detailed study of astronomical problems brings us inevitably to a broader and broader concept of continuities in this field.

The "either-or" approach grows progressively more inadequate to describe the newly discovered shadings and relationships between phenomena. The concept of "giant" and "dwarf" stars, with its great importance in the historical development of stellar astronomy, has had to be modified successively by the introduction of subdividing categories—subgiants, supergiants, subdwarfs—and, finally, by the recognition of continuities.

The picture that developed out of Baade's brilliant discovery of the two stellar populations has had to be successively modified, first by recognition of an increasing number of subdivisions and now by development of the concept of a continuity of populations lying

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This article is adapted from an address delivered 15 March at the dedication of the Kitt Peak National Observatory, near Tucson, Ariz. The article also appears in the June issue of *Publications of the Astronomical Society of the Pacific*.