

Science's Issues: Our Response^{1,2}

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Scientists generally are concerned and defensive about the apparent disaffection of society from the scientific community and the charge that they are responsible for causing and ineffective in solving the "ecological crisis." Moreover, many scientists are themselves deeply involved in re-evaluating the methods, goals, and values of science. Such a time of reflection is difficult, but it is necessary. When it is over and it can be viewed dispassionately, the period may well prove to have been a significant era in the history of science.

What has happened? For one thing, we were caught with our communication lines too thin. We are ourselves inadequately informed, and we inform inadequately. I do not have reference only to the information that is being passed to the lay public; the public seems to understand some of the problems and ramifications better than we do, although we could greatly improve the breadth of their understanding. I also have reference to the lack of communication between scientists; it has allowed the solutions to problems to themselves become problems.

The type of solutions of which I speak were found through the efforts of highly specialized and compartmentalized groups, both scientists and technologists; indeed, this specialization and the concomitant analytic approach were responsible for their success because this method is most suitable for reaching well-defined and isolated objectives. Such problem-oriented teams and laboratories have therefore been developed by Federal, state, and private institutions and university departments too have specialized to serve a unit of science.

Today's great issues, however, are generally concerned with broad "quality-of-life" perception and with the realization that these qualities are the total of a number of interacting components. Solutions will thus be found only through more holistic approaches than our social and professional structures now permit. And specialization and compartmentalization have actually reduced the perception of problems, thus leading to the "eco-problems" that confront us, because the problems lie at the interfaces between our specialties.

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At the same time that we scientists are thus concerned about the means whereby science can approach modern issues, I find that I, and I suppose other scientists, am reacting strongly to a number of trends in the discourses on modern issues. Among these are the extravagant doomsday predictions being made, and particularly the extremity of positions taken, both pragmatic and altruistic, in relation to specific threats to the environment. I do not argue at all that technology has posed serious threats to our life-support system, but I suspect that extravagance is often used for effect. I also decry the unwillingness I see to accept that compromises must be made concerning both our tangible and our intangible assets.

The solutions of our problems will require a much greater effort on our part in the decision-making, policy-forming realm than in the past—decisions based on careful and probably painful estimates of the loss-benefit relationships that would result from alternative sources. We will have to carefully consider both the substantive and the intangible values, and as scientists we must be exemplary in our formation of rational decisions, decisions that are based on an honest evaluation of the threat to the environment as we know, enjoy, and use it, for use it we must. An excessively pragmatic (or truly dispassionate) scientist-observer would no more mourn the passing of the brown pelican than he would regret the passing of *Tyrannosaurus rex*; after all, as he might say, the passage of species is as scientifically interesting as the formation. But our scientist-observer must also be keenly intent on not *joining Tyrannosaurus rex*, so the threat to the pelican should serve as a biological assay of threat to himself, and morally and realistically, he cannot afford to remain dispassionate. A sound case can be made for both the scientific and the more intangible values we derive from the study of and communion with nature and, thus, for the preservation and protection of as much of the variety of life as possible. Certainly man benefits from sharing with other life, whether as a student or a kindred spirit, and the scientist must place such intangibles in the balance along with pragmatic values. However, he must, at the same time, read the measure with an eye open to reality. Some sacrifices of intangibles will have to be made. We are currently being asked to weigh human disease against environmental pollution, conservation of wild areas against urban confinement and its resultant mental illness, and the quality and quantity of food and fiber against a host of issues. There is no question but that compromises must be made and payment exacted in the form of a loss or losses for each benefit, and sometimes the losses will be listed among the intangibles.

Scientists are enjoined today to participate in the value-judgments from which decision-making must proceed, partly because they are thought most suited to see that the value-judgments are made with a maximum of objectivity and intellectual honesty. However, the scientist's experience

has been in the application of objectivity to the analysis of a single objective rather than to the synthesis of opinions across the boundaries of science. To illustrate, the agricultural scientist has typically evaluated his results in terms of the benefit received by the most direct recipient, often a farmer or nurseryman. His decisions, therefore, have been based principally on analytic evidence. He must now expand the area of his consideration of loss-benefit to—the consumer, the downstream habitat and user, wildlife, the alternative land-user, the economy, and elsewhere. He must estimate the losses and benefits from many possible courses, and he must synthesize a reasoned value-judgment based on the priorities as he sees them. This judgment may seem to those colleagues who differ with him to be emotional and unreasoned (for, in the final analysis, all our opinions have emotional basis), but if his intellectual honesty in synthesizing judgments is as complete as it has been in making analytical decisions, then his value-judgments will have weighted merit in the public forum. Unfortunately, in many cases, such honesty has not been maintained, and the result has been destructive of public confidence in scientists as decision-makers. Almost always when that has happened, objectivity was lost in an attempt to support a single point of view, so that the scientist-scholar had become a lawyer-advocate.

Actually, I myself am less concerned about what is happening to the web of life than of what may happen to the fabric of society. Society is a delicate structure, and today's anti-intellectualism poses a greater threat than DDT to what most of us think is a worthwhile life-style, even for the anti-intellectual. After all, the siren does not put out the fire; fires are controlled by the complex organization of water resources, hoses, men, and equipment—in other words, by society, and a torn society has little hope of controlling its fires. Society's problems can be solved, but not by emotionalism. The loss of objectivity by the scholar is an internal threat to reason and a demonstration to the layman that the scientific approach is no longer viable or valid.

After this thumbnail philosophy, is anything happening that holds out hope for a solution of our problems? Are we making the holistic approaches that depend on better integration of the work of our scientific disciplines?

Yes. The creation of the Environmental Protection Agency demonstrated the concern at the Federal level for administrative coordination of the activities that affect our eco-problems. Moreover, one of the tools developed to provide review, the Environmental Impact Statement, may have a considerable and beneficial impact on science and science-administration by forcing consideration of the secondary effects of a proposed project. Such consideration has been left entirely to conscience in the past and thus has been occasionally slighted.

Also, with specific reference to research in biology and agriculture,

the Federal structure is being reorganized to make it responsive to new national priorities. As Senator William V. Roth of Delaware describes it, "In the present structure, problems are often defined to fit the limits of organizational authority, and organization missions are often inconsistent with one another in terms of servicing national purposes." Thus, agricultural research was to be transferred to a new Department of Economic Affairs, which, "by bringing together in one organization the many separate programs dealing with these complex interrelated problems, could develop optimum solutions to the benefit of all economic groups." Though this proposal has now been put aside in favor of continued separate administration of agricultural activities, in my opinion, whatever the outcome, the national interest will be best served by viewing our capabilities to produce food and fiber as a national resource rather than as an exploitive industrial activity.

Within the Agricultural Research Service too, the Entomology and Plant Science Research Divisions have now been placed under a single Deputy Administrator, and the work will be more highly coordinated than in the past. Also, the Agricultural Research Service has for some years been creating multi-divisional laboratories where scientists from several disciplines work together in a common general cause. Some of these are the Metabolism and Radiation Research Laboratory in Fargo, North Dakota, where entomologists and plant scientists share common facilities; the Bioenvironmental Insect Control Research Laboratory in Stoneville, Miss.; and the Insect Attractants, Behavior, and Basic Biology Research Laboratory in Gainesville, Fla., where entomologists specializing in both crops and market quality work with engineers to develop new pest control techniques. (Planning for these laboratories began more than 14 years ago so they are not recent reactions to public outcry.)

Another principal site of agricultural research is the university, and here too the trend is to break down the barriers to interdisciplinary communication. Dael Wolfe wrote in a recent *Science* editorial that "the American university department has served science well. It has been a congenial unit, fostering esprit among its members and becoming the strongest unit in academic politics. The department has permitted... flexibility and innovation in both teaching and research... . But new conditions have arisen. Reductionism is not the only way to advance science. In terms of public interest, the most urgent problems do not fit into departmental boundaries. Those multiplex problems require synthetic as well as analytic studies and call for close collaboration of scholars from several disciplines... ." The fact is that many universities are considering or have carried out consolidation of departments and have used a variety of formats. These reorganizations may appear to produce principally administrative benefit, but they will necessarily help to loosen the ties that bind scientists so tightly to their respective disciplines.

Finally, general and specific scientific associations such as the American Association for the Advancement of Science (AAAS), the American Institute of Biological Science, and our own Hawaiian Entomological Society (HES) have questioned their roles and responsibilities and are trying to find ways to inform the public, the policy-makers, and their own memberships about science and science-related problems. Obviously, a large, broadly representative society such as the AAAS has facilities for expression of different opinions through its publications and its well-publicized meetings; a small, highly specialized society such as the HES does not. Thus, the public is aware that scientists in the AAAS have different conclusions about an issue and hear both sides. In other words, decisions made after discussion in a public forum can be based on full exposure to the value-judgments of concerned scientists with a variety of viewpoints. I believe that it is also important that the HES ensures this same full disclosure of opinion. When the Society takes a stand on the basis of majority opinion without equal disclosure of the alternative points of view, such advocacy may falsely indicate a simplistic analysis of a complex problem. I urge that we be as intellectually honest and as academically thorough in our value-judgments as we are in our own data analysis and that we develop means whereby we can demonstrate that concern about public issues is based on the understanding that they are complex problems deserving of consideration from more than one angle. More, when we take a stand, we must demonstrate that as an organization we have considered the several points of view, evaluated their merits, estimated the losses and benefits, and made a value-judgment of the priorities, just as we do, hopefully, as individuals in our work. Inevitably, such activity will be more difficult to express to the public than simple support or opposition to a proposal but it will be far more meaningful.

Let us consider a hypothetical problem. Suppose the Hawaiian Society for the Care of Craters proposes legislation to convert Diamond Head Crater into a closed fruit fly preserve. Simultaneously, an activist group proposes use of the crater as a memorial golf course and driving range to counter the movement of another alphabetical group to create a ping pong pavillion. The local garden club has already collected a fund to put a "no-fence" zoo in the crater. The military has other and legitimate interests in the area. How does the HES respond? I propose the following:

An Ad Hoc Crater Committee is formed that enlists expertise from within and without the society. It conscientiously attempts to consider the losses and benefits arising from each proposed use, which represent purposely such normal categories for consideration as conservation, international relations, sports and recreation, tourism and education, and defense, if a trifle facetiously. The committee then gives each use a rating (Priority Value) on a scale from - 10 to + 10 (Table 1) in such a way

TABLE 1. *Proposed uses of Diamond Head Crater, rated on scale of -10 to +10.*

		<i>Conservation</i>	<i>International relations</i>	<i>Sports & recreation</i>	<i>Tourism & education</i>	<i>Defense</i>	<i>Total</i>
1.	Fruit Fly Preserve	+8 ^a	0	+1	+2	-1 ^b	+10
2.	Golf Course and Driving Range	-3	0	+3	+1	-1	0
3.	Ping Pong Pavillion	-3	+2	+1	+1	-1	0
4.	No-Fence Zoo	+4 ^c	0	+5	+8	-1	+16
5.	National Guard	-4	0	0	0	+4	0

^aAlthough the use is meritorious, alternative (and more remote) sites would be more desirable.

^bA loss is shown because of the elimination of a present use. However, loss-value does not equal use-value because alternative sites could be found. (A fifth column indicating the "uniqueness factor" could be added.)

^cIncorporation of conservation is stipulated in the planning.

that the value of a use in one category can be shown to be partially or totally offset by detrimental effects in another category. Finally, the Committee drafts a review of the problem which the membership considers and votes on in an open meeting. The President of HES is now in position to write the appropriate policy-maker stating that the Society has considered the problem in as objective a manner as possible, has greater or lesser expertise in each area, but has assumed a responsibility for participating in the public decision-making process. He notes the most significant benefits and losses which might arise from each use and acknowledges any possible self-interest of the Society. Therefore, based on a 70-30 vote (of the 12 dynamic members present), the Society judges that the use-priorities fall in the order shown in Table 1 after considering the merit of each proposed use in all impact categories.

The method is only one of a variety that could be used in grappling with policy-decisions, but it does combine analysis and synthesis and does require the consideration of the many aspects. I believe the decision-makers would find it more meaningful, and therefore would be more influenced by it, than by a typical letter of advocacy. Perhaps more importantly, the ability of scientists to make value-judgments based on full and honest consideration of the problems that challenge us would be impressed upon the public.

This, then, is the core of my message: We are, as scientists, challenged to discard our role of uninvolved observers in favor of active participation in public events. However, as John Fowles says in his latest bestseller (1969), the scientist is the repository of modern society's idealized code of conduct in the same way as gentlemen were in an older society. Thus, the scientist sets a standard for the intellectual ethics of our time. If we discard our intellectual honesty along with our uninvolvedness, we forfeit our greatest strength and reduce rather than enhance our role.

The old proverb about the three blind men (scientists?) examining and describing an elephant has been expanded today. A fourth blind man has joined the team, a lay member as it were. He, while examining the tail, exclaims, "You'd better do something about this waste disposal problem." Well, we had better, but not through additional gut reaction.

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