The Science Court Experiment: An Interim Report

Task Force of the Presidential Advisory Group
on Anticipated Advances in Science and Technology

There are many cases in which technical experts disagree on scientific facts that are relevant to important public decisions. Nuclear power, disturbances to the ozone layer, and food additives are recent examples. As a result, there is a pressing need to find better methods for resolving factual disputes to provide a sounder basis for public decisions. We accordingly propose a series of experiments to develop adversary proceedings and test their value in resolving technical disputes over questions of scientific fact (*1*). One such approach is embodied in a proposed Science Court that is to be concerned solely with questions of scientific fact. It will leave social value questions—the ultimate policy decisions—to the normal decision-making apparatus of our society, namely, the executive, legislative, and judicial branches of government as well as popular referenda. Similar proposals have been made by several authors, and those which have come to the attention of the Task Force are listed in the bibliography.

In many of the technical controversies that are conducted in public, technical claims are made but not challenged or answered directly. Instead, the opponents make other technical claims, and the escalating process generates enormous confusion in the minds of the public. One purpose of the Science Court is to create a situation in which the adversaries direct their best arguments at each other and at a panel of sophisticated scientific judges rather than at the general public. The disputants themselves are in the best position to display the strengths of their own views and to probe the weak points of opposing positions. In turn, scientifically sophisticated outsiders are best able to juxtapose the opposing arguments, determine whether there are genuine or only apparent disagreements, and suggest further studies which may resolve the differences.

We have no illusions that this procedure will arrive at the truth, which is elusive and tends to change from year to year. But we do expect to be able to describe the current state of technical knowledge and to obtain statements founded on that knowledge, which will provide defensible, credible, technical bases for urgent policy decisions.

The basic mechanism proposed here is an adversary hearing, open to the public, governed by a disinterested referee, in which expert proponents of the opposing scientific positions argue their cases before a panel of scientist/judges. The judges themselves will be established experts in areas adjacent to the dispute. They will not be drawn from researchers working in the area of dispute, nor will they include anyone with an organizational affiliation or personal bias that would clearly predispose him or her toward one side or the other. After the evidence has been presented, questioned, and defended, the panel of judges will prepare a report on the dispute, noting points on which the advocates agree and reaching judgments on disputed statements of fact. They may also suggest specific research projects to clarify points that remain unsettled.

The Science Court is directed at reducing the extension of authority beyond competence, which was Pascal's definition of tyranny. It will stand in opposition to efforts to impose the value systems of scientific advisers on other people. As previously stated, the Science Court will be strictly limited to providing the best available judgments about matters of scientific fact. It is so constructed in the belief that more broadly based institutions should apply societal values and develop public policies in the areas to which the facts are relevant.

It is proposed to do a series of experimental Science Court cases on important policy issues. It is expected that the early procedures will be faulty and that considerable procedural development will be necessary before the results of the proposed procedure are persuasive. During its experimental development the Science Court will also surely suffer from difficulties associated with its lack of standing that would not be present in a developed institution. It is hoped that, in addition to the direct contributions a developed Science Court might make toward creating a more reliable base for policy decisions, the experiments will stimulate creative thinking about other methods for dealing with major controversies.

Procedures

Issue selection. The word issue is used in this article to refer to a decision pending before a governmental agency. These decisions will frequently involve important social values as well as controversial scientific facts. We will, below, describe a procedure through which questions of scientific fact can be separated from value-laden issues. Some examples of issues under consideration are: Should fluorocarbons be banned because of their impact on the ozone layer? Is Red Dye #40 safer than Red Dye #2? Should water supplies be fluoridated? We do not at present intend to use the nuclear power issue as a subject in the initial experiments with the Science Court concept. Later it is hoped that a developed Science Court will be able to contribute to the making of public policy even on as divisive and pervasive an

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issue as nuclear power. Issues to be examined in the experiments will be selected by the Task Force responsible for the experiments according to three criteria:

1) Issues must be relevant to policy and must have technical components that are both important and apparently disputed.

2) Issues allowing easy separability of facts from values will be favored for the experiments.

3) Issues will be favored for which informed and credible case managers can be obtained. To simplify the process, it will be valuable to choose an issue in which two case managers can fairly represent all facets of the controversy.

Funding. Frequently the opposing parties to a technical controversy have vastly different resources available to them. We see no way to eliminate such inequalities, but it is certainly imperative that each side be provided with sufficient funding to prepare an adequate presentation for the Science Court.

Considerable doubt has been expressed about the wisdom of seeking funding directly by a government agency involved in the issue. It is argued that, although money could be given without strings, there might be an implication that the next time the Science Court came for funds the agency's decisions would depend on whether the first ruling was "acceptable." Therefore, it has been suggested that initial funding come from the National Science Foundation (NSF). In addition to the NSF, there would be considerable advantage in having a variety of funding sources for the Science Court experiment, including private foundations or business sources. In every case assurances must be had that no strings are attached.

It is important to have involvement of an agency in whose jurisdiction the issue falls so that it can help in formulating the issue, advise on the procedure, and provide necessary power to compel release of relevant information.

Selection of advocates. Once an issue has been selected and funding obtained, the next step is to choose the adversaries, specifically a chief adversary for each side, whom we call the "case managers." Two procedures are currently under consideration.

1) The Science Court or a collaborating agency issues Requests for Proposals (RFP's) for case managers. Each submitted proposal should exhibit that the bidder has the expertise and constituency to speak for one side of the issue and name its case manager. For example, a group such as the Union of Concerned Scientists, the Sierra Club, or Friends of the Earth might be a reasonable bidder to represent the antinuclear power side of that issue. It might form an alliance with a scientific institution such as a nonprofit analysis group, with individual consultants, or both. In any case, the objective is to exhibit that the bidder can provide the best case for its side of the issue. Combinations of groups opposing nuclear energy would be encouraged, and the RFP would point out that such coalitions will be favored to receive the contract. In this example, the Atomic Industrial Forum might well bid to represent the side favoring nuclear energy, though conceivably it would choose to join other scientific groups.

The scientific credentials and constituency of the proposers will be examined carefully by the Science Court, the collaborating agency, or both, and a selection will be made by processes similar to those used in selecting contractors for other purposes. The two chosen case managers will then be funded to participate in the procedure outlined below, perhaps on a time-and-materials basis or by some other suitable contractual mechanism.

2) When an issue is clearly polarized, the case managers might be found by polling the interest groups involved on each side.

Selection of judges and referees. It is currently envisioned that the Science Court with consultation from appropriate scientific societies and organizations will produce a list of prospective judges certified as unusually capable scientists having no obvious connections to the disputed issue. These will then be examined by the case managers for prejudice. After acceptance, a panel of judges, say, three for the first experiment, will be formed.

In addition to the panel of judges, there should be a referee, selected by the Science Court, who is concerned with the implementation of agreed procedures in a scientific setting. For discussion we propose that the referee should be a scientist advised by legal counsel, so that full responsibility for this procedure can be retained by the scientific community.

Several questions are still under discussion concerning these functions. One is whether the role of referee should be undertaken perhaps by a chief judge advised by legal counsel. This might simplify the organizational structure and centralize the authority necessary to maintain an orderly procedure. Another question has been raised as to whether the prospective judges should be selected by "elite" institutions such as the National Academy of Sciences. It might be advantageous to have some prospective judges chosen by random selection from competent members of the various professional societies.

Transition from issue to factual questions. As was pointed out above, an issue selected for a Science Court experiment will be an issue that is before a government agency. It is most important that the issue be stated in a manner as close as possible to the actual decision which must be made by the agency. Thus, we propose to prevent selection of a part of the issue which might prejudice the result. For example, the issue would not be, Are nuclear power plants explosive in the sense of an atomic bomb? but, Should a specific nuclear plant be licensed or not be licensed? The broader question will provide the case managers with an opportunity to state all the scientific facts which they consider important to their case. Selecting the narrower issue concerning explosive potentialities would be prejudicial because a negative answer (conceded, we believe, by most participants in this dispute) would be prejudicial without affording case managers a full opportunity to develop the facts basic to their opinions.

The selected issue will probably be a value-laden, controversial matter. It is proposed that the Science Court go through a process by which factual questions under dispute can be isolated. The first step is the formulation by the case managers of a series of factual statements which they regard as most important to their cases. Factual statements must conform to the definition given earlier—they must be results or anticipated results of experiments or observations of nature. This definition excludes statements such as "if X occurs, then Y *may* occur." Such a statement is valid even if the probability of the occurrence of Y is infinitesimally small, so the experiment required to refute the statement is impossible. An acceptable version of the statement must specify a finite probability which could be refuted by a possible experiment.

After the statements have been examined by the referee or the judges to be sure that they are confined to statements of scientific fact, the statements will be exchanged between case managers. Each side is then invited to accept or challenge each of the opposition's statements. Since the statements are drafted in the knowledge that they will be subjected to sophisticated challenge, it is

hoped that exaggeration and vague language will be deemed counterproductive. Therefore, many or even all of the statements made may not be challenged. In this case, the Science Court procedure will have been extremely successful in coming forth with an accepted series of factual statements.

Challenges. The case managers will examine the lists of statements of fact made by their opponents and decide which they can accept and which they challenge. The challenged statements will first be dealt with by a mediation procedure in which attempts are made to narrow the area of disagreement or to negotiate a revised statement of fact that both case managers can accept. If this procedure does not result in an agreed upon statement, the challenge will be the subject of an adversary procedure.

Adversary procedures. Several important aspects of the adversary procedure are still being worked out. First, it must be decided to what extent the experimental Science Court will be able to compel disclosure (employing legal powers vested in the collaborating government agency) of scientific information by subpoena, discovery, or other such processes. A second important matter under discussion is the relative desirability of keeping the rules of procedure flexible enough to allow a more rapid development of fair and effective procedures versus the probable necessity of fixing the rules before the case managers agree to accept the Science Court procedure. We propose now to have the initial rules agreed upon by the case managers and changed only with the agreement of both case managers during the experiment or at the start of a new experiment.

The adversary proceeding will begin with a case manager's putting forth his substantiation of a challenged statement in the form of experimental data and theoretical calculations. This evidence will be subjected to detailed scrutiny conducted in the tradition of a scientific meeting but with the added discipline of adhering closely to the challenged statement. It is important to recognize that the applied rules of evidence will be the scientific rules of evidence and not the legal rules of evidence. Thus, ad hominem attacks will be ruled out. There will be no necessity to prove the expertise of a witness, since his statements will be open to detailed challenge. We are unaware of any codification of the rules of scientific evidence, and intend to proceed at the outset on the simple statement that we will observe the rules that are traditional in the scientific community. On the other hand, we have a great deal to learn from the legal community on procedures. For example, the Science Court should not proceed unless representatives of both case managers are present. It should preserve the right of each case manager to cross-examine completely the positions taken by his adversary.

Considerable discussion has taken place regarding the degree to which the challenge resolution procedure should be conducted in writing or orally. The advantages of a written procedure are that (i) it might make it easier to guard against such dramatic presentations as often obscure the merits of a case in oral procedures; (ii) it might make it easier to avoid the difficulties of "heavy" legal procedures; (iii) it might well be more acceptable to the scientific community and more consistent with its traditions.

On the other hand, some members of the Task Force insist that an important part of the procedures should be oral. The advantages are that (i) the process could go foward more rapidly; (ii) an oral presentation makes public observation and public scrutiny easy, and this is essential for credibility.

The complete proceedings of the Science Court will be open to the public, with special provisions for the protection of proprietary information when necessary. However, the judges' deliberations after hearing the evidence should be conducted in private as in legal procedure.

An initial trial procedure is being drafted. However, the Science Court should not be bound by precedents but should continuously seek to refine its procedures to produce factual statements of the highest presumptive validity consistent with time constraints.

Results of the Proceeding

The primary results to be expected are a series of factual statements which will be arrived at in two ways. First there will be the statements of fact made by the case managers and not challenged by their opponents. A second group of results will be the opinions of the judges regarding statements that were challenged. Some or most of these statements of fact will be qualified with statements about probable validity or margins of error. An important secondary consequence will be the lines drawn between areas where scientific knowledge exists and where it does not exist. Since important knowledge that is lacking will be pointed out, judgments of the science court will suggest areas where new research should be stimulated. In almost all cases the boundary between knowledge and ignorance will continuously shift, and revisions to take account of new knowledge may have to be made frequently when issues of great national importance are at stake.

It bears repeating that the Science Court will stop at a statement of the facts and will not make value-laden recommendations.

Evaluation of the Experiment

Any attempt to evaluate the outcome of this experimental adversary procedure is susceptible to bias. A prime entry point for bias is the initial decision of what it is about the project that will be evaluated. If it was decided to examine only those features of the adversary process that seem, a priori, trouble free, then the evaluation is likely to come out positive; conversely, if attention is limited to troublesome features of the process, then the overall evaluation will almost certainly come out more negative. Therefore, it is essential to examine all those aspects of the experiment which are crucial to an informed decision on whether or not it "worked."

It seems useful to evaluate the operation of the Science Court separately from the effect of the judges' decision. By "operation" we mean the behavior of the Science Court's principals—case managers, judges, and referee. By "effect" we mean the alteration (if any) of attitudes and behavior of people outside of the experiment—regulatory agencies, industry, the mass media, legislators, interested citizen groups, and the wider public.

Operation. At a minimum, we need to know whether the various principals fulfilled their assigned roles. Did they stick to questions of fact, avoiding value issues? Did the case managers agree on the selection of judges? Did they perceive themselves, and were they perceived by the other principals, as having made credible cases for their sides? Was the referee successful in keeping the other principals to the codified procedures? Were the codified procedures themselves satisfactory? Did the principals perceive that the judges reached reasonable and unbiased conclusions?

The evaluation should be as objective as possible, but we must recognize the great potential for a biased selection of small bits of data from the volume of experimental data, and also for a biased

interpretation of data. Perhaps it would be useful to use three evaluators: one intending to present objective conclusions, one whose intent is to provide a positive picture of the experimental result, and one whose intent is to provide a critical picture. Ultimate evaluation of the experiment will benefit from exposure to these three diverse viewpoints.

Effect. At a minimum, we need to know whether partisans perceive that "their" case manager did a credible job in making the case. Do they consider the procedures of the Science Court to be fair, even if they feel that their side lost? Do partisans change any of their attitudes or behavior as a result of the Science Court findings? Do regulatory agencies or other relevant governmental bodies take actions that appear to be based on the findings? Do they take contrary actions? Do the mass media provide accurate coverage of the debate and do they accept the findings? Are members of the wider public aware of the experiment? If so, do they understand the procedure, and do they know the Science Court findings? If so, do they express opinions that are consistent with the findings, even when they held contrary views prior to the hearing?

Future Plans

The next proposed step in developing the Science Court is to conduct a meeting (*2*) devoted to two topics. First, it would be useful to have a discussion in depth in which proponents and opponents of the Science Court will have an opportunity to state and debate their positions. Such a debate would bring to light opportunities to improve the concept and its acceptability. Second, it is proposed to have a series of sessions in which people who have been active in scientific controversy surrounding issues such as food additives, nuclear power, and fluorocarbons help to criticize and develop the rules of procedure for the Science Court. It is currently contemplated that partisans from each side of the issues used will be present and that these sessions will afford an opportunity to see whether indeed the active opponents in these vigorously contested issues can agree on rules for an adversary procedure. This would help to visualize the problems which would be encountered when an attempt is made to negotiate agreed procedures between two case managers for the Science Court experiments.

It is our hope that following this meeting enough understanding and procedural development will have been achieved to justify a series of experiments.

Notes

1. We use the expression "scientific fact" to mean a result, or more frequently the anticipated result, of an experiment or an observation of nature.
2. This meeting will be held on 20 and 21 September at the Xerox Center, Leesburg, Va. For further information contact Mrs. Florence Feinberg, U.S. Department of Commerce, Washington, D.C. Telephone: 202-377-5065.

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NEWS AND COMMENT

Chinese Earthquakes: The Maoist Approach to Seismology

With unusual shrewdness for Occidentals, a nine-member delegation of American earthquake specialists visited China last month to learn about Chinese earthquake programs—and then left the country shortly before two highly destructive quakes shook a region northeast of Peking. The demonstrated ability of the Chinese to predict major quakes, as well as to take precautionary measures, has become a subject of fascination in the American seismology community, where earthquake prediction is barely coming into its own (*Science*, 7 May).

Of course the Americans did not leave China because they believed a major quake would occur—in fact, the Chinese failed to predict the quakes of Richter magnitude 8.2 and 7.9 that devastated the industrial city of Tangshan on 28 July. But, while there, the Americans studied several events: a long-term prediction that was in effect for the Tangshan-Tientsin region; the successful prediction of a pair of magnitude 6.9 quakes which struck in Yunan province last 29 May; and the successful prediction of a magnitude 7.4 quake which struck Liaoning province on 4 February 1975. Thus, the Americans have filled out their picture of Chinese earthquake prediction. Frank Press of the Massachusetts Institute of Technology, a geophysicist who was not on the delegation but who has widely publicized the Chinese achievements, says that such an understanding "is the most important thing that can be done for American earthquake programs."

As practiced in China, seismology fits the Maoist ideal of a "people's science." It utilizes thousands of amateurs; yet its leading professionals can compete with their counterparts in the West. The goal of prime importance to the Chinese government is to apply seismology to reduce the horrendous toll of human life and industry due to earthquakes which China has suffered throughout her history. (The most devastating disaster on record, for example, was the great Shensi earthquake of 1556, which killed 820,000 people.) Ideologically, another goal is to fight so-called "reactionary" myths and superstitions which surround earthquakes—one widely held belief, for example, equates the occurrence of great quakes with the passing of dynasties.

C. Barry Raleigh of the U.S. Geological Survey, who led the nongovernment delegation,* explains that the Chinese seem to be working with the same set of hypotheses about the causes of earthquakes that Westerners use. The Chinese were early adherents of plate tectonics; they cite the theory that the India plate is pushing against the Asia plate under the Tibetan Plateau to explain the high seismicity of Yunan, which is on the

*The delegation was sponsored by the Committee on Scholarly Communication with the People's Republic of China of the National Academy of Sciences.